Our Wealth Maintained: A Strategy for Conserving Alaska's Diverse Wildlife and Fish Resources

A Comprehensive Wildlife Conservation Strategy

Emphasizing Alaska's Nongame Species

April 2006

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Cover photo: Snow Bunting in winter plumage; C. Lensink, USFWS.

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Information and data from many existing reports and plans were used to develop this document; these sources are cited in numerous places. We would like to recognize this contribution and also acknowledge all the "silent" partners in Alaska and across the nation who knowingly or unknowingly helped provide inspiration and materials for our efforts.

This Comprehensive Wildlife Conservation Strategy (CWCS) document is only the most visible result of our multiyear planning effort. Of even greater value is the web of cross-organizational and cross-disciplinary networks that is being developed. The ultimate test of usefulness for the CWCS will rest in our ability to develop collaborative efforts and address priority needs for the conservation of Alaska's unique habitats and wildlife species. The material generated in the CWCS planning process is already being used in ways we could not have predicted. We are confident that the final effects of our planning process will outlive individual participants' careers, as others embrace the task of implementing and updating needed approaches for conserving Alaska's wealth of wildlife and fish resources. For wildlife and fisheries managers, and for Alaskans, there is no better legacy than that.

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Executive Summary

Introduction

The state of Alaska covers a vast area, 656,425 square miles. The name is derived from an Aleut word meaning "great land," and a land of superlatives it is: Alaska has over 3 million lakes and 44,000 miles of coastline, more coastline than the rest of the nation combined. A population of 630,000 is spread across the state, with 78% of those people living in metropolitan areas. The state's natural beauty and outstanding wildlife[1] populations are important factors in sustaining residents and attracting tourists. Residents of Alaska depend greatly on natural resources in their daily life.-

Article VIII of the Alaska Constitution directs that: "fish, forests, wildlife, grasslands, and all other replenishable resources belonging to the State shall be utilized, developed, and maintained on the sustained yield principle, subject to preferences among beneficial uses." Alaska has been largely successful managing species and habitats under this mandate via an existing regulatory framework administered by a variety of boards and agencies. Only 17 of its 1,073 vertebrate species are federally listed as Threatened or Endangered (T&E), one of the lowest numbers of listed species among the states.

Designating protected areas is a common conservation strategy. Approximately 53% of Alaska has been designated in some form of conservation unit. These units effect differing levels of protection, ranging from national parks, sanctuaries, and refuges with a heavy emphasis on landscape and species conservation to recreation areas, marine parks, state forests, and other lands designated for multiple use. Alaska's high percentage of lands in conservation status has often been credited with helping ensure there is little need for T&E listings here.

Traditionally, federal and state funding for wildlife management in Alaska has been directed primarily at those species that are commercially or recreationally hunted, trapped, and fished—i.e., "game." Management practices and research on these species can benefit other species as well, particularly when focused on habitat protection and ecosystem conservation. In this regard, a beneficial partnership in conserving Alaska's species has been in place for many years. These successes aside, for many hundreds of Alaska's species, even the most basic information, such as distribution, remains largely unknown.

[1] In the Strategy, use of the word "wildlife" includes fish unless specified otherwise.

Purpose and Scope

Having recognized the benefits of conserving a broader array of species, Congress is poised to provide millions of dollars annually to states through a new federal program—State Wildlife Grants (SWG)—administered by the U.S. Fish and Wildlife Service (USFWS). To qualify for these funds, each state or territory must prepare an approved comprehensive wildlife conservation strategy (CWCS). As did its precursors in Congress, the national SWG legislation is meant to "provide funding for wildlife conservation activities that have not been adequately funded through traditional means (i.e. license revenues, Wildlife Restoration and Sport Fish Restoration Programs)."[2]

With initial annual receipt of nearly three million dollars[3] in federal SWG funding, Alaska can begin collecting and organizing information about species that are little known and poorly understood, underrepresented in the mix of species receiving traditional funding, or which experts believe have specific conservation needs that cannot be adequately met with existing funding sources. Congress specified eight elements that each CWCS must address (see Section I, page 3) and these have guided Alaska's planning effort.

The goal of Alaska's Comprehensive Wildlife Conservation Strategy (CWCS or "Strategy") is to conserve the diversity of Alaska's wildlife resources, focusing on those species with the greatest conservation need. A key intent of the Strategy is to coordinate and integrate new conservation actions and strategies with Alaska's existing wildlife management and research programs, building upon the demonstrated successes of these earlier efforts.

In this way, the Strategy is intended to be a blueprint for an overall conservation approach, one that sustains Alaska's overall diversity of wildlife—both game and nongame. Via this blueprint, Alaska can effect broad strategies that promote wildlife conservation while furthering responsible development and addressing other needs of a growing human population. It also helps Alaska prevent T&E species listings of its wildlife resources, thereby reducing the potential for federal oversight of listed species and their habitats.

The Strategy outlines the conservation needs of hundreds of species and many species assemblages, and highlights the need for initial cataloging and inventory efforts on poorly known species. For a subset of Alaska's species and habitats, the Strategy provides detailed natural history information and measurable conservation objectives to be achieved. The Strategy places an emphasis on the conservation needs of nongame species without excluding the needs of traditional game resources.

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[2] Memo dated October 25, 2002 from Brent Manning, President, International Association of Fish and Wildlife Agencies (IAFWA), to State Fish and Wildlife Directors, titled "State Wildlife Grants."
[3] For 2005, the figure is almost $4 million once mandatory nonfederal matching funds are included.

Developing the Strategy

Planning participants recognized early on that little is known about many of Alaska's wildlife species. Past research and management have focused on developing sustainable management strategies for Alaska's game resources, and an effective regulatory framework, based on the sustained yield principle, exists with which to conserve these species. Given this, the department directed only limited planning activity to them and instead focused primarily on assessing the conservation status and needs of the state's nongame wildlife resources.

Alaska began its CWCS process by reaching out to partners and the public, including government agencies, conservation interests, resource users, and landowners for ideas on process and goals. That was followed by several months of work with scientific experts, peers, and others with Alaskan expertise on species in 14 taxonomic groups. The groups are: amphibians and reptiles, marine fish, marine invertebrates, seabirds, marine mammals, terrestrial mammals, landbirds, raptors, terrestrial invertebrates, waterbirds, shorebirds, freshwater fish, waterfowl, and freshwater invertebrates.

With time and resources for Strategy development limited, the department prepared a list of CWCS nominee species, i.e., Alaska's species of greatest conservation need. We then asked experts to apply specific criteria and select a subset of species to feature in the CWCS. Seventy-four featured species or species groups were chosen after applying criteria on vulnerability of a species, subspecies, or distinct population[4] and addressing such factors as abundance, incidence of deformity or disease, rarity, isolation, endemism, sensitivity to environmental disturbance, representation, international importance, and formal "at-risk" designation (e.g., T&E). The featured species and groups range from relative unknowns, such as a cave-dwelling invertebrate, to familiar groups, such as loons and whales.

Experts and peers provided information on the distribution and abundance of species; described key habitats and threats or concerns associated with those habitats; developed objectives with performance measures; and crafted specific conservation actions, including needed research, survey, and monitoring efforts. Additional specialists with species assemblage and/or habitat expertise reviewed the results of these expert and peer review processes. They evaluated the types and locations of key habitats at risk in Alaska and recommended how these habitats should be addressed in the CWCS. For some habitats, specific conservation actions were developed.

Alaska's planning process also highlighted the conservation challenges facing a small number of commercially or recreationally hunted species, such as the Tule White-fronted Goose. These are species for which management plans exist but do not

[4] In this document the term "species" is applied broadly and means "species, subspecies and distinct populations." This is standard terminology used in state, national, and international conservation planning efforts. We believe its use will help avoid having species be listed as Threatened and Endangered in Alaska, when in fact Alaska's distinct population of the species is in good health.

sufficiently address the species' long-term conservation needs; their inclusion in the CWCS is intended to raise awareness of their conservation needs and promote opportunities for effective collaboration across funding sources to meet those needs. As for many other species addressed in the Strategy, information gaps and habitat loss and fragmentation are key concerns in conserving and managing these species over the long term. Not surprisingly, many actions proposed in the CWCS are expected to benefit a broad array of species and species groups.

Value of Conserving All Wildlife—Nongame as Well as Game

The value of game species is well understood by most Alaskans. Commercial and sport fishing, sport hunting, guided hunting and fishing, wildlife viewing, and harvesting for traditional uses are central to the Alaskan economy and lifestyle. Historically, however, species not taken for sport or commercial uses were perceived as having little direct economic value. However, the contribution of nongame resources to Alaska's economy and reputation is substantial, though difficult to quantify. Nongame species are an integral part of every Alaskan ecosystem and many are also important for traditional subsistence purposes: Along with plants, nongame species form the foundation of the food chain that produces Alaska's wealth of harvestable resources. For example, most insect pollination in the Arctic is done by flies and bumblebees. Many of the plants that benefit from their activity, like the arctic willow, are critical for caribou, which in turn are prized by humans for their meat and hides. Other predator/prey relationships of note include the sand lance populations that feed beluga whales, seabirds, and young halibut; invertebrates that nourish trout and salmon; and voles that sustain owls and furbearers.

The state's nongame species, including its many endemics[5], provide opportunities for scientific study in such fields as habitat adaptation, the effects of climate change, and evolution. Some Alaska species enjoy wide acclaim by specialists. For example, the threespine stickleback is a model species internationally for discoveries in the fields of evolutionary biology, developmental genetics, animal behavior, ecology, environmental toxicology, and medicine.

The interrelationships between and high value of Alaska's wildlife species extend to viewing as well. In the past 20 years, fish and wildlife viewing has become increasingly valuable to the state's economy. Many Alaskans and most visitors travel to view wildlife in Alaska, resulting in significant in-state expenditures each year. Surveys show that wildlife viewing is second only to scenery as the most important reason tourists come to Alaska. Even some of the state's more remote communities are seeing economic benefits from wildlife tourism, especially birding.

Clearly, many state citizens depend on healthy fish and wildlife populations for their livelihoods. Alaskans involved in subsistence, commercial, and sport fishing and hunting, wildlife tourism, and the industries surrounding them recognize the need for

[5] An endemic species is one that occurs primarily in one region; because of their limited geographic range, endemics are often vulnerable to extinction.

healthy ecosystems upon which wildlife depend. As wildlife-related spending has continued to grow, policymakers, wildlife managers, and local community leaders are recognizing the importance of protecting and managing a broad diversity of wildlife resources.

Common Themes

Information Needs

A serious impediment to the goal of better conserving broad arrays of species, and a central theme that quickly emerged in the CWCS development process, is the lack of information on most Alaskan species and their habitats. We've barely scratched the surface in terms of recording the diversity, abundance, distribution, and habitat relationships of most wildlife species in the state. To date, much of that effort has focused on game species that are important for commercial, recreational, and subsistence users. Little attention has been directed at the state's other wildlife resources, including invertebrates, fish, amphibians, the smaller mammals, and birds. As basic inventory work takes place in the state, new species are being found. Recent advances in genetic techniques for identifying distinct subspecies and reproductively linked populations will further expand recognition and appreciation of the diversity of Alaska's wildlife.

For most species that have been well studied, populations and habitats are largely intact except in certain parts of the state. The exceptions generally include areas such as the Kenai Peninsula, Anchorage Bowl, and Matanuska-Susitna valleys, which are experiencing increased urbanization. Also, some areas have experienced significant industrial activity, including Southeast Alaska, where portions of the coastal forest are intensively managed for timber harvest, and the North Slope, where major oil and gas activity is occurring. For the hundreds of species about which little is known, we are unable to provide an accurate assessment of the health of populations or their habitats. A key need for Alaska is to complete a systematic statewide species ranking process in the next 18 months. This will help us prioritize efforts to fill information gaps and direct actions toward species of greatest conservation need.

Data Gaps and Strategy Limitations

As with any project, limitations of time, funding, and base data impacted the scope of Alaska's comprehensive planning effort. During CWCS development, the Alaska Department of Fish and Game (ADF&G) gathered information from many sources. At the same time, planning team members identified a number of management tools that were either partially or entirely unavailable. In this first CWCS, the ability to use area- or species-specific spatial data (e.g., mapped species ranges) was hampered because information is incomplete or simply unavailable for many Alaska species.

We were also unable to incorporate certain themes in as much depth as we would have liked, but these will be incorporated more fully in future versions of the Strategy. These themes include species migration patterns, a systematic analysis of data gaps in species' distribution information, cultural and subsistence information, and traditional knowledge. Future iterations of the Strategy could also compile information from other states and countries that manage habitats used by wide-ranging and migratory Alaskan species.

Lack of Long-Term Monitoring

With its large, remote, and dynamic landscape, Alaska poses significant monitoring challenges. A growing but limited body of information is available on how habitats change naturally over time (e.g., in response to recurring wildfires, isostatic uplift, etc.). However, there is frequently no documented baseline against which to compare future population or habitat monitoring results. This makes it difficult to separate anthropogenic effects from natural effects, or even to gauge natural variability in loss, degradation, or gain of habitats. Enhanced geographic information system (GIS) capability in the state would help present what is known, but GIS capability must be based on first having scientific control areas and the best available information or data to manipulate and compare. As new funds become available for wildlife and fish conservation, it will take a concerted effort to draft project selection criteria that give appropriate weight to monitoring projects. Reliability of long-term funding and net cost will be a critical issue for developing monitoring strategies.

A key recommendation from our process is to promote and facilitate meaningful participation by communities in monitoring and sharing information about the species and ecosystems they use. Indeed, community monitoring programs may prove to be cost-effective tools for assessing species that are not commercially or recreationally harvested. Traditional and other local user knowledge[6] can be very helpful to conservation efforts, e.g., by describing climate-related changes in northern species and habitats. Use of other creative ideas, such as tapping university science students for a term's work on part of a long-term monitoring project, should also be explored.

Experts in our process noted possibilities for conducting basic species inventory in ways that contribute to future monitoring efforts. Monitoring to accomplish multiple purposes makes sense. For example, evaluating bycatch in marine and aquatic fisheries can help detect nonindigenous or invasive species. Similarly, monitoring of migratory birds can flag the arrival of wildlife diseases (e.g., avian influenza) that could potentially harm humans.

[6] Includes individuals who may have a long history of observation about species and habitats, such as hunters, trappers, commercial and recreational fishermen, guides and charter operators, long-time rural residents, and birders.

Primary Recommendations: Alaska's Greatest Wildlife Conservation Needs

During the course of the CWCS planning process, participants suggested dozens of conservation actions, many of them common across multiple taxa. We've highlighted here, in seven categories, what we consider some of the most significant and timely general recommendations for conserving Alaska's wildlife diversity.

Information and Data Gathering

- Implement studies to collect baseline inventory and life history information on select species and their habitats; develop and implement management strategies for wildlife species of greatest conservation need.
- Implement a systematic approach such as Florida's (Millsap et al. 1990) for evaluating and quantitatively analyzing the state's wildlife and fish conservation needs.
- Conduct regional GAP analyses across Alaska as part of the National Gap Analysis Program (GAP); to help states maintain biodiversity, this program develops overlay maps showing land cover, stewardship, and species distribution.
- Integrate local knowledge into species and habitat data/information systems.
- Ensure that scientific data and pertinent traditional knowledge are available to decision-makers.
- Synthesize and distribute scientific information about species distribution, abundance, and habitat use.

Data and Classification Systems

- Enhance mapping and GIS capability in resource management agencies.
- Develop and maintain coordinated data storage, retrieval, and management systems.
- Develop and implement uniform/complementary habitat classification systems.
- Develop procedures for contributing Alaska information to regional or national databases and conservation initiatives.

Monitoring

- Conduct long-term monitoring of selected species and their habitats, including in Alaska's existing conservation areas.
- Monitor the effects of climate change and invasive species on wildlife and their habitats.
- Evaluate the benefits and feasibility of establishing long-term ecological research (LTER) sites in additional biomes in Alaska, especially the marine environment.
- Increase monitoring of water quality and quantity to support healthy aquatic ecosystems.

Species and Habitat-related Planning

- Support long-term land management planning that balances the needs of wildlife conservation with the need for community growth and responsible economic development.
- Develop wildlife habitat maps, including connectivity corridors, for use in designing and planning growth.
- Develop and implement effective conservation incentives for landowners and land management agencies.
- Identify and protect important habitats to help achieve long-term habitat or species population goals.
- Identify statutory and regulatory gaps that require attention to clarify responsibilities for conserving and managing species and their habitats.
- Develop protocols between agencies to better coordinate wildlife actions.
- Evaluate and establish a network of scientific control areas in representative habitats distributed across Alaska.
- Improve and maintain water quality in Alaska's estuaries and fresh waters, and water quantity in lakes, streams, and rivers.
- Support national/international efforts to reduce dumping, or loss at sea, of materials harmful to wildlife (e.g., nets, plastics, petroleum products).
- Ensure that existing conservation areas, including state special areas, are managed to maintain the wildlife values and use opportunities for which they were designated.

Funding and Collaboration

- Expand involvement of agencies, communities, industries, and organizations, especially those that have species or habitat expertise or local knowledge, in conducting tasks related to CWCS conservation targets (e.g., research, inventory, and monitoring).
- Seek opportunities for funding source collaboration to meet the needs of species and habitats for which conservation concerns were noted in the CWCS planning process.
- Develop mechanisms for multiyear funding; this is especially important to long-term monitoring efforts.
- Identify opportunities to align proposal deadlines and selection criteria across funding sources to achieve shared wildlife and fish conservation goals and objectives.
- Consider establishing a dedicated funding source for the purchase of conservation easements important for restoring or maintaining at-risk wildlife populations.

Education and Outreach

- Foster public understanding of and support for maintaining and improving the diversity and health of Alaska's wildlife, fish, and habitat resources
- Use website development, citizen science programs, school programs, outreach through the media, and other techniques to reach and engage the public in actions that support wildlife goals outlined in the CWCS.

Enforcement

- Support law enforcement activities that help conserve wildlife and their habitats.

Investing Today for a Legacy of Diversity and Abundance

The state of Alaska is fortunate to have a rich diversity of wildlife resources. Many citizens recognize the value of these resources and our collective responsibility to conserve them. Alaska's Strategy can and should "serve as a blueprint for strategic investments and activities that [reflect] the public interest regarding conservation."[7] Its comprehensive approach recognizes the challenges and opportunities we face in maintaining the state's diversity of species over the long term, including investing in measures now that will prevent costly species or habitat recovery activities later. It also recognizes the benefits of building on Alaska's existing wildlife management programs.

By law, each state must review its CWCS at least once every 10 years and Alaska plans to meet this requirement. In cooperation with our partners and the public, ADF&G also plans to keep the Strategy dynamic and updated during interim periods, and to incorporate new information as it is being generated.

The department intends to continue working with a variety of partners to meet the conservation needs of all native wildlife and fish in Alaska. With updated information on species distribution and abundance, we can begin to evaluate trends and population changes, and work to keep species at healthy and sustainable levels. Now more than ever, Alaskans must look for every opportunity to unite in their conservation efforts. This will ensure that the state's full biological diversity can be enjoyed by future generations.

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[7] Memo dated September 15, 2003 from Duane L. Shroufe, Chair, IAFWA Teaming With Wildlife Committee, to State Directors, titled "Recommendations Concerning Public Participation in Comprehensive Wildlife Conservation Strategies (Plans)."

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Impetus for Improved Wildlife Conservation

Many Alaskans depend upon the state's diverse wildlife resources in their daily lives. Commercial and sport fishing, sport hunting, guided hunting and fishing, and harvesting for traditional uses are central to the Alaskan economy and lifestyle.

Article VIII of the Alaska Constitution directs that "fish, forests, wildlife, grasslands, and all other replenishable resources belonging to the State shall be utilized, developed, and maintained on the sustained yield principle, subject to preferences among beneficial uses." Under this mandate, significant effort has been directed at managing wildlife populations that are commercially or recreationally hunted, trapped, or fished. Alaska has been largely successful managing these so-called game resources via an existing regulatory framework administered by a variety of regulatory boards and agencies. For details, see Section IIIA under "Legal Basis for Conservation of Fish and Wildlife."

ADF&G has conducted limited nongame and marine mammal programs for a number of years. Information about these programs is available at: http://www.wildlife.alaska.gov/management/nongame/nongame.cfm. Meanwhile, for decades existing funding has focused primarily on programs designed to ensure conservation and sustainable use of species sought by hunters, trappers, commercial fishermen, and anglers. It is widely recognized that many management activities focused on these species (e.g., instream flow/water volume maintenance, prescribed burning, or habitat protection) benefit nontarget species as well. The collection of information specifically directed toward management and conservation of nongame species has generally been inadequately funded, however, and scientists and others remain unsure of their status. Indeed, Alaska's nongame species, including its numerous endemics, provide ample opportunities for new discoveries in such fields as taxonomy, genetics, evolution, and habitat adaptation.

Although basic biological information on life history, population levels, and other parameters is lacking for many species, the majority of Alaska's wildlife resources are considered healthy. Only 17 of Alaska's 1,073 vertebrate species[8] are listed as Threatened or Endangered. In contrast, more than 1,200 species are listed nationally, with the number expected to increase over the next decade. For specific information on the USFWS and State of Alaska endangered species programs, see http://www.r7.fws.gov/fisheries/endangered/listing.htm and http://www.wildlife.alaska.gov/index.cfm?adfg=endangered.main, respectively.

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[8] Appendix 1 lists all vertebrate species known to occur regularly in Alaska. Federally listed Threatened or Endangered species are shown with an asterisk; included among them are the five species the State of Alaska has designated as endangered (Eskimo Curlew, Short-tailed Albatross, humpback whale, right whale, and blue whale).

Northern Hawk Owl banding near Fairbanks.
J.Whitman, ADF&G

After years of working with a broad coalition including state, federal, and international fish and wildlife agencies, businesses, nongovernmental organizations, and citizens, Congress has recognized the need to conserve a broader array of species.

Between 2001 and 2004, Congress passed a series of bills designed to encourage and facilitate a greater level of coordination and joint funding among and within fish and wildlife programs and funding sources. One of these appropriations bills laid out the requirements by which states, territories, and tribes could begin receiving millions of dollars in federal funding under a new program administered by USFWS called the State Wildlife Grants (SWG) program. The intent is that SWG funds be used to address conservation needs of species in the United States that are: a) little known and poorly understood; b) underrepresented in the mix of species receiving more traditional funding; or c) believed by experts to be in need of specific conservation actions.

Comprehensive Wildlife Conservation Strategies

To qualify for SWG funds, each state or territory must produce a Comprehensive Wildlife Conservation Strategy (CWCS or Strategy). Congress' intent is captured under H.R. 2217, the Department of the Interior and Related Agencies Appropriations Act, 2002 (Public Print), which reads in part:

> No State, territory, or other jurisdiction shall receive a [SWG] grant unless it has developed, or committed to develop by October 1, 2005, a comprehensive wildlife conservation plan, consistent with criteria established by the Secretary of the Interior, that considers the broad range of the [State's] wildlife and associated habitats, with appropriate priority placed on those species with the greatest conservation need and taking into consideration the relative level of funding available for the conservation of those species.

The criteria mentioned consist of eight required elements (paraphrased below) that a CWCS must include for final federal approval. Appendix 2 contains a guide showing where Alaska's CWCS addresses each element.

The Eight Required Elements of a CWCS

1. Information on the distribution and abundance of species, including low and declining populations, that are indicative of the diversity and health of the state's wildlife.
2. Descriptions of locations and relative condition of key habitats and community types essential to conservation of species identified in (1).
3. Descriptions of problems that may adversely affect species identified in (1) or their habitats, and priority research and survey efforts needed to identify factors that may assist in restoration and improved conservation of these species and habitats.
4. Descriptions of conservation actions proposed to conserve the identified species and habitats and priorities for implementing such actions.
5. Proposed plans for monitoring species identified in (1) and their habitats, for monitoring the effectiveness of the conservation actions proposed in (4), and for adapting these conservation actions to respond appropriately to new information or changing conditions.
6. Descriptions of procedures to review the CWCS at intervals not to exceed 10 years.
7. Plans for coordinating the development, implementation, review, and revision of the CWCS with federal, state, and local agencies and Indian tribes that manage significant land and water areas within the state or administer programs that significantly affect the conservation of identified species and habitats.
8. A plan to ensure broad public participation in implementing the CWCS and the projects that are carried out as the CWCS is being developed.

Alaska's Strategy: Comprehensive and Collaborative

The goal of the Alaska CWCS planning effort was to generate the blueprint of an overarching conservation vision for the state. To achieve this goal, ADF&G has worked closely with multiple partners and interests to look comprehensively at needs for our wildlife and create a multiyear strategy that:

- conserves the diversity of Alaska's unique fish and wildlife resources;
- promotes partnering and coordination among agencies, organizations, and programs; and
- encourages multisource funding to implement conservation strategies for multiple species and species assemblages.

Alaska's Strategy has numerous benefits and potential uses. It informs citizens about what's unique and valuable in the natural world around them. It improves public understanding and support by fostering greater agency efficiency and collaboration in programs. The Strategy establishes new partnerships and enhances old ones. It also highlights exciting opportunities for scientific study in various specialties of biology, toxicology, and medicine. Further, Alaska’s CWCS aims to improve the sharing of wildlife conservation information with others.

Implementation of the Strategy decreases the likelihood of additional Alaskan species being listed as threatened or endangered. This, in turn, reduces the likelihood of the federal government imposing species recovery-related restrictions on resource development or hunting/fishing opportunities in habitats used by that species. Finally, Alaska’s CWCS provides general sideboards to focus activities conducted under the auspices of Alaska’s SWG program. The importance of this program will increase in coming years with the influx of SWG funding and as our understanding of conservation needs related to nongame species improves.

Partnering to Implement the Strategy

ADF&G prepared the Strategy with the involvement of a broad array of partners, including government agencies, resource users, conservation groups, landowners, representatives of the Native community, and the general public. Not surprisingly, the CWCS planning effort relied heavily on the experience and best professional judgment of scientists and other Alaskans most knowledgeable about particular species and habitats. In the case of the scientists, these were often the same individuals, or individuals representing the same agencies, that have authored species-specific recovery or management plans.

The planning process highlighted the fact that habitat-related management practices and research directed at species that are commercially or recreationally hunted, trapped, or fished often benefit other species, and vice versa. In this regard, a rewarding partnership in conserving Alaska’s biodiversity has been in place for many years. This relationship is expected to grow as needs identified in the CWCS are addressed.

The emphasis Alaska’s CWCS places on increased partnering creates numerous benefits and beneficiaries. For example, multidisciplinary efforts to document nonharvest effects caused by humans (e.g., via wildfire suppression) can yield information important to managers of game and nongame species, and across taxa. In addition, collaborative efforts to gather local knowledge about species’ life histories, habitat needs, and changing environmental conditions will benefit wildlife conservation in Alaska and, for migratory species, in other geographic areas as well.

Conservation and management of Alaska’s fish and wildlife resources is aided by the department having professional and technical staff in a network of distant outposts across the state. These staff frequently possess broad knowledge of species found in their areas, and they are well-positioned to interface with sources of local knowledge to provide integrated management of biological resources.

The Strategy is meant to provide guidance and information to all partners, not just ADF&G. Similarly, it cannot be implemented by the department alone. Successful implementation through time will require the commitment and support of many parties, including Alaska's Native corporations, military installations, state and federal land managers, conservation groups, industries, landowners, resource users, and neighboring jurisdictions. Continuing to build broad support for CWCS implementation will be a key activity for the department and its partners in coming years.

Species of Greatest Conservation Need: The "Featured Species" and "Key Habitats" Approach

Alaska's Strategy outlines measurable conservation goals and proposed actions for a broad array of wildlife. Rather than directing attention to the few species in Alaska known to be in serious decline, the Strategy highlights the conservation needs of a large number of species, species groups, and/or species assemblages and the habitats that support them. Appendix 3 lists these species and groups, which we've termed "featured species." Appendix 4 provides specific conservation action plans for Alaska's featured species and species groups. As part of this, the CWCS describes the conservation needs for a small number of commercially or recreationally hunted species. The Strategy also provides a list of Alaska species that have been raised in other planning processes as having significant conservation concerns. In combination, these wildlife and fish species constitute Alaska's "species of greatest conservation need" – a term being used nationally as part of the CWCS development process.

For more than 40 of the featured species, the Alaska Natural Heritage Program (AKNHP) prepared detailed information, including on distribution and abundance, concerns, level of protection, conservation status, and potential conservation and management actions (see http://aknhp.uaa.alaska.edu/zoology/zoology_adfg.htm). Key habitats of featured species are described in Appendix 5. Section VI of the Strategy provides information on how they were selected and general conclusions that can be drawn about location of especially important or at-risk habitats in Alaska.

In this document, bird names follow the *Checklist of Alaska Birds* (http://www.uaf.edu/museum/bird/products/checklist.pdf, Gibson et al. 2003). Mammal names follow the *Checklist to the Mammals of Alaska* (http://www.uaf.edu/museum/mammal/AK_Mammals/Checklist.html, Jarrell et al. 2004). Amphibian and reptile names follow Crother et al. 2000, and fish names follow Nelson et al. 2004.

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II. Methodology and Approach

A. Project Management Structure and Planning Focus

Alaska established its CWCS planning team in 2003. The team consisted of a Task Force of five staff from ADF&G's Wildlife Conservation and Sport Fish divisions and an Oversight Committee composed of an Assistant Director from each of these divisions. A written Charter spelled out the parties' respective roles and responsibilities. The Task Force developed and maintained a website (http://www.sf.adfg.state.ak.us/statewide/ngplan/) that included a flowchart with timeline and schedule for completing the Strategy.

The planning team recognized early on that little is known about many of Alaska's wildlife species. Past research and management has focused on developing sustainable management strategies for game resources (i.e., those that are commercially or recreationally hunted, trapped, or fished). Given this, the Task force focused much of our early planning effort on assessing the conservation status of Alaska's nongame wildlife resources. Only limited planning activities were directed at game resources because a regulatory framework based on the sustained yield principle exists with which to conserve these species and their uses.

B. Public and Agency Involvement

During summer 2003, the department made initial contacts with prospective partners to discuss their ongoing conservation planning efforts, options for sharing data, and ways to work together to benefit nongame species. These parties were informed about the CWCS and asked to provide comments on the proposed planning process. This initial effort resulted in strong support for the process and was a significant first step in developing working partnerships for the Strategy. Initial contacts included the Alaska Department of Natural Resources (DNR); U.S. Geological Survey (USGS); federal Bureau of Land Management (BLM); National Park Service (NPS); National Oceanic and Atmospheric Administration/Fisheries (NOAA Fisheries); the U.S. Forest Service (USFS); USFWS, including the National Wildlife Refuge System, Marine Mammals Management, and Ecological Services Unit; AKNHP; University of Alaska; The Nature Conservancy of Alaska (TNC); Audubon Alaska; U.S. Air Force; U.S. Army; and a variety of sportsmen's and other user groups.

The most active early partners in the CWCS planning process were the AKNHP/University of Alaska, TNC, Audubon Alaska, and the USFWS Federal Assistance Office. Drawing on their previous experiences with conservation planning efforts in Alaska, individuals from these organizations provided suggestions about process and draft products. The Task Force held several group meetings with these parties to review progress and seek their recommendations for completing the next steps of the process. The AKNHP was asked to assemble and summarize species information. TNC staff provided descriptions, maps, and photos for the 32 ecoregions in Alaska. The USFWS provided substantial support in the form of travel costs and staff participation at the expert team meetings described elsewhere in this section. Staff from many agencies and organizations helped write sections of the CWCS. Biologists within ADF&G contributed to the CWCS effort by identifying species of concern, serving on expert groups, writing habitat descriptions and various other sections, and reviewing portions of the draft Strategy.

As the CWCS planning process got underway, the planning team developed a list of stakeholder groups and interested individuals to contact via direct mailings. In October 2003, the Task Force sent a letter and/or email to all ADF&G staff and over 350 members of the public, other agencies and organizations, announcing the start of the planning effort and asking for input about species in need of additional conservation effort. Organizations representing hunters, anglers, and other wildlife users, such as the state's local Fish and Game Advisory Committees and the Alaska Outdoor Council, were among the many entities contacted for their views. The outreach effort yielded comments regarding concerns for the conservation of Alaskan species and their habitats. Several organizations and agencies, including USFWS, Audubon Alaska, AKNHP, TNC, DNR, and the U.S. Army provided extensive comments. The department created a website that made the CWCS planning process open and accessible to agency staff, partners, and the public. The website allowed people to submit comments and concerns either online or via email.

In the fall and winter of 2003, the Task Force spoke with leaders in the Alaska Native community about the best ways to involve Native entities in the planning process. The planning team then contacted potentially interested parties, including several nonprofit Native organizations actively engaged in natural resource management, such as the Association of Village Council Presidents, the Indigenous Peoples Council on Marine Mammals, and the Bristol Bay Native Association. Task Force staff spoke or met with representatives of many of these groups and explained that the Strategy can provide new resources to help conserve species, including species used for subsistence, which have not been funded under other conservation programs. Staff also explained that major landholders play a critical role in the conservation of Alaska's wildlife and that it is important for landholders to be involved in developing and implementing the Strategy.

CWCS planning team members also contacted nearly two dozen entities with a potential interest in particular species that are not commercially or recreationally hunted, trapped, or fished. For example, the USFWS-sponsored Alaska Migratory Bird Co-Management Council was invited to provide expert peer review because several of the waterbird and seabird species included in the Strategy are listed on the Alaska Migratory Bird Co-Management Council's website.

During the planning process, various state and national organizations indicated their interest in assisting with preparation, review and/or implementation of Alaska's CWCS. These include NatureServe, the International Association of Fish and Wildlife Agencies (IAFWA), Partners in Amphibian and Reptile Conservation (PARC), the Natural Areas Association, the Ornithological Council, and local or regional land trusts in Alaska, such as the Kachemak Heritage Land Trust. Relationships with these and other parties will continue to evolve as we learn more about mutual interests and opportunities for collaboration.

The department conducted an extensive public and experts' review of the draft Strategy document from February to April 2005. This review opportunity was announced via email or letter to a mailing list of nearly 2,000 organizations and individuals and through a press release, selected newsletters, the state's CWCS website, letters to state/federal agency heads, a national CWCS ListServe, and a notice published in major in-state newspapers. Appendix 6 summarizes and presents results of Alaska's CWCS public scoping and review efforts.

C. Strategy Development

Review of Existing Plans and Efforts

Partners and agency staff advised the CWCS planning team not to "reinvent the wheel." From the outset, the Task Force sought to ensure that the state's process built on foundations already laid during meetings in 2001 of nongame specialists from around the state and in strategic plans completed in 2002 by the department's Sport Fish and Wildlife Conservation divisions. We also got input and advice from other states and U.S. possessions, including at three national or regional workshops of CWCS planners and biologists held between May 2003 and August 2004.

In addition, the Task Force assembled a list of more than 275 plans that may contain information relating to the Strategy's target species, species groups, or assemblages. Relatively few of these plans are strategic plans, ecoregional plans, or multipartner bird plans such as by Partners in Flight. Most are land management plans produced by the USFWS, Alaska Coastal Management Program (ACMP), NPS, DNR, U.S. Department of Defense (DOD), USFS, and ADF&G. After scanning a number of these products, we found that, other than particular species or species group recovery or management plans, few plans on the list address nongame species in any substantive way.

Nominee Species List

The Task Force prepared a nominee list (Appendix 7) containing over 300 species, by taxonomic group, to be considered for initial selection as potential planning targets. For all taxa, this list was primarily a compilation of species identified as "at risk" by various conservation plans and organizations. These included the Alaska Bird Conservancy, American Fisheries Society (AFS), Audubon Alaska, Alaska Shorebird Conservation Plan, British Columbia Provincial Red and Blue Lists (2002), Boreal Partners in Flight, BLM, Convention on International Trade in Endangered Species (CITES), Committee on the Status of Endangered Wildlife in Canada (COSEWIC), National Heritage Program, The World Conservation Union (IUCN), North American Wetlands Conservation Plan, NOAA Fisheries, State of Alaska, USFS, and USFWS. Several other species were added to various taxa lists based on staff and public comment. The sources of other agencies' "at-risk" species and detailed rationales for their designations were posted on our website throughout the planning process.

Species Selection Criteria

Using standard references on conservation planning (e.g., Groves 2003), together with partner and public comments, the planning team developed 11 criteria with which to select from among the Nominee Species those species that should appear in the Strategy (see below):

Species Selection Criteria

- Species has noticeably declined in abundance or productivity from historical levels outside the range of natural variability.
- Species has an unusual incidence of deformity, disease, malnutrition, or pollutant-caused mortality.
- Species is rare (i.e., small/low overall population size/density).
- Species is designated as at risk (threatened, candidate, or endangered under the federal Endangered Species Act; state endangered or species of concern; depleted under the federal Marine Mammal Protection Act).
- Species is endemic (i.e., occurs primarily in Alaska or occurs entirely within an ecoregion found in Alaska).
- Species makes seasonal use of a restricted local range (breeding, wintering, migration).
- Species is sensitive to environmental disturbance.
- Species is disjunct (i.e., isolated from other populations or occurrences in adjacent ecoregions).
- Species status is unknown (e.g., population information is unknown, or taxonomy is questionable).
- Species is representative of broad array of other species found in a particular habitat type.
- Species is important internationally (e.g., targeted for cross-jurisdictional action and/or recognized in bi- or multi-lateral agreements; or useful for cross-jurisdictional monitoring).

These criteria assess the level of vulnerability of a species, subspecies, or distinct population to declines that would adversely affect Alaska's biodiversity. They address such factors as abundance, incidence of deformity or disease, rarity, isolation, endemism, sensitivity to environmental disturbance, representation, international importance, and formal designation as at risk (e.g., threatened or endangered).

Draft "Featured Species" List

The Task Force applied the species selection criteria above against the Nominee Species List and, from that, prepared an initial *draft* "featured species" list for each taxonomic group. In this early phase of the planning process, the team excluded from consideration: a) all species whose occurrence in Alaska is believed to be only accidental or incidental (e.g., several marine turtle, fish, and migratory bird species); and b) most of the state's species that are commercially or recreationally hunted, trapped, or fished—i.e., species whose conservation actions are directed through an existing management mechanism or process, such as the Alaska Boards of Fisheries or Game, or a species management plan. We later learned from taxa experts about a few game species or populations warranting inclusion in the Strategy.

Although the primary focus of Alaska's Strategy is on species not commercially or recreationally hunted, trapped, or fished, our planning process allowed for the inclusion of any species with high priority conservation issues, if the species or population is believed to be at risk and met one of two criteria:

- If an "at risk" species or population has no management or recovery plan/strategy, that species or population was selected and addressed as a featured species, with a conservation action plan, in the CWCS.
- If a species or population has an applicable plan or strategy but scientists believe the plan/strategy does not adequately address long-term conservation needs, that species or population was instead highlighted elsewhere in the Strategy.

Based on this second criterion, the conservation needs for five species or populations—Tule White-fronted Goose, Spectacled and Steller's eiders, the Chisana caribou herd, and the Kenai Peninsula population of brown bear—are included in the Strategy. Information about each appears in the waterfowl and terrestrial mammals sections of Appendix 4.

Spectacled eider C.Dau, USFWS

Expert Group Meetings and Products

Conducting face-to-face expert meetings was chosen as the method likely to be most effective in gathering available species and habitat information. The Task Force located experts in 14 taxa subgroupings who were willing to serve on a species expert group or a follow-up peer review group. These experts came from organizations and communities around the state and from some out-of-state academic institutions. The taxa subgroupings were amphibians and reptiles (results presented separately), marine fish, marine invertebrates, seabirds, marine mammals, terrestrial mammals, landbirds, raptors, terrestrial invertebrates, waterbirds, shorebirds, freshwater fish, and freshwater invertebrates.

In March and April 2004, the planning team held expert group meetings for all taxa except waterfowl and terrestrial invertebrates; these were addressed later in the planning process. To encourage interdisciplinary review of species assemblage and habitat issues, individual taxa expert group meetings were scheduled to occur with those of experts for other taxa in the same ecosystem. For example, all of the "marine ecosystem" experts (i.e., on invertebrates, fish, mammals, and seabirds) met jointly, as well as in separate breakout sessions.

The Task Force distributed the draft featured species list at the species expert meetings and asked for deletions or additions. Expert groups also received the draft products from a Candidate Conservation Workshop that USFWS sponsored in May 2003. In recommending a final suite of CWCS featured species, most experts applied the 11 criteria shown on the preceding page; any additional criteria used were described in the expert group's meeting products. The experts and Task Force used their best professional judgment when applying criteria.

After selecting featured species, experts provided information on the distribution and abundance of species, described key habitats and threats or concerns associated with those habitats, developed objectives with performance measures, and crafted specific conservation actions, including priority research and survey needs. The experts also identified the most important recovery or management plans (see "Review of Existing Plans and Efforts" above) and extracted findings and conservation actions relating to featured species. An expert team's final products typically consisted of an introduction about the taxonomic group and detailed conservation action plans on anywhere from two to 14 species or species assemblages. These are described in Section V. In total, the expert process generated information and recommendations for 74 featured species or species groups and five game species or populations.

Peer and Technical Review

The Task Force coordinated a peer review of products from each of the species expert groups, including the descriptions of game species with special conservation needs. Selected leaders in the Native community were also contacted to request comments from subsistence users of many of the species included in the Strategy. The experts' input and subsequent peer and technical review processes were key in determining which species to include in the CWCS. The planning team received extensive peer review comments and incorporated this input into the draft conservation action plans with assistance from the chair of each taxa expert group.

Habitats Review

Congress directed that each state identify key habitats associated with the species presented in its Strategy. From the beginning, Alaska's CWCS team and partners were concerned that the planning effort's short time frame precluded initiating a comprehensive analysis to identify Alaska's key habitats. Currently, there is only one statewide ecosystem map available from the USGS (Nowacki et al. 2001). This map describes 32 ecoregional landscapes, is very coarse, and is not intended to present specific habitat classifications of fish and wildlife. Alaska also lacks statewide aquatic classifications for lake, river, stream, and marine habitats.

To meet this Strategy requirement, the planning team did an initial habitat assessment by asking species experts and peers to describe the location and relative condition of key habitats associated with featured species or species groups, and to note threats associated with those habitats. In addition, the species experts sometimes proposed conservation actions relating to the habitats used by featured species. This information is captured in the conservation action plans for each species, located in Appendix 4. During CWCS development, experts regularly noted habitats that fell into the following categories:

1) Habitats used by a species that is: a) federal T&E, state Endangered or state Species of Concern, b) proposed for federal or state listing, c) officially considered a candidate for listing, or d) has undergone a significant verifiable but unexplained population decline but has not yet been officially recognized in category a–c.
2) Habitats in need of restoration, and research and survey efforts that may be needed to identify which factors relating to that habitat type are most important for its restoration.
3) Habitats facing imminent threat of loss or degradation from human activities.

The Task Force consulted additional specialists with species assemblage and/or habitat expertise to review results of the expert and peer review processes, evaluate in greater depth the types and locations of habitats at risk in Alaska, and recommend how they should be addressed in the CWCS.

Experts agreed that Alaska needs to develop a statewide habitat classification system that incorporates both aquatic and terrestrial parameters and provides utility for quantifying and qualifying the State's expanse of biological resources. Only then can the state's biodiversity be uniformly monitored, managed for sustainable use, and conserved using a scientifically based approach. Lacking such a tool for this iteration of the CWCS, we used the experts' input to help identify key habitats associated with the featured species and species groups. Section VI highlights these habitats and makes a preliminary assessment concerning habitats at particular risk of adverse impact.

In coming years, the CWCS planning process will be updated to highlight additional and more specific habitats. This flexibility is needed to support and complement other conservation planning efforts, e.g., those conducted by state, national, or international ornithological organizations.

D. Development of Summary Products

Species of Greatest Conservation Need

For CWCS planning purposes, Alaska intends to use the Nominee Species List in Appendix 7, described above on page 9, as its list of species of greatest conservation need. This list contains within it all species for which experts raised conservation concerns during our process.

List of Primary Recommendations

In developing the Strategy, experts evaluated and discussed both the broad-scale needs relative to Alaska's wildlife and species- or group-specific needs. Experts generated hundreds of proposed conservation actions. Not surprisingly, many of the needs identified apply to all wildlife in the state, and common themes to conserve and sustain Alaska's diverse wildlife resources emerged. These were summarized into the list of CWCS primary recommendations found in Section VII.

E. Participants

Appendix 8 lists the more than 250 individuals who participated in the CWCS planning process as experts, reviewers, and support staff, or by contributing text or photographs.

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III. Overview of Alaska

With 365 million acres of land, Alaska is one fifth the size of the contiguous 48 states and includes more wetlands and coastline than other 49 states combined. Topography, climate, wildlife, vegetation, and human communities within this expanse are diverse, and the range of variation is dramatic. Contributing to this overall diversity is the position of Alaska between the cold Arctic Ocean and warmer North Pacific Ocean. Spanning roughly 20 degrees of latitude and 60 degrees of longitude, ecosystem types range from wet temperate rain forests in the south to vast boreal forests in the interior to polar deserts in the far north. Tall mountain ranges and major river systems dissect the state. Alaska has the fourth largest glaciated area in the world and the tallest mountain in North America. Range in the number of frost-free days is substantial, from more than 200 days in portions of southeastern Alaska and the Aleutian Islands to 40 days in the Arctic. Annual precipitation also ranges greatly, from approximately 200 inches in parts of southeastern Alaska to roughly 10 inches in the Arctic.

Brant at Izembek Lagoon USFWS

Some of Alaska's habitats are recognized nationally and internationally. For example, with creation of the Kachemak Bay National Estuarine Research Reserve in 1999, Alaska now contains one of the nation's 26 National Estuarine Research Reserves (NERRs). Five sites of the 58 sites designated in the Western Hemisphere Shorebird Reserve Network (WHSRN) are located in Alaska (see http://www.manomet.org/WHSRN/sites.php). These include the Copper River Delta, a site identified as being of hemispheric importance (≥ 500,000 birds) and Kachemak Bay, a site of international importance (≥ 100,000 birds). Izembek Lagoon and its associated uplands are known for extensive eelgrass beds and extraordinary numbers and diversity of waterfowl. For this reason, the Convention on Wetlands of International Importance ("Ramsar") designated the Izembek State Game Refuge and adjacent Izembek National Wildlife Refuge as the United States' first Wetland of International Importance in 1986. The internationally recognized areas listed above are all critical stopover points for millions of shorebirds and waterfowl; for example, almost the entire world population of black brant (*Brant bernicla nigricans*) congregates at Izembek each fall and spring.

Approximately 53% of the state has been designated in federal or state conservation units. These units effect differing levels of protection, ranging from national parks, sanctuaries, and refuges with a heavy emphasis on landscape and species conservation to recreation areas, marine parks, state forests, and other lands often designated for multiple uses, including resource extraction activities. Permanent ice and snow and alpine tundra and barrens cover about 15.7% of the state (Duffy et al. 1999), but make up 20% of the conservation units.

Alaska's diversity of marine habitats and landscapes makes it home to a rich and diverse fauna. Nearly 1,070 vertebrate species occur regularly in the state, and the efforts undertaken as a result of the CWCS planning process increase the likelihood of discovering even more species. It is thought that Alaska has many thousands of invertebrate species in habitats as diverse as subterranean karst caves, benthic marine and intertidal substrates, and countless rivers, lakes, and bogs. Overall physiographic and climatic differences across the state highlight the need for regional approaches to conservation.

Although colder climates are generally indicative of reduced biodiversity, Alaska's geographic location and largely undeveloped landscapes provide some of the largest and most productive areas of remaining habitat for many species. This is especially true for migratory species.

Overall, Alaska has been successful in sustaining its wildlife resources. However, as the human population increases and resources are developed, wildlife managers will face new challenges.

A. Sociological Framework: Demography and Use of Fish and Wildlife

People of the Land

Alaska's population of about 627,000 (2000 Census) is one of the lowest in the nation, and about 42% of its people live in Anchorage, the largest city. Alaska's population is not uniformly distributed: In 2002, 78% of the state's human population was concentrated in the Municipality of Anchorage (269,070), Fairbanks North Star Borough (84,791), Matanuska-Susitna Borough (65,241), Kenai Peninsula Borough (51,187), and City and Borough of Juneau (30,981) (Williams 2004). These five boroughs comprise 9.2% of Alaska's area. The highest population density is in the Municipality of Anchorage (411.3/km^2), and the lowest density is in the Yukon-Koyukuk Census area (0.10 persons/km^2). Appendix 9 provides Year 2000 Census numbers, together with 2004 Census-based estimates of Alaska's population by community name and within each ecoregion of the state. Sixty-nine percent of the 347 Alaska communities listed in Appendix 9 have fewer than 500 residents, many of whom are Alaska Natives.

Land Status

Land ownership in the state is divided as follows: national parks and refuges, 40%; other federal lands, 19%; state and municipal lands, 28%; and private lands, the bulk of it owned by Native corporations, 12%. Multiple modes of travel are used across Alaska, with boat, snowmachine, off-road vehicle, and air travel being the primary means of access outside of the relatively few heavily roaded regions of the state. Not surprising given Alaska's size, per capita ownership of small airplanes (private aircraft) is 14 times greater than anywhere else in the United States. Although airplane use is critical for commerce and enjoyed for recreation and tourism, air travel and the growing number of "backcountry" users increase some of our long-term conservation challenges, such as preventing introductions of invasive animal and plant species.

Use of Fish and Wildlife

A wide variety of people use the lands and waters of Alaska, and society's demands on the state's fish, wildlife, and habitat resources vary greatly. These demands include community growth, extractive industries, commercial and recreational hunting and fishing, trapping, gathering, wildlife-related tourism, and subsistence fishing and hunting.

Commercial Fishing


Processing sablefish on a longline vessel, Gulf of Alaska
J. Keaton, Fishery Observer

Commercial fishing is the largest use of the state's fish and wildlife, with commercial fishermen taking 97% of the resources harvested in Alaska, subsistence users taking 2% and sport users harvesting 1% (Wolfe 2000). In 2002, the commercial fishing industry (i.e., fisheries harvesters and crew, plus seafood processing employment) accounted for 17,090 jobs, or 6.3% of total private sector jobs in Alaska. This was second only to the construction industry and greater than employment figures for the oil and gas industry (Alaska Department of Labor and Workforce Development 2004).

Commercial fisheries harvested about 5.4 billion pounds of fish and shellfish with an exvessel value (i.e., "raw fish" price paid to fishermen) of about $1.2 billion. The wholesale (processed seafood) value was about $2.6 billion in 2003. This activity generated about $50 million in tax revenues for the State of Alaska; commercial fishing permits, and vessel and crew member license fees brought in another $6 million. Revenue-sharing programs return a portion of these taxes back to the communities that generate them.

Major fisheries in Alaska include groundfish, salmon, herring, shellfish and halibut. Groundfish make up 82% of the harvest by volume and 49% by exvessel value. Salmon make up 15% of the harvest by volume, but 20% by exvessel value.

Sport and Personal Use Hunting, Trapping, and Fishing

Hunting, trapping, and fishing are also an important part of Alaska's heritage and economy. The opportunities fish and wildlife resources provide are a key reason many people choose to live in Alaska.

Hunting and trapping have been practiced for millennia in Alaska, and this tradition continues today. Enjoyed by nonresidents and residents, in both urban and rural areas, hunting and trapping enhance quality of life and provide direct economic benefits, such as jobs, food for the freezer, and pelt sale proceeds in the bank.

Fall caribou hunt, Interior Alaska R. Lowell, ADF&G

Revenues from hunting and trapping licenses and fees contribute directly to ongoing ADF&G management and research programs, while revenues generated through purchases of equipment and services spread through local economies. Approximately 12% of Alaska residents (age ≥ 16 years) participate in hunting (USFWS and U.S. Census Bureau 2001). In 2001, resident and nonresident hunters spent 1.1 million days hunting and a total of almost $217 million in hunting-related expenses to pursue Alaska's wildlife resources (USFWS and U.S. Census Bureau 2001). In 2004, resident hunting license sales generated $1.7 million; nonresident hunting license sales generated $1.1 million (ADF&G 2004). Approximately $4.7 million in revenue was generated by Big Game Tag purchases; the nonresident contribution was $4.5 million (ADF&G 2004), indicating Alaska remains a world-class hunting destination.

The goal for many hunters, especially residents, is to fill the freezer with moose, deer, or caribou. Others want the challenge of stalking a trophy Dall sheep, mountain goat, or brown bear. An average of 7,552 moose, 33,815 caribou, 18,839 deer, 906 Dall sheep, 471 mountain goats, and 1,544 brown bears are taken annually in Alaska for food or trophy (ADF&G 2003).

The quest for winter income and sport sends trappers into the field in pursuit of wolves, wolverines, beavers, and other furbearer species. In accordance with state and federal sealing requirements, on average 13,246 furbearers are sealed annually

(Peltier and Scott 2003). Harvest of other furbearer and fur animal species, such as coyotes and hares, occurs but is not subject to sealing regulations. ADF&G Trapper Questionnaire (Peltier and Scott 2003) data shows that the number, age, and experience of trappers, the number of seasons in the same area, and fur disposition trends remain relatively constant. Out of 1,766 questionnaires sent for the 2002–2003 trapping season, 69% of respondents said they actively trapped during the 2001–2002 season; over 50% of respondents kept their furs, and of the trappers who sold their furs, most sold them in Alaska. This information suggests the trapping heritage remains strong, and that trapping continues to provide sustenance and sport for Alaskans.

Approximately 30 percent of Alaska residents participate in sport fishing each year. The Statewide Harvest Survey estimated that over 450,000 anglers fished in 2003. Residents spent 1.4 million days and nonresidents spent over 800,000 days fishing. Anglers harvest the five species of Pacific salmon, plus trout, char, grayling, halibut, rockfish and other species.

Based upon information from the 2001 National Survey of Fishing, Hunting and Wildlife Viewing, the American Sportfishing Association (2003) estimates that U.S. residents over age 16 spent approximately $640 million on fishing trips and equipment in Alaska in 2003. This does not include equipment or supplies that nonresident U.S. anglers bought before arriving in the state or expenditures by foreign residents who came to Alaska to fish. These sport fishing expenditures in Alaska in 2003 generated 12,065 jobs and $259 million in wages and salaries.

A popular fishing spot during salmon season
USFWS

Alaskans' increasing dependence on fisheries resources has caused new types of fishing opportunity, including personal use fisheries, to be created. Personal use fisheries arose from legal challenges to the state's subsistence priority law during the last decade. Usually administered through a by-household permit process, personal use fisheries allow the taking of fish or invertebrates if that take is in the broad public interest and will not negatively impact an existing resource or sustained yield of that resource.

Not surprisingly, whether small or large in scale, these additional fishing opportunities are popular and highly valued by Alaskans. As an example, approximately 35,000 permits are issued annually to dipnet for sockeye salmon in summer fisheries located in Upper Cook Inlet and on the Copper River; a few pink, coho and chum salmon are also taken in these fisheries. In 2004, over 450,000 sockeye salmon were harvested in Upper Cook Inlet and Copper River personal use fisheries. The 2004 sockeye harvest on the Kenai and Kasilof Rivers represents approximately 6 percent of the overall Cook Inlet sockeye harvest. The harvest of king salmon is allowed in several personal use fisheries, but on a very limited basis. Smelt and herring are also important personal use species in selected locales.

Subsistence Harvest

Subsistence fishing, hunting, and gathering are also important to the economies and cultures of many families and communities in Alaska. Subsistence uses are central to the customs and traditions of many cultural groups in Alaska, including Aleut, Athabascan, Alutiiq, Euroamerican, Haida, Inupiat, Siberian Yupik, Tlingit, Tsimshian, and Yup'ik.

Beluga muktuk at Elephant Point, Kotzebue Sound
G. Seaman, ADF&G

State and federal law define subsistence as the "customary and traditional uses" of wild resources for food, clothing, fuel, transportation, construction, art, crafts, sharing, and trade. At present, these federal and state laws differ in who qualifies for participation in subsistence hunting and fishing. Under federal law, only rural residents qualify for subsistence preference on federal lands—about 20% of Alaska's population (about 125,000 people) lived in rural Alaska in 2000. Federal laws apply to federal lands and decisions on subsistence management on federal lands (national parks, national wildlife refuges, national forests, and BLM lands) are made by the Federal Subsistence Board. Under state law, all state residents are eligible to participate in subsistence hunts and fisheries as established by the Alaska Board of Game and Alaska Board of Fisheries, with preference being based on an individual's customary use of and dependence on a particular wildlife or fish population.

Subsistence harvests continue to provide a large portion of the food supply in rural Alaska. Based on studies by the ADF&G's Division of Subsistence, an estimated 45 million pounds (usable weight) of wild foods are harvested annually by subsistence users. This harvest provides about 35% of caloric requirements and 242% of mean daily protein requirements for the rural population.

Families harvest wild foods with fish wheels, nets, motorized skiffs, rifles, all-terrain vehicles (ATVs), and snowmachines. Successful families in rural Alaska's "mixed economy" combine wage-paying jobs (e.g., tourism, guided hunting, or the service sector) with subsistence hunting, fishing, and gathering. They share their harvests with households having members who cannot hunt or fish, including elders, small children, and the disabled. The social bonds created by exchanges of subsistence foods are central to the survival of rural communities and traditional cultures.

The composition of subsistence wildlife harvests across Alaska differs from region to region based largely on the relative abundance of key species. Particularly along Alaska's western and northern coasts, marine mammals play a major role, while in portions of Interior Alaska, big game species and fish are especially important. Herds of caribou are highly valued throughout their ranges. In most communities along the coast and the major rivers, salmon are the dominant fish resource in annual harvests. In the state overall, about 60% of the annual subsistence harvest is fish, about 20% is land mammals, and 14% is marine mammals. Birds (2%), shellfish (2%), and wild plants (2%) make up the rest.

Although abundant resources such as salmon, halibut, moose, caribou and marine mammals make up a large portion of Alaska subsistence harvests, a key element in subsistence is the use of a wide variety of wild foods. For example, families in coastal communities in Southcentral and Southwest Alaska use many marine invertebrate species, such as chitons, octopus, snails, clams, crab, and sea urchins. In addition to halibut and salmon, they harvest other kinds of marine and freshwater fish, including herring and herring roe on kelp, eulachon, rockfish, whitefish, blackfish, grayling, pike, char and trout. A variety of birds and their eggs are used, such as multiple species of ducks and geese, marine birds, and gull eggs. Trading for coastal and inland species between regions is common.

Another key feature of the subsistence way of life is learning by doing and observing, as well as absorbing the knowledge passed down through the traditions of one's community. Through interacting with the environment in subsistence activities across generations, a large body of traditional ecological knowledge has developed in rural Alaska. This traditional knowledge is not confined to what one needs to know in order to harvest fish or wildlife, but also includes detailed knowledge of animal behavior, habitat, diet, condition, and population trends, as well as cultural values that shape relationships with the natural world.

Increasingly, Alaska's fish and wildlife management plans acknowledge the essential role of subsistence harvests in supporting the economies and cultures of Alaskan communities. The plans also recognize the detailed ecological knowledge held by rural subsistence hunters and fishermen. Management plan goals are more likely to succeed when subsistence perspectives, as well as urban-based recreational, academic, or management agency perspectives, are included. Planning efforts that tap both traditional and scientific knowledge promote resource stewardship and encourage effective communication between all groups with a stake in conservation of fish and wildlife resources.

The Division of Subsistence maintains a Community Profile Database that includes the results of systematic household harvest surveys conducted periodically in communities throughout the state (Scott et al. 2001). A list of the animal and plant resources that are currently used for subsistence purposes in Alaska communities and additional readings about subsistence can be found at: http://www.subsistence.adfg.state.ak.us/.

Finding and Viewing Wildlife

Opportunities to view and photograph wildlife in their natural habitats are important to both Alaska residents and visitors. Wildlife viewing enhances quality of life and economies across Alaska. In a survey of Alaska voters, 96 percent agreed that wildlife adds a great deal to their enjoyment of living in Alaska (80 percent strongly agreed), and 78 percent wanted to know more about how to find and watch wildlife. Visitor studies show that wildlife viewing is second only to scenery as the most important reason that tourists come to Alaska.

Photographing wildlife ADF&G

Many Alaskans and most visitors travel to view wildlife. Using a strict "primary purpose" definition, the USFWS estimates that 420,000 U.S. residents aged 16 and older participated in wildlife viewing in Alaska in 2001, spending $499 million, including $358 million in expenditures by nonresidents. The economic impact of wildlife as a draw for international tourists has not been measured. However, Alaska's unique and abundant wildlife makes it a world class viewing destination. The Alaska Travel Industry Association estimates annual in-state visitor expenditures at $1.8 billion, with a significant portion attributed to Alaska's wildlife viewing opportunities.

Demand for quality wildlife viewing opportunities exceeds existing capacity in Alaska and is expected to continue to rise with increasing population, growing tourism (Fay 2000) and rising education levels. More and more travelers are seeking "life enriching experiences" such as guided tours, group educational tours and learning activities such as wildlife viewing (Eagles 2002). Travelers also expect more sophistication and higher standards in professional guides, tours, interpretive facilities, and information (Eagles 2002). Maintaining Alaska's position as a national and global wildlife tourism destination will require cooperative efforts among resource agencies, nongovernmental organizations and the visitor industry.

Legal Basis for Conservation of Fish and Wildlife

ADF&G's legal framework for managing fish and wildlife in Alaska is derived from the Alaska Constitution, Article VIII, and implementing statutes. Article VIII, Section

3 states: “Wherever occurring in their natural state, fish, wildlife, and waters are reserved to the people for common use.” Additional guidance appears in Article VIII, Section 4: “Fish, forests, wildlife, grasslands, and all other replenishable resources belonging to the State shall be utilized, developed, and maintained on the sustained yield principle, subject to preferences among beneficial uses.”

The department, the Alaska Board of Fisheries, and the Alaska Board of Game work within a legal framework formed by the Alaska Constitution, statutes enacted by the state legislature, and administrative rules, or regulations. Alaska Statute Title 16 is the primary statute governing management of Alaska’s fish and wildlife resources. This statute directs the commissioner of ADF&G to “manage, protect, maintain, improve, and extend the fish, game, and aquatic plant resources of the state[9] in the interest of the economy and general well-being of the state.” In addition, it assigns primary responsibility for allocation of resources by user group or gear type to the Alaska Board of Fisheries and the Board of Game. One statute, AS 16.20.185, directs the commissioners of ADF&G and DNR to “take measures to preserve the natural habitat of species or subspecies of fish and wildlife that are recognized as threatened with extinction.” Other sections of AS 16.20 codify the purposes for state wildlife refuges, sanctuaries, and critical habitat areas, and designate particular places for these purposes.

The department’s fish and wildlife management activities include inventorying and, monitoring populations, researching health parameters and other aspects of biology, protecting public access, monitoring and rehabilitating habitat, determining sustained yield, actively managing populations, and participating with DNR in review and issuance of water rights, including instream flow reservations. ADF&G also manages the lands that have been legislatively designated as state game refuges, game sanctuaries, or critical habitat areas (see Section IVD of the CWCS); unit-specific guidance regarding allowable uses and incompatible activities is common.

The Boards of Fisheries and Game allocate harvest through regulations for trapping, subsistence and recreational hunting, and subsistence, commercial, recreational, and personal use fisheries. The boards with input from the department establish seasons, quotas, bag limits, harvest levels, and means and methods employed in the pursuit, capture, transport, and related uses of fish and wildlife.[10]

The Alaska Constitution and Statutes recognize the authority and responsibility for management of Alaska’s public trust doctrine resources. The doctrine provides that public trust lands (those below mean high tide and within ordinary high water

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[9] The Alaska Statutes define the “fish, game, and aquatic plant resources” managed by the Department as follows: "*fish*" means any species of aquatic finfish, invertebrate, or amphibian, in any stage of its life cycle, found in or introduced into the state, and includes any part of such aquatic finfish, invertebrate, or amphibian; "*game*" means any species of bird, reptile, and mammal, including a feral domestic animal, found or introduced in the state, except domestic birds and mammals; and "*aquatic plant*" means any species of plant, excluding the rushes, sedges, and true grasses, growing in a marine aquatic or intertidal habitat.

[10] The Federal Subsistence Board also sets regulations for subsistence harvests by rural residents on certain federal lands.

boundaries), waters, and living resources are held by the state in trust for the benefit of all the people and establishes the public's right to use these lands, waters, and resources for a wide variety of public uses. The public has a right to use all waterways in Alaska regardless of ownership of the underlying land.

The state's wildlife and fish conservation laws and regulations apply across all land ownerships, unless superseded by federal law (e.g., the Marine Mammal Protection Act, Migratory Bird Treaty Act, Endangered Species Act and federal subsistence regulations promulgated pursuant to Title VIII of Alaska National Interest Lands Conservation Act [ANILCA]). On federal lands, the department and the federal agencies share responsibilities for fish and wildlife resources and their habitats and cooperate in conservation and management programs.

Enforcement

Law enforcement is a critical element of effective wildlife management plans. In Alaska, with a varied and extensive resident and nonresident user group, enforcement of fish and wildlife regulations helps ensure that wildlife and fish populations remain robust and that people can enjoy the many use opportunities provided under law through actions of the department and the boards. Programs that educate the public about fish and wildlife regulations are important for gaining voluntary compliance; however, enforcement is needed to deter those who would violate regulations for personal gain or profit, such as through poaching.

The Alaska Department of Public Safety, Division of Alaska State Troopers, Bureau of Wildlife Enforcement, is the primary enforcement agency for state laws protecting wildlife. The USFWS also enforces federal wildlife and fish laws and regulations. ADF&G does not provide enforcement services per se. Instead, with appropriate training, ADF&G provides support to these enforcement agencies by supplying technical and professional management information and by passing on violation reports as appropriate.

Effective enforcement of wildlife-related laws helps reduce unlawful harvest or harassment of wildlife. In so doing, it also decreases the need to further restrict activities being conducted within the law. A coordinated and fully funded enforcement effort is important to the success of Alaska's CWCS and other fish and wildlife management plans.

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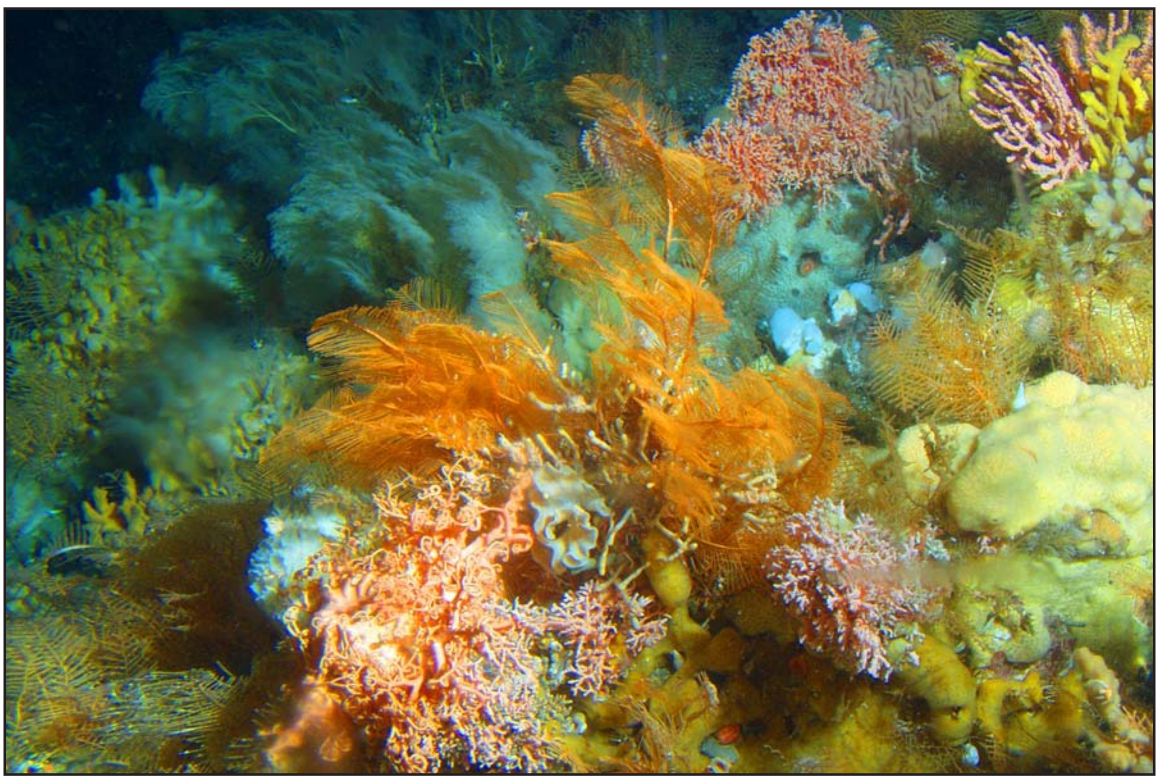
B. Ecological Framework: The Lands and Waters that Produce Our Fish and Wildlife

Introduction: Alaska's 32 Ecoregions

This section describes the rich mosaic of landscapes and wildlife in each of the state's 32 ecoregions, as delineated by Nowacki et al. (2001). Ecoregions can be defined as large areas of land and waters containing vegetation communities that share species and ecological dynamics, environmental conditions, and interactions that are critical for their long-term persistence. This section also touches on other important facets of Alaskan ecoregions: their people, land use, and land management. In the land management tables for each ecoregion, private ownership includes private individuals and entities, such as Native corporations. Local ownership includes city and borough governments, and "percent of ecoregion" refers to the portion of the ecoregion in the United States.

A description of each ecoregion follows the statewide map on page 27. This map combines the Bailey and Omernik approach to ecoregion mapping in Alaska and was developed cooperatively by the USFS, NPS, USGS, TNC, and personnel from many other agencies and private organizations.



Newly discovered coral and sponge gardens off the Aleutian Islands A. Lindner, NOAA Fisheries

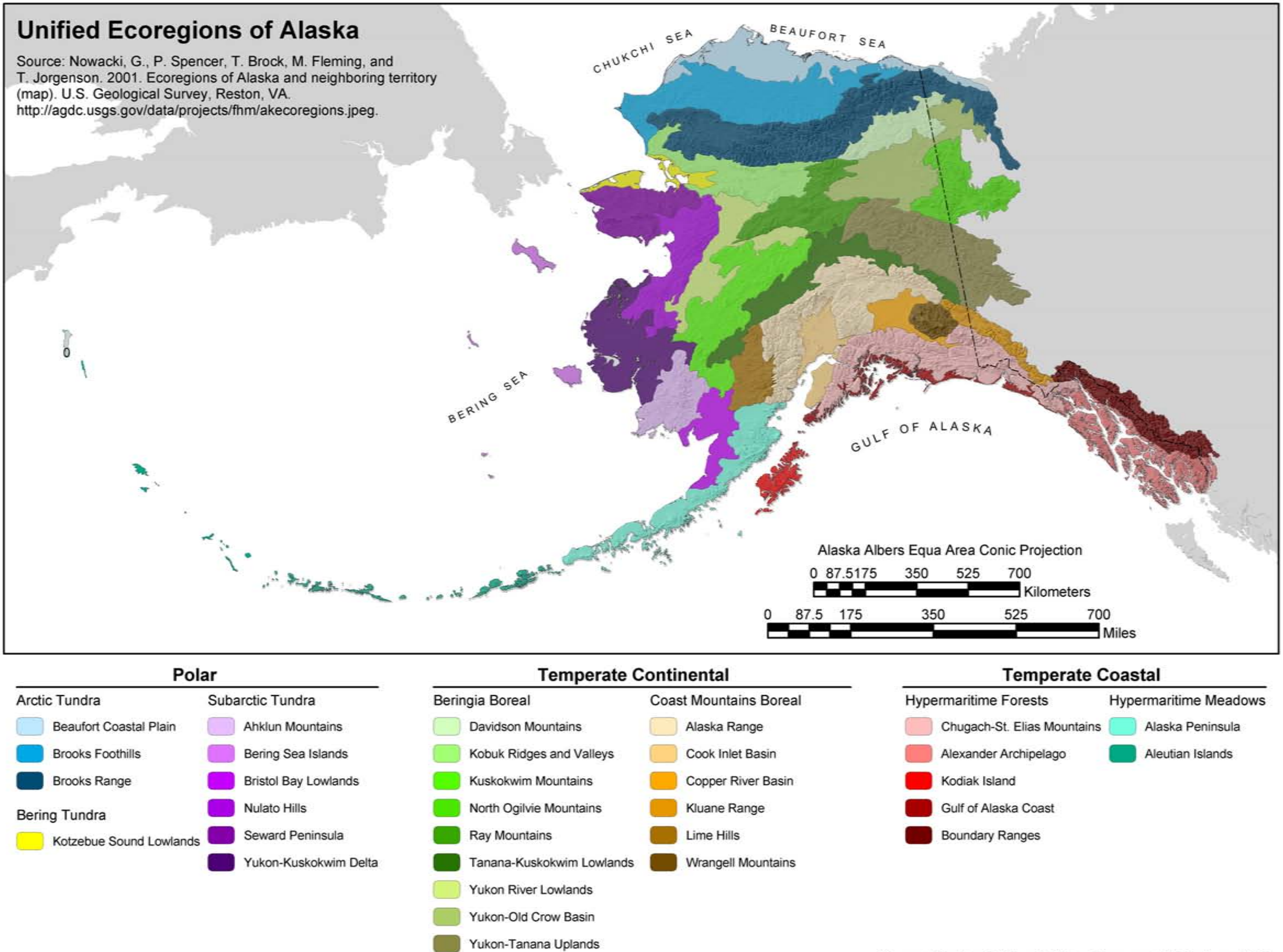


Figure 1. Statewide ecoregions map

Polar Arctic Tundra

Beaufort Coastal Plain

Area: 15,862,580 acres (6,419,385 hectares)
Alaska 92%, Canada 8%

Landscape:


Beaufort Coastal Plain in winter USFWS

The Beaufort Coastal Plain is a treeless, windswept landscape stretching across the Alaska coast of the Arctic Ocean and into Canada. The ecoregion is characterized by an abundance of lakes, wetlands, and permafrost-related features such as pingos, ice-wedge polygon networks, peat ridges, and frost boils. Permafrost is almost continuous across the region, so soils typically are saturated and have thick organic horizons. The plain gradually ascends from the coast southward to the foothills of the Brooks Range. Numerous large, braided rivers, originating in the Brooks Range, drain northward across the coastal plain. Small streams dry up or freeze completely in the winter. Thousands of shallow rectangular lakes cover the coastal plain in a north-northwest orientation due to winds on the shorelines. These thaw lakes cover up to 50% of the Arctic coastal plain. Small sand dunes irregularly occur along the coast.

Due to the abundance of lakes and saturated soils, over 82% of the ecoregion is considered wetland. Vegetation is dominated by wet sedge tundra in drained lake basins, swales, and floodplains, and by tussock tundra and sedge-*Dryas* tundra on gentle ridges. Low willow thickets grow on well-drained riverbanks.

A dry, polar climate produces short, cool summers and long, cold winters. Proximity to the Arctic Ocean and abundant sea ice contribute to the cool, frequently foggy, summers. Annual precipitation is low [4 to 6 inches (10 to 15 centimeters)] and mostly falls as snow during the winter. The average annual temperature varies from 8 to 14 °F (–13 to –10 °C).

Wildlife and Fish:

Many species of waterfowl nest on the coastal plain, including Greater White-fronted Geese; Snow Geese; Tundra Swans; Brant; Common, King, and Spectacled Eiders; and Yellow-billed Loons. Numerous seabirds, including Glaucous Gulls and Black Guillemots, can be found here in the summer. Ptarmigan and Long-tailed Jaegers move from the foothills to the plains to breed.

Polar Arctic tundra is important to shorebirds, both nationally and internationally. The bulk of the U.S. breeding population of Long-billed Dowitcher, Dunlin, and Semipalmated, Pectoral, Buff-breasted and

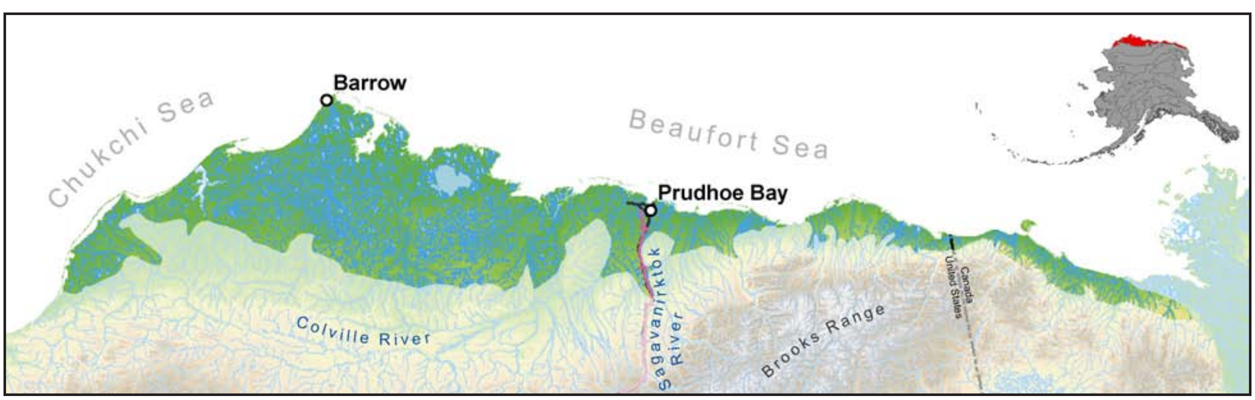
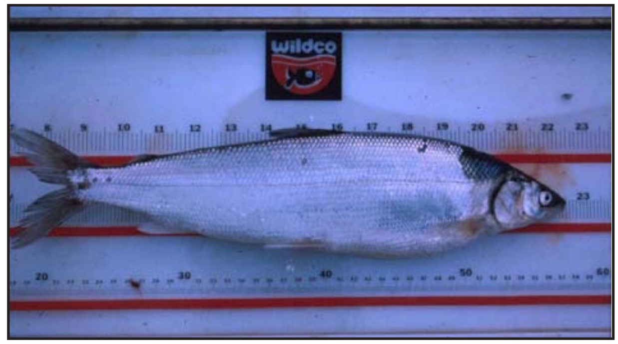


Figure 2. Beaufort Coastal Plain ecoregion

Stilt Sandpipers occurs here. In total, more than two dozen shorebird species breed here, with over 6 million birds estimated to breed on the National Petroleum Reserve-Alaska alone. Many shorebird species also use the coastal areas of the region for staging prior to migrating to southern parts of the Western Hemisphere, Southeast Asia, Oceania, Australia and New Zealand.



Arctic cisco R. West, USFWS

Four caribou herds (Central Arctic, Porcupine, Teshekpuk Lake, and Western Arctic) use this ecoregion, seeking its windier areas for relief from insects. The Central Arctic, Porcupine, and Teshekpuk Lake herds calve on the coastal plain, while the largest herd, the Western Arctic, calves in the Utukok Uplands. Other herbivores include muskoxen, lemmings, barren ground shrews, singing voles, and arctic ground squirrels. The main mammalian predators near the coast are arctic foxes and polar bears; gray wolves and brown bears occur throughout the ecoregion. Marine mammals found in the nearshore areas include walruses in low densities; minke, beluga, gray, and bowhead whales; and bearded, spotted, and ringed seals. The coastal waters in this region are an important feeding area of the endangered bowhead whale during the fall.

Arctic cisco, broad whitefish, least cisco, and Dolly Varden char overwinter in the larger rivers that do not freeze completely.

People:

Villages are located along the coast or inland a few miles on rivers. Most residents are Inupiaq. The largest communities are Barrow, Wainwright, and Nuiqsut. People have traditionally depended on bowhead and beluga whales, seals, and walruses, caribou, edible plants and waterfowl for subsistence in this ecoregion. Many oil field workers live temporarily in and around Prudhoe Bay.

Land Use:

Most development is related to oil exploration and extraction. Subsistence activities are similar to those that have been practiced for centuries. More than 90% of the habitat within the ecoregion remains intact, with development largely restricted to the town of Barrow and other villages, and oil fields at Prudhoe Bay and Kuparuk.

Land Management:

The federal government manages 73% of this ecoregion, with management primarily by the Bureau of Land Management (BLM) at the National Petroleum Reserve-Alaska. The State of Alaska owns over 18%. The North Slope Borough has jurisdiction over most of this ecoregion.

Table 1. Beaufort Coastal Plain land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	66.5%
Federal	DOD	<1.0%
Federal	USFWS	6.5%
Local	Local	<1.0%
Private		8.7%
State	DNR	18.3%

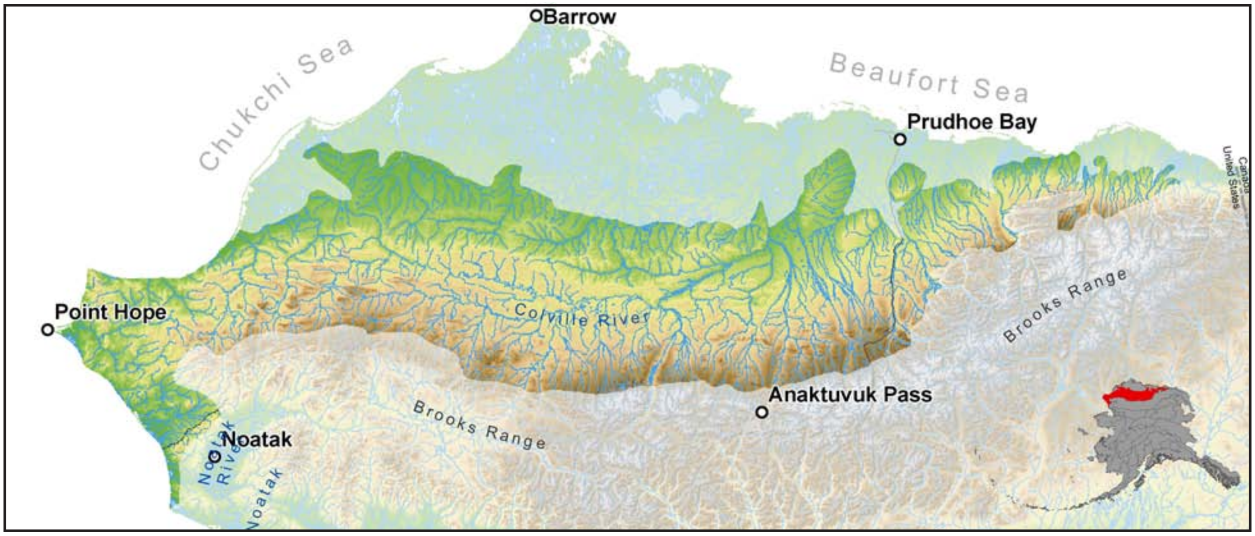


Figure 3. Brooks Foothills ecoregion

Brooks Foothills

Area: 28,474,479 acres (11,523,464 hectares)

Landscape:

Composed of gently rolling hills and broad, exposed ridges, the Brooks Foothills ecoregion stretches from Point Hope at the Chukchi Sea eastward, almost to the Canadian border. Long, linear ridges, buttes, and mesas composed of tightly folded sedimentary rocks divide narrow alluvial valleys and glacial moraines. Above a thick, continuous layer of permafrost are ice-related features, such as gelifluction lobes, pingos, and ice-wedge polygon networks. Because the permafrost impedes drainage, soils are usually saturated and have fairly thick organic horizons. Lakes are infrequent, but many swift streams and rivers originating in the Brooks Range cross through the foothills, occasionally braiding across gravel flats. Some streams freeze solid each winter, creating large aufeis deposits that last well into summer.

A dry polar climate dominates the land, but is somewhat warmer and wetter than the climate of the Beaufort Coastal Plain. The average annual precipitation ranges from 6 to 10 inches (15–25 centimeters), and average annual temperature ranges from 9 to 20 °F (–13 to –7 °C).

Peregrine Falcon USFWS

Vegetation along rivers is dominated by willow. The rest of the ecoregion is dominated by vast expanses of mixed shrub-sedge tussock tundra. *Dryas* tundra occurs on ridges, and calcareous areas support sedge-*Dryas* tundra. Wetlands are present in more than 83% of the ecoregion.

Wildlife and Fish:

The Brooks Foothills provide habitat for wide-ranging mammals. The Western Arctic, Porcupine and Central Arctic caribou herds migrate through the foothills to reach their calving grounds in the Utukok Uplands (Western Arctic herd) and Beaufort Coastal Plain (Porcupine and Central Arctic herds). The foothills contain denning sites for brown bears and wolves. Additionally, the area is important to muskoxen, arctic ground squirrels, Smith's Longspurs, and Peregrine Falcons. The moist tundra provides nesting habitat for Baird's, Stilt and Buff-breasted Sandpipers and small mammals such as the insular vole. The Colville River bluffs contain nesting and feeding habitat for the Peregrine Falcon and other raptors. Arctic char, lake trout, and whitefish are found in many foothill lakes. Dolly Varden spawn and overwinter in larger rivers. Arctic grayling are year-round residents in both lakes and streams. Dolly Varden and five species of Pacific salmon spawn in some west coast rivers.

At the west end of the ecoregion at the Chukchi Sea, bowhead, beluga, and minke whales can be observed in the nearshore waters, and bearded and ringed seals haul out at the sea ice edge. Black-legged Kittiwakes nest at Cape Lisburne.

People:

Few people live in this ecoregion, though it provides important subsistence resources for Alaskans living on the Arctic coast. The largest communities are Point Hope and Kivalina.

Land Use:

Most development is related to oil exploration and extraction. Subsistence activities continue as they have for centuries. The Brooks Foothills remains an almost continuous block of habitat, bisected once by a corridor containing the Dalton Highway and the oil pipeline.

Land Management:

The State of Alaska owns over 24% of this ecoregion, and the federal government holds 62%. The BLM is the primary land manager, with the National Petroleum Reserve-Alaska making up 41% of the ecoregion. The North Slope Borough has jurisdiction over most of this ecoregion.

Table 2. Brooks Foothills land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	54.5%
Federal	NPS	1.6%
Federal	DOD	0.0%
Federal	USFWS	6.1%
Local	Local	<1.0%
Private		13.2%
State	DNR	24.5%

Brooks Range

Area: 38,590,824 acres (15,617,493 hectares)

Alaska 82.4%, Canada 17.6%

Landscape:

Eastward from the Delong Mountains near the Chukchi Sea, the Brooks Range ecoregion reaches across Alaska, finally curving southeast into Canada to include the British Mountains. Representing the northern extension of the Rocky Mountains, the range is characterized by steep mountains composed of uplifted sedimentary and metamorphic rock with scattered glaciers above above 5,940 feet (1,800 meters). Within the ecoregion, elevations range from 1,640 to 8,530 feet (500 to 2,600 meters). The high central portion of the range has steep angular summits draped with rubble and scree. To the west and east, the topography becomes less rugged, with more flat-topped summits. High-energy streams and rivers cut through narrow ravines with steep headwalls, creating a branched pattern in the terrain. In the central and eastern part of the Brooks Range are numerous large lakes that were created from glacial moraine dams.

The dry polar climate has short, cool summers and long, cold winters, with average annual temperatures of 10 to 22 °F (–12 to –6 °C). Average annual precipitation ranges from 6 to 13 inches (15 to 33 centimeters). All soils, except for a few south-facing slopes, are underlain by permafrost. Wildfire is common.

The Brooks Range is the main divide between the Arctic and Interior Alaska, and vegetation on either side of the range reflects this. Valleys and lower mountain slopes on the north side of the range are covered by mixed shrub-sedge tussock tundra with willow thickets along rivers and streams. Many of the highest ridges are barren or ice-covered. On the south side, lower mountain slopes and valleys possess sedge tussocks and shrubs. Sparse conifer-birch forests and tall shrubs are restricted to larger valleys on the south side of the range in Alaska, but the Arctic tree line extends across the range in Canada. The steepest slopes remain barren due to instability. Upper and intermediate slopes contain alpine heath communities; lower slopes have moist sedge-tussock meadows; and shrub communities form in thickets along major rivers. Wetlands occupy at least 20% of the ecoregion.

Brooks Range in summer USFWS

Wildlife and Fish:

Dall sheep, gray wolves, brown bears, Alaska marmots, and caribou inhabit the mountains. Birds, such as Golden Eagles, Horned Larks, and Smith's Longspurs, and small mammals, such as singing voles, are found in the wide valley floors. Deep lakes provide habitat for Arctic char, lake trout, Arctic grayling, and whitefish, while ground water springs provide spawning habitat for Dolly Varden and chum salmon. Arctic grayling and slimy sculpin live in most of the area's waterways.

People:

The Brooks Range is sparsely populated. Traditionally, Inupiat lived in the west, and Koyukon and Gwichin Athabascans in the east. Anaktuvuk Pass is the largest community.

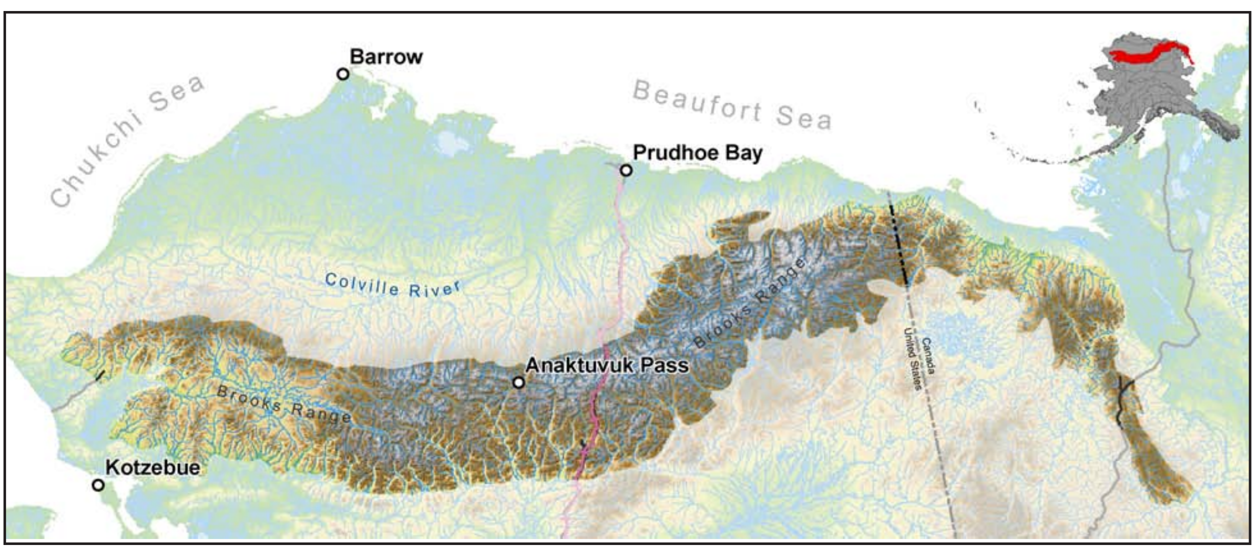


Figure 4. Brooks Range ecoregion

Land Use:

Most development is related to oil exploration and extraction. The Dalton Highway bisects the ecoregion, acting as the primary land transportation route to the oil and gas fields to the north. This ecoregion remains almost entirely intact, except for development at Red Dog Mine, the Dalton Highway, and the trans-Alaska pipeline. Subsistence activities are important uses of the land and waters, as they have been for centuries.

Land Management:

Over 17% of this ecoregion is in Canada, where a portion has been designated as Ivvavik National Park. The majority of the Alaska portion of the ecoregion has been legislatively set aside as national parks and wildlife refuges: Gates of the Arctic National Park, Noatak National Park, Kobuk Valley National Park, and the Arctic National Wildlife Refuge. The NPS and USFWS together manage over 75% of the Alaska lands. The BLM has designated several Areas of Critical Environmental Concern.[11] The State of Alaska owns more than 13% of the ecoregion. Private ownership is very low. The North Slope and Northwest Arctic boroughs have jurisdiction over parts of this ecoregion.

Table 3. Brooks Range land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	7.7%
Federal	NPS	50.0%
Federal	USFWS	31.9%
Private		2.0%
State	DNR	13.4%

Bering Taiga

Nulato Hills

Area: 14,433,528 acres (5,841,169 hectares)

Landscape:

The low, rolling Nulato Hills form a divide between the Bering Sea and the Yukon River, with streams on the east side flowing into the river and those on the west draining into Norton Sound. An ancient mountain range has been eroded down to these southwest-northeast oriented hills with a maximum elevation of 4,040 feet (1,230 m) and narrow valleys rising from sea level. Some valleys have thaw lakes, and permafrost underlies most of the ecoregion.

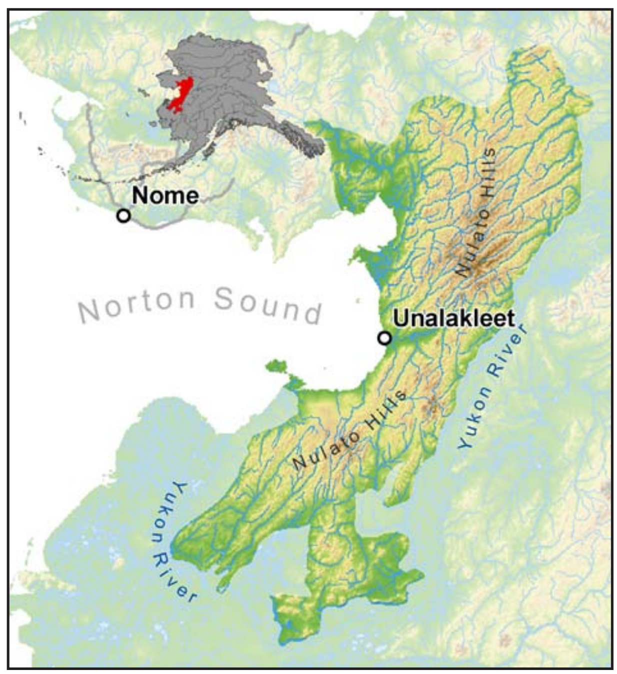


Figure 5. Nulato Hills ecoregion

The vegetation pattern is largely based on the elevation and terrain. Higher elevations are barren or alpine tundra of *Dryas*-lichen or sedge-ericaceous shrubs. As one descends in elevation, the vegetation changes to dwarf shrubs, followed by taller willow-birch-alder shrublands. Spruce and birch forests occur at lowest elevations. Wildfires are a common disturbance in this ecoregion.

[11] An area designated pursuant to the federal Land Policy and Management Act of 1976, where special management attention is required to protectand prevent irreparable damage to important historic, cultural, or scenic values, fish and wildlife resources, or other natural systems or processes, or to protect life and safety from natural hazards.

The moist polar climate is somewhat moderated by the Bering Sea, though the presence of sea ice early in the winter allows direct passage of cold air from Siberia. The average annual temperature ranges from 23 to 28 °F (–5 to –2 °C), and the average annual precipitation is 12 to 16 inches (30 to 40 centimeters).

Nulato Hills in winter S. Steinacher, ADF&G

Wildlife and Fish:

As part of the ice-free Beringia corridor linking North America and Asia in the past, this ecoregion still possesses species more common in Eurasia than the rest of Alaska. Yellow and White Wagtails, Bluethroats, and Red-throated Pipits are found here. Species more common to Alaska also live here—moose, brown bears, caribou, arctic foxes, and Alaska hares. River otters occur in the major river valleys. Polar bears; spotted, bearded, and ringed seals; beluga and minke whales; and walruses are seen near the coast and on adjacent ice floes. Five species of Pacific salmon ascend area rivers to spawn. Dolly Varden spawn and overwinter in most rivers, and Arctic grayling are resident in larger streams. Bering cisco and Alaska blackfish are common residents of the fresh waters.

People:

Native Alaskans in the area include Inupiat, Koyukon Athabascans, and Central Yup'iks. The largest communities are Unalakleet and Mountain Village.

Land Uses:

Subsistence remains an integral part of the people and economy of this ecoregion, with an emphasis on caribou and fish. Mining exploration and prospecting continue on a limited basis.

Land Management:

The federal government manages over 85% of the Nulato Hills. The BLM has responsibility for most of the federal lands and has designated several Areas of Critical Environmental Concern. The majority of the USFWS lands are part of Yukon Delta National Wildlife Refuge. Private landowners, primarily Native corporations, own more land than the state.

Table 4. Nulato Hills land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	67.0%
Federal	DOD	<1.0%
Federal	USFWS	18.4%
Local	Local	<1.0%
Private		11.2%
State	DNR	3.4%

Yukon-Kuskokwim Delta

Area: 18,965,040 acres
(7,675,047 hectares)

Landscape:

The Yukon-Kuskokwim Delta in southwest Alaska results from the deposition of heavy sediment loads from the glacial Yukon and Kuskokwim Rivers. Abundant thermokarst lakes, meandering streams, and highly productive brackish marshes and wet meadows characterize the flat coastal plain. Isolated basalt hills and volcanic cinder cones less than 400 feet (120 meters) punctuate the landscape. Discontinuous permafrost impedes drainage and contributes to shallow organic soils. Large tidal fluctuations near the coast, along with occasional storm tide surges, flood coastal areas with salt water, creating invertebrate-rich coastal marshes.

Fall tundra USFWS

Wet tundra communities on the coastal plain primarily consist of sedge mats, moss, and low-growing shrubs. Uplands due to peat mounds, sand dunes and volcanic soils support dwarf scrub communities of birch and ericaceous shrubs. Inland bogs contain tussock-forming sedges and sedge-moss communities. Willow thickets form along rivers and on better-drained slopes, and alders and stunted spruce and birch grow along the major streams.

The Bering Sea somewhat moderates the moist polar climate, though sea ice in winter allows cold Siberian winds into this ecoregion. Average annual precipitation is 15 to 22 inches (38 to 56 centimeters), and the average annual temperature varies from 25 to 31 °F (–4 to –1 °C).

Wildlife and Fish:

The combination of lakes, streams, tidal flats, wet tundra, and sedge flats supports abundant populations of waterfowl and shorebirds; more than 20 species of waterfowl and 10 species of shorebirds breed here. The Yukon-Kuskokwim Delta supports 50% of the world's Black Brant, the majority of the world's Emperor Swans, all of North America's nesting Cackling Canada Geese, and the highest densities of nesting Tundra Swans. Long-tailed Duck, Scaup, Common Eider, Spectacles Eider, Northern Pintail, Green-winged Teal, and Northern Shoveler can also be found here. Hundreds of thousands of shorebirds use the coastal littoral and wetland areas during spring and fall migration. Breeding shorebirds include Bristle-thighed Curlew; Black-bellied Plover; Bar-tailed Godwit; Ruddy and Black Turnstone; Red-necked Phalarope; Long-billed Dowitcher; Red Knot, Semipalmated, and Western Sandpiper; and Dunlin.

The coastal portions of the ecoregion provide feeding grounds for beluga and minke whales; Pacific walruses; and bearded, spotted, ribbon and ringed seals. Large runs of anadromous fishes, including Arctic lamprey, Dolly Varden, humpback and broad whitefish, Bering cisco, and five species of Pacific salmon, migrate up the Yukon and Kuskokwim Rivers annually. Northern pike, Arctic grayling, whitefish and rainbow trout are resident in many streams. Blackfish, sticklebacks and whitefish are abundant in low-lying watersheds. Sheefish, Bering cisco and broad whitefish are important for subsistence. Terrestrial mammals include river otters, brown bears, moose, and wolves.

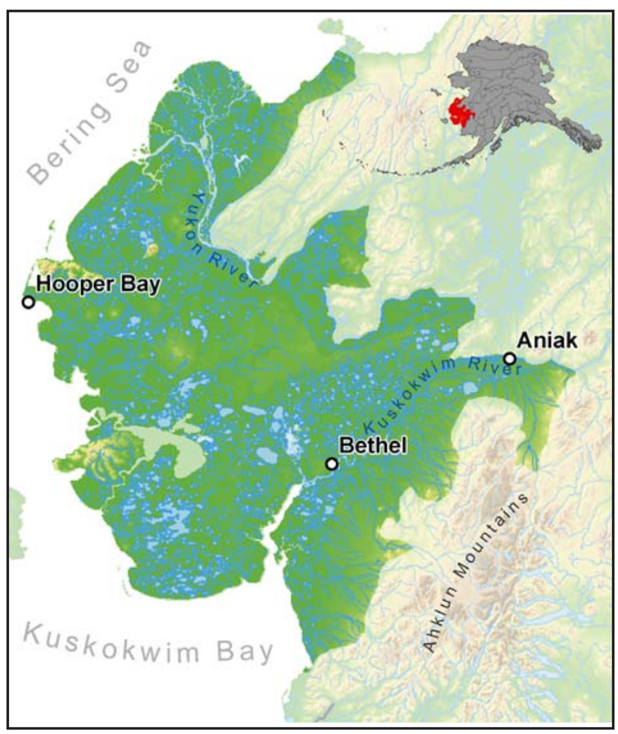


Figure 6. Yukon-Kuskokwim Delta ecoregion

People:

This ecoregion is the heart of the area inhabited traditionally by the Yup'ik people. Bethel is the largest community.

Land Use:

This ecoregion is almost entirely intact, with minimal development around several small communities along the rivers and coast. A commercial salmon fishery employs some people, and subsistence fishing and hunting is prevalent.

Land Management:

The federal government manages 74% of the land in this ecoregion, almost entirely as the Yukon Delta National Wildlife Refuge. Private landowners are the other major landowner, with Native corporations holding most of that land.

Table 5. Yukon-Kuskokwim Delta land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	<1.0%
Federal	USFWS	73.7%
Local	Local	<1.0%
Private		24.1%
State	DNR	1.9%

Ahklun Mountains

Area: 9,565,938 acres (3,871,282 hectares)

Landscape:

Located in the southwest part of the state, the Ahklun and Kilbuck Mountains define the divide between the drainages into Kuskokwim and Bristol Bays. These mountains are steep and sharp, with elevations reaching 4,950 feet (1,500 meters). Past glaciers carved broad U-shaped valleys, and a few small glaciers still persist. Great northeast-trending faults have cut through the underlying sedimentary and volcanic rock, and large "finger" lakes fill valleys on the south side of the mountains. Permafrost is generally absent from soils covered by forests, but exists in most low-lying areas and in high mountains.

Figure 7. Ahklun Mountains ecoregion

The Bering Sea influences the continental climate of this ecoregion by moderating temperatures in the summer and allowing access for cold Siberian air across the ice pack in the winter. Annual average precipitation ranges from 102 centimeters in lowlands to 203 centimeters at higher elevations, with average annual temperatures from 33 to 39 °F (–2 to 1 °C).

The Ahklun Mountains separate two extensive wetland complexes (Yukon-Kuskokwim Delta to the north and Bristol Bay Lowlands to the south) along the southern Bering Sea, and wetlands of sedge-tussock tundra occupy up to 55% of the ecoregion. Vegetation in the higher elevations is largely dominated by lichen tundra and dwarf scrub communities with ericaceous shrubs. The proportion and size of the willow, birch, and alder shrubs increases at lower elevations. In valleys, shrublands and wetlands are mixed with forests of white spruce, balsam poplar, or mixed white spruce and paper birch.

Wildlife and Fish:

The large lakes and rivers have rainbow trout, grayling, lake trout, Arctic char, Dolly Varden, whitefish, and northern pike. Five species of Pacific salmon spawn in the river systems, with abundant runs of sockeye salmon to headwater lakes. Beavers are found in the lakes and wetlands, and Wood Frogs inhabit diverse habitats.

The different habitats at varying elevations support a wide range of terrestrial species. Moose and arctic hares thrive in the shrubby habitats. Caribou and brown bear can be found throughout the ecoregion, but black bear populations are limited to the northern and eastern parts. Common small game and furbearers include muskrat, river otter, fox, wolverine, mink, and porcupine. Ground squirrels and marmots are abundant in alpine tundra. Birds nesting in the area include a wide variety of waterfowl, gulls, Bald Eagles, Golden Eagles, Arctic Terns, various loons, Spotted and Least Sandpipers, Semipalmated Plovers, Willow Ptarmigan, Spruce Grouse, Rusty Blackbirds, and Blackpoll Warblers.

Cape Newenham on the Togiak National Wildlife Refuge
M. Smith, USFWS

The coastline and islands of this ecoregion provide important habitat for marine mammals and seabirds. Common Murre, Pigeon Guillemot, and Black-legged Kittiwake colonize here. The Walrus Islands group gets it name from the large number of bachelor walruses that haul out on its beaches each summer. The largest concentration occurs on Round Island, where Steller sea lions also haul out. Harbor seals are also found here. This area is unique as the only region where ranges of the closely related harbor seal and spotted seal overlap. These marine waters support the largest Pacific herring stock in Alaska, as well as larval and juvenile red king crab. Gray, beluga, killer, and minke whales feed along the coast.

People:

Yup'ik groups from Bristol Bay and the Yukon-Kuskokwim Delta live here. Salmon, freshwater fish, seals, beluga whales, caribou, migratory waterfowl, eggs and plants are traditional foods derived from this ecoregion. Most of the population lives in Togiak on Togiak Bay.

Land Use:

This ecoregion is almost entirely intact, with minimal development around several small communities along the rivers and coast. Sockeye salmon are the most important fish commercially. Whitefish are an important subsistence species in the Tikchik Lakes.

Land Management:

A majority (58.4%) of the land in the Ahklun Mountain ecoregion is owned by the federal government. The USFWS manages most of the federal lands as Togiak National Wildlife Refuge. The State of Alaska owns a third of the ecoregion. The Ahklun Mountain ecoregion contains most of the largest state park in the nation, Wood-Tikchik State Park, and the entire Walrus Islands State Game Sanctuary is here. No borough has been organized in this ecoregion.

Table 6. Akhlun Mountains land status

Owner	**Agency**	**Percent of Ecoregion**
Federal	BLM	6.9%
Federal	USFWS	51.5%
Private		8.4%
State	DNR	33.2%

Bristol Bay Lowlands

Area: 7,903,937 acres (3,198,679 hectares)

Landscape:

Past glaciation in the surrounding Ahklun Mountains and Aleutian Range resulted in this flat-to-rolling moraine and outwash-mantled lowland around Bristol Bay in Southwest Alaska, with elevation ranging from sea level to 500 feet (150 meters). These lowlands contain numerous morainal and thaw lakes and ponds. Streams originate mostly from headwater lakes in ice-carved basins and empty into large meandering rivers, which terminate in broad estuarine areas around Bristol Bay. Much of the shoreline of Bristol Bay is characterized by mixed sand and gravel beaches and exposed tidal mudflats.

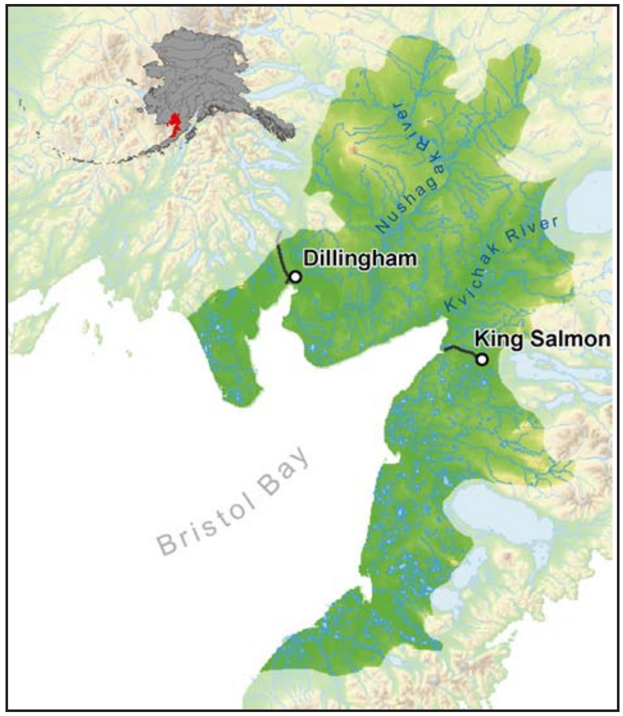


Figure 8. Bristol Bay Lowlands ecoregion

Due to wet organic soils throughout the ecoregion, moist and wet tundra dominates the landscape. Low and dwarf shrub communities of willow, birch, and alder and mosses and tussock-forming sedges characterize these wetlands. Spruce and birch forests occur along major rivers and streams. Sand dunes are present along bluffs on the coast and riverbanks.

The climate is transitional between maritime and continental. Average winter lows range from 5 to 14 °F (–15 to –10 °C), while average winter highs hover around freezing. Average summer lows are just above freezing, while average summer highs are 64 °F (18 °C). Precipitation ranges from 13 to 32 inches (33–81 centimeters). Ice occasionally spans the Bering Sea in winter, allowing cold Siberian air to flow into this ecoregion. Discontinuous permafrost is present.

Wildlife and Fish:

The many lakes, ponds, rivers, and wetlands in the Bristol Bay Lowlands make it an important staging, migration, and nesting area for waterfowl and shorebirds. Nushagak and Egegik Bays host large concentrations of shorebirds annually, including Dunlin, Black-bellied Plover, Marbled Godwit, Bar-tailed Godwit, Rock Sandpiper, Western Sandpiper, and Least Sandpiper. The endemic Beringian Marbled Godwit breeds only in the wetlands along the north side of the Alaska Peninsula. The Bristol Bay Lowlands may host up to 25% of the North American population of Greater Scaup and roughly 10% of the breeding population of Red-throated Loons, as well as breeding Black Scoters and Long-tailed Ducks. Eiders molt in shoals near the mouth of the bay.


Marbled Godwit at shoreline G. Thomson, USFWS

Five species of Pacific salmon are present in the waters of the ecoregion, as are other anadromous species, such as steelhead, rainbow smelt and Dolly Varden. The Kvichak River may be one of the most productive sockeye systems in the world, and the Nushagak River supports the third largest king salmon run in the world. These large salmon runs feed large populations of brown bears, eagles, and osprey. Rainbow trout, Arctic grayling, whitefish, and northern pike are resident in the area's lakes and streams.

The lowlands also provide important habitat for moose, black bears, wolverines, wolves, lynx, martens, and foxes. The Mulchatna caribou herd migrates and calves throughout. Beaver are abundant in most streams and large lakes. Landbirds, including Blackpoll Warblers and Rusty Blackbirds, breed in the forests.

Bristol Bay supports a diverse assemblage of marine species. The Bristol Bay population of the beluga whale, a separate stock from the eastern Bering Sea stock, resides in the northeast bays in summer, following returning salmon and smelt. Minke whales feed in the bays and shallow coastal waters in the summer. Killer whales feed on several abundant marine mammal species in the coastal waters and bays throughout the summer. Gray whales travel in the nearshore waters during their spring migration north. Adult male walruses and harbor seals use haulouts around the bay. The waters of northeast Bristol Bay are known for their extensive clam beds and abundant benthic marine life, which in turn support a wealth of large predators such as walruses and migrating gray whales. Pacific herring and Pacific halibut also occur in the marine portions of the ecoregion, as do several shellfish species, such as scallops, crab, shrimp and many species of groundfish.

People:

Permanent settlements occur along coastal areas and major rivers. Dillingham is by far the largest community. The Bristol Bay Yup'ik settled the northern half of the region, while the Alutiiq settled the southern half. Coastal communities use whales, walruses, seals, salmon, sea lions, halibut, sea otters, clams, mussels and seaweed. Communities away from the coast use salmon, caribou, moose and plants.

Land Use:

Commercial fishing and processing and recreational hunting and fishing are the primary land uses in Bristol Bay and the Nushagak lowlands. This ecoregion is almost entirely intact, with minimal development around several towns and communities.

Land Management:

The state government manages more than 43% of the land, with less than 1% designated as critical habitat areas.[12] The federal government manages over 36%. The BLM and USFWS are the major federal land managers. Native corporations are among the most significant private landowners. The ecoregion falls in the jurisdictions of the Bristol Bay and Lake and Peninsula boroughs.

Table 7. Bristol Bay Lowlands land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	21.4%
Federal	NPS	1.7%
Federal	USFWS	13.5%
Local	Local	0.1%
Private		19.9%
State	DNR	43.4%

Bering Tundra

Kotzebue Sound Lowlands

Area: 3,462,948 acres (1,401,436 hectares)

Landscape:

This ecoregion consists of the coastal plains surrounding Kotzebue Sound on the Chukchi Sea in northwest Alaska. These lowlands, under 330 feet (100 meters), tend to be poorly drained, though terraces, low

[12]For information on legislatively designated state game refuges, game sanctuaries, and critical habitat areas, refer to Section IVD.

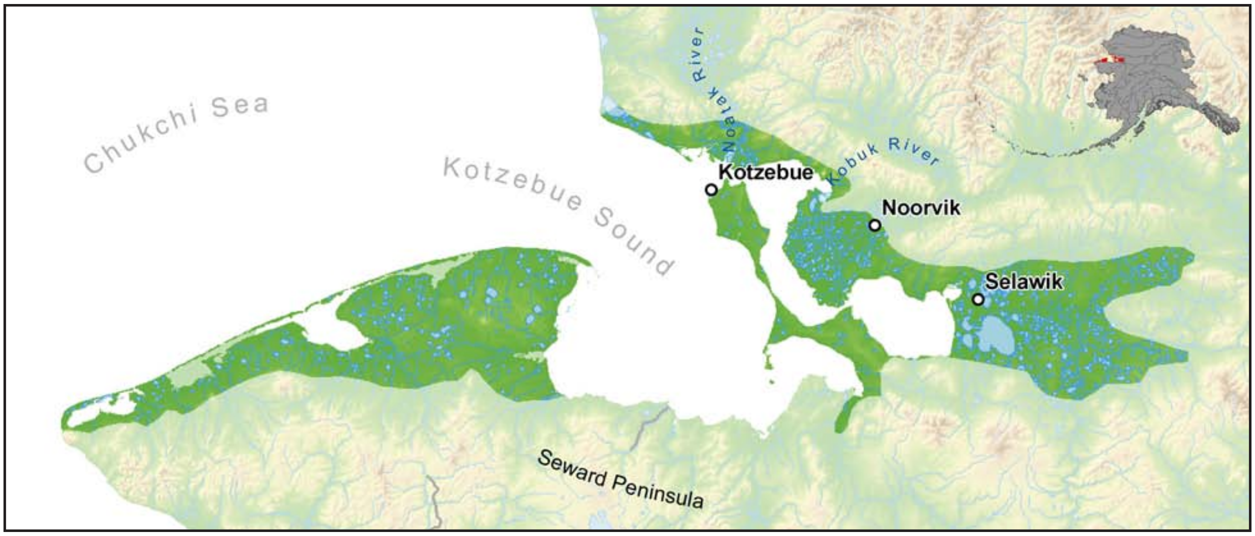


Figure 9. Kotzebue Sound Lowlands ecoregion

hills, and sand dunes do drain well. Permafrost is deep under some areas and absent from others. Ice-related features dominate the landscape, with pingos around the Selawik River and numerous thaw lakes throughout. Because most soils are wet, or standing water is present, wet tundra communities of sedge mats dominate. In the better-drained areas, such as peat ridges and on top of polygonal features, white spruce, willows, alder, and paper birch can occur. Grasses grow on the dunes along the coast. The major disturbance is flooding of rivers in the spring or during summer storms or along the coast due to tidal inundation.

A dry, polar climate produces short, cool summers and long, cold winters, though moister and warmer than in areas along the rest of the Chukchi Sea or the Arctic Ocean. Annual precipitation ranges 4 to 12 inches (18 to 30 centimeters). The average annual temperature varies from 20 to 23 °F (–7 to –5 °C).

Wildlife and Fish:

The vast amounts of water in this ecoregion make it prime habitat for nesting waterfowl and shorebirds. Spectacled Eiders, Ruddy Turnstones, and Black Turnstones are common breeders here. The Arctic Loon, which breeds only in western Alaska, is found in this ecoregion. Predators include Snowy Owls, arctic foxes, and polar bears. Kotzebue Sound is the northern limit of the range for king, sockeye, and silver salmon. The longest-lived and largest sheefish in Alaska are found in the Kobuk-Selawik river systems. Dolly Varden and chum salmon migrate past the Baldwin Peninsula en route to the Noatak and Kobuk Rivers. Hotham Inlet provides habitat for fourhorn sculpin, saffron cod and several species of whitefish. Northern pike and whitefish are abundant in the lower Kobuk and Selawik river drainages, and Arctic char are found in several lakes near Cape Espenberg.

Arctic Loon and brood W. Troyer, USFWS

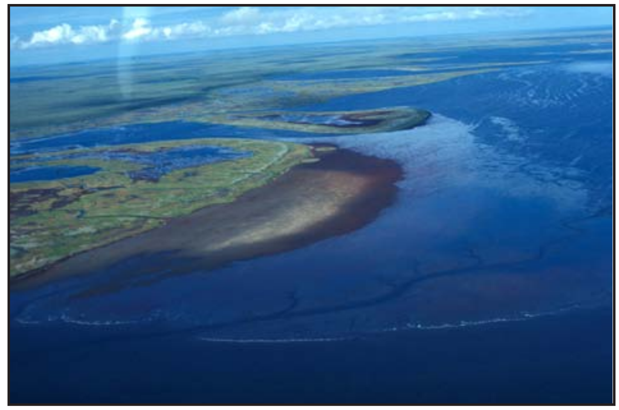
In the nearshore marine waters, bowhead, gray, minke, and beluga whales can be found. Spotted, bearded, and ringed seals are found in abundance throughout this region. The large lagoon systems provide sheltered water and abundant prey for seals of all age classes.

People:

Historically, the Inupiaq people settled this area. Kotzebue is the largest town, and small communities and seasonal camps are located along the coast and rivers.

Land Use:

Subsistence remains an integral part of the culture and economy of this ecoregion, with an emphasis on caribou, walrus, seals, beluga whales, waterfowl, and salmon. Mining exploration and prospecting continue on a limited basis. A chum salmon commercial fishery exists on the Noatak and Kobuk Rivers.



Wetlands near Cape Espenberg USFWS

Land Management:

The federal government manages 79% of this ecoregion, with the NPS and USFWS as the primary land managers. The major federal units are Bering Land Bridge National Preserve and Selawik National Wildlife Refuge. Private landowners hold 21% of the ecoregion. The Northwest Arctic Borough has jurisdiction over part of this ecoregion.

Table 8. Kotzebue Sound Lowlands land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	10.4%
Federal	NPS	37.4%
Federal	USFWS	31.1%
Local	Local	<1.0%
Private		21.0%
State	DNR	<1.0%

Seward Peninsula

Area: 11,699,545 acres (4,734,741 hectares)

Landscape:

The Seward Peninsula juts out of western Alaska, separating the Bering Sea from the Chukchi Sea. This peninsula was once part of the ice-free migration corridor between North America and Asia. Ice now spans the Bering Strait much of the year, so bitterly cold air from Siberia sweeps across this mostly treeless landscape. The terrain varies from coastal plains to convex hills with broad valleys to isolated groups of glaciated mountains reaching heights of 4,600 feet (1,400 meters). Streams occupy the larger valleys, and many small inland and coastal lakes exist.

Figure 10. Seward Peninsula ecoregion

A continuous permafrost layer of varying thickness keeps most soils wet, shallow, and organic. Ice-related features, such as pingos and patterned ground, occur across the landscape. Vegetation is principally tundra, with alpine *Dryas*-lichen tundra and barrens at high elevations and moist sedge-tussock tundra at lower elevations. This region is the transition between Arctic and sub-Arctic tundra, and diversity of tundra plants is high due to this location, the past connection to Asia, and the presence of both acidic volcanic rock and limestone. Better-drained areas support low-growing ericaceous and willow-birch shrubs, and willow, birch, and spruce-hardwood forests occur in river valleys. Wildfires are a common occurrence, spreading across the tundra in the summer after the grasses dry.

The moist polar climate is characterized by cold and windy winter conditions and summer fog along the coastline. The average annual precipitation is 10 to 20 inches (25 to 51 centimeters) in the lowlands and more than 40 inches (100 centimeters) in the mountains. The average annual temperature varies from 21 to 26 °F (–6 to –3 °C).

Solomon River S. Steinacher, ADF&G

Wildlife and Fish:

As part of the ice-free Beringia corridor linking North America and Asia in the past, this ecoregion still possesses birds more common in Eurasia than the rest of Alaska. Bluethroats and Yellow and White Wagtails are found here. The numerous lakes and ponds attract abundant waterfowl, including the rare Arctic Loon. More typical Alaskan coastal plain breeders include Spectacles Eiders and Ruddy and Black Turnstones. One of only two known breeding grounds of the Bristle-thighed Curlew occurs on the peninsula. Cliff-nesting alcids, such as Common and Thick-billed Murres and Tufted Puffins, and Black-legged Kittiwakes nest in colonies along the coastline.

Common terrestrial mammals include arctic foxes, singing voles, and tundra hares. Reindeer and muskox were both introduced. Polar bears; ribbon, spotted, bearded, and ringed seals; bowhead, gray, beluga, killer, and minke whales; harbor porpoises; and walruses are observed near the coast and on adjacent ice floes. Five Pacific salmon species occur here, with pink salmon the most numerous. Sheefish occur in the northeast corner of this ecoregion, and Arctic char reside in some of its high altitude lakes. Both of these species, as well as Bering cisco, are common. Dolly Varden and Arctic grayling are widespread throughout the area. The Alaska blackfish is a reminder of the former link to Asia.

People:

This ecoregion is the historic range of the Inupiaq people. Miners who arrived in the area in the late 1900s founded the largest town, Nome. Sixty percent of the current population lives in Nome, with the rest dispersed in small communities throughout the ecoregion.

Land Use:

Subsistence remains an integral part of the culture and economy of this ecoregion, with an emphasis on caribou, seals, beluga and bowhead whales, berries, and greens. Mining exploration and prospecting continue on a limited basis. This ecoregion is almost entirely intact, with minimal development around Nome and several small villages along the rivers and coast.

Land Management:

The federal government owns 53% of the Seward Peninsula. The BLM manages most of that land. The NPS manages its lands as Bering Land Bridge National Preserve. The state owns more than 30% of the ecoregion. Private landowners, primarily Native corporations, hold more than 16%. The Northwest Arctic Borough has jurisdiction over part of this ecoregion.

Table 9. Seward Peninsula land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	39.4%
Federal	NPS	13.2%
Federal	USFWS	<1.0%
Local	Local	<1.0%
Private		16.1%
State	DNR	30.8%

Bering Sea Islands

Area: 2,347,545 acres (950,038 hectares)

Landscape:

Five major islands—St. Lawrence, Nunivak, St. Matthew, and the two Pribilof Islands of St. George and St. Paul—and their adjacent islets dot the inner shelf of the Bering Sea and constitute the Bering Sea Islands ecoregion. The largest island, St. Lawrence, is 1,278,000 acres, and the smallest, St. George, is just 22,150 acres. The relatively shallow marine waters surrounding these islands host a high concentration of benthic invertebrates.

The climate is a mix of polar and maritime, with the season determining which one predominates. Sea ice forms on the inner shelf of the Bering Sea, and dry polar air from Siberia travels across the ice pack to these islands. After the ice breaks up in the spring, cool, moist maritime conditions are typical through the summer. Soils are thin and rocky and underlain by thin to moderately thick permafrost.

The intercontinental access available during past glaciation and annual ice pack has contributed to vegetation with North American and Asian affinities. These rocky volcanic islands are treeless and characterized by moist tundra meadows of sedges, grasses, low shrubs, and lichens. The shorelines are a mix of rocky sea cliffs and sand dunes.

Red-legged Kitttiwake colony USFWS

Wildlife and Fish:

These islands possess globally important populations of seabirds, waterfowl, and marine mammals. The Pribilof Islands provide habitat for approximately 3 million seabirds, including nearly the entire world population of Red-legged Kittiwakes. Other large breeding colonies exist on the islands for the Black-legged Kittiwake, Parakeet Auklet, Crested Auklet, Least Auklet, Northern Fulmar, Red-faced Cormorant, Pigeon Guillemot, Leach's and Fork-tailed Storm-petrels, and Common and Thick-billed Murres. In the winter, an ice-free area south of St. Lawrence Island hosts the entire population of Spectacles Eiders. King and Common Eiders and Long-tailed Duck feed along the southern coast of that island in the summer and winter along the edge of the ice pack. The Pribilof Rock Sandpiper only breeds on Bering Sea islands. McKay's Bunting, the only passerine endemic to Alaska, breeds only on St. Matthew and Hall Islands.

The Bering Sea shelf supports king, Tanner, and hair crabs. One of the richest pockets of invertebrate life in the Bering Sea is found near St. Lawrence Island, where extremely productive benthic communities, including bivalve mollusks and amphipods, support marine mammals and waterfowl. A diverse mix of marine fish, including pollock, halibut, salmon, and forage fish, such as herring, Pacific sandlance, capelin, and lanternfish (Myctophids), also contribute to the abundance of birds and mammals. Breeding and wintering walruses inhabit the open ocean near St. Lawrence Island. Bowhead whales winter in the region near St. Lawrence Island. The ice-associated seals—ringed, bearded, spotted, and ribbon—can be found at the northern islands. The Pribilof Islands provide critical breeding grounds for Steller sea lions and approximately 80% of the world's northern fur seals. An important gray whale feeding area is located just north of St. Lawrence Island in the Chirikov Basin. Blue, bowhead, minke, beluga, killer, sei, northern right, humpback, and gray whales swim through the waters of the Bering Sea shelf. Dolly Varden, chum, coho and pink salmon spawn on St. Lawrence and Nunivak Islands. Resident populations of Arctic grayling, whitefish, and northern pike live in the area's lakes and streams.

Figure 11. Bering Sea Islands ecoregion

Few terrestrial mammals naturally occur on the islands; reindeer and muskoxen have been introduced. The Pribilof Island (St. Paul) and St. Lawrence Island shrews are endemic and limited in range to those islands. Declines in population levels of seabirds, some fish and shellfish, and marine mammals are likely a result of trophic changes in the Bering Sea ecosystem due to commercial harvest of fish and whales over the last 40 years, as well as climate change.

People:

Alaskan and Siberian Yupik people settled the larger islands closer to the Alaska mainland. Most of the population of this ecoregion lives in one of the four communities on St. Lawrence Island and the Pribilof Islands.

Land Use:

Commercial fishing and subsistence fishing and hunting are the main uses of natural resources in this ecoregion. These islands remain largely undeveloped except for small villages; however, pollution from the U.S. Department of Defense remains on St. Lawrence Island.

Land Management:

Private ownership of the land in this ecoregion makes up a larger percentage (56.8%) than for any other ecoregion because one Native corporation owns most of St. Lawrence Island. The USFWS is the other major landowner, with most of Nunivak Island and parts of St. Paul and St. George managed as national wildlife refuges (Yukon Delta and Alaska Maritime National Wildlife Refuges).

Table 10. Bering Sea Islands land status

Owner	**Agency**	**Percent of Ecoregion**
Federal	BLM	<1.0%
Federal	USFWS	43.2%
Private		56.8%

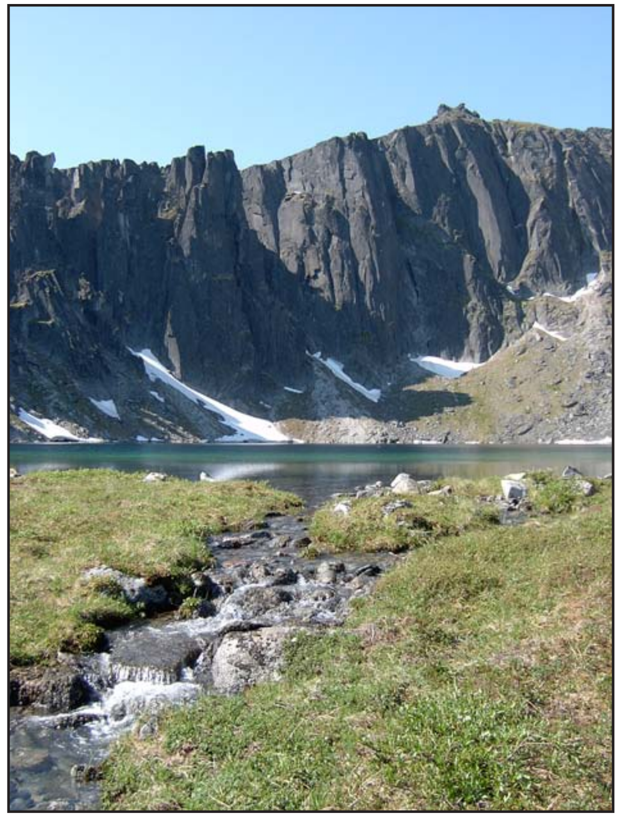
Intermontane Boreal

Kuskokwim Mountains

Area: 21,092,700 acres (8,536,099 hectares)

Landscape:

The Kuskokwim Mountains are rolling mountains with elevations generally below 4,000 feet (1,210 meters). Swift streams and rivers meander through the deep narrow valleys, following fault lines and highly eroded bedrock seams of the southwest-northeast trending ridges. Meandering streams and rivers have resulted in oxbow lakes in the valleys. Thaw lakes occur in the valleys and cirque lakes occur in the mountains.



Sunshine Mountains J. Whitman, ADF&G

Permafrost is almost continuous under this ecoregion, but varies in thickness from thin to moderate. Most lowlands and high mountains are underlain by permafrost, but forested lands or those covered by grasses and alders do not have permafrost beneath. The continental climate is relatively dry, with average annual precipitation of 12 to 22 inches (30 to 56 centimeters). Influence from the Bering Sea can bring more moisture to the southwest portion of the ecoregion in the summer. The average annual temperature ranges from 22 to 29 °F (–6 to –2 °C).

Boreal forests characterize the Kuskokwim Mountains. The lowlands contain black spruce and tamarack, while stands of white spruce, white birch, and trembling aspen occur on the slopes and uplands. Areas affected by recent forest fires have tall willow, birch, and alder shrubs. Smaller willow and alder shrubs can also occur in alpine areas, along with sedges and tundra.

Wildlife and Fish:

The boreal forest supports a large variety of birds and terrestrial mammals. Sharp-shinned Hawks, Golden Eagles, Horned Larks, Surfbirds, and White-tailed Ptarmigan inhabit the alpine areas. Landbirds using this ecoregion include Olive-sided Flycatchers, Blackpoll Warblers, Boreal Owls, Great Gray Owls, and Rusty Blackbirds.

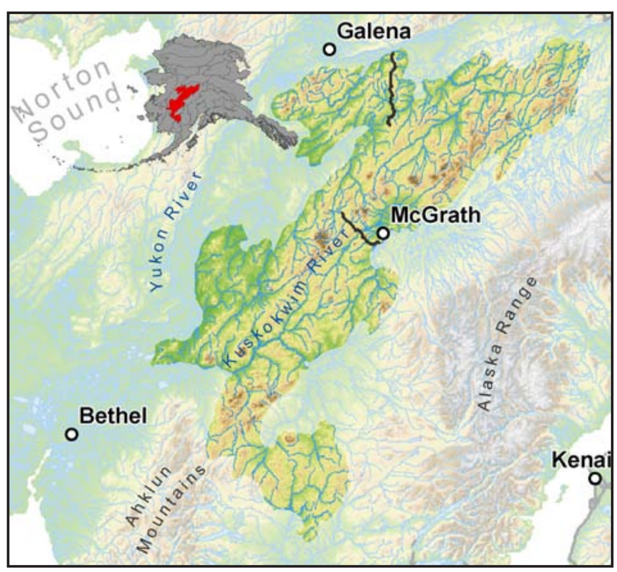


Figure 12. Kuskokwim Mountains

Furbearers include marten, mink, short-tailed and least weasels, and Canada lynx. Brown bear densities are low to moderate, while moose and beaver are abundant. Several small caribou herds live in this ecoregion, and northern bog lemmings can be found here. Five species of salmon migrate up the Kuskokwim River to spawn in tributary streams. The deep lakes provide habitat for lake trout. Sheefish, whitefish, Dolly Varden, northern pike and Arctic grayling are common freshwater residents.

People:
The Native people of this ecoregion are Koyukon and Holikachuk Athabascans. McGrath is the largest community.

Land Use:
This ecoregion is almost entirely intact, with minimal development around several small villages. Subsistence and recreational hunting and fishing occur throughout the ecoregion. The mining industry still has a presence.

Land Management:
Governments manage most of the land in this ecoregion, with the federal government holding more than a third and the state owning over 55%. The primary federal managers are the BLM and USFWS. The BLM has designated several Areas of Critical Environmental Concern, and portions of several national wildlife refuges occur in the ecoregion.

Table 11. Kuskowkim Mountains land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	32.1%
Federal	NPS	<1.0%
Federal	DOD	<1.0%
Federal	USFWS	6.1%
Local	Local	<1.0%
Private		6.2%
State	DNR	55.5%

Yukon River Lowlands

Area: 12,782,700 acres (5,173,088 hectares)

Landscape:
The Yukon River Lowlands encompass the lower stretches of the Yukon and Koyukuk Rivers in west-central Alaska. Glacial sediments were deposited along these rivers during the last glacial retreat, contributing to the formation of nearly flat bottomlands between the Kuskokwim Mountains and the Nulato Hills.

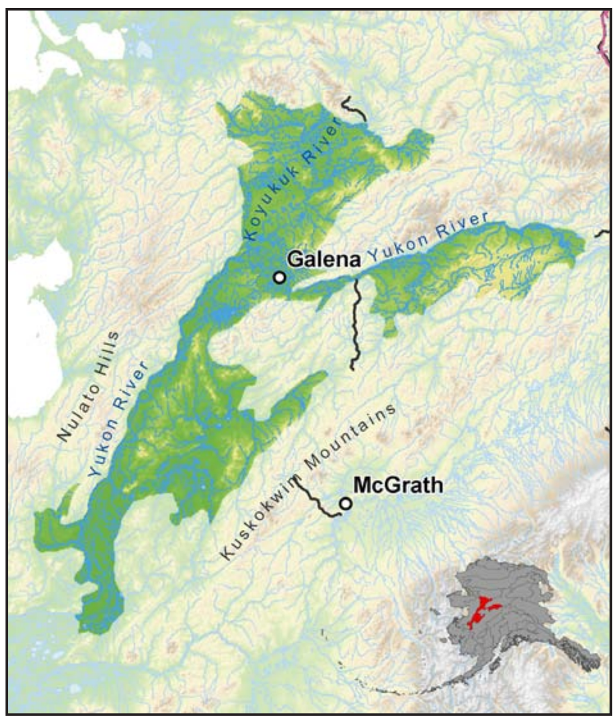


Figure 13. Yukon River Lowlands ecoregion

Permafrost under this ecoregion is thin and discontinuous and continuing to retreat due to long-term climate warming. This thawing results in thaw lakes and collapse-scar bogs. Remaining patches of permafrost, combined with poor soil drainage, the gentle topography, and moist summers, contributes to the prevalence of wet organic soils. A mosaic of black spruce stands, birch-ericaceous shrubs, and sedge-tussock bogs occurs in these conditions. Many of these flat organic areas contain a dense concentration of lakes and ponds.

Along the major rivers, highly productive stands of white spruce and balsam poplar prevail. Where the meandering streams have left oxbows or cut-off sloughs, wet sedge meadows and aquatic vegetation occur. Tall alders and willows dominate active floodplains and river bars. Seasonal changes in water levels affect these lowlands, with water levels dropping in the fall during freeze-up and then flooding during spring breakup due to ice jams.

Wetlands, Innoko National Wildlife Refuge USFWS

Wildlife and Fish:

The wet habitats of these lowlands support many birds, mammals, and fish. Common Loons, Horned and Red-necked Grebes, Trumpeter Swans, and Common Goldeneyes breed near the lakes and wetlands. The forests along the river valleys attract Ruffed Grouse, Belted Kingfishers, Alder Flycatchers, and Hammond's Flycatchers. Landbirds inhabiting this ecoregion include Olive-sided Flycatchers, Blackpoll Warblers, Boreal Owls, Great Gray Owls, and Rusty Blackbirds.

This ecoregion also provides prime habitat for mink, marten, muskrat, moose, and river otter. Smaller mammals include red squirrels, northern bog lemmings, yellow-cheeked voles, and the recently discovered tiny shrew. Several caribou herds range throughout the broad expanse of these lowlands, as do populations of black bear.

The rivers and streams commonly contain coho, chum, and king salmon. Northern pike and whitefish are common in lowland drainages, and Arctic lamprey migrate up the Yukon River in vast numbers in the fall.

People:

Koyukon and Holikachuk Athabascans are the traditional inhabitants of this ecoregion. The largest communities are Galena, Nulato, and Tanana.

Land Use:

The Yukon River provides transportation of people and supplies through the ecoregion to locations in eastern and northern Alaska. This ecoregion is almost entirely intact, with minimal development around small villages. Subsistence and recreational hunting and fishing occur throughout the ecoregion.

Land Management:

The largest landowner is the federal government, with the USFWS responsible for the majority. The ecoregion contains all or part of four national wildlife refuges—Koyukok, Innoko, Nowitna, and Yukon Delta. The BLM has designated the Arms Lake Research Natural Area and Dulbi-Kaiyuh Area of Critical Environmental Concern here. Native corporations own most of the privately held land.

Table 12. Yukon River Lowlands land status

Owner	**Agency**	**Percent of Ecoregion**
Federal	BLM	10.2%
Federal	USFWS	63.1%
Private		18.4%
State	DNR	8.3%

Kobuk Ridges and Valleys

Area: 13,624,124 acres (5,513,607 hectares)

Landscape:

The ecoregion consists of several large rivers (Kobuk, Noatak, Huslia, and Selawik), their broad valleys, and numerous small mountain ranges south of the Brooks Range. Past ice sheets from glaciers in the Brooks Range carved out immense U-shaped valleys. The mountain ranges vary from the the low, rounded Selawik Hills, which top out at 3,300 feet (1,000 meters), to the steeper, taller Baird and Schwatka Mountains, with a maximum elevation of 8,570 feet (2,600 meters).

The valleys conduct cold air from the Brooks Range during the winter, which deepens the cold of the winters. The dry, continental climate is characterized by long, cold winters and short, cool summers.

Permafrost is almost continuous under this ecoregion, but varies in thickness from thin to moderate. The presence of permafrost and floodplains contributes to poorly drained soils and wet conditions along the rivers. These areas are dominated by black spruce in bogs. Better-drained places along the rivers support white spruce and balsam poplar. White spruce, paper birch, and trembling aspen grow on uplands. Toward the western part of this ecoregion, trees become smaller and occur in stands that are less dense and restricted to lower elevations.

Throughout the ecoregion, mountain peaks are either barren or have alpine tundra. Tall willow, birch, and alder communities can also be found in this ecoregion. Relatively warm and dry summers and frequent lightning storms during that season combine to make forest fires a common disturbance in these mountains.

Wildlife and Fish:

The rivers and lakes in this ecoregion support freshwater and anadromous fish species and represent the northernmost range of king, sockeye, and silver salmon. Chum salmon runs are strong in the Kobuk and Noatak Rivers. The longest-lived and largest sheefish in Alaska are found in the Kobuk-Selawik river systems. Large runs of least cisco and broad and humpback whitefish ascend the Noatak and Kobuk Rivers to spawn. Dolly Varden spawn and overwinter in both rivers. Northern pike and whitefish are common residents in lowland drainages.

The boreal forest supports a large variety of birds and terrestrial mammals. The mixed forests are inhabited by breeding landbirds, such as Gray Jays, Boreal Chickadees, Boreal Owls, and Great Gray Owls.

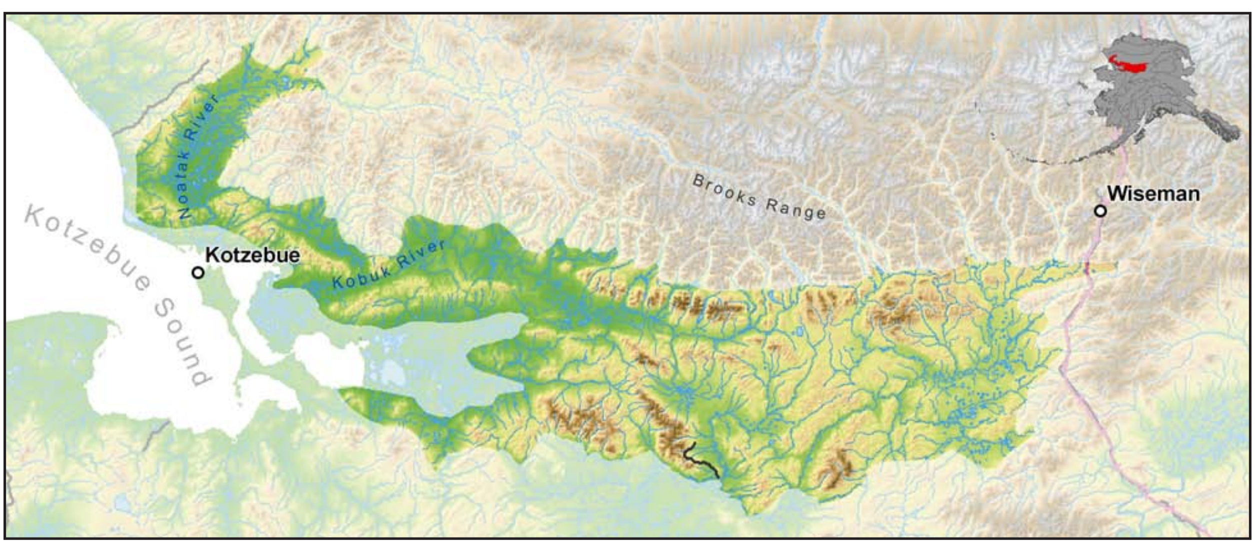


Figure 14. Kobuk Ridges and Valleys ecoregion

Furbearers include marten, mink, short-tailed and least weasels, and Canada lynx. This ecoregion represents the northern extent of American beaver and muskrat in Alaska. Arctic ground squirrels inhabit the high mountainous areas. The Western Arctic caribou herd winters in the southern portion of this ecoregion and migrates through the ecoregion to reach calving and summering grounds to the north. Top-level predators include brown bears, wolverines, and gray wolves.

Kobuk River John Hyde, ADF&G

People:

The Inupiaq people are the principal Native Alaskan inhabitants of this ecoregion, but the Koyukon Athabascans have used the resources at the eastern end. Kiana, Noatak, and Ambler are the largest communities.

Land Use:

This ecoregion is almost entirely intact, with minimal development around several small villages. Subsistence remains an integral part of the culture and economy, with an emphasis on terrestrial mammals, especially caribou and moose, and salmon. Mining exploration and prospecting continue on a limited basis.

Land Management:

The federal government manages 71% of this ecoregion, with the BLM, USFWS, and NPS as the major managers. The BLM has designated several Research Natural Areas[13] and Areas of Critical Environmental Concern. The ecoregion contains portions of several national parks and wildlife refuges. The most significant in size are Selawik and Kanuti National Wildlife Refuges and Noatak and Kobuk Valley National Parks and Preserves. The Northwest Arctic Borough has jurisdiction over part of this ecoregion.

Table 13. Kobuk Ridges and Valleys land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	31.7%
Federal	NPS	17.5%
Federal	DOD	<1.0%
Federal	USFWS	22.4%
Local	Local	<1.0%
Private		12.9%
State	DNR	15.5%

[13]An area that has received a special designation because of its importance for educational and/or research purposes.

Ray Mountains

Area: 12,662,345 acres (5,124,381 hectares)

Landscape:

The Ray Mountains lie south of the Brooks Range and are bounded by the Yukon River valley on the south and east. These mountains are composed of metamorphic rock that has formed into east-west trending ranges. Few lakes occur in these mountains, but meandering streams originate in numerous small ponds. Because few glaciers existed in this ecoregion during the Pleistocene ice age and none remain today, streams and rivers run clear. A discontinuous permafrost layer varies from thin to moderate thickness.

Figure 15. Ray Mountains ecoregion

Black spruce forests dominate these mountains, with black spruce bogs occurring in lowlands near the Yukon River. Stands of white spruce, birch, and aspen occur on warm, south-facing slopes with good drainage and along floodplains with alders and willows. Shrub birch and *Dryas*-lichen tundra characterize the alpine areas. The relatively warm summers of the continental climate contribute to some forest fires, though summers are relatively moist. Winters are cold and dry.

Wildlife and Fish:

Several small caribou herds inhabit these mountains. Lynx and marten are typical in the boreal forest, and moose, brown bears, wolves, and red fox are also found here. Landbirds found in this ecoregion include Olive-sided Flycatchers, Blackpoll Warblers, Boreal Owls, Great Gray Owls, and Rusty Blackbirds. The mountain streams provide important habitat for Arctic grayling and also support Dolly Varden and king, chum, and coho salmon.

People:

This ecoregion has a few communities, mainly populated by Koyukon Athabascans; Manley Hot Springs and Rampart are the largest.

Land Use:

Subsistence and recreational hunting and fishing occur here. The transportation corridor for the trans-Alaska pipeline also passes through this ecoregion. This ecoregion is almost entirely intact, with a small amount of development around communities and along the Dalton and Elliott Highways.

Bog and scattered spruce USFWS

Land Management:

The state owns almost 32% of the ecoregion, with a small portion managed as Tanana Valley State Forest. The BLM manages 43% and has designated several Areas of Critical Environmental Concern. Most of the land managed by the USFWS is within Yukon Flats National Wildlife Refuge.

Table 14. Ray Mountains land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	43.0%
Federal	USFWS	17.5%
Local	Local	<1.0%
Private		7.8%
State	DNR	31.7%

Tanana-Kuskokwim Lowlands

Area: 15,818,518 acres (6,401,667 hectares)

Landscape:

The Tanana-Kuskokwim Lowlands ecoregion forms an arch north of the Alaska Range and Lime Hills. This alluvial plain slopes down to the north, with numerous rivers radiating from the mountains and eventually draining into the Tanana or Kuskokwim Rivers. These meandering rivers with side sloughs are the dominant landscape feature in this ecoregion. Oxbow lakes exist where river routes have changed. Glacial moraines and morainal lakes across the lowlands are evidence of past glaciation.

Tetlin National Wildlife Refuge USFWS

Permafrost under this ecoregion is thin and discontinuous and continuing to retreat due to long-term climate warming. This thawing results in thaw lakes, collapse-scar bogs, and fens. Remaining patches of permafrost, combined with poor soil drainage and the gentle topography, contribute to high surface moisture despite the rain shadow cast by the Alaska Range. In addition, ground water-charged seeps and springs commonly occur in gravel deposits.

The general wetness of the ecoregion offers prime conditions for the boreal forest. Black spruce occurs in bogs, and white spruce and balsam poplar are found along rivers. Birch-ericaceous shrubs and sedge tussocks occur on cold, wet flatlands underlain by permafrost. Tall shrub communities of willow, birch, and alder can be found throughout the ecoregion. Warmer, south-facing slopes have stands of white spruce, white birch, and trembling aspen.

The climate is classified as dry continental. Average annual temperatures vary from 22 to 30 °F (–6 to –1 °C). Average annual precipitation ranges from 10 to 24 inches (25 to 62 centimeters). Warm, dry summers with lightning storms frequently produce wildfires. Spring flooding is also common.

Wildlife and Fish:

The wet habitats of these lowlands support many birds, mammals, and fish. Common Loons, Horned and Red-necked Grebes, Trumpeter Swans, and Common Goldeneyes breed near the lakes and wetlands. The forests along the river valleys attract Ruffed Grouse, Belted Kingfishers, Alder Flycatchers, and Hammond’s Flycatchers. Landbirds in this ecoregion include Olive-sided Flycatchers, Blackpoll Warblers, Boreal Owls, Great Gray Owls, and Rusty Blackbirds.

This ecoregion also provides prime habitat for mink, marten, muskrat, moose, and river otter. Smaller mammals include red squirrels, northern bog lemmings, and yellow-cheeked voles. Several caribou herds range throughout these lowlands, as do populations of black bear. The rivers and streams commonly contain pike, sheefish, whitefish, and chum and king salmon.

People:

These bottomlands have attracted people for centuries for the food sources and transportation routes provided by the rivers. Native people are mainly Koyukon, Tanana, and Kuskokwim Athabascans. The western half of the ecoregion contains many villages that depend on the river, winter trails, and aviation for transportation. The eastern half contains the Alaska Highway, and thus, has a greater population. Fairbanks is the largest town, and North Pole, Tok, and Delta Junction are important communities along the Alaska Highway.

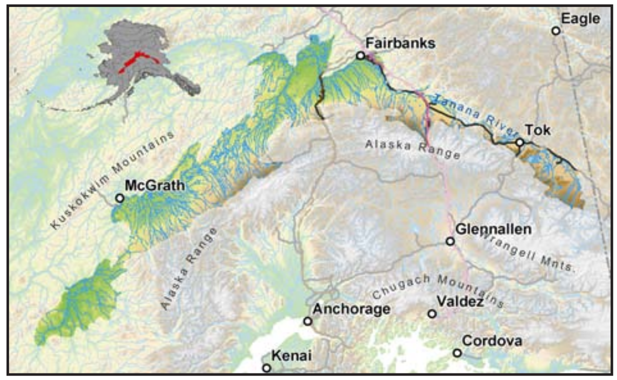


Figure 16. Tanana-Kuskokwim Lowlands ecoregion

Land use:

The greater population in the east has a more diversified economy than the west. Use of the land includes transportation of people and oil, timber production, and limited agriculture. Subsistence and recreational hunting and fishing occur throughout the ecoregion. Tourism also plays a large role and is based mainly on the landscape and wildlife values of the greater region.

Land Management:

The State of Alaska owns 45% of this ecoregion and manages a small portion of it as game refuges and state forest. The federal government owns 40%, with the main managers being the BLM, Department of Defense, and NPS. This ecoregion contains part of Denali National Park. Private landowners hold 15% of the land. The Fairbanks North Star and Denali boroughs have jurisdiction over parts of this ecoregion.

Table 15. Tanana-Kuskokwim Lowlands land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	15.7%
Federal	NPS	13.9%
Federal	DOD	7.2%
Federal	USFWS	3.2%
Local	Local	<1.0%
Private		15.1%
State	DNR	44.6%

Yukon-Tanana Uplands

Area: 25,331,894 acres (10,251,677 hectares)

Alaska 62.2%, Canada 37.8%

Landscape:

The Yukon-Tanana Uplands are rounded mountains and hills located between the Yukon and Tanana Rivers and spanning the Alaska-Yukon Territory border. The underlying geology results in exposed bedrock and coarse rubble on ridges and colluvium on lower slopes. Rivers cut deep, narrow V-shaped valleys into the uplands. Elevations range from 1,650 feet (500 meters) in the valleys to more than 4,950 feet (1,500 meters) on the peaks. Small lakes occur primarily in valleys where drainage has been blocked. Discontinuous permafrost lies beneath north-facing slopes and valley bottoms, so the terrain can be hummocky in these areas. In the valley bottoms, the permafrost is thin, ice-rich, and near its melting point.

Black spruce favors north-facing slopes underlain with permafrost; spruce also occurs with sedge tussocks and scrub bogs in valley bottoms. White spruce, birch, and aspen dominate south-facing slopes.

White spruce, balsam poplar, alder, and willows occur in floodplains on better-drained sites. Low birch-ericaceous shrubs and *Dryas*-lichen tundra are the primary vegetation above tree line, and some peaks are barren.

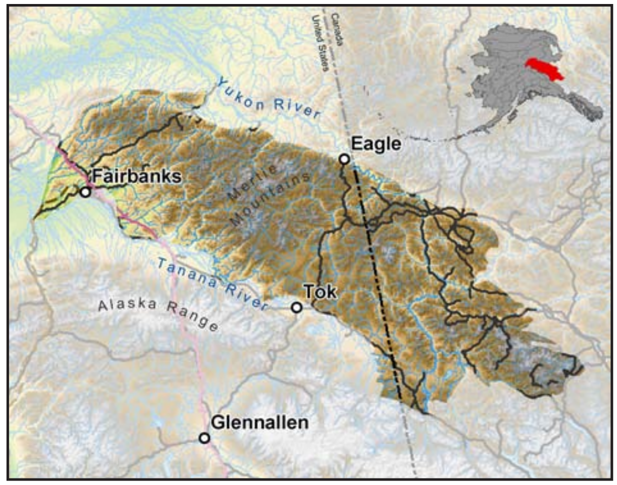


Figure 17. Yukon-Tanana Uplands ecoregion

The continental climate features long, very cold winters and dry, warm summers. Summer lightning storms are frequent; the region has the highest incidence of lightning strikes in Alaska and the Yukon Territory, so forest fires are very common. In the lower elevations, mean annual precipitation is about 13 inches (32.5 centimeters), but precipitation increases from east to west and with increasing elevation. Mean January temperatures can drop to –22 °F (–30 °C), and mean July temperatures are near 61 °F (16 °C). Mean annual temperature is 23 °F (–5 °C).

Wildlife and Fish:

The open, mixed deciduous-conifer forests support a large variety of birds, including Smith's Longspurs, Gray Jays, Boreal Chickadees, Northern Flickers, Red-tailed Hawks, and Boreal Owls. Peregrine Falcons favor cliffs in the area. Dall sheep, hoary marmots, and arctic ground squirrels inhabit the high mountainous areas. Top-level predators include black and brown bears, wolverines, and gray wolves, and smaller predators are marten, mink, short-tailed and least weasels, and Canada lynx. Small mammals include long-tailed and yellow-cheeked voles and northern flying squirrels. Caribou and moose are also found in this ecoregion.

Northern Flicker USFWS

The clear headwater streams in this ecoregion are important spawning areas for chinook, chum, and coho salmon. Northern pike, whitefish, and burbot are common in the larger lakes and rivers, and Arctic grayling tend to be found in smaller streams.

People:

Athabascans, including Tanacross, Tanana, and Han groups, have inhabited this ecoregion for centuries. The largest Alaska communities in this ecoregion are Fox, Ester, and Eagle.

Land Use:

Historically, mining has been a major industry here, with open pit, underground, and placer operations. Timber is harvested along the south side of the ecoregion. Major transportation routes lie to the south of the ecoregion and through the west and east ends, promoting recreation and tourism. Subsistence harvest occurs throughout the region.

Land Management:

Over one-third (37.8%) of this ecoregion is in Canada. The State of Alaska owns half of the Alaska portion and has designated a small portion of it as state forest, refuges, and recreation areas. The federal government manages 24.2%, with the BLM managing a majority of that land. The BLM manages three wild and scenic rivers, Steese National Conservation Area, and White Mountains National Recreation Area. The NPS's major unit in this ecoregion is Yukon-Charley Rivers National Preserve. The Fairbanks North Star Borough has jurisdiction over part of this ecoregion.

Table 16. Yukon-Tanana Uplands land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	30.5%
Federal	NPS	8.1%
Federal	DOD	1.4%
Federal	USFWS	1.6%
Local	Local	<1.0%
Private		6.8%
State	DNR	49.9%

Yukon-Old Crow Basin

Area: 17,934,802 acre (7,258,115 hectares)
Alaska 77.8%, Canada 22.2%

Landscape:

Beaver Creek — D. Spencer, USFWS

The Yukon-Old Crow Basin is characterized by meandering rivers and sloughs, sandbars, oxbow and thaw lakes, and marshy flats that occur along the Yukon, Porcupine, Chandalar, Christian, Sheenjek, and Old Crow Rivers. The rolling uplands surrounding the flats have fewer water bodies. The Old Crow Basin in the Yukon Territory, at elevations below 990 feet (300 meters), with surrounding uplands between 990 and 1,980 feet (300 and 600 meters), has numerous squarish lakes oriented southeast to northwest. The Alaska portion of the ecoregion, often called the Yukon Flats, ranges in elevation from 300 to 820 feet (90 to 250 meters).

The dry, continental climate is colder in the winter than surrounding ecoregions, due to the influence of Arctic high-pressure systems, and warmer in the summer as surrounding mountains block many cooler weather systems. In the Old Crow Basin, average annual precipitation varies from 7 to 10 inches (17 to 25 centimeters), and the mean annual temperature ranges from 10 to 16 °F (–9 to –12 °C). Temperatures and precipitation levels are slighter higher in the Alaska portion. Due to the dryness of the basin, water levels in lakes and bogs are maintained primarily by spring flooding of the rivers. Warm summers create conditions favorable for frequent forest fires.

Flooding and poor drainage due to nearly continuous permafrost keep soils wet. Vegetation varies with soil drainage. Wet grass marshes and low shrub swamps occur in the flats among the streams, rivers, and lakes. Open black spruce stands also grow at lower elevations, with white spruce growing on better drained sites. Paper birch, balsam poplar, and aspen are most likely found in early successional stands following fires. Extensive thickets of birch, willow, and some alder occur in openings and under trees from lower elevations to above tree line. Sedge and cottongrass tussocks are found throughout the ecoregion.

Wildlife and Fish:

The Yukon Flats have been called the most productive Arctic habitat on the continent (McNab and Avers 1994). The rich aquatic habitats attract millions of waterfowl and provide prime habitat for moose, river otters, beavers, and muskrats. Species breeding here include Lesser Scaup; Northern Pintail; Scoter; Widgeon; Sandhill Crane; Arctic, Red-throated and Common Loons; and Horned and Red-necked Grebes. Most of the Canvasback Ducks that nest in Alaska do so on the Yukon Flats.

The Porcupine caribou herd inhabits the northeast portion of this ecoregion. Snowshoe hare and lynx occur here, with their populations linked in a cycle of abundance and scarcity.

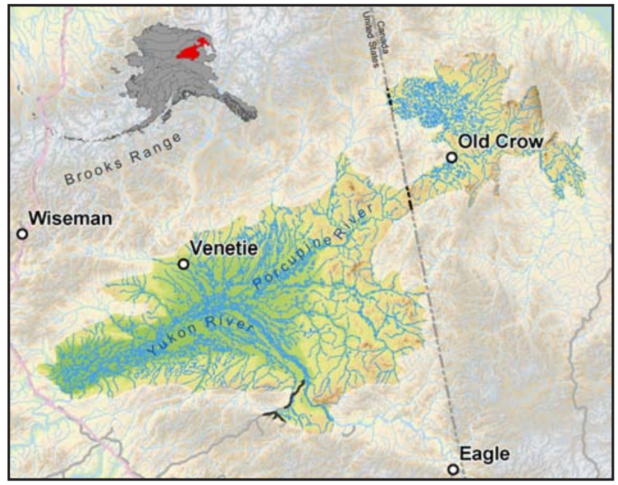


Figure 18. Yukon-Old Crow Basin ecoregion

The rivers support king, silver, and chum salmon. Resident fish include northern pike, sheefish, burbot, whitefish, and Arctic grayling.

People:

Several small villages occur in the Yukon Flats area, including those of the Gwichin Athabascans, who have traditionally lived there. The largest communities are Fort Yukon and Venetie. Salmon, freshwater fish, caribou, moose, smaller mammals and plants are traditional subsistence foods.

Land Use:

Mining has occurred in the Canadian portion of the ecoregion, with open pit, underground, and placer operations. In the Alaska portion, this ecoregion is almost entirely intact, with limited development around several small communities. The Yukon River provides transportation of people and supplies. Subsistence and recreational hunting and fishing occur throughout the ecoregion.

Land Management:

Over one-fifth (22.2%) of this ecoregion is in Canada and includes the Canadian Ivvavik and Vuntut National Parks. The U.S. federal government manages roughly three-quarters of the Alaska portion of the ecoregion, with USFWS as the primary land manager. Most of those holdings are managed as Yukon Flats National Wildlife Refuge, and part of the Arctic National Wildlife Refuge is found in the northern part of the ecoregion. Private ownership is high in this ecoregion.

Table 17. Yukon-Old Crow Basin land status

Owner	**Agency**	**Percent of Ecoregion**
Federal	BLM	9.8%
Federal	NPS	<1.0%
Federal	USFWS	62.4%
Local	Local	<1.0%
Private		22.9%
State	DNR	4.3%

Davidson Mountains

Area: 8,335,732 acres (3,373,425 hectares)
Alaska 86%, Canada 14%

Landscape:

South of the Brooks Range rise the rugged Davidson Mountains reaching heights of 8,000 feet (2,420 meters). Large, glacially originated rivers, such as the Sheenjek, and their broad floodplains dissect the mountains and drain to the Yukon River. The climate is continental with long, cold winters and short, cool summers. Permafrost is continuous under this ecoregion, but varies in thickness from thin to moderate.

This ecoregion represents the northern extent of boreal forests in Alaska. The presence of permafrost and floodplains contributes to poorly drained soils and wet conditions along the rivers. These areas are

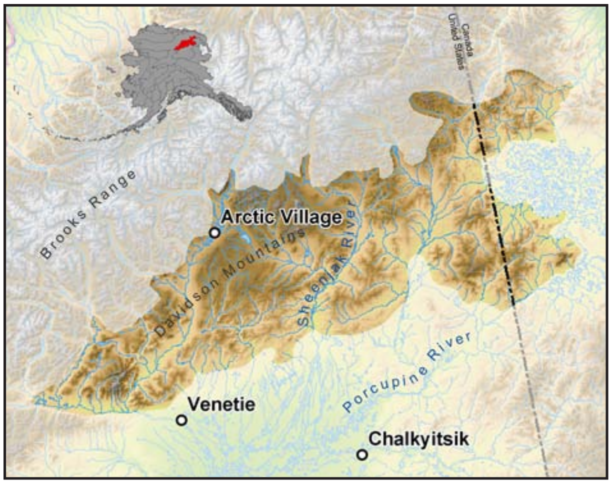


Figure 19. Davidson Mountains ecoregion

dominated by black spruce bogs. Better-drained places along the rivers support white spruce and balsam poplar. White spruce, paper birch, and trembling aspen grow on uplands. Mountain peaks are either barren or have alpine tundra.

Tall willow, birch, and alder communities can also be found in this ecoregion. Relatively warm and dry summers and frequent lightning storms during that season combine to make forest fires a common disturbance in these mountains.

Mancha Creek near Mancha Pinnacles D. Cline, USFWS

Wildlife and Fish:

The boreal forest supports a large variety of birds and terrestrial mammals. The mixed forests are inhabited by breeding landbirds, such as Gray Jays, Boreal Chickadees, and Boreal Owls. Landbirds inhabiting this ecoregion include Olive-sided Flycatchers, Blackpoll Warblers, Rusty Blackbirds, Great Gray Owls, and Boreal Owls.

Furbearers include marten, mink, short-tailed and least weasels, and Canada lynx. Dall sheep, hoary marmots, and Arctic ground squirrels inhabit the high mountainous areas. This is part of the Porcupine caribou herd's overall range. Top-level predators include brown bears, wolverines, and gray wolves.

Northern pike, whitefish, and Arctic grayling are common in the lakes and rivers.

People:

Gwich'in Athabascans inhabit this ecoregion on both sides of the border. The only Alaska community in this ecoregion is Arctic Village.

Land Use:

This ecoregion is almost entirely intact, with limited development. Subsistence and limited recreation remain the primary uses of the land.

Land Management:

Fourteen percent of this ecoregion is in Canada, and part of that has been designated as Ivvavik National Park. The U.S. federal government manages almost two-thirds of the Alaska portion of this ecoregion. Of that total, the USFWS manages more than 70% as the Arctic or Yukon Delta National Wildlife Refuges. The other major landowners on the U.S. side of the border are private individuals and Native corporations.

Table 18. Davidson Mountains land use status

Owner	Agency	Percent of Ecoregion
Federal	BLM	<1.0%
Federal	USFWS	72.1%
Private		18.5%
State	DNR	9.2%

North Ogilvie Mountains

Area: 12,896,610 acres (5,219,187 hectares)
Alaska 24.4%, Canada 75.6%

Landscape:

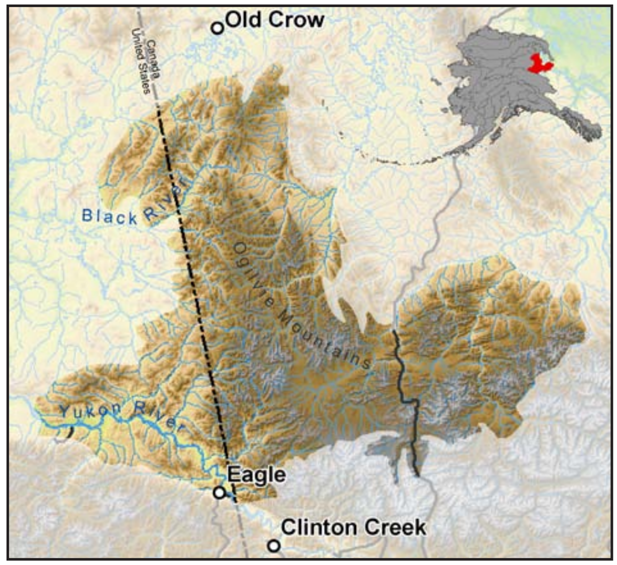


Figure 20. North Ogilvie Mountains ecoregion

The North Ogilvie Mountains span the Alaska-Yukon border, with most of their mass in Canada. These flat-topped hills are remnants of a former plain that has been eroded for a long period of time. Most elevations are between 2,970 and 4,450 feet (900 to 1,350 meters), with the highest peak at 5,940 feet (1,800 meters). Limestone and other sedimentary rock underlies most of the area. These rocks are exposed as angular outcrops on ridge tops and scree material on upper slopes. Lakes are not common in these mountains, but ponds and thermokarst basins occur in the valley bottoms. Numerous streams originate here and flow to the Porcupine, Yukon, and Peel Rivers through deeply cut valleys.

Frequent landslides and soil creep disturb the steeper upper slopes. Soils are deeper and more stable on lower slopes, where permafrost is almost continuous. The presence of permafrost is evidenced by pingos, earth hummocks, peat polygons, and stone stripes. Sedge-tussock tundra is the most prevalent vegetation type in the ecoregion. Shrub birch and willow also form extensive communities and can be found from lower elevations to above tree line. Black spruce and some paper birch occur on low elevation wetlands. White spruce is found in protected areas and well-drained river valleys. Recent floodplains and warmer sites with good drainage support aspen and balsam poplar.

The continental climate results in long, cold winters and short, cool summers. Annual precipitation is 20 inches (50 centimeters) in the hills and 26 inches (65 centimeters) in the higher elevations with annual snowfall at 51 inches (130–205 centimeters). The mean annual temperature ranges from 19 to 16 °F (–7 C to –9 °C), but temperature inversions may make valleys colder.

Wildlife and Fish:

The North Ogilvie Mountains are home to the Porcupine caribou herd, brown bears, wolverine, and gray wolves. Dall sheep and pikas inhabit the alpine areas, and moose can be found in the river valleys. Northern collared lemmings are in the northern part of the ecoregion. Landbirds found in this ecoregion include Olive-sided Flycatchers, Blackpoll Warblers, Great Gray Owls, Boreal Owls, and Rusty Blackbirds. Chum and king salmon migrate through the Yukon River en route to spawning areas in Canada. Arctic grayling are common in streams.

People:

There are very few permanent communities in the Alaska portion of these mountains, with the town of Eagle at the southern boundary being the largest. Newer residents, as well as the descendents of the Gwich'in Athabascans, rely on salmon, caribou, moose, small mammals, and plants for subsistence.

Rusty Blackbird USFWS

Land Use:

Gold, silver, platinum, and tin have been mined in these mountains, though not extensively. Energy-related resources, including coal, petroleum, and uranium, also occur here, but have not been tapped yet.

Land Management:

Over three-fourths (75.6%) of this ecoregion is in Canada and is included as parts of Ivvavik National Park and Fishing Branch Territorial Park. On the U.S. side of these mountains (24.4% of the ecoregion), the BLM and the NPS are the major land managers. Yukon-Charley Rivers National Preserve is the largest federal unit. Private landowners hold 23% of the ecoregion.

Table 19. North Ogilvie Mountains land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	35.7%
Federal	NPS	29.2%
Federal	USFWS	10.1%
Private		22.9%
State	DNR	2.1%

Alaska Range Transition

Lime Hills

Area: 7,095,672 acres (2,871,579 hectares)

Landscape:

The Lime Hills ecoregion lies at the southwest end of the Alaska Range. The topography reflects the transition from the rugged Alaska Range to a more rolling landscape. Here, peaks over 6,500 feet (1,970 meters) are found in the east, while lower ridges and broad valleys characterize the rest of the ecoregion. The influence of heavy glaciation is evident in the repeated sharp mountain ridges, thin deep lakes, and broad U-shaped valleys, primarily oriented northeast to southwest. Several large rivers begin in this ecoregion, passing through broad valleys lined with wetlands.

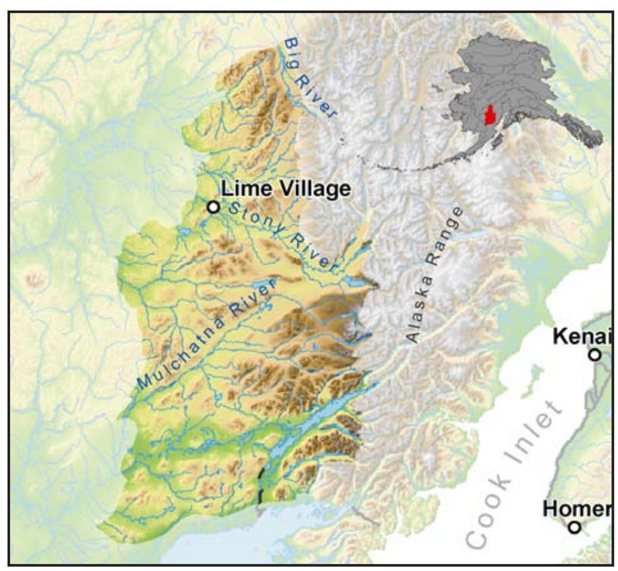


Figure 21. Lime Hills ecoregion

Permafrost exists in isolated areas in the ecoregion. Maritime influences of the Bering Sea and Gulf of Alaska moderate the continental climate of the Lime Hills. The average annual precipitation ranges from 22 to 30 inches (56 to 76 centimeters), with average annual temperatures from 27 to 32 °F (–3 to 0 °C).

Higher elevations are barren or covered with alpine tundra and heath. Communities of tall and low shrubs and assemblages of willow, birch, and alder dominate most of the Lime Hills. Spruce forests and spruce-aspen-birch forests occur at lower elevations. Wildfires are frequent.

Golden Eagle G. Atwell, USFWS

Wildlife and Fish:

The Lime Hills provide habitat for many of the larger species—moose, brown bears, and the Mulchatna caribou herd. White-tailed Ptarmigan and Golden Eagles can be found in the alpine tundra. Northern bog lemmings are common in the more poorly drained areas. Dolly Varden, sockeye, king and coho salmon spawn in most of the area's rivers. Rainbow trout and Arctic grayling are common residents in streams, and Arctic char are common in lakes.

People:

Tanaina Athabascans are the traditional inhabitants. The largest communities are Nondalton and Port Alsworth.

Land Use:

The ecoregion remains primarily intact, with some development around communities and along the shores of Lake Clark. The major uses of this ecoregion remain subsistence, with a growing tourism industry based on recreational hunting and fishing.

Land Management:

The State of Alaska owns most of this ecoregion. Management by the federal government is split between the NPS and the BLM. Lake Clark National Park and Preserve constitutes 18% of the ecoregion. Private and local ownership is low.

Table 20. Lime Hills land status

Owner	**Agency**	**Percent of Ecoregion**
Federal	BLM	14.3%
Federal	NPS	18.3%
Federal	DOD	<1.0%
Local	Local	<1.0%
Private		4.5%
State	DNR	62.6%

Cook Inlet Basin

Area: 7,186,358 acre (2,908,279 hectares)

Landscape:

Bisected by Cook Inlet, the Cook Inlet Basin is encompassed by the Aleutian Range to the west, the Alaska Range to the north, and the Talkeetna, Chugach, and Kenai Mountains to the east. Elevation within the basin spans from sea level to 1,980 feet (600 meters). The gently sloping lowlands were extensively glaciated during the Pleistocene epoch. Hundreds of small lakes, swamps, and bogs occur on ground moraines. Several large rivers, including the Susitna, Kenai, and Matanuska, drain glaciers in the surrounding mountains. The basin experiences a mix of maritime and continental climates. Temperatures range from the winter average minimum 5 °F (–15 °C) to the summer average maximum 64 °F (18 °C), and annual precipitation is 15 to 27 inches (38–68 centimeters), with snowfall 63 to 100 inches (160–255 centimeters).

Spruce and hardwood forests dominate the landscape, but the varying climatic influences, sporadic permafrost, and rolling topography support diverse vegetation. Lowlands with wet, organic soils support black spruce stands, and ericaceous shrubs are dominant in open bogs. Uplands have mixed forests of white and Sitka spruce, aspen and birch. Tall scrub communities, dominated by willow and alder, occur in floodplains. A mixture of wetland habitats occurs, from low scrub bog communities to freshwater wet graminoid communities, with a dominance of bluejoint grass in many wetlands.

Disturbance from wildfire in the ecoregion varies from low in the northern parts to moderate on the Kenai Peninsula. An outbreak of spruce bark beetle (*Dendroctonus rufipennis* [Kirby]) over the past decade has heavily affected the southern portions of the ecoregion, killing up to 80% of mature spruce stands.

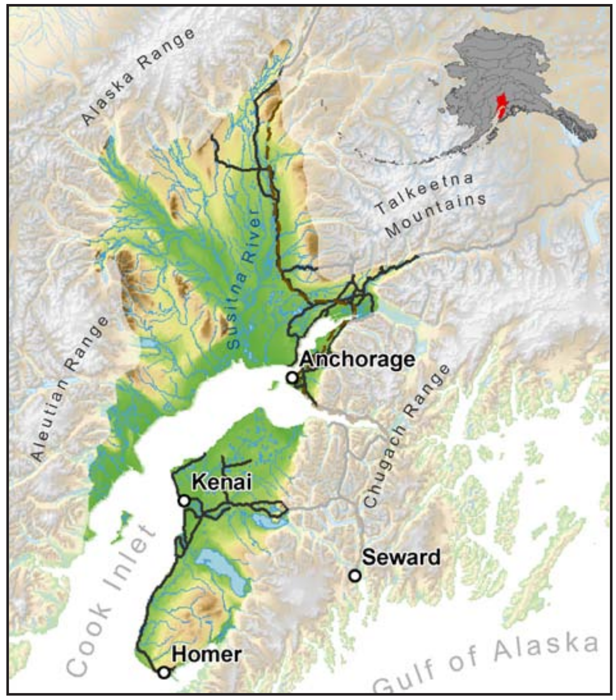


Figure 22. Cook Inlet Basin ecoregion

Wildlife and Fish:

The diversity of habitats results in a diversity of species. The numerous lakes, ponds, and wetlands attract large numbers of shorebirds and waterfowl, including tundra and Trumpeter Swans. Significant numbers of Western Sandpipers, Dunlins, Rock Sandpipers, long- and Short-billed Dowitchers, and Hudsonian Godwits use Cook Inlet for breeding, resting, or wintering. Black-legged Kittiwakes and Common Murres nest in colonies along its shores. Nearly the entire population of Wrangell Island Snow Geese migrates across the mouth of the Kenai River and Trading Bay in the spring. Sensitive landbirds in the ecoregion include Olive-sided Flycatchers and Blackpoll Warblers. The mixture of wetland habitats supports moose, brown and black bears, beavers, muskrats, pygmy shrew and northern water shrew. Extirpated on the Kenai Peninsula early in the 20th century, caribou were reintroduced there in the 1960s. The Kenai Peninsula is also home to a small relatively isolated population of brown bears.

The river systems support salmon runs, which attract bears and ravens. The Kenai River watershed has five species of Pacific salmon, including a unique run of the world's largest chinook salmon. Dolly Varden, Arctic char, rainbow trout, and whitefish also occur in the ecoregion's fresh waters.

The Cook Inlet beluga population, listed as depleted by the National Marine Fisheries Service in 2000, lives entirely within the ecoregion. Harbor seals and Dall's and harbor porpoise are also found in Cook Inlet. Minke whales feed in the bays and shallow coastal waters each summer.

Tule White-fronted Goose G. Smart, USFWS

People:

The Cook Inlet Basin is the most populated region in the state. Anchorage is by far the largest community, but neighboring towns in the Matanuska-Susitna valleys and the north side of the Kenai Peninsula also host populations that are large by Alaska standards. Traditionally, Tanaina Athabascans subsisted on abundant salmon, moose, caribou, beavers, small game and birds, migratory waterfowl, freshwater fish, and plants. The diverse population today still makes widespread use of wildlife for hunting and fishing.

Land Use:

Although this ecoregion has had the greatest impacts from humans in the state, it is estimated that only about 10% of its area has been heavily altered. Most development is concentrated in several areas. Today, tourism and recreation, the oil and gas industry, limited agriculture, and government employment support most residents.

Kenai National Wildlife Refuge lakes USFWS

Land Management:

Cook Inlet Basin is characterized by a higher percentage of private land ownership than in most other ecoregions, but still the majority of land is publicly managed. State-managed lands constitute half of the ecoregion, and federally managed lands make up 15%. The State of Alaska has set aside lands around Cook Inlet to protect fish and wildlife habitat; these small areas have been designated critical habitat areas, game refuges, and wildlife refuges. Several recreation areas also exist here. The Kenai National Wildlife Refuge is the largest federal area. The ecoregion falls in the jurisdictions of the Kenai Peninsula Borough, Matanuska-Susitna Borough, and the Municipality of Anchorage.

Table 21. Cook Inlet Basin land status

Owner	**Agency**	**Percent of Ecoregion**
Federal	BLM	<1.0%
Federal	NPS	1.1%
Federal	DOD	<1.0%
Federal	USFWS	13.1%
Federal	USFS	<1.0%
Local	Local	11.3%
Private		24.6%
State	DNR	49.1%

Alaska Range

Area: 25,534,440 acres (10,333,440 hectares)

Landscape:

The mountains of the Alaska Range ecoregion are high, very steep, and covered with glaciers, rocky slopes, and ice fields. Elevations vary from broad valleys at 1,980 feet (600 meters) to peaks greater than 12,870 feet (3,900 meters), with the tallest mountain in North America, Mount McKinley, rising to 20,320 feet (6,100 meters). Glaciers, which still remain in some places, have shaped these mountains, so cirques and U-shaped valleys are common features due to extensive glaciation. Streams and rivers, heavy with sediment, run swiftly down mountain ravines and braid across valley bottoms. Permafrost is discontinuous. Disturbance processes are primarily landslides and avalanches on the steep, scree-covered slopes. Active volcanoes also occur here.

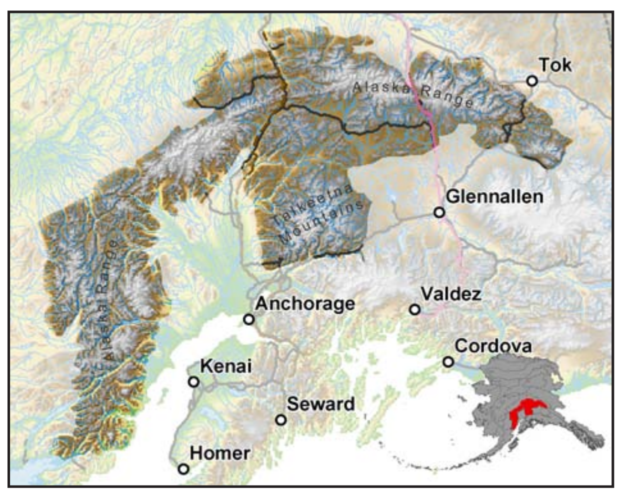


Figure 23. Alaska Range ecoregion

Due to the Alaska Range's height, a cold, continental climate prevails. The highest mountains occasionally intercept streams of Pacific moisture to help feed small ice fields and glaciers. In the lower elevations mean annual precipitation is approximately 15 inches (380 millimeters), with snowfall ranging from 60 to 120 inches (150 to 305 centimeters). At the higher peaks, average annual precipitation is 41 inches (103 centimeters), with snowfall estimated at 40 inches (101.5 centimeters).

Aeriel view of Alaska Range in winter USFWS

Vegetation is sparse, with dwarf scrub communities commonly occurring in windswept areas. Shrub communities of willow, birch, and alder occupy the more protected lower slopes and valley bottoms. Spruce forests occur in some valleys and lower slopes, with white spruce dominating and black spruce interspersed in areas with poorer drainage. About 7% of the ecoregion is wetlands.

Wildlife and Fish:

Top-level predators—brown bears, gray wolves, and wolverines—are common in the Alaska Range. They prey on Dall sheep in the alpine tundra and large migrating caribou herds in the broad valleys and passes. Small mammals include hoary marmots, singing voles and pikas. Lake trout are found in deep lakes and salmon migrate, rear, and spawn in many of the streams. Dolly Varden and Arctic grayling are resident in many streams. This may be the northern extent of the water shrew's range. Smith's Longspurs probably breed along the Denali Highway.

People:

Due to the harshness of the landscape and climate, this ecoregion is sparsely populated. Historically, several seminomadic Athabascan groups, such as the Tanaina, Ahtna and Tanacross, lived there; they relied on salmon, freshwater fish, large mammals, smaller fur-bearing mammals and edible plants. Today the largest communities are Healy, McKinley Park, Cantwell, and Chickaloon.

Land Use:

Little of this ecoregion has been developed due to the low population. The George Parks Highway bisects the ecoregion into east and west halves. Most human use is subsistence and sport hunting and fishing, though recreation and tourism are growing. Limited mining also occurs, including coal mining at Healy.

Land Management:

Half of this ecoregion is owned by the State of Alaska. The largest state designated area is the Nelchina Public Use Area. The federal government is also a major landowner (44%). The NPS manages most of its lands as Denali National Park and Preserve or Lake Clark National Park and Preserve. The Denali, Kenai Peninsula, and Matanuska-Susitna Boroughs have jurisdiction over parts of this ecoregion.

Table 22. Alaska Range land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	16.4%
Federal	NPS	26.4%
Federal	DOD	<1.0%
Federal	USFWS	<1.0%
Local	Local	<1.0%
Private		5.5%
State	DNR	50.7%

Copper River Basin

Area: 4,729,208 acres (1,913,884 hectares)

Landscape:

The Copper River Basin ecoregion occupies the former bed of Lake Ahtna. A large lake during glacial times, the lake broke through an ice dam and started the flow of the Copper River. The basin is characterized by rolling to hilly moraines and nearly level alluvial plains where the glacial lake was. Elevation ranges from 1,380 to 2,950 feet (420 to 900 meters). The basin is bounded by the Talkeetna Mountains on the west, the Wrangell Mountains on the east, the Alaska Range on the north, and the Chugach Mountains on the south.

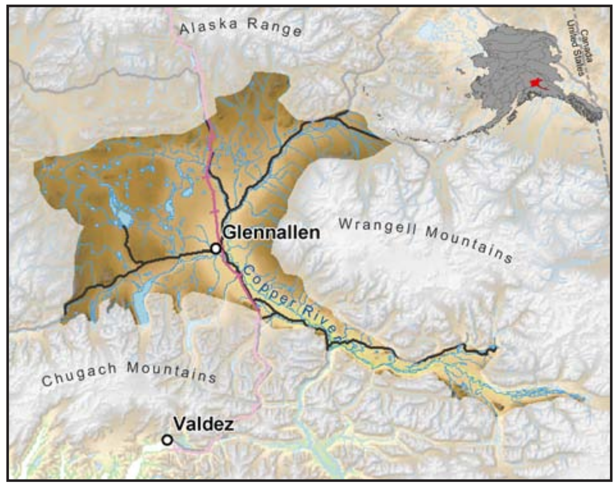


Figure 24. Copper River Basin ecoregion

Shallow, discontinuous permafrost results in poorly drained soils and numerous wetlands and thaw lakes. Black spruce forests and woodlands dominate the landscape. Wetlands, which occupy about 36% of the ecoregion, also include low scrub bog communities with birch and ericaceous shrubs and wet, graminoid, herbaceous communities dominated by sedges. Well-drained sites have coniferous forests dominated by white spruce or broadleaf forests dominated by black cottonwood and quaking aspen. Stream and river corridors are lined with cottonwood, willow, and alder. Spring floods are common along drainages.

The continental climate has steep seasonal temperature variation. The basin acts as a cold-air sink, and winter temperatures can be bitterly cold. The average annual temperature is 26 to 30 °F (–3 to –1 °C), and the average annual precipitation is 10 to 20 inches (250–500 millimeters).

Wildlife and Fish:

The Nelchina and Mentasta caribou herds occupy this basin, as do black and brown bears and wolverines. Sockeye salmon is the major anadromous fish, but king salmon also occur. Arctic grayling, lake trout, whitefish, and burbot live in lakes throughout the ecoregion.

The thaw lakes and wetlands provide excellent stopover and nesting habitat for a variety of migratory bird species that travel up the Copper River from the coast. A high number of Trumpeter Swans breed in the north-central portion. Ruffed Grouse inhabit the forests in the lower elevations.

People:

Traditionally, Ahtna Athabascans relied on salmon, freshwater fish, large mammals, smaller, fur-bearing mammals, and edible plants. Today most residents live along the three highways passing through this ecoregion. The largest towns are Copper Center, Glennallen, and Kenny Lake.

Land Use:

This area is a major transportation crossroads in Alaska for the movement of people and oil. Subsistence and recreational hunting and fishing occur throughout the ecoregion. Tourism also plays a large role. A small agriculture industry exists.

Copper River Basin T. Paul, ADF&G

Land Management:

Compared to other ecoregions, the Copper River Basin has a large percentage of privately owned land (23.6%) The state owns a third of the ecoregion and manages more than a quarter of its land as the Nelchina Public Use Area. The federal government is the largest landowner (42.5%) with management split almost equally between the BLM and the NPS. Wrangell-St. Elias National Park and Preserve makes up more than one-fifth of the ecoregion.

Table 23. Copper River Basin land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	20.2%
Federal	NPS	22.3%
Local	Local	<1.0%
Private		23.6%
State	DNR	33.9%

Aleutian Meadows

Aleutian Islands

Area: 2,929,397 acres (1,185,511 hectares)

Landscape:

Arcing 1,180 miles (1,900 km) westward from the Alaska Peninsula to the island of Attu, the Aleutian Islands are a chain of volcanic islands that were formed by the Pacific plate being forced beneath the Bering Sea plate. Fog often shrouds the steep, rubble-covered peaks, which rise to 6,230 feet (1,900 meters) above sea level. Icecaps or small glaciers occur on many of the volcanoes, and past glaciation is evident. Short, swift streams have carved fjords into the sides of the cones. High cliffs, wave-beaten platforms, boulder beaches, or small dune fields ring the islands.

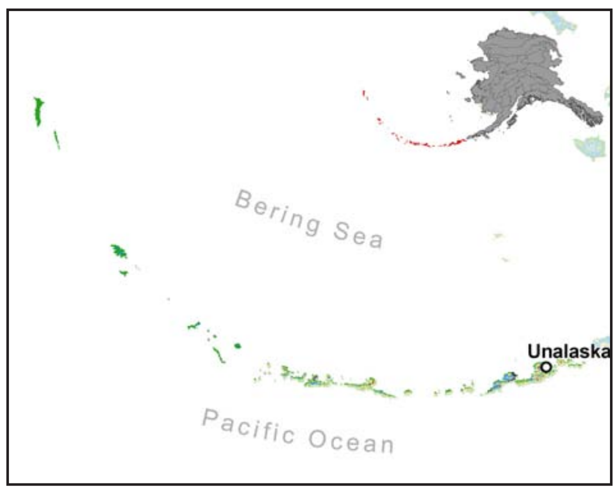


Figure 25. Aleutian Islands ecoregion

The archipelago's location over an active seismic fault results in frequent volcanic and seismic activity. Forty of the 76 volcanoes in the chain have been active in the past 250 years. Intense ocean storms are also an important disturbance process, bringing strong winds and heavy rains. A cool, maritime climate brings abundant, yet varying, precipitation throughout the chain, from 20 inches in some places to 82 inches in others (53 to 208 centimeters), with average annual temperatures from 36 to 39 °F (2 to 4 °C). The islands are permafrost free, and the winter sea ice pack does not reach here.

The islands are treeless. The flora is a blend of species from the North American and Asian continents. The alpine tundra contains species not found to the north or in Interior Alaska, including Alaska arnica, Siberian spring beauty, caltha-leaved avens, western buttercup, and Kamchatka rhododendron. Low shrub communities of willow, birch, and alder dominate mountain flanks and coastlines, interspersed with ericaceous-heath, *Dryas*-lichen, and grass communities. Uplands are characterized by peat and mats of heath tundra with sedges. Several plants are endemic to the Aleutians: Aleutian draba, Aleutian chickweed, Aleutian wormwood, Aleutian shield-fern (endangered under the U.S. Endangered Species Act) and Aleutian saxifrage. Roughly 11% of the island complex is wetlands. Shallow marine waters contain eelgrass beds.

Amagat Island USFWS

Wildlife and Fish:

The Aleutian Islands are important breeding grounds for birds and marine mammals. Large, globally important colonies of seabirds are found throughout the chain; these rugged cliffs provide habitat for Red-faced Cormorants, Leach's and Fork-tailed Storm Petrels, Red-legged and Black-legged Kittiwakes, Common and Thick-billed Murres, and Least and Crested Auklets. The Aleutian Canada Goose breeds only in the Aleutians and on islands nearby off the Alaska Peninsula. The archipelago provides wintering habitat for Steller's Eiders and Emperor Geese and nesting grounds for Peale's Peregrine Falcon and Bald Eagles. The majority of the western population of endangered Steller sea lions give birth at rookeries on the chain, and northern sea otters live in the more protected waters among the islands. Fin, humpback, killer, and minke whales feed in the nearshore and offshore waters in the summer. Passes between the islands, especially Unimak Pass, focus migrating marine and avian species into biologically important and sensitive areas.

Crested Auklet
A. Sowls, USFWS

The natural fragmentation of the islands contributes to a higher level of endemism than in most of Alaska. Endemic bird subspecies include Evermann's Rock Ptarmigan, Yunaska Rock Ptarmigan, and Aleutian Song Sparrow.

Up to 14 species of terrestrial mammals occur naturally on many of the islands. Large predators like brown bear and gray wolf can be found in the eastern islands, but both diversity and size of native mammal species decrease westward until only two smallish animal species—the collared lemming and red fox—can be found on Umnak Island.

The Aleutian Islands unit of the Alaska Maritime National Wildlife Refuge is thought to have more salmon spawning streams than any other refuge in the country, providing a rich food resource for birds and terrestrial and marine mammals.

Recent research suggests that the Aleutian chain may have the highest diversity and abundance of deep-sea coral in the world. Coral gardens provide habitat for dozens of species of sea life, including rockfish, perch, flatfish, mackerel, crab, shrimp, cod, pollock, sea stars, snails, and octopus.

Intentional and accidental introductions of cattle, reindeer, foxes, rabbits, and rats to various islands have altered the habitat and seabird colonies of the islands through overgrazing and predation. Declines in population levels of seabirds, some fish and shellfish, and marine mammals are likely a result of trophic changes in the Bering Sea ecosystem due to commercial harvest of fish and whales over the last 40 years, as well as climate change.

People:

The Native people of the islands are Aleut. Their subsistence foods come from the diverse habitats of the islands, including the marine mammals, caribou, salmon, chitons, fish, mussels, urchins, octopus, birds, eggs, and plants. The largest communities are Adak Station and Unalaska.

Land Use:

Commercial fishing and subsistence are the major uses of natural resources in this ecoregion. The archipelago also defines a major shipping route. Active and shuttered military installations exist on the islands. Pollutants are locally acute, and radioactivity from nuclear testing persists on Amchitka Island.

Land Management:

The federal government is the largest landholder (80.4%). The USFWS manages most of the ecoregion as the Alaska Maritime National Wildlife Refuge. Private owners are the other major landholders.

Table 24. Aleutian Islands land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	<1.0%
Federal	DOD	<1.0%
Federal	USFWS	80.3%
Local	Local	<1.0%
Private		19.6%
State	DNR	<1.0%

Alaska Peninsula

Area: 15,745,664 acres (6,372,183 hectares)

Landscape:

The Alaska Peninsula and Unimak Island, the northernmost island of the Aleutian Archipelago, compose this ecoregion, which separates the Gulf of Alaska from the Bering Sea. The dominant feature of the ecoregion is the Aleutian Range, the peninsula's volcanic spine, which reaches elevations of 8,580 feet (2,600 meters) above sea level. Extensive glaciation has carved U-shaped valleys into the mountains. Because glaciers remain in the high peaks, many lakes and rivers contain suspended glacial flour. The lowlands contain numerous lakes, estuaries, and large river basins, which terminate in broad estuarine areas on the Bering Sea. On the south side, deeply cut fjords characterize the landscape. Volcanic activity and major ocean storms from the Gulf of Alaska have also shaped the topography and soils. The Alaska Peninsula is largely free of permafrost.

Alaska Peninsula volcano K. Bollinger, USFWS

Much of the shoreline along the Bering Sea is characterized by mixed sand and gravel beaches and exposed tidal mudflats. The protected bays and lagoons often have eelgrass beds, which form the food base for many fish and waterfowl. Izembek Lagoon contains one of the largest eelgrass beds in the world.

The rugged Gulf coast has intertidal and subtidal algal forests, characterized by kelp attached to rocky substrates.

The maritime climate affects the south slope of the Aleutian Range, with average annual precipitation ranging from 24 to 65 inches (61 to 165 centimeters), and average annual temperature ranging from 34 to 39 °F (1 to 4° C). Sea ice does not form along this coast, except in a few protected bays and inlets. On the north side, the transitional climate creates a slightly cooler, yet drier, climate.

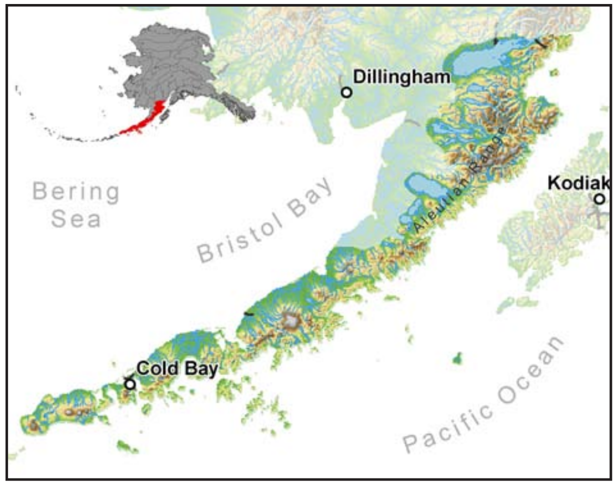


Figure 26. Alaska Peninsula ecoregion

Due to topography, past glaciation, and climate, tundra vegetation characterizes this ecoregion below the barren and ice-covered peaks. The alpine tundra is a semiarid habitat that supports low shrubs, lichens, mosses, and grasses. Moist tussock tundra of mosses, lichens, and tufted hair grass occurs in mountain valleys and along plateaus. Wet tundra is confined to low-lying coastal areas around Bristol Bay. Ponds, lakes, and wetlands cover most of these areas. High brush communities of alder and willow dominate floodplains. Black spruce occurs primarily in interior lowlands, on north-facing slopes, and on poorly drained flats. Mixed forests of black or white spruce, balsam poplar, black cottonwood, paper birch and quaking aspen can also be found.

Wildlife and Fish:

The diverse habitats of the Alaska Peninsula support a rich wildlife assemblage. Five species of Pacific salmon, steelhead, rainbow smelt, Arctic grayling, and Dolly Varden are present in the ecoregion; Dolly Varden, steelhead and salmon spawn in many of the region's streams. Healthy populations of many top-level predators live here, including brown bear, wolf, wolverine, and lynx. Several caribou herds range across the region. Moose inhabit the uplands and riparian corridors. Smaller mammals include hoary marmots and tundra hares.

Coastal wetlands, lagoons, and bays provide staging areas for large seasonal aggregations of waterfowl and shorebirds. Izembek and Moffet Lagoons host concentrations of more than 500,000 shorebirds each spring, including Marbled Godwits and Rock Sandpipers, and the majority of the eastern Pacific population of Black Brant each fall. Aleutian Terns, Arctic Warblers, Red-faced Cormorants, and Kittlitz's Murrelets breed here. The ecoregion provides prime wintering habitat for several bird species—Emperor Goose, King Eider, Steller's Eider, and McKay's Bunting.


Red-faced Cormorant
USFWS

Rookeries and haulouts for Steller sea lions are distributed primarily along the Gulf coast, while harbor seals haul out on beaches along both coastlines. Sea otters have recolonized the lower half of the peninsula, but the population has decreased dramatically in recent years. Fin, humpack, and minke whales feed in the nearshore and offshore waters in the summer. Pacific herring and halibut occur in the marine portions of the ecoregion, as do several shellfish species, such as scallops, crab, shrimp and many species of groundfish.

Several species are endemic to the islands, including tundra voles, the Amak Island Song Sparrow, the Semidi Islands Winter Wren, McKay's Bunting, and the Beringian Marbled Godwit. The globally rare Bristle-thighed Curlew also inhabits this ecoregion.

Many species that live here and in the Bering Sea have seen dramatic decreases in populations, including Steller sea lions and sea otters.

People:

Human communities occur primarily along the coast; the largest are King Cove and Sand Point. The Aleut people traditionally lived at the west end of the ecoregion and Alutiiqs to the east.

Land Use:

This ecoregion is almost entirely intact, with minimal development around several small communities. The major components of the region's economy are commercial fishing, transportation services, government jobs, Native corporations, subsistence, and tourism. Oil and gas development has been proposed for the area, and this development and its attendant infrastructure may become a reality with current trends in energy policy.

Land Management:

The federal government owns 73% of the ecoregion. The NPS manages its holdings as Katmai National Park and Preserve and Aniakchak National Monument. Boundaries of four national wildlife refuges intersect the ecoregion; Alaska Peninsula National Wildlife Refuge is the largest. A small portion of state-managed lands have been designated game refuges, critical habitat areas, state parks, and state recreation rivers. The ecoregion falls in the jurisdictions of the Kodiak Island, Lake and Peninsula, and Aleutians East boroughs.

Table 25. Alaska Peninsula land status

Owner	**Agency**	**Percent of Ecoregion**
Federal	BLM	5.7%
Federal	NPS	29.0%
Federal	DOD	<1.0%
Federal	USFWS	38.0%
Local	Local	<1.0%
Private		11.9%
State	DNR	15.2%

Coastal Mountains Transition

Wrangell Mountains

Area: 3,537,164 acres (1,431,471 hectares)

Landscape:

The steep Wrangell Mountains, at the northwest edge of the St. Elias Mountains, are covered with ice fields and glaciers. The terrain includes shield and composite volcanoes, with elevations ranging from 2,000 to 12,800 feet (600 to 3,900 meters) or more. This exceedingly rugged terrain results from the ongoing collision of the Pacific and North American tectonic plates. Sediment-laden rivers originate in the glaciers, and small lakes remain in some high valleys where glaciers have receded. The Wrangell Mountains are highly dynamic due to active volcanism, avalanches, landslides, glaciers, and stream erosion.

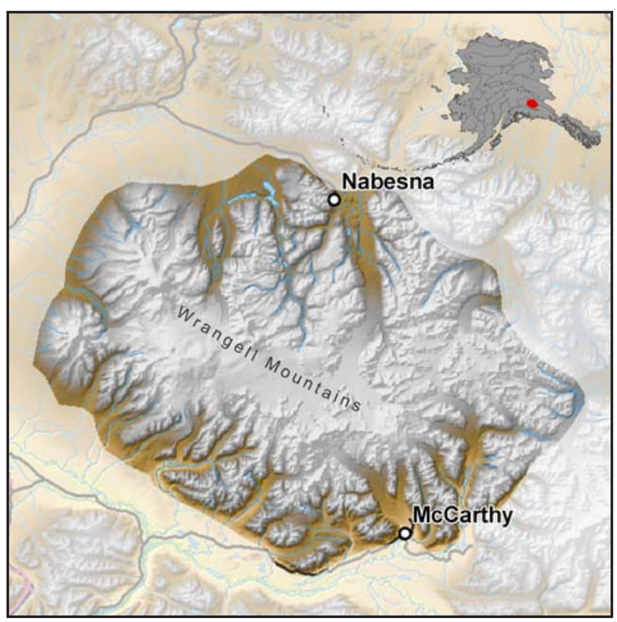


Figure 27. Wrangell Mountains ecoregion

The climate is continental, but the size of the mountains and nearness to the coast alter the moisture characteristics. The extreme height of the Wrangell Mountains allows interception of moisture-laden air from the North Pacific Ocean. The abundant maritime snows feed the extensive ice fields and glaciers. The climate becomes dry continental at lower elevations where the Wrangell Mountains abut the cold-air basin of the Copper River.

Chitistone Canyon T. Paul, ADF&G

Much of this ecoregion is dominated by rocky slopes, ice fields, and glaciers, and soils are thin and stony; thus much of the ecoregion is devoid of vegetation. Dwarf scrub communities made up of mountain avens, ericaceous shrubs, and/or willows occur on well-drained windy sites. Tall scrub communities occur on floodplains and along drainages and include species such as willow and alder with an understory of mosses, herbs and graminoid species. Broadleaf forests of quaking aspen and paper birch and needleleaf forests dominated by white spruce are found at lower elevations.

Wildlife and Fish:

This ecoregion may be best known for the prime habitat it provides for Dall sheep. Mountain goats, brown bears, caribou, wolverines, and gray wolves also occur here. Trumpeter Swan, Widgeon, and Lesser and Greater Scaup nest in river valleys. Smith's Longspurs probably breed here. Arctic grayling can be found in clear waters.

People:

Upper Tanana and Ahtna Athabascans are the traditional inhabitants of the Wrangell Mountains. McCarthy and Nabesna are the largest communities.

Land Use:

This ecoregion is almost entirely intact. Historically, mining has been the major industry. Major transportation routes to the west and north of the ecoregion promote recreation and tourism. Subsistence harvest occurs throughout the ecoregion.

Land Management:

The ecoregion is contained almost entirely within the boundaries of Wrangell-St. Elias National Park and Preserve, which is managed by the NPS.

Table 26. Wrangell Mountains land status

Owner	Agency	Percent of Ecoregion
Federal	NPS	96.0%
Federal	USFWS	4.0%

Kluane Range

Area: 5,170,434 acres (2,092,446 hectares)
Alaska 24%, Canada 76%

Landscape:

Kluane Range T. Paul, ADF&G

The Kluane Range ecoregion lies primarily in Canada. Tall mountains to the south force much of the moisture from the Pacific Ocean to drop along the coast, so the Kluane Range has a dry continental climate. Lower elevations receive 7 to 11 inches (19 to 28.5 centimeters) of precipitation a year, with possibly greater amounts at higher elevations in the northern part of the ecoregion. The mean annual temperature ranges from 27 to 23 °F (–3 to –5 °C), with cold winter temperatures of –22 °F (–30 °C) being common.

Few glaciers exist in this ecoregion, except for those extending down from the St. Elias Mountains. Permafrost is discontinuous, but ground freezing results in solifluction lobes, ice wedges, and patterned ground, especially on north-facing uplands. Due to the steepness of the slopes, the dominant disturbance processes in the mountains are scree movement, rock falls, landslides, and soil creep. On the steep mountainsides, streams are swift. In the valleys, streams meander and soil drainage is poor in valley bottoms.

Black spruce stands and sedge tussock fields dominate vegetation in the poorly drained areas. White spruce occurs on better-drained sites at lower elevations. Much of the ecoregion is above tree line, with alpine tundra and barrens of lichens, prostrate willows, and ericaceous shrubs. Shrub birch and willow are prevalent in the subalpine.

Wildlife and Fish:

Ungulates typically found in alpine areas—Dall sheep and mountain goats—are abundant in this ecoregion, with moose and caribou occurring in the valleys and subalpine areas. Predators include brown bears, wolves, and wolverines.

People:

The Alaska portion of this ecoregion has few people due to its ruggedness and location within Wrangell-St. Elias National Park. Traditionally, Athabascan people lived in the northern part of the ecoregion and Tlingit in the south.

Land Use:

The Alaska Highway runs through this ecoregion, bringing supplies and tourists from Canada to Alaska. In Alaska, this ecoregion remains intact due to its ruggedness. Historically, mining has been a major industry here, with open pit, underground, and placer operations. Coal deposits also exist but have not been developed.

Land Management:

More than three-quarters of this ecoregion falls in Canada. Canada has included parts of it in Kluane National Park and Tatshenshini-Alsek Provincial Park. The Alaska portion is almost entirely part of Wrangell-St. Elias National Park and Preserve.

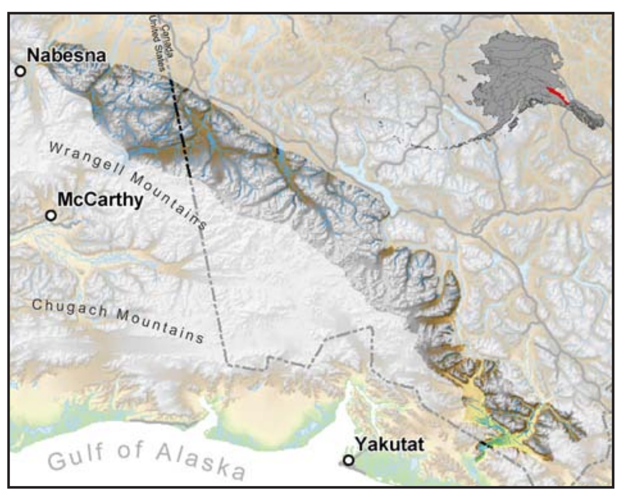


Figure 28. Kluane Range ecoregion

Table 27. Kluane Range land status

Owner	Agency	Percent of Ecoregion
Federal	NPS	99.8%
Federal	USFWS	<1.0%

Coastal Rain Forests

Kodiak Island

Area: 3,145,004 acres (1,272,766 hectares)

Landscape:

This ecoregion comprises Kodiak Island, the Trinity Islands to the south, and Afognak Island and the smaller islands to the north. These islands are a geologic extension of the Chugach Mountains on the mainland to the north. In the past, an ice sheet across Shelikof Strait connected these islands to the mainland, engulfing all but the highest points and some seaward coastlines. The retreating ice carved deep fjords into the northwest sides of Kodiak and Afognak. Smooth rounded ridges separate fjords, and high, sharp peaks to 4,470 feet (1,362 meters) punctuate the spine of Kodiak. Cirque glaciers and lakes sit in the highest valleys. Glacially fed streams run swift and for short distances.

Fireweed on Kodiak hillside L. Van Daele, ADF&G

The last Pleistocene glaciation, combined with volcanic activity in the more recent past, has dramatically impacted the vegetation of these islands. Trees did not survive the glaciation, so Sitka spruce and black cottonwood have only recently reestablished on the islands. Most of the island is covered with willow and alder thickets or wet and moist sedge meadows. Barrens or alpine tundra exist in the higher elevations.

The maritime climate exhibits little seasonal temperature variation, with an average annual temperature of 38 to 41 °F (3 to 5 °C). Clouds and fog are common, and precipitation is heavy, ranging from 50 to 70 inches (127 to 178 centimeters) annually. Storm events are the primary source of natural disturbance, though earthquakes and volcanic eruptions have played a major role on Kodiak.

Sea otter riding an ocean swell D. Menke, USFWS

Wildlife and Fish:

These islands have highly productive marine and freshwater ecosystems that support a diverse group of species. Offshore waters contain halibut, cod, sea otters, Steller sea lions, and whales. Tugidak Island supports one of the largest harbor seal haulouts in the state. Puffins, auklets, Black-legged Kittiwakes, and other seabirds nest in cliff colonies along the rocky shorelines. Aleutian Terns and Harlequin Ducks live at the saltwater bays. A high concentration of Black Oystercatchers nests along the shoreline.

The streams and rivers here are short, but they draw abundant runs of five species of Pacific salmon. The returning salmon transport important nutrients to the freshwater and terrestrial portions of the islands and feed the largest brown bears on earth—the Kodiak brown bears. Arctic char, Dolly Varden, steelhead, and rainbow trout can also be found in the fresh waters of the islands. The other native land mammals include red fox, river otter, short-tailed weasel, little brown bat, and tundra vole. Sitka black-tailed deer, Roosevelt elk, beaver, snowshoe hare, and mountain goat were all introduced.

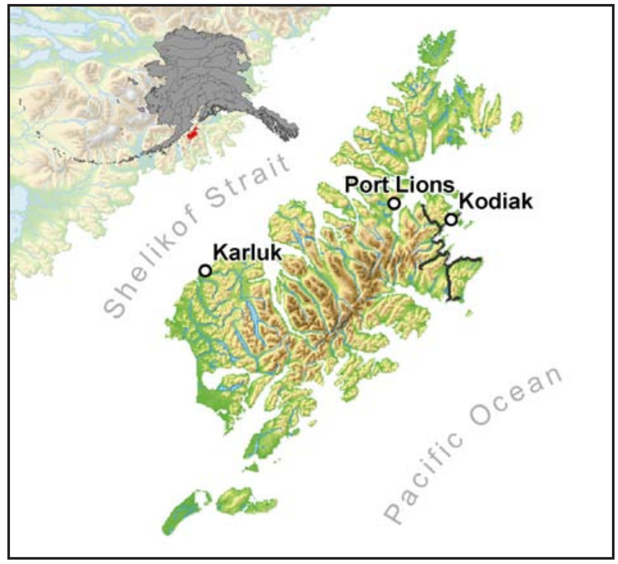


Figure 29. Kodiak Island ecoregion

People:
Human settlements largely occur along the shoreline in small villages. Kodiak is the largest city in the ecoregion. Koniag people were the original inhabitants.

Land Use:
The major economic activities related to natural resources are commercial fishing, recreation, and tourism.

Land Management:
This ecoregion has a high level of private ownership relative to the rest of the state (32%). Most of the federal government's land is managed by the USFWS as Kodiak or Alaska Maritime National Wildlife Refuges. Shuyak Island State Park and Tugidak Island Critical Habitat Area make up less than 1% of the State of Alaska's holdings. The Kodiak Island Borough has jurisdiction over this ecoregion.

Table 28. Kodiak Island land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	<1.0%
Federal	USFWS	54.4%
Local	Local	1.2%
Private		32.1%
State	DNR	11.9%

Gulf of Alaska Coast
Area: 4,346,191 acres (1,758,879 hectares)

Landscape:
The Gulf of Alaska Coast ecoregion sweeps around the north Gulf coast, including lands from the Barren Islands off the south tip of the Kenai Peninsula, around the Gulf side of the peninsula, through Prince William Sound, and along the coast to the Yakutat Forelands. The rugged, ice-covered Chugach and St. Elias Mountains form the backdrop for these lowlands. Fjords and archipelagos characterize the western coastlines, while broad coastal plains, river deltas, barrier islands, and sand tidal flats define the shoreline east of Prince William Sound. The continental ice sheet and recurring glaciers carved deep fjords that

filled with seawater when the glaciers retreated, leaving broad U-shaped valleys, and well above current sea level, hanging glaciers. In the eastern part of the ecoregion, unconsolidated glacial, alluvial, and marine deposits have been lifted by tectonics and isostatic rebound after glacial retreat to produce a relatively flat plain. Most larger streams in this ecoregion originate in glaciers; in the eastern portion, silt-laden streams are low gradient and braided, terminating in broad deltas and wetlands. The prime example of this is the Copper River Delta, which at 700,000 acres, constitutes the largest contiguous wetland on the Pacific Coast of North America. Small lakes occur high in glacially carved valleys. Glacial outburst floods, land subsidence, isostatic rebound, and localized high wind events continue to dominate and influence landscape patterns.

Orca in winter, Prince William Sound USFWS

The marine environments of this ecoregion vary, from exposed coastlines to sandy barrier islands to deep fjords. In Prince William Sound, depths reach 800 meters and icebergs float at the base of tidewater glaciers. Tides are strong, and a large amount of fresh water flows into the ocean from this section of coast.

The cool, maritime climate brings extended periods of clouds and fog with abundant precipitation. The average annual precipitation ranges from 30 to 160 inches (76–206 centimeters). Mean annual snowfall varies from 80 to 600 centimeters. The average annual temperature also has a large range: 30 to 42 °F (–1 to 6 °C). Permafrost is absent from this ecoregion.

Abundant precipitation and braided streams keep organic soils on the flat plains saturated. Wetlands in these locations support black spruce muskeg, tall scrub communities, low scrub bogs, wet graminoid herbaceous communities, and wet forb herbaceous communities. Where soils are better drained along the shoreline and on mountain slopes, a lush temperate rain forest predominated by western hemlock and Sitka spruce grows. Cottonwood and alder stands occur along river valleys throughout the ecoregion, with birch occurring in valleys only in the Kenai Peninsula.

Figure 30. Gulf of Alaska Coast ecoregion

Wildlife and Fish:

Migratory birds find important stopover, nesting and feeding areas in this ecoregion. One of the most important shorebird stopover sites in North America is the Copper River Delta. Along with nearby Controller Bay (Bering River Delta), the area supports the largest spring concentration of shorebirds in the Western Hemisphere (Bishop et al. 2000). Thirty-six species of migrating shorebirds have been counted in the Copper River Delta alone, with the two most abundant species being Dunlins and Western Sandpipers. Waterfowl, passerine, and shorebird species of importance include an extremely dense population of Trumpeter Swans; the entire breeding population of Dusky Canada Geese; a sizable population of Aleutian Terns, Red-throated Loons, Harlequin Ducks, and Black Oystercatchers; a large concentration of Surfbirds each spring; and high nesting concentrations of Bald Eagles and Marbled Murrelets. Yellow-billed Loons and many species of sea ducks winter along the coast in Prince William Sound. Parasitic Jaegers are known to breed in the area, and Long-tailed Jaegers migrate through seasonally. Sensitive landbirds in the ecoregion include Olive-sided Flycatchers and Blackpoll Warblers.

Black Oystercatcher ADF&G

This ecoregion also hosts a diverse assemblage of marine species. Steller sea lions and harbor seals haul out on its rocky shores and icebergs, and sea otters forage along its shoreline. Cetaceans include Dall's and harbor porpoises and orca, fin, humpback, and minke whales; also, an isolated pod of beluga whales has recently been documented in Disenchantment Bay. Forage species, particularly herring, capelin, and sand lance, are abundant and form the food base for most marine fishes and seabirds. Marine invertebrates and fish, such as the many species of rockfish, inhabit many different niches in the Gulf. Important nutrients from the marine environment are transported to the terrestrial and freshwater ecosystems by returning salmon and by other marine life, such as forage fish, which can be carried inland by nesting seabirds.

The many streams and rivers support mainly Dolly Varden, coastal cutthroat trout, and all five species of Pacific salmon. Two species of lamprey occur on the Yakutat Foreland. Large runs of steelhead are found in the Copper River and in the Situk River near Yakutat. Small runs of steelhead are documented in the Doame, Akwe, Italio, Yahtze, Tsiu, and Kiklukh Rivers; Steelhead Creek (Lituya Bay); Humpback Creek; Manby Stream; and the Anhau Lagoon/Lost river system. Some number of steelhead probably inhabit just about every coastal stream along the Gulf in this ecoregion (Robert Johnson, ADF&G, personal communication). Alaska blackfish are known to occur in the Tsiu River, far south of their normal range. Sticklebacks are found in the brackish water margins between the glacial lakes and ponds at the headwaters of many streams.

Terrestrial mammals include snowshoe hares, black and brown bears, moose, mountain goats, and Sitka black-tailed deer. Moose were introduced to the Copper River Delta during the 1950s, and deer were introduced to Yakutat Bay islands from Sitka about 1950; both species have flourished. Furbearers include wolves, wolverines, coyotes, foxes, lynx, martens, mink, beavers, weasels, and red squirrels. The Montague Island vole is a large subspecies of tundra vole occurring only on Montague Island. Hoary marmots occur in a patchy distribution from sea level to alpine; sightings of Alaska marmot have also been reported, but visual identifications have not been confirmed with sampling (Robert Johnson and Phil Mooney, ADF&G, personal communication).

Two amphibians are found here: Wood Frog and Western Toad. As for reptiles, several Olive Ridley Seaturtle carcasses have washed ashore in this ecoregion over the years.

People:

Tlingit people have traditionally inhabited the eastern portion of the ecoregion, while Eyak, Chugach, and Koniag people settled in different parts of the west. Mainland dwellers subsisted on salmon, eulachon, mountain goats and, in very limited locales prior to introduction, moose. Island dwellers used more marine resources, including marine mammals, shellfish, salmon, herring, halibut, seaweed, and berries. Seward and Cordova are the largest towns.

Land Use:

Timber harvest, commercial fishing, and recreation are the primary economic activities related to natural resources in the area. Mining of metallic and nonmetallic elements and energy-related commodities also occurs. This area received substantial oil exploration activities, both onshore and offshore, in the 1950s through mid 1970s.

Land Management:

This ecoregion has a relatively high level of private ownership (19.7%). The federal government owns 63%. Due to the extensive east-west reach of this ecoregion, Wrangell-St. Elias, Glacier Bay, and Kenai Fjords National Parks and Preserves, as well as Tongass and Chugach National Forests, all intersect its boundaries. Most of the federal land here is managed as Chugach National Forest. The State of Alaska has designated several critical habitat areas, marine parks, refuges, and recreation areas here.

Table 29. Gulf of Alaska Coast land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	2.1%
Federal	NPS	8.1%
Federal	USFWS	<1.0%
Federal	USFS	52.9%
Local	Local	<1.0%
Private		19.8%
State	DNR	16.4%

Chugach-St. Elias Mountains

Area: 23,013,682 acres (9,313,510 hectares)
Alaska 85.2%, Canada 14.8%

Landscape:

The Chugach and St. Elias Mountains form a crescent behind the Gulf of Alaska coastline, reaching from the southern tip of the Kenai Peninsula around to the Fairweather Range in the Alaska Panhandle. These rugged mountains contain the largest collection of ice fields and glaciers outside of the polar regions.

Scott Glacier USFWS

Elevation ranges from 330 feet to more than 14,750 feet (100 to 4,500 meters) and greater, with huge ice fields, snowfields, and glaciers surrounding steep angular peaks. Small isolated peaks called nunataks jut from the middle of broad glaciers. Some glaciers still run all the way to tidewater, but where others have receded, broad U-shaped valleys with long lakes and deep fjords were left. The deeper soils in these valleys, formed from unconsolidated morainal and fluvial deposits, insulate isolated pockets of permafrost. During the summer, meltwater from the snow and ice flows along the base of the glaciers and eventually forms swift, short streams in valleys or inundates coastal flats. Only two rivers, the Alsek and Copper, breach these mountain ranges.

Ice and snow cover much of this ecoregion, and many peaks are covered with active scree, making snow and rock avalanches common disturbances. Where thin and rocky soils exist at some high elevations, alpine tundra of sedges, grasses, and low shrubs occur. Alder shrublands grow on slopes at lower elevations. Mixed forests of mountain hemlock and Sitka spruce occur in valleys.

The climate is transitional between maritime and continental, so temperatures tend to be cold and precipitation high. Elevation, latitude and geographic position determine local conditions. On the whole, the average annual precipitation ranges widely, from 12 to 160 inches (20 to 406 centimeters), increasing with elevation and from south to north. Similarly, the average annual temperature varies greatly throughout the ecoregion, from 24 to 40 °F (–4 to 4 °C).

Wildlife and Fish:

Due to the height of these ranges and the expansiveness of the ice fields, diversity of species in this ecoregion is low. The alpine tundra supports mountain goats, Dall sheep, hoary marmots, pikas, and ptarmigan. Moose, brown bears, and black bears forage on vegetated slopes and in valley bottoms. Dolly Varden, rainbow trout, Pacific salmon and steelhead are present in many rivers and streams. These river corridors also provide passage for migratory waterfowl and passerines.

People:

This ecoregion encompasses historic regions of several Native peoples, including Tanaina and Ahtna Athabascan, Alutiiq, Eyak, and Tlingit. Valdez is the largest town.

Land Use:

This ecoregion is almost entirely intact, with minimal development around several small communities, mine sites, and a few roads. Historically, mining has been the major industry. The Alaska portion of the ecoregion contains major transportation routes, has an active recreation and tourism industry, and is near the majority of the state's population. Timber harvest occurs in the Chugach Mountains. Subsistence harvest occurs throughout the ecoregion.

Land Management:

Almost 15% of this ecoregion is in Canada. Canada has included parts of this ecoregion in Kluane National Park and Tatshenshini-Alsek Provincial Park. The federal government manages 79% of the Alaska portion; management is shared primarily by the BLM, NPS, and USFS. Due to the extensive east-west reach of this ecoregion, Wrangell-St. Elias, Glacier Bay, and Kenai Fjords National Parks and

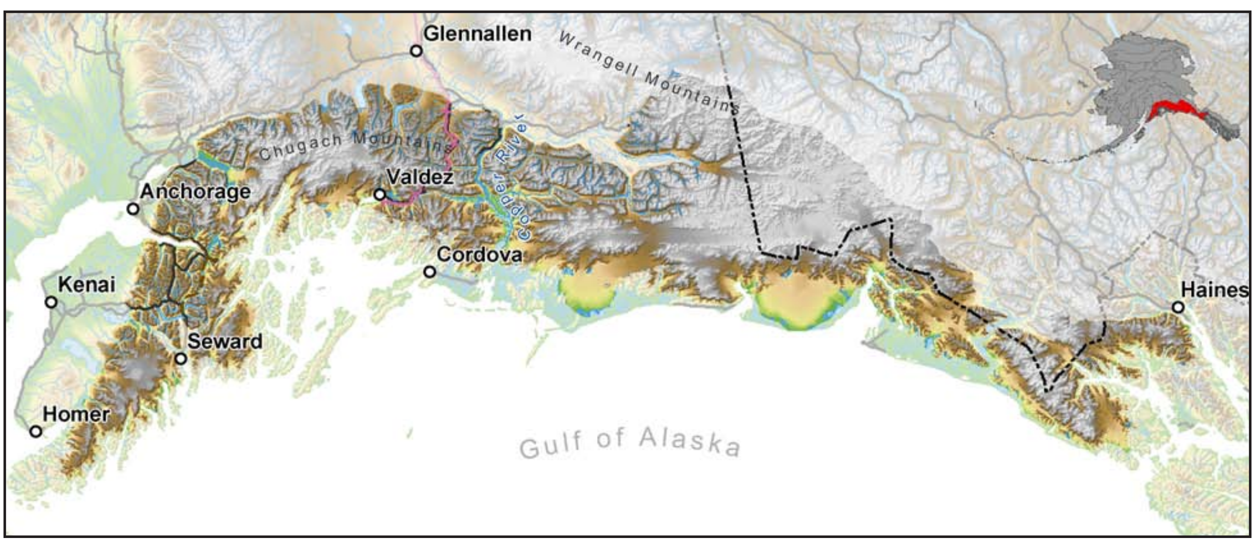


Figure 31. Chugach-St. Elias Mountains ecoregion

Preserves, as well as Tongass and Chugach National Forests, all intersect its boundaries. The State of Alaska has designated several state parks and marine parks here. The ecoregion falls in the jurisdictions of the Kenai Peninsula Borough, Matanuska-Susitna Borough, the City and Borough of Yakutat, and the Municipality of Anchorage.

Table 30. Chugach St. Elias Mountains land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	9.1%
Federal	NPS	43.6%
Federal	DOD	<1.0%
Federal	USFWS	4.1%
Federal	USFS	22.1%
Local	Local	<1.0%
Private		2.8%
State	DNR	18.1%

Northern Coast Mountains

Area: 10,448,214 acres (4,228,334 hectares)
Alaska 48.4%, Canada 51.6%

Landscape:

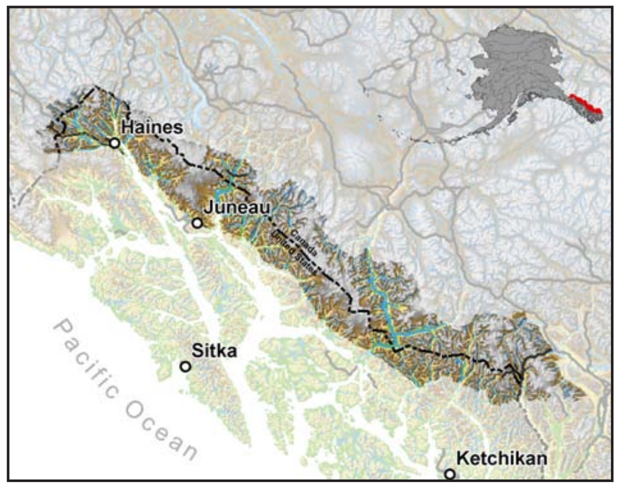


Figure 32. Northern Coast Mountains ecoregion

The Northern Coast Mountains ecoregion encompasses the rugged coastal mountain range that straddles the border between Alaska and British Columbia. During the Pleistocence, massive ice sheets covered these mountains. Today heavy winter snows still feed ice fields and glaciers in this ecoregion, but steep, rugged peaks, called nunataks, are exposed, and the retreating glaciers have left deep V-shaped and U-shaped valleys. Elevation in this ecoregion ranges from sea level to 9,840 feet (3,000 meters). During the summer, melting ice feeds swift streams and rivers to the coast. Two interior rivers pass through these mountains—the Taku and Stikine. This is also the southernmost extent of tidewater glaciers on the North American continent.

The transitional climate from maritime to continental results in large amounts of precipitation and surprisingly warm temperatures, given the extent of ice in the ecoregion. The average annual temperature ranges from 39 to 43 °F (4 to 6 °C), though frost is possible at any time of year. Precipitation varies from an average of 40 to 100 inches (102–254 centimeters). Avalanches occur often due to steep slopes and heavy snowfall.

Much of the land not under glaciers is barren rock or alpine tundra of sedges, grasses, and low shrubs. Dwarf and low scrub communities also occur, and Western hemlock, alpine fir, and Sitka spruce inhabit river valleys.

Wildlife and Fish:

This ecoregion provides habitat for a limited number of species. Mountain goats, hoary marmots, and ptarmigan live in the alpine areas. Moose, brown and black bears, coyote, lynx, wolverine, otters, beaver, and gray wolves inhabit the ecoregion, as do birds, including Vancouver Canada Geese, Trumpeter Swans, and Golden Eagles. The streams, headwater lakes, and rivers support large runs of five Pacific salmon species, which transport important, marine-derived nutrients back to the freshwater and terrestrial ecosystems and draw brown bears and other scavengers. Other resident and anadromous fish species in these watersheds include Dolly Varden, and bull, cutthroat, rainbow, and steelhead trout. Other anadromous fish include lampreys and eulachon. Large spawning concentrations of eulachon can occur during spring near the mouths of rivers, attracting large concentrations of Bald Eagles, gulls, and Steller sea lions.

Taku Inlet in winter J. Hyde, ADF&G

People:

This ecoregion is on the eastern side of the region traditionally inhabited by the Tlingit people. Juneau is the largest community in this area and the capital of Alaska.

Land Use:

Major components of the economy are tourism and recreation, government, commercial fishing, and mining. Historically, mining has been a major industry here, with open pit, underground, and some placer operations. Today, mining exploration and production occur primarily in the Purcupine district northwest of Haines, at the Kensington gold mine north of Juneau and, in Canada, at the Tulsequah Chief mine area located adjacent to the Taku River. Limited timber harvest occurs in the Chilkat River valley. Major transportation routes to the Interior extend from Skagway and Haines, promoting recreation and tourism. Subsistence harvest occurs throughout the region. In the Canadian portion, this ecoregion is almost entirely intact, with limited development along the Haines and Skagway Highways and at small mine sites.

Land Management:

Over half (51.6%) of this ecoregion falls in Canada. British Columbia has included part of it in Atlin Provincial Park. On the Alaska side of the border, the federal government owns almost 90%. The USFS manages the majority of the Alaska portion as the Tongass National Forest. The State of Alaska owns 10%, mostly located at the northwest end of the ecoregion, and has designated a state forest and critical habitats, preserves, and parks in the ecoregion. The ecoregion falls in the jurisdictions of the Haines Borough and the City and Borough of Juneau.

Table 31. Northern Coast Mountains land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	5.7%
Federal	NPS	<1.0%
Federal	USFS	83.6%
Local	Local	<1.0%
Private		<1.0%
State	DNR	9.9%

Alexander Archipelago

Area: 13,634,178 acres (5,517,676 hectares)

Landscape:

Figure 33. Alexander Archipelago ecoregion

The Alexander Archipelago is characterized by its temperate rain forests, long fjords, abundant islands, and maritime climate. Past glaciers carved deep, narrow valleys, which filled with seawater when the glaciers retreated. A few alpine glaciers still remain in broad U-shaped valleys at the heads of fjords, but most major glaciers have retreated to the adjacent ecoregions. Mainland rivers passing through this ecoregion typically start in glaciers farther inland. Elevations in this rugged ecoregion range from sea level to over 3,280 feet (1,000 meters), with rounded mountains and steep-sided angular mountains both present. Rolling moraine landforms dominate the hills and valley bottoms. Tectonic movement and the forces of rebound after glacier retreat have raised and lowered marine terraces, forming rich coastal lowlands and estuaries. The large rivers slow near the coast and end in broad deltas. Limestone underlies parts of the ecoregion, and karst topography of sinkholes, caves, underground streams, and fractured bedrock fosters high levels of endemism in plants.

Various disturbance regimes affect the landscape—localized intense winter winds topple coastal trees, frequent landslides and avalanches denude steep mountain slopes, and flooding recurs in streams and rivers. With many narrow passages for tidewaters to transit, tidal range and currents can be extreme.

The cool maritime climate sees relatively little seasonal temperature variation, large amounts of precipitation, mostly in the form of rain, and extended periods of cloudiness and fog. Mean annual precipitation ranges from 30 to 220 inches (76 to 559 centimeters), and the mean annual temperature varies from 33 to 46 °F (1 to 8 °C). The northern part of the ecoregion experiences the drier and colder weather.

The temperate rain forest, consisting primarily of western hemlock and Sitka spruce, reaches from the coastline to the steeper, rockier mountain slopes. Salal and western red cedar are also found in the southern parts of the archipelago. Mixed conifer, black cottonwood, and lodgepole pine occur on drier sites. Where bedrock is not exposed, the forest gradually transitions to shrublands and alpine tundra of mosses and sedges. Water-tolerant plants such as sphagnum moss, sedges, bog kalmia and shore pine occur in peat lands. Poorly drained soils support open muskeg and forested wetlands.

Wildlife and Fish:

The natural fragmentation of the archipelago has influenced species distribution and promoted a level of endemism high for Alaska. Furbearers such as river otter, marten, mink, weasel, beaver and red squirrels are on the mainland and some of the islands. Brown bears roam the mainland and northern islands, including Admiralty, Baranof and Chichagof, and some adjacent smaller islands. Black bears occur on the mainland and most islands south of Frederick Sound. Gray wolves occur everywhere in the ecoregion except Admiralty, Baranof, and Chichagof Islands and a host of inconsequentially small islands. Wolves are most abundant on southern islands of the archipelago (i.e., south of Frederick Sound), where they occur as an endemic subspecies, the Alexander Archipelago wolf. As a result of Southeast Alaska's unique island biogeography and variable glaciation through time, populations of many other endemic birds, invertebrates, and mammals, including Gapper's red-backed vole, occur here.

This ecoregion is also rich—in comparison to the rest of the state—for the presence of amphibians, including Rough-skinned Newts, Northwestern Salamanders, Long-toed Salamanders, Wood Frogs, Spotted Frogs, and Boreal Toads. When leatherback or green turtles follow the Japan or North Pacific currents north, there are also occasionally reptiles in this ecoregion. Additionally, there are five species of bats (little brown, long-legged, Keen's, silver-haired, and big brown), some of which also occur elsewhere along the Gulf of Alaska coast.

Chichagof Island T. Paul, ADF&G

The forests, estuaries, wetlands, and rivers provide rich habitat for birds and fish. Dolly Varden and cutthroat, rainbow, and steelhead trout occur here. Five species of Pacific salmon return to the streams each year, transporting important nutrients back to the freshwater and terrestrial ecosystems. Other anadromous fish include lampreys and eulachon. Spawning fish also provide rich food for bears, wolves, ravens, gulls, and the highest nest density of Bald Eagles in the world. Other birds include Vancouver Canada Geese, Trumpeter Swans, Red-tailed Hawks, Peregrine Falcons, Red-breasted Sapsuckers, Pacific-slope Flycatchers, Rufous Hummingbirds, Golden-crowned Kinglets, Varied Thrush, Red and White-winged Crossbills, Blue Grouse, ptarmigan, sandpipers, sea ducks, Black Oystercatchers, Common Murres, Tufted Puffins, Marbled Murrelets, Great Blue Herons, Western Screech-owls, and goshawks (Northern Goshawk and its subspecies, the Queen Charlotte Goshawk). Southeast Alaska encompasses the largest Marbled Murrelet population in the world; Marbled Murrelets are listed as threatened throughout their range south of Southeast Alaska.

Wood Frog USFWS

Sitka black-tailed deer are the most wide-ranging large mammal in the ecoregion. Mountain goats occur naturally on the mainland mountains and steep fjord coasts; due to introductions, they are also now found on Baranof and Revillagigedo Islands. Moose are primarily found in the mainland river valleys. Small mammals include northern water shrews, deer mice, and long-tailed voles. Humpback, gray, orca, and minke whales; Dall's and harbor porpoises; harbor seals; Steller sea lions; and sea otters inhabit the marine waters. The Forrester Island complex supports the largest Steller sea lion rookery in Alaska. Northern (pinto) abalone is abundant in the outside coastal waters.

People:

Human settlements occur almost entirely along the coastline in this ecoregion. The Tlingit and Haida Natives traditionally subsisted on salmon, moose, eulachon, mountain goat, herring, halibut, seaweed, deer, waterfowl, grouse, seals, clams, cockles, chitons, and edible plants, and many still maintain subsistence lifestyles today. The largest towns are Sitka and Ketchikan.

Land Use:

The major components of the economy are timber harvest and processing, tourism and recreation, commercial fishing, and mining. Greens Creek Mine, one of the nation's largest producers of silver, is located in this ecoregion.

Land Management:

The federal government manages 91% of this ecoregion, with management largely by the USFS. Tongass National Forest includes Misty Fjords National Monument. The NPS manages Glacier Bay National Park and Preserve. Some of the state-managed lands have been designated game refuges, critical habitat areas, state parks, marine parks, and recreation rivers, but altogether these small units make up less than 2% of the ecoregion. The ecoregion falls in the jurisdictions of the Haines Borough, Ketchikan Gateway Borough, the City and Borough of Sitka, and the City and Borough of Juneau.

Table 32. Alexander Archipelago land status

Owner	Agency	Percent of Ecoregion
Federal	BLM	<1.0%
Federal	NPS	6.1%
Federal	USFWS	85.0%
Local	Local	<1.0%
Private		5.7%
State	DNR	3.2%

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IV. Challenges for Wildlife and Fish Conservation

Not surprisingly, Alaska's wildlife managers face some formidable odds as we work to maintain the state's wealth of wildlife, prevent species from becoming listed as threatened or endangered, and keep common species common. Some of the challenges we face are unique to our geographic location, the dynamic landscape around us, and our lack of information and analytical tools. Others are common challenges that all jurisdictions face in protecting and conserving their natural biotic communities; these include minimizing impacts of needed development and properly managing existing conservation lands in the face of an increasing population of human users and limited fiscal resources.

All of these challenges factored heavily into the types of conservation actions experts believe would be effective in better conserving Alaska's wealth of wildlife. The specific conservation action plans that experts created for dozens of featured species and species groups are addressed in Section V (Conservation Action Plans), and relative priorities of conservation effort are addressed in Section VII (Primary Recommendations: Alaska's Greatest Wildlife Conservation Needs).

A. The Changing Natural World

Climate Change

At a time when the human population and demand for natural resources development are both expanding, so is the need to document, understand, and maintain the diversity of fish and wildlife species. For Alaska, this task will be complicated by the substantial biological response of natural systems to the climate changes expected here. Some physical changes Alaska is experiencing, such as rising average temperatures, thinning sea ice, and changing ocean circulation patterns, have been building or underway for at least a couple of decades (Anderson and Weller 1996). However, according to a newly released report described below, the Arctic—especially Alaska and the Canadian Yukon—is now experiencing some of the most rapid and severe climate change on Earth, and this trend is expected to accelerate over the next century.

Arctic Climate Impact Assessment (ACIA) Report

In November 2004, two working groups of the Arctic Council (Conservation of Arctic Flora and Fauna [CAFF]) and Arctic Monitoring and Assessment Programme [AMAP]), in conjunction with the International Arctic Science Committee, released a comprehensive assessment of the causes and consequences of climate change in the Arctic. Titled "Impacts of a Warming Arctic: Arctic Climate Impact Assessment," this 139-page summary document took four years to prepare and involved more than 300 scientists from the United States, Canada, Finland, Greenland, Iceland, Norway, Russia, and Sweden, as well as indigenous peoples' leaders in all eight countries.

Each country defines "Arctic" slightly differently: In Alaska, the Arctic boundary roughly corresponds to present-day treeline from about McNeil River on the west side of Cook Inlet, south to Kodiak and Afognak Islands, westward to the Aleutian Islands, then north and eastward to the Canadian border, together with the associated marine waters. To view a map, see: http://www.caff.is/sidur/sidur.asp?id=2&menu=about.

The ACIA report contains informative graphics and photos and specific examples illustrating climate change impacts in Arctic countries. The phenomena described include rising temperatures, river flows, and sea level; melting ice sheets and glaciers; thawing permafrost; increasing precipitation; declining snow cover; diminishing lake and river ice; changes in ocean salinity and circulation patterns; and retreating summer sea ice.

Significantly, the report describes projected impacts based on a moderate, not worst case, scenario of future warming. Even so, the changes it describes for the Arctic will be dramatic, contributing to major physical, ecological, social and economic impacts in Alaska and elsewhere.

Selected Key Findings: Effects on Alaska Wildlife and Users

The ACIA report's Executive Summary lists 10 key findings. Five findings (and selected bullets) pertaining directly to wildlife and fish, their habitats, and users of these species are provided verbatim below. These are followed by a discussion of anticipated effects in Alaska and neighboring parts of Arctic Canada. For the full text of the ACIA report, go to: http://www.amap.no/acia/.

Key Finding #1: Arctic climate is now warming rapidly and much larger changes are projected.

- Annual average arctic temperature has increased at almost twice the rate as that of the rest of the world over the past few decades, with some variations across the region.
- Increasing global concentrations of carbon dioxide and other greenhouse gases are projected to contribute to additional arctic warming of about 4–7 degrees Centigrade [10–18 degrees Fahrenheit] over the next 100 years.
- Increasing precipitation, shorter and warmer winters, and substantial decreases in snow cover and ice cover are among the projected changes that are very likely to persist for centuries.

Key Finding #2: Arctic warming and its consequences have worldwide implications.

- Increases in glacial melt and river runoff add more freshwater to the ocean, raising global sea level and possibly slowing the ocean circulation that brings heat from the tropics to the poles, affecting global and regional climate.
- Impacts of arctic climate change will have implications for biodiversity around the world because migratory species depend on breeding and feeding grounds in the Arctic.

Key Finding #3: Arctic vegetation zones are very likely to shift, causing wide-ranging impacts.

- Treeline is expected to move northward and to higher elevations, with forests replacing a significant fraction of existing tundra, and tundra vegetation moving into polar deserts.
- Disturbances such as insect outbreaks and forest fires are very likely to increase in frequency, severity, and duration, facilitating invasions by non-native species.

Key Finding #4: Animal species' diversity, ranges, and distribution will change.

- Reductions in sea ice will drastically shrink marine habitat for polar bears, ice-inhabiting seals, and some seabirds, pushing some species toward extinction.
- Caribou/reindeer and other land animals are likely to be increasingly stressed as climate change alters their access to food sources, breeding grounds, and historic migration routes.
- Species ranges are projected to shift northward on both land and sea, bringing new species into the Arctic while severely limiting some species currently present.

Key Finding #8: Indigenous communities are facing major economic and cultural impacts.

- Many Indigenous Peoples depend on hunting polar bear, walrus, seals, and caribou, herding reindeer, fishing, and gathering, not only for food and to support the local economy, but also as the basis for cultural and social identity.
- Changes in species' ranges and availability, access to these species, a perceived reduction in weather predictability, and travel safety in changing ice and weather conditions present serious challenges to human health and food security, and possibly even the survival of some cultures.
- Indigenous knowledge and observations provide an important source of information about climate change. This knowledge, consistent with

complementary information from scientific research, indicates that substantial changes have already occurred.

Not all regions of the Arctic will experience the same effects due to climate change; changes in certain regions will be more severe than in others. Although scientists have been documenting increased air temperatures over most of the Arctic (exceptions are eastern North America and Greenland), Alaska and the Canadian Yukon are particular “hot spots,” showing the greatest average increase in temperature of any areas in the Arctic: According to the Alaska Climate Research Center, average temperatures in the state rose 3.3 degrees Fahrenheit between 1949 and 2003 (Rozell 2005).

Not surprisingly, ACIA identifies the subregion containing Alaska, Chukotka, the Western Canadian Arctic, and adjacent seas as the area where biological diversity in the Arctic is most at risk from climate change. One reason is that this quadrant is home to the highest number of threatened species, many of which are plants.

Like the ACIA authors, experts in the CWCS planning process are concerned about the likelihood of significant declines in plant and animal species over coming decades. This includes species very specifically adapted to the Arctic climate (e.g., various species of lichens, mosses, voles, and lemmings; and predators, such as Arctic fox and Snowy Owl).

Some of the greatest concern is for species that depend on sea ice for one or more critical stages of their life history (e.g., polar bear, walrus, and four species of ice seal). Models have shown that sea ice thickness has decreased by 40 percent during the past 30 years, and the average annual extent of ice coverage in the polar region has diminished substantially, with an average annual reduction of over 1 million square kilometers. Scientists now expect that radical seasonal retreats and overall thinning of sea ice will cause the marine mammals (e.g., ringed seals) on which many indigenous cultures depend to decline, become less accessible, or possibly go extinct in the next century (NOAA website: www.beringclimate.noaa.gov).

Polar bear USFWS

Experts expect sea ice reductions to cause circulation and salinity changes that could provide advantages for some species and harm others. The ACIA report mentions Beaufort Sea research suggesting that the increasing layer of meltwater now found beneath multiyear ice may already have profoundly affected species of ice algae that form the base of the marine food web. The report contains an excellent illustration of the complex trophic relationships among ice-edge and marine plants, fish, birds, and mammals.

Coastal non-Arctic species may also be hard hit—due to melting of glaciers, both near the coast and well inland. Experts have been astounded at the rapid rate of glacial thinning and retreat in Alaska in recent decades. The ACIA report estimates that the projected contribution to global sea level rise by melting glaciers in Alaska is nearly double that of the Greenland Ice Sheet during the past 15 years. Ongoing sea level rise due to melting glaciers, and inundation of low-lying coastal areas, such as the Yukon-Kuskokwim Delta, may alter intertidal areas and harm invertebrate prey species populations important to migratory shorebirds, many of which are of national and international importance.

Other species likely to see significant ice melt-related effects are the species and species groups narrowly adapted to periglacial environments (e.g., Myctophids, a marine fish group; and Kittlitz' murrelets). As marine glaciers retreat inland, the sea-and-ice interface habitats required by these species disappear.

Destruction of ground surface and vegetation due to thawing of ice-rich permafrost and thermokarst formation, near Fairbanks.
V. Romanovsky, Geophysical Institute, UAF

Experts also expect Alaska's terrestrial landscapes and natural vegetative communities to be significantly altered. Alaska has more than 175 million acres of wetlands covering approximately 43% of the surface area of the state. Melting of permafrost beneath vast expanses of wetlands will alter hydrological flows and drainage patterns within and adjacent to wetland systems.

Mature old-growth forests are experiencing other forms of climate-related disturbance and loss, including increased occurrence of insect outbreaks and wildfire. Alaska's Kenai Peninsula and Canada's Tatshenshini and Kluane Lake areas have undergone historic levels of infestation and forest decimation by spruce bark beetles in the past decade. The numbers, acreage, and intensity (e.g., destructiveness to soils) of Interior Alaska forest fires have also increased. One ACIA projection suggests that, as a result of climate change, we can expect a threefold increase in total area burned per decade, with loss of coniferous forests eventually leading to a deciduous forest-dominated landscape, including on the Seward Peninsula, an area currently dominated by tundra.

Participants in the CWCS experts' meetings noted that a warming climate may benefit the distribution and/or abundance of some species currently at the edge of their range (e.g., trout-perch, which thrives in milder climates). Others expressed concern that climate change may increase the threat Alaska already faces from opportunistic nonnative species, such as Atlantic salmon (*Salmo salar*) and the

European green crab (*Carcinus maenas*), both of which are invasive species on the west coast of North America. However, they recognized that what is one day considered a nonindigenous or invasive (i.e., *harmful* nonindigenous) species may ultimately become a valued replacement for other species whose ranges shift farther northward. For more information on concerns with nonindigenous and invasive species, see Section IV(C), under "Introduced, Nonindigenous, and Invasive Species."

Projected to persist for centuries, the climate change affecting Alaska is likely to have significant impacts on the distribution and abundance of many species, especially those narrowly adapted to their environment or otherwise at risk (e.g., from human disturbance, such as oil spills and habitat fragmentation). Over time, we can also expect to see climate-related shifts in the timing and location of key events we associate with harvest opportunity, such as diurnal movements and seasonal migration.

Physical access to many species may also be affected. Due to thinning and loss of sea ice, Native elders report that hunting of marine mammals is noticeably more dangerous and less productive today than in the past. People in pursuit of other species also face increased travel difficulties over time, e.g., as tundra areas become covered in chest-high brush, and as thawing of permafrost degrades and alters existing travel routes and infrastructure.

Tectonic and Isostatic Uplift

Alaska is located on the seismically active north Pacific rim, where expanding plates of the Earth's crust collide and descend below the North American continent. The pressures this creates are released in the form of volcanic and earthquake activity. With the exception of the Wrangell volcanoes and Mt. Edgecumbe in Southeast Alaska, most of the state's active volcanoes occur in an arc that includes the entire Aleutian Island chain eastward to Mt. Spurr, opposite Anchorage. Volcanic activity can cause sudden, cataclysmic change in surrounding ecosystems. However, subsidence and uplift of the earth's surface due to earthquakes and deglaciation probably has a greater overall effect on the abundance, diversity, and distribution of fish and wildlife.

In addition to causing earth tremors, differential slippage of tectonic plates along geologic faults often results in vertical and horizontal displacements of the earth's crust. During an earthquake, wide swaths of terrestrial or benthic habitat can suddenly be jolted to a different elevation, causing displacement or loss of the wildlife populations and habitat types that had been present.

The Great Alaska Earthquake of 1964 (Richter magnitude of 9.2) caused notable changes in land level over an estimated 70,000 to 110,000 square miles (180,000 to 285,000 square kilometers), much of it on and adjacent to the continental shelf. Five-mile long Middleton Island, located 160 miles southeast of Anchorage in the Gulf of

Alaska, rose by 12 feet and gained more than 1,000 acres of shoreline—a boon to ground-nesting shorebird populations, but devastating for cliff-nesting seabirds such as kittiwakes, whose chicks could no longer flutter directly into the ocean.
Uplift measurements along the coast of the Gulf of Alaska averaged 6 feet (1.8 meters), with elevation gain on the seafloor adjacent to Montague Island recorded as 38 feet (11.5 meters), but estimated to have been as much as 50 feet (15.25 meters) in places. Such large changes in seafloor elevation would have significantly altered the composition of benthic communities if it caused uplift into, or subsidence out of, the photic zone (ocean depths penetrated by light).

The degree of subsidence in the affected region was less, averaging 2.5 feet (0.75 meter). A maximum subsidence of 7.5 feet (2.25 meters) was measured along the southwest coast of the Kenai Peninsula (Alaskool website). Evidence of subsidence can easily be seen from the highway at the south end of Turnagain Arm, in the form of standing dead trees—the remnants of forests killed by an altered tidal regime.

During the 1964 earthquake, Prince William Sound experienced both vertical and horizontal shifts along some sections of the coast. These changes are believed to have caused many formerly anadromous streams and stream reaches to shift course and/or become impassable to upstream migrants, limiting the range of some fish stocks.

A change in substrate elevation can occur rapidly, as in an earthquake event, or more gradually, e.g., through isostatic uplift. This term refers to the gradual elevation rise that occurs as land is relieved of the weight of retreating glaciers. This process is occurring in many places around the state, including in and around Glacier Bay National Park. At nearby Gustavus, 3,210 acres of former tidelands were recently purchased by a coalition of private interests including The Nature Conservancy. Of that amount, 1,439 acres were donated to the State of Alaska for eventual expansion of the Dude Creek Critical Habitat Area, the largest expanse of undisturbed wet meadow habitat in the region and a key resting area for migrating Lesser Sandhill Cranes.

Not far away, the Mendenhall Wetlands State Game Refuge in Juneau is experiencing an uplift rate of about 0.6 inches per year (Hick and Shofnos 1965, cited in Armstrong et al. 2004). Recent surveys show that composition and location of key vegetation types, and bird species' distribution on the refuge, are changing as a result. In many places, "high marsh" complexes dominated by grass species have replaced the sedge-dominated low marsh communities. Migrating Pipits and Longspurs favor the former, while the latter is nutritionally critical for waterfowl such as Vancouver Canada Geese, which graze on sedge sprouts in the spring and sedge seeds in fall (Armstrong et al. 2004). Habitat succession and use studies can help identify areas important for wildlife resources.

Ongoing climatic change, tectonic shifts, and isostatic uplift highlight three important conservation and management needs for Alaska. These are to: 1) assess species distribution, abundance, and habitat use, and the potential impacts to wildlife from climate and tectonic change; 2) institute robust long-term monitoring programs to document baseline and changing conditions for species, species assemblages and ecosystems; and 3) build capacity in terms of data management, mapping, and GIS tools available to assist fish and wildlife managers, as well as development interests.

Other needs are to identify and better manage key habitats, including existing conservation units used by poorly known and at-risk species, and to educate the public about observed or predicted changes in wildlife populations and their habitats. Together with these needs come unique opportunities. For example, by placing informative time-series photo displays along roadsides and trails, Alaska could market itself not only for its wildlife values but also as a fascinating and accessible laboratory on tectonic climate change.

Wildfire

Fire is a natural phenomenon affecting the Alaskan landscape. Across the state, lightning starts approximately 200 fires per year, and human actions cause about 400 more. Historically, the natural fire cycle of Interior Alaska has burned 1.5 million–2.5 million acres each year, or about 1 percent of the landscape. However, as noted above in the ACIA report's Key Finding #3, the frequency, severity, and duration of forest fires in the state are expected to increase.

Periodic wildfires generally benefit wildlife. Because wildfires typically burn erratically, they leave a patchwork of vegetation across the landscape. This mosaic pattern is the key to habitat diversity because it maintains multiple stages of forest succession. Some species thrive in the new growth that comes after a fire, while others need the patches of older unburned forest that are left standing after a typical wildfire. Some species use both types of habitats, but need them at different times of the year or for different life stages.

Mosaic pattern in vegetation after wildfire
BLM, Alaska Fire Service

Although many animals can escape fire by fleeing or by hiding underground, some die when the forest burns. Those that remain usually thrive in the years and decades after a fire. For instance, the black-backed woodpecker moves into recent burn areas, where it eats bark beetles that invade the dead and dying trees. Major historic fires have created unparalleled improvements in habitat for moose and bison. Periodic fires also provide benefits by clearing fuel and creating natural fire breaks, thus reducing the risk of more intense, damaging fires.

Land managers sometimes try to simulate wildland fires through prescribed burns. This is occasionally used as a management tool to enhance wildlife habitat. At other times, the intent is to manage forest fuels, thus helping to prevent more intense and potentially dangerous fires, especially around areas inhabited or otherwise valued by humans.

Despite the potential benefits of wildfire, many fires in the state are purposely extinguished because of concern for human safety, private property, and commercial timber. While concerns for human safety and private property must always come first, not allowing wildfires to burn can cause unnatural aging of the forest and loss of the typical habitat mosaic and associated wildlife species that previously occupied the area.

Vulnerability of Species with Restricted or Limited Distributions

Natural changes and other factors can cause a species to have a limited distribution within an area or within the state. Similarly, a species may have a limited distribution year-round or during a particular season, such as the breeding season.

Spatially and temporally restricted species are generally considered more susceptible to threats and more vulnerable to extirpation and extinction than species that are common and broadly distributed. Unpredictable events are much more likely to have a critical impact on a species when a large proportion of the population is concentrated in a few locations. Species with restricted ranges may be catastrophically affected by predictable or random threats such as:

- changes in climate (extreme weather, severe storms, flooding, temperature regime shift);
- natural disasters (wildfires, earthquakes, volcanoes, tsunamis);
- industrial contamination (oil spills, toxic discharges, pesticides);
- introduction of exotic predators or competitors;
- changes in interspecific interactions and trophic relationships (predation, competition, disease, trophic regime shift);
- human overuse (unsustainable harvest and poaching);
- natural or human-related habitat alteration and loss.

A number of factors may exacerbate the vulnerability of species with limited distributions. Small population size, low reproductive potential, slow rates of population growth, long generation time, highly variable or cyclic populations, poor dispersal or colonization capacity, and narrow niche specialization all contribute to the susceptibility of a species to extirpation and extinction.

Both spatial and temporal elements must be considered when evaluating any species' range and vulnerability. Some species, such as island endemics and so-called "sky island" (i.e., mountain top-restricted) species, have a generally limited spatial distribution: The entire population is always concentrated in a limited space. For other species, the restriction in range may only occur at specific times during their life cycle, as is the case for most migratory and colonial breeding species.

The conservation of species with restricted ranges depends on the protection of key habitats and the management of potentially deleterious human activities at those times and locations a species is most vulnerable. Due to the general paucity of available information, survey, inventory, and monitoring efforts are vital in Alaska to define the distribution and abundance of a vast number of species and assessing their vulnerability. In many instances, research will be necessary to elucidate the likely or potential threats facing a species during each life stage (e.g., breeding, rearing, nesting, refugia).

B. Lack of Shared Information and Understanding

Natural phenomena, many of them largely out of human control, pose unique challenges for Alaska's wildlife managers. Other challenges result from the size and remoteness of the state, coupled with the expense and logistical difficulties of conducting inventory, research, or monitoring efforts.

Fish sampling using beach seine
F. DeCicco, ADF&G

While there are many good examples of existing data and information sharing, this section was developed to look at the difficulties we face from lack of information about species and habitat associations. We encourage incorporation of existing traditional and local user knowledge into Alaska's toolbox for species conservation. This section describes our lack of spatial data and data management systems and provides suggestions for addressing some major needs. It ends with a discussion of the substantial conservation benefits to be gained through targeted education and outreach efforts to Alaskan residents and visitors.

Lack of Information about Species or Habitats

A serious impediment to the goal of better conserving broad arrays of species is the dearth of readily available information on most Alaskan species and their associated habitats. To date, much of our existing information focuses on game species and economically important fish species. We have focused little scientific attention on the nongame wildlife resources of the state, including invertebrates, amphibians, fish, birds, and the smaller mammals.

Information sources on these nongame species do exist, however: Alaskans engaged in subsistence activities possess a wealth of information about the life histories, preferred habitats, and changing conditions of the species they use. This knowledge, generally passed orally from generation to generation, is often referred to as traditional knowledge. Such sources exist, especially among Native elders and leaders, in communities across the state. Other sources of valuable information on CWCS species are commercial fishermen and long-established sport and commercial guides. For example, herring fishermen are acutely aware of seabird and marine mammal activity and often use these species to help locate targeted fish species and determine imminence of spawning. They also frequently have detailed timing and behavioral observations of species such as shorebirds and sea ducks that forage on herring eggs. Residents who hunt, trap, and fish often have valuable observations to share based on many years of activity in Alaska's wild lands and waters.

At expert meetings held during our planning process, we asked participants to provide ideas on how best to present relevant species distribution and abundance data. Many of them expressed concern about the lack of scientific data on a large number of the CWCS' potential target species and the high costs of gathering basic data on species distribution, abundance, trends, threats, and habitat parameters. Many also expressed concern about Alaska's lack of data management infrastructure, including GIS capability (see following subsection).

A key recommendation coming from scientists and other CWCS planning participants is to tap the network of knowledge that resides with Native Alaskans and other long-term resource users. Another was to promote and facilitate meaningful participation by remote communities in monitoring and sharing information about the species they use. This knowledge and information can then be combined with Western scientific data to better conserve and manage Alaska's diverse resident and migratory species.

Lack of Spatial Data, Data Systems, and Compatible Terms

During development of the CWCS, ADF&G identified a number of management tools that were either partly or entirely unavailable for our efforts. It will take a high level of commitment by all state and federal agencies, as well as other conservation-oriented organizations, to make progress in this arena to the benefit of our future management efforts.

In this first Alaska CWCS, we did not attempt to work with area-or species-specific spatial data. Species information from the AKNHP "Biotics 4" database was incorporated whenever practical. (Biotics 4 is the newest generation of NatureServe's biological data management software.) Also, ADF&G provided SWG program funding to the AKNHP to summarize recent information on species, and to provide current state status ranks for them. Status ranks reflect the species' vulnerability and range, from S5 "Secure" to S1 "Critically Imperiled."

ADF&G also was unable to incorporate certain themes in as much depth as we would have liked, but these will be incorporated into future iterations of the Strategy. These themes are species migration patterns, a systematic analysis of data gaps in species' distribution information, cultural and subsistence information, and traditional knowledge of our indigenous peoples. Future iterations of the Strategy should also compile information on collaborative efforts with other states (Washington, Oregon, California) and countries (Canada, Mexico, Russia, Japan) that manage habitats used by wide-ranging and migratory Alaskan species.

Spatial Data

Sound management and conservation of species requires spatial data. However, the development of detailed land cover data layers is in its infancy in Alaska, and challenged by the size of the state; this problem is even more overwhelming when applied to the marine environment. Even when data exist, different thematic classifications and resolutions hamper integration across regions. In addition, a consistent boundary between terrestrial systems and coastal waters is often lacking. Most existing systems lack accuracy assessments. Spatial data are generally lacking for distribution of nongame animals, including those living in benthic, subtidal, and intertidal ecosystems. Participants in our planning process found that available data was often at a coarse scale, incomplete, or in need of expert review and updating. Preferred habitats of nongame species generally are also unknown, so habitat models cannot be developed. Because the state and its component ecoregions are so large, it is more practical to use coarse-scale information because it tends to be more comprehensive. Assessment at this scale provides needed ecological context for the species we want to manage, but its utility for finer-scale land management decisions is limited. Typically, some areas in an ecoregion have been studied more intensively than others, creating disparities in the quality, type, and scale of data available.

Land status data also exists at a very coarse scale. For other than municipal lands, spatial data at the section level tends to miss most private lands, including lands owned by Native corporations, individuals, and local governments. Even if this level of information were available, there is no consistent framework for applying conservation status categories, such as those used by the USFWS GAP program or IUCN, to Alaska’s unique land laws and diverse management prescriptions for federal, state, and private lands. Spatial data regarding land use is incomplete. In some ecoregions, comprehensive road coverage is unavailable requiring data sets to be stitched together even though scales and resolutions vary widely. Much of the infrastructure data related to the oil industry is considered proprietary, and thus unavailable. Data sets for locations of ports, shipping routes, primary trails, ice roads, and tundra scars are inadequately mapped or not readily available. No one agency holds data for active oil and gas leases, so data sets must be compiled from private, state, and federal entities. Human impact information could be improved by translating printed information, like that compiled in the recent report “Cumulative Environmental Effects of Oil and Gas Activities on Alaska’s North Slope,” published by the National Academies Press, into a spatial format.

Spatial analysis, under the broader discipline of “landscape ecology,” has tremendous power for understanding how patterns in the physical, biological, and cultural landscapes influence and interact with ecological processes. Landscape ecology includes spatially explicit modeling of habitat quality based on species occurrence or biological fitness and the subsequent prediction of how proposed human developments, which often fragment natural habitats, may influence species

distribution or abundance in other areas. Expansion of this capacity is particularly important for conservation, because decisions on resource development often must be evaluated based on limited or nonexistent data, but in a timely manner.
In recent years, greater emphasis has been placed on documenting the observations and knowledge of Alaska Natives and rural residents. Yet effort is still needed to archive and manage this information for both ongoing and new projects. Standardized data management protocols are needed to ensure that projects are complementary and that research results are preserved. In addition, the information should be managed in ways that make it available to rural communities and the people who contributed it. Currently, the proposed Arctic Peoples' Observation Center (APOC) provides one example of a central data portal providing data management service and networking service related to the knowledge of Arctic peoples. APOC is designed to serve indigenous knowledge projects and Arctic communities by developing new management systems for data in nonnumerical formats, such as video, audio, maps, artwork, photographs, and context-specific data, such as interviews and recorded oral histories. Linkages with this effort might create a synergistic effect for the CWCS and conservation activities of many partners.

Birds

Of all taxa covered in the Strategy, the greatest amount of data exists for birds. Among the different groups of birds, data are most available for migratory landbirds, raptors, shorebirds, and waterbirds. Densities for nesting and breeding are known for many species through existing surveys such as the USFWS Aerial Breeding Pair Surveys, annual Breeding Landbird Surveys, and ongoing raptor monitoring efforts of USFWS, NPS, BLM, and ADF&G. Other sources, such as the USFWS Seabird Colony Catalog, are in need of updating. The Seabird Colony Catalog is only useful for those species that are colonial nesters and does not include very reliable information on species with dispersed breeding populations.

In general, we lack information about the locations and use of habitats by many bird species outside their breeding and nesting season. Migratory stopovers and routes have not been mapped, or data are not easily accessible, although coastal migration sites and routes of shorebirds have been identified. The distribution of some birds remains unknown, except for anecdotal information and studies in small areas. Studies resolving genetic issues, particularly of island endemics, are typically lacking. The water quantity and quality needs of all birds, especially those that directly depend on waterbodies for nesting, feeding and other activities, are not well understood.

Most breeding landbirds in Alaska are not adequately sampled by any of the continental monitoring programs currently used throughout the rest of North America. Basic information on the distribution of species, their habitat associations, population sizes, and trends is lacking. Several well-established and widely accepted methodologies used throughout the conterminous United States and southern Canada provide insufficient coverage and potentially biased information in Alaska. For example, the USFWS and Canadian Wildlife Service North American Breeding Bird Survey routes are restricted to the existing road system, which covers only a tiny fraction of Alaska's area and available habitats. The Audubon Society Christmas Bird Counts are largely clustered in the small fraction of urban areas in the state and miss a large percentage of potential winter habitats. The Monitoring Avian Productivity and Survivorship (MAPS) program, developed by the Institute for Bird Populations, has been useful in documenting changes in population, productivity, and survival for large numbers of birds in most of North America, but is only able to detect a statistically significant change in these parameters for a handful of species in Alaska. In an effort to address traditional program limitations, Boreal Partners in Flight and USGS developed the Alaska Landbird Monitoring Survey (ALMS) to monitor long-term trends in breeding landbirds in all ecoregions of Alaska. ALMS is a statistically rigorous, standardized methodology based on a stratified random sampling design. Despite a 2004 Memorandum of Understanding among ADF&G, USFS, USFWS, USGS, BLM, NPS, AKNHP, Alaska Bird Observatory, and Audubon agreeing to support and execute the ALMS, greater participation and sampling will be required in order to detect significant population changes for most landbirds in Alaska.

Terrestrial Mammals

Northern flying squirrel J. Nichols, ADF&G

The distribution of many small terrestrial mammals remains unknown except for anecdotal information and isolated studies in small areas. Specific habitat use and migratory movements of most mammals have not been mapped. It may be more appropriate to model these habitat uses and migratory routes once adequate land cover data are available. There is a need for additional understanding of the genetic relationship among island endemics and their taxonomic status.

Marine Mammals

Areas of open water, including leads and polynyas, are important habitats for marine mammals, but they have not been reliably mapped. Haulout locations have been mapped for many marine mammals, but recent data about their use is lacking, and habitat use information for other portions of a species' life cycle is typically unavailable. Movement patterns and haulout locations of some marine mammals are difficult to map due to their relationship to ice. The Alaska Habitat Management Guides (circa 1985) are available for some species (e.g., ringed seals), but were not incorporated into the CWCS because they are now outdated. The Guides need to be updated and thoroughly reviewed by biologists to reflect current knowledge. Because of the changing habitat conditions for many marine mammals (e.g., timing and extent of sea ice), defining and mapping consistent concentration areas will remain a challenge. The influence and effects of freshwater input on the estuarine environment and forage species of marine mammals is not well known in Alaska.

Fish and Aquatic Invertebrates

Information on life history, species distribution, and habitat associations of nongame freshwater fish is virtually nonexistent in Alaska. Some information about habitat use and distribution can be gleaned from the ADF&G Fish Distribution Database, which includes the Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes and its associated atlas. However, less than 50% of the streams, rivers and lakes actually used by anadromous species have been documented across the state. Another problem is that the database does not provide specific habitat data for river segments or data regarding nonanadromous resident fish species distribution. Freshwater data, such as stream habitat information, is sparse and disjunct. As a result, smaller lakes and lakes directly or seasonally connected by rivers are not always represented on larger scale maps, such as 1:1,000,000. Hydrologic Unit Classification (HUC) data currently available from the USGS may help refine this spatial data.

Known locations of many aquatic invertebrate and vertebrate species primarily result from opportunistic inventories and not from comprehensive surveys. The locations of overwintering areas used by invertebrates and resident fish, including springs, deep lakes or side channels of rivers, are not generally known for most watersheds in the state. Data on spawning and rearing areas and refugia sites are also poorly known. Since the early 1980s when the Alaska Habitat Management Guides were written, there has been no central repository for the fish habitat data of agencies and nongovernmental organizations.

The mayfly *Rhithrogena*
D. Gregovich, ADF&G

Amphibians
Specific habitat use, including water quantity needs, and dispersal pathways, of most amphibians have not been mapped. It may be more appropriate to model these once adequate land cover data are available. The distribution of many amphibians remains unknown except for anecdotal information and isolated studies in small areas. Conclusive studies resolving genetic issues, particularly of island endemics, are typically lacking.

Terrestrial Invertebrates
Similar to other taxonomic groups, there is an absence of general and site specific knowledge about species. The habitat use and distribution of most species remains unknown except for anecdotal information and studies in small areas.

Ecological Systems
In the absence of information about species and habitats, ecological systems can act as surrogates. To facilitate this in Alaska, resources need to be devoted to developing terrestrial, freshwater, marine, and coastal ecological system classifications and maps for the various ecoregions. The classification of ecological systems as an alternative to the long-term process of filling information gaps for every species should help the state improve decision-making and move more quickly with on-the-ground actions.

Management decision making might also benefit by increasing scientific data on relevant geographic, climatic, and hydrologic factors.

Better resolution and/or coverage of digital elevation models (DEMs), geology, hydrology, hydrography, and glacier data sets would improve the compatible fish, wildlife and habitat resource selection models. When completed, the USGS National Hydrography Dataset (NHD) will provide detailed hydrologic information on water bodies throughout Alaska for evaluating aquatic ecosystems and the many species that depend on them. The state has recently begun using the NHD over the previously used DNR hydro data set for GIS applications. Biological inventories, aquatic resource assessments, ecological change detection programs, regulatory environmental impact and compliance evaluations, and accurate and precise hydrological monitoring and modeling all require digital, georeferenced mapping.

An ongoing need is to prioritize "at-risk" waterbodies across the state and, based on those results, provide adequate instream flow/water volume protection (quantity and quality) based on their importance for fish and wildlife. Such efforts are critical to sustaining ecosystem functions important for both aquatic species and terrestrial species that depend on water resources for survival.

Recommendations to Collaboratively Address Gaps and Needs

The efforts of ADF&G benefited significantly from the input of numerous other governmental agencies, nongovernmental organizations, academia, residents, Native organizations, and consultants. Continued collaboration among stakeholders and future involvement of landowners and industry will help identify and address important data gaps and provide useful information for land use and management decisions affecting Alaska species.

Following are some suggestions for addressing data issues across multiple cooperators and taxonomic groups:

a) Reconvene CWCS stakeholders and invite additional experts to review preliminary results and prioritize data gaps; develop shared research and inventory agendas among stakeholders.
b) Support USGS GAP in developing digitized species range maps showing gaps and uncertainties, land cover maps showing vegetation classifications, and stewardship maps that show conservation status and level of management; similar information is needed for coastal, marine, and freshwater systems.
c) Explore other tools for increasing data capacity through the use of model-based predictions of species distribution and abundance, GIS platforms, such as the Global Biodiversity Information Facility (www.gbif.org), and related approaches.
d) Increase capacity of ADF&G in spatial database management and information sharing for all species under its jurisdiction in cooperation with the Alaska State Geo-Spatial Data Clearinghouse (http://www.asgdc.state.ak.us/)
e) Encourage ADF&G and partners to share spatial data and its associated metadata on the Internet, possibly through University of Alaska Fairbanks, which now coordinates a Geospatial Metadata Server (GMS: http://www.geo.ed.ac.uk/~anp/gms/main.htm). Develop and maintain

department website for this purpose, perhaps similar to the NPS Alaska Region Inventory and Monitoring Program (http://www.nature.nps.gov/im/units/AKRO/index.htm).

f) Update the species and information in the Alaska Habitat Management Guides (1985), e.g., by first digitizing the range maps to provide baseline spatial data on species distribution that could be easily updated with current knowledge.
g) Translate written, tabular, and other database information into a spatial context; as part of this, direct effort toward gathering traditional and local user knowledge and integrating it, along with Western scientific knowledge, into accessible databases that include spatial components whenever possible and appropriate.
h) Explore options for developing data in nonnumerical formats, linking with existing projects as appropriate, to enhance communication with rural communities and Alaska Natives.
i) Assess importance of Alaska to/for individual species (i.e., what percent of each species' range occurs in Alaska); identify key ecological attributes of species and habitats and select monitoring targets at differing scales (circumpolar, ecoregion, landscape, habitat) and for different purposes (e.g., detection of invasive species introductions, modeling of habitat effects due to climate change).
j) Collaborate with existing international monitoring and biodiversity protection efforts, e.g., the circumpolar biological diversity working groups operating under the auspices of the Arctic Council (see Section VIII).
k) Develop uniform/integrated marine (including benthic and nearshore), coastal, and freshwater classification systems.
l) Complete detailed assessments and descriptions for each of the state's ecoregions.
m) Complete regional habitat assessments (system types), and evaluate habitats that are important or limiting for a species (i.e. boreal forest, Arctic tundra); identify the percentage of important habitat types already in conservation status.
n) Develop statewide habitat maps, which include the means to track and report on cumulative changes resulting from climate change, habitat alterations, contaminants, etc. The maps also could help determine regional conservation priorities.
o) Conduct connectivity analyses with emphasis on dispersal and migration routes (e.g., for birds, whales, mammals, amphibians, anadromous fish); identify and compile information on routes and timing of use, and provide to decision-makers.
p) Develop an operational plan for increasing our knowledge about distribution, abundance, habitat requirements, and life history of nongame species.
q) Develop MOUs and partnerships covering such areas as:
    - Protocols for data sharing (e.g., national and international LTER programs);
    - Monitoring networks;
    - Partnering networks (models include those used under the Exxon Valdez Oil Spill [EVOS] Gulf Ecosystem Monitoring [GEM] program, Alaska

Ocean Observing System [AOOS], and North Pacific Research Board [NPRB]);
- Management of Traditional Ecological Knowledge;
- Regional partnerships like the North Slope Science Initiative (NSSI).

r) Assess the types of information decision-makers in Alaska currently have available; identify needs and products that would improve the decision-making process.

s) Work with other partners to support a single, statewide database that includes a spatial component and makes species information available to managers, planners, and developers.

t) Continue participation in the existing statewide species working groups, such as Boreal Partners in Flight, to coordinate conservation efforts; explore needs and options for formation of new groups.

u) Continue to add species information to the AKNHP Biological Conservation Database (BCD) and update species status ranking information (i.e., how imperiled are some of Alaska's species according to national/global ranking protocols).

Insufficient Public Understanding About Fish and Wildlife Needs

Enhancing Alaska's data collection, management, and presentation infrastructure are critical elements in providing long-term conservation of its species and habitats. In reality, many years will probably elapse before this state acquires the level of coverage and capability, including training in cutting-edge analytical tools, that land use and wildlife managers employ in other states. In that time, Alaska's population and its influx of seasonal visitors are expected to increase, further complicating the task for Alaska's natural resource managers.

According to the Alaska Department of Community and Economic Development, nearly 1.3 million visitors arrived in Alaska in 2002, a 6 percent increase from the previous year. Also, Alaska saw a 55.4% increase in numbers of summer visitors from 1994 to 2004. If the same growth rate applies in the coming decade, by 2015 Alaska will be hosting nearly 2 million visitors each summer. Meanwhile, the numbers of state residents is expected to increase at a rate of 1.0 to 1.5% annually; a portion of this increase may be due to visitors and military personnel who decide to make Alaska their home.

As elsewhere in the nation, a growing percentage of the state's population will be senior citizens. For the past decade, the rate of growth of the over-65 population in Alaska was second only to that of Nevada (Goldsmith 2004). The state's urban areas will continue to see a large influx of Alaska Natives moving from rural places (Goldsmith 2004). Given that people 19 and younger make up 44% of the Native population (compared to 29% of all Americans), a large number of Native immigrants to Alaska's urban centers will likely be school-age (Goldsmith 2004).

Fostering informed decision-making and involvement in conservation and management issues is important to achieving the goals of the CWCS and avoiding degradation of fish- and wildlife-related opportunity. The public, elected officials, and other decision makers will take actions that influence conservation positively or negatively, based on the level of understanding they possess. However, there are many challenges to reaching these audiences with information and education that will enable them to assist in conservation efforts.

Reaching remote villages throughout Alaska requires use of various forms of media, partnerships with multiple tribal entities, and effective cross-cultural communication. As conservation needs for various species change, these outreach efforts are crucial to keeping large numbers of people who interact directly with fish and wildlife updated and engaged in actions addressing those needs.

Sampling invertebrates in the Chena River
ADF&G

The education and outreach (EO) efforts conducted by ADF&G, other agencies, and nongovernmental organizations constitute an essential tool for achieving better conservation of Alaska’s diverse wildlife resources. EO programs result in:

- increased public knowledge about basic biological concepts, ecosystem relationships, and wildlife conservation principles and regulations;
- increased understanding of the natural and human processes occurring in Alaska’s terrestrial, riparian, freshwater, coastal, estuarine, and marine environments;
- opportunities for citizens, including through “citizen science” initiatives, to help gather needed traditional knowledge or scientific data, and monitor trends in species, species assemblages, and habitats; and
- public support for, and participation in, scientifically based decision-making about species and the habitat elements needed to produce them.

Implementing a comprehensive statewide strategy offers opportunities for outreach to, and involvement of, many constituencies. For example, encouraging retirees as well as young people to become involved in “citizen science” efforts may prove to be a win-win proposition. Further, all citizens will benefit from readily available and user-friendly public information.

C. Humans as Elements in the Ecosystem

Alaska has long been known as The Last Frontier and, for many, its name conjures images of personal freedom and untrammeled wilderness. However, like many other places, Alaska faces community planning and wildlife management challenges due to continued human population growth and increased access to remote areas, including for recreation.

Not only does the state have many more people than back in the "frontier days" (e.g., a six-fold increase since World War II [Williams 2004]), Alaskans are less nomadic and more concentrated. Over 75% of recent growth in the state's population has been in the Municipality of Anchorage and the Matanuska-Susitna Borough. Growth in these areas is expected to outpace population growth anywhere else in the state, with these two population centers eventually merging into a "Greater Anchorage" area (Goldsmith 2004). Implementing measures to reduce the effects of sprawl (e.g., zoning that promotes "node," or "core area," development) is critical to maintaining diverse populations of fish and wildlife over the long term. This is particularly true for migratory fish and wildlife species whose resting and important feeding, courting or breeding habitats occur in or near our communities and recreational haunts.

The need for economic development and improved infrastructure to support communities across the state will continue to grow with Alaska's population and visitorship. Although best management practices (BMPs) and regulatory regimes are applied, community and economic development have both immediate and cumulative impacts on fish and wildlife and their habitats. During Alaska's CWCS planning process, a variety of "human-effects" themes arose regularly regardless of taxonomic group. These are listed in the box below and addressed in more detail in the following section.

Issues of Concern in Managing Species and Habitats in Alaska

- Industrial and community development
- Increased human access, disturbance, motorized traffic
- Introduced, nonindigenous, and invasive species
- Bycatch
- Overharvest
- Unknown/unrecorded level of human use

Industrial and Community Development

Alaska's large area, low but concentrated population density, relatively recent history of resource extraction and urbanization, and sound conservation laws combine to minimize habitat and fish and wildlife population-level effects seen in many other states. In addition, the relative abundance and wide distribution of some species may help them withstand significant, but localized, impacts.

Better project planning and reduced construction impacts over the last 20 years have resulted in marked improvements in major community and industrial development projects. Even so, commercial resource extraction activities, such as oil and gas development, timber harvest, mining, commercial fishing, and power generation may pose challenges for fish and wildlife conservation. Local impacts are generally related to community growth, recreation activities, and commercial projects. Appendix 5 provides descriptions of the regulatory framework guiding development activities in Alaska, by key habitat type.

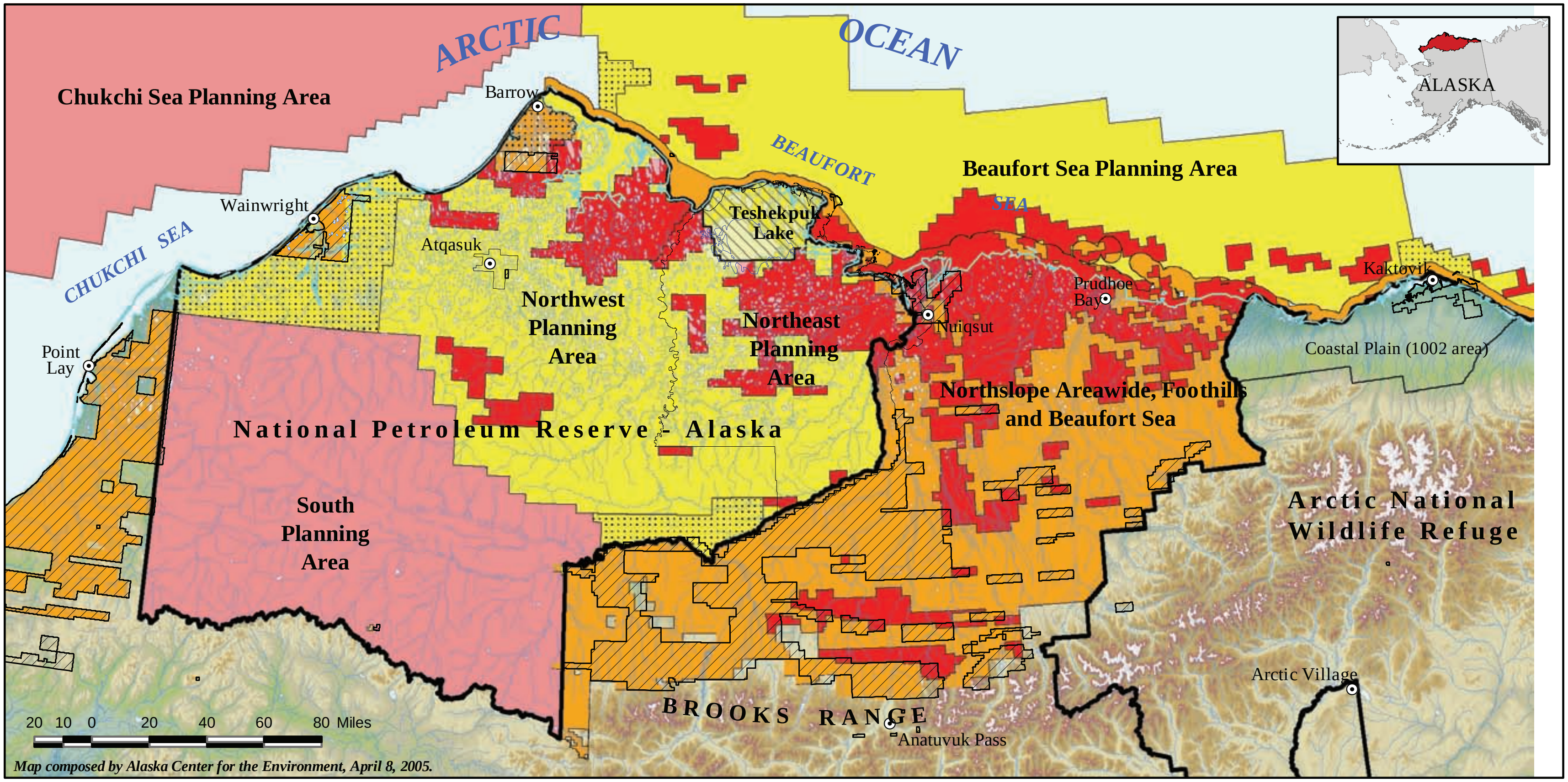
Oil and Gas Industry

Oil and gas exploration occurs in many places across the state, with production activities currently centered in Cook Inlet and on the North Slope. Oil development in Alaska is expanding, especially on the state's Arctic coastal plain. There, exploration and development currently extend over 120 miles along the coast and inland some 30 miles, with existing state and federal leases extending south into the Brooks Range foothills (see Figure 34, below). Much of the visible North Slope oil field development consists of gravel fill for drill pads, roads and processing facilities, and elevated pipelines that lie on tundra habitats.

New small-footprint oil production pad on North Slope
K. Titus, ADF&G

Environmental impacts associated with today's oil and gas projects are much reduced over those for projects done just 10–15 years ago. However, drill pads, roads, pipelines, airstrips, and other support infrastructure result in direct and indirect habitat loss and degradation, including changes in drainage patterns and thermokarst (National Research Council 2003). Transportation corridors and associated facilities can restrict wildlife use of adjacent habitats. Also, without proper long-term planning by land managers, seismic exploration routes and utility corridors can result in unanticipated effects on fish and wildlife as trails become heavily used as recreational corridors, as has occurred on the Lower Kenai Peninsula, and upper Cook Inlet.

Current and Proposed Oil & Gas Leases on Alaska's North Slope



- Existing Federal and State leases
- Active Federal Lease Plan Area
- Proposed Federal Lease Plan Area
- 1999 Teshekpuk Lake Area deleted from leasing. June 2004 BLM releases a new plan to lease the area.
- State Lease Areas
- ASRC Surface and/or subsurface lands
- Barrow Native Lands

National Petroleum Reserve - Alaska (Federal BLM)

* *Northeast Planning Area*
4.6 million acres - 87% opened to lease 1998
Next lease sale June 2005

* *Northwest Planning Area*
8.8 million acres - 100% opened to lease 2004
Open to exploration but deferred from development until 2014
Next lease sale June 2005

* *South Planning Area*
9.2 million acres
Scoping starts January 2005

Arctic Ocean (Federal MMS)

* *Beaufort Sea Planning Area*
9.4 million acres - 87% opened to lease 1998
Lease Sales 186 and 195 offered 97% September 2003, March 2005
Next lease sale (202) March 2007
Barrow and Kaktovik Whaling Deferrals

* *Chukchi Sea Planning Area*
33.8 million acres
Call for Industry Nominations April 2004

State

* *Northslope Areawide, Foothills and Beaufort Sea*
14.4 million acres in active lease plan areas
4.0 million acres in existing leases
Next lease sales October 2005

Figure 34. Current and Proposed Oil & Gas Leases on Alaska's North Slope

On the North Slope, construction of winter ice roads and pads in lieu of gravel fill requires large amounts of fresh water. Road-related fisheries issues are addressed through culvert and water-use permit stipulations, e.g., properly designed fish passage structures are required prior to permit issuance. Water withdrawal levels that will not compromise fisheries aquatic habitats are determined prior to the issuance of water-use permits. Climate change has already shortened the winter ice road season and near total loss of sea ice is projected for late this century, facilitating increased shipping and offshore drilling in Arctic waters (see: http://www.amap.no/acia/, especially Key Finding #6 and ACIA Executive Summary, page 13). New northern sea routes along Alaska's coast would elevate concerns for effects of spills, leaks, and noise on sensitive Arctic species, such as bowhead whales.

The types and severity of potential adverse effects of oil and gas development on birds and mammals vary across the state and by season. For most species, adverse effects would likely be most harmful during the short summer breeding season. However, the entire population of Pribilof Rock Sandpipers overwinters along Cook Inlet's mud and sand flats, feeding on tiny clams exposed by the shifting ice floes. This puts the Pribilof Rock Sandpiper at serious risk of extirpation should a major oil spill occur there during winter.

Displacement of migratory birds from feeding areas is of particular concern in the Arctic because feeding habitats are limited. The Western Arctic population of snow geese, for example, requires access to the entire staging area on the Arctic National Wildlife Refuge to ensure that it can locate adequate feeding habitat in all years (Hupp et. al. 2002).

Reduced nesting success due to increased predation is another potential effect of oil development, one that is especially significant for at-risk bird species. Oil and gas production and support companies typically implement strict policies to discourage lax garbage handling and intentional feeding of wildlife. However, human-built structures often provide nesting and denning habitats for species that prey on eggs and nestlings, and reduce the prey species' reproductive success (Truett et al. 1997).

One of the most significant oil-related wildlife concerns overall, especially on the North Slope, is the incremental expansion of industrial structures and activity. This was identified by the National Research Council as a particular concern for caribou, in part because it appears that some caribou, especially cow-calf pairs in the weeks following birth, avoid or are less likely to cross infrastructure, such as roads and pipelines (Nellemann and Cameron 1998; Griffith et al. 2002). Also, scientific models predict that cumulative effects of petroleum exploration and development activities may create sufficient disturbance to have notable caloric consequences in caribou (Bradshaw et al. 1998). These concerns are supported and magnified by findings of the 2004 ACIA report described above in Section IV(A), which indicates that climate change will cause additional stresses to animals with long migration routes, including through alterations in habitat and food availability.

There is a growing need for a comprehensive conservation strategy for the North Slope, one that addresses habitat fragmentation, effects of climate change, pollution, and options available to maintain and protect key habitats of at-risk species when considering natural resource exploration and developments. Given the high cost of hauling gravel, oil companies sometimes take steps to reuse abandoned gravel fill and restore the exposed substrate. However, one concern raised by the National Research Council is that production infrastructure may be abandoned in place, with effects accumulating over time (National Research Council 2003). Especially as North Slope production levels decline, Alaska needs to develop and implement a long-term rehabilitation strategy that will optimize fish and wildlife use of restored habitats across this ecoregion. This effort should be a cooperative endeavor involving all pertinent agencies and stakeholders. This need is especially critical for migratory species we share with other states and countries.

Petroleum Product Spills

While petroleum exploration, production, and transport are monitored to prevent spills, continuing vigilance is critical. Environmental harm can occur from a spill or persistent discharge resulting from marine transport, drilling platforms, transfer facilities, or pipelines. The coastline of Alaska and its offshore area provide seasonal feeding, breeding, reproduction, and staging grounds for large numbers of migratory birds and marine and terrestrial mammals. In some cases, a majority of the world’s population of a particular species may be present. Moreover, these wildlife populations often represent important subsistence resources.

Workers tend to Common Murre after 2004 Selendang Ayu oil spill near Unalaska
USFWS

Because of their interdependence with the freshwater, terrestrial and marine environments, fish and wildlife may contact spilled oil on the water surface, in the water column or benthos, and/or along shorelines, marshes, or tidelands. The number of individuals and species affected depends on several variables, such as the location and size of the spill, the characteristics of the oil, weather, prevailing currents and water conditions, types of habitat affected, and the time of year a spill occurs.

Preventing spills is an effective way to help protect fish and wildlife from oil and hazardous substances. Alaska also has proactively developed spill contingency plans. The primary response strategy emphasizes controlling the spill at the source and removing oiled debris, particularly contaminated food sources.

In 1987 a working group was established to develop appropriate Wildlife Protection Guidelines that federal and state on-scene coordinators could use during response to an oil spill. The guidelines are included as Annex G of Volume I of the *Alaska Federal/State Preparedness Plan for Response to Oil and Hazardous Substance*

Discharge/Releases (Unified Plan). This plan is updated periodically to reflect changing conditions, including advancements in treatment technology.

In 2002, the USFWS finalized "Best Practices for Migratory Bird Care During Spill Response." This document was initiated in 2001 by a working group consisting of state and federal wildlife resource agency representatives, rehabilitators, veterinarians, and industry representatives.

Wildlife impacts associated with land-based and marine oil spills have been significantly reduced in the last decade in Alaska. However, additional scientific and engineering research is needed so industry and agencies can continue to refine prevention and response measures to minimize overall impacts.

Timber harvest

Southeast Alaska rain forest T. Paul, ADF&G

Historically, large-scale timber harvest has been concentrated in the coastal forest of Southeast Alaska, with more scattered and localized operations in the coastal forests of the northern Gulf of Alaska. In response to favorable markets and widespread tree mortality caused by spruce bark beetle infestation, extensive areas on the Kenai Peninsula and, to a lesser extent, the Copper River basin, were logged in the 1990s. Timber has also been harvested at lower intensities in the Tanana River basin. Early timber harvest activities did at times significantly affect terrestrial and aquatic habitats, particularly the easily accessible large-volume estuarine and riparian fringes in coastal Alaska. Some of this harvest occurred in association with early mining developments and community growth.

Over the 50 years of commercial timber harvest in Southeast Alaska, the vast majority of logging has occurred in lower elevation productive forestlands away from the beach. This continues to be the approach taken in the current Tongass Land Management Plan, which places the region's remaining riparian and estuarine fringes off-limits to logging.

Through time, techniques have been developed to help minimize and mitigate impacts from timber harvest activities. However, clearcutting remains the most economically viable approach for timber harvest in Alaska. Clearcutting removes not only the living trees from an area but also, for worker safety reasons, the standing dead trees. This eliminates food resources, breeding sites, roosting sites, and escape cover for many wildlife species, some of which require snags (dead, standing trees), or are adapted to unique deep-forest and understory microhabitats.

Old-growth forests are complex ecological communities that cannot be replaced or replicated under standard 100- to 200-year timber rotations. Significant conservation concerns exist regarding clearcutting old-growth forests, particularly the rare big tree stands that occur on Southeast Alaska's Tongass National Forest and, in the Interior, on forested floodplains and islands. In the Interior, these riparian habitats experience a lower incidence of wildfire and tend to become the oldest component of boreal forest on the landscape. Therefore, they may hold a substantial proportion of the boreal forest's wildlife species diversity (particularly invertebrates and nonvascular plants) that depend on these older successional habitats.

Loss of canopy cover has an obvious impact on forest floor physical conditions (e.g., humidity, temperature, light, stability), and it can change subcanopy vegetation community structure. The dense second-growth stands that replace old growth also have a significant impact on many wildlife species and to the forest ecology. Extensive timber harvest, including the dense growth in early phases of second-growth stands, can also fragment wildlife habitats by restricting movements of wildlife between core habitats. These effects, in turn, can lead to decreased wildlife abundance and diversity, and/or shifts in species representation. Precommercial thinning of trees can reduce some of these impacts (e.g., by fostering understory growth that benefits young-growth bird communities [See http://elibrary.unm.edu/sora/Condor/files/issues/v098n04/p0706-p0721.pdf.], but it is expensive and often a low priority, especially in times of market downturn.

Like several other types of resource development in Alaska, timber harvest is a pioneering industry that often creates the first road access to an area. Southeast Alaska alone contains over 5,000 miles of pioneered logging roads on federal and private timber lands.

Road construction associated with timber harvest poses special challenges for fish and wildlife conservation. For example, roads constructed to haul harvested timber later provide greater public access that may exacerbate other population-level impacts on wildlife, e.g., island biogeographic effects (Person et al. 1996). The postharvest fate of newly accessible areas depends on land ownership and ease of access from human population centers. Remote areas may receive little postharvest use; areas near population centers may receive increased recreational use or may be converted to other uses, such as residential developments.

The cumulative impacts of road building need to be anticipated and monitored by land managers. Even where access is strictly controlled and/or roads are "put to bed" (culverts removed), the existence of a roadbed network increases the likelihood of human access to and disturbance of at-risk species. This includes disturbance expected when market conditions again become favorable, precommercial thinning is needed, and/or commercial tree removal resumes.

Whether through road building and use or via runoff from cleared lands, timber harvest activities can affect aquatic habitats due to changes in sediment levels, streamflow, water temperature, and amount of large woody debris available for pool formation. These potential impacts are addressed through modern preharvest planning and permitting processes. Road design and construction today includes stream-crossing structures that ensure adequate streamflow for fish passage. In addition, removing stream-crossing structures after active harvest is now a standard industry practice that minimizes long-term aquatic impacts. Projects to remove culverts in older harvest areas are also underway. Localized effects on benthic marine environments, where bark and other debris settle beneath log transfer facilities (LTFs), reduce species richness; however, today's development standards help minimize this impact.

On state and private land, timber harvest regulations are designed to limit impacts to water quality and identified habitats of anadromous and harvested resident fish (Alaska Statute 41.17), but they do not address cumulative effects and habitat fragmentation. Continuing research and monitoring to refine timber harvest practices remains an important element for helping to conserve wildlife populations and riparian fish habitat in the future.

Mining

Alaska's early development, particularly in the Interior, was closely tied to mining. Since the late 1800s, placer, coal, and hard rock mining have all occurred throughout the state, with the level of activity fluctuating in response to market forces and mineral prices. Placer operations target surface deposits, while coal and hard rock mining can occur either in open pits or underground.

The impacts from older mines, which operated prior to the adoption of environmental legislation, were often substantial. Hydraulic mining techniques were particularly detrimental to stream habitats, but large-scale placer operations, as well as the cluster of small-scale operations associated with local gold "rushes," also resulted in impacts to surface waters as streams were diverted and used to wash the materials being "worked." Specific impacts from these operations have included: stream channel incision, bank erosion, and the homogenization of complex stream systems. In addition, these operations often lead to increased levels of suspended sediment and sediment transport, and channel diversions around spawning reaches or damage to spawning gravels from channel erosion, silt deposition, and ground water flow alterations.

Loss or degradation of valuable habitats from the clearing of vegetation, excavation, contaminants from spills or mobilized native bedrock materials (e.g. heavy metals), and acid drainage are additional impacts that may be associated with mining operations and can have broad effects on fish and wildlife, including long-term persistence of the contaminant in the environment or effects far from the source.

Mines typically eliminate habitats within the footprint of the active mining area, plus associated infrastructure and roads. Mining operations can also reduce wildlife use of adjacent areas due to dust, noise and human presence.

As with other resource extraction industries, advancements in mine design and technology, along with planning and permitting requirements for mining activities, have helped to reduce or eliminate impacts that were once common. For example, hydraulic mining is now tightly controlled, and most placer mining operations use zero-discharge water recycling. In addition, the state's Abandoned Mine Program works to restore areas mined decades ago that were abandoned in poor condition as fish and wildlife habitat. Alaska is committed to integrating environmental protections into all of its primary industries. New mine projects, such as Pogo, Donlin Creek, and Pebble Copper, the large gold and copper mine proposed near Lake Iliamna, are carefully reviewed by DNR's Large Project Unit (http://www.dnr.state.ak.us/opmp/LPP/lpp.htm) to identify ways to mitigate potential effects. Where feasible, they also consider potential cost-effective enhancements that might benefit fish and wildlife resources.

Agriculture

Most commercial agricultural in Alaska is located within the Matanuska-Susitna Valleys, Tanana Valley and Kenai Peninsula. Most of these operations are small-scale, and habitat impacts tend to be local. The most widespread impacts are related to land conversion and the loss of native vegetation. This could be significant if the lost habitats were locally limited, needed by migratory species, or important as conduits for wildlife movement to other habitats. Land clearing can also result in impacts to wildlife habitat on adjacent lands, such as from exposing trees to risk of windthrow. To a lesser extent, localized impacts to surface waters have resulted from runoff carrying sediment and agricultural chemicals. Impacts from the commercial use of chemicals are addressed under the pesticide section. Agriculture can also impact wildlife by attracting it in large concentrations to ready food sources, increasing animals' vulnerability to hunters, or making wildlife the target of depredation control efforts.

Agriculture in Alaska is expanding. ADF&G typically has the opportunity to review and comment on proposed agricultural land disposals and grazing leases. This review should allow any potentially significant impacts on fish and wildlife resources to be addressed.

Commercial Fishing

The impact of fishing gear on benthic habitats, particularly biogenic structures such as corals, has recently received increasing scrutiny. The extent of habitat damage has not been assessed, but studies have identified positive relationships between faunal density and diversity, and biogenic structures. This has led to concerns that damage to biogenic structures will cause declines in faunal abundance and diversity. In response, the North Pacific Fisheries Management Council recently designated nearly 1 million square kilometers around the Aleutian Islands as a marine protected area. This includes 380 square kilometers in which all bottom gear contact is prohibited, in order to protect newly discovered deep-sea coral and sponge gardens. Technological advances, alternative fishing gear and methods, selective temporal closures, and designation of additional marine protected areas will help minimize adverse effects to sensitive seafloor species and ecosystems, and help maintain robust populations of marine fish and other species that depend on them.

Bubble Gum Coral, Aleutian Islands
A. Lindner, NOAA Fisheries

Onshore fish processing plants can damage local habitats by depositing waste products on benthic habitats. Permitting and monitoring programs administered under the Clean Water Act by the Alaska Department of Environmental Conservation (DEC) guide outfall structure placement and limit waste discharge volume on the seabed.

Dams

Approximately 163 dams have been cataloged in Alaska. Fewer than 20 of those are major hydroelectric dams and around 40 are smaller municipal hydroelectric projects. Most other dams are primarily for water supply purposes. The majority of dams (87%, DNR 2004) are along the coastline, from Southeast Alaska to the Aleutian Islands. While Alaska has relatively few dams compared to the Pacific Northwest, the number is growing. Rising oil and gas prices and demand for electricity, as well as planned intertie connections in Southeast Alaska, will increase interest in hydropower projects in the state. A study done for the Alaska Department of Community and Regional Affairs (Lochner Interests, LTD 1997) identified 1,093 potential sites for small hydropower projects in rural areas. Of these, 131 (or 12%) were considered economically viable, with the report predicting an even larger number if the price of petroleum products increased substantially. Today, the price of oil is several times higher than in 1997.

No comprehensive summary exists on the effects dams have had on fish and wildlife habitat in Alaska. Because many dam locations are remote and coastal terrain is generally steep, the kinds of impacts associated with dams on long rivers in other states occur only rarely here. Still, some Alaska dams have caused a direct loss of upland fish and wildlife habitat, alteration of aquatic thermal regimes, changes in instream flows, barriers to fish migration, and substantially reduced salmon populations; examples include Eklutna River, Cooper Creek, and Ward Creek.

Swan Lake dam, Ketchikan ADF&G

Most attention on the effects of dams in Alaska has focused on salmon and salmon habitat; however, other anadromous and resident fish, as well as wildlife, can be affected. For example, artificial reservoir levels, including fluctuations due to seasonal variation in hydropower generation, can adversely affect shoreline habitats and the diverse species, such as lake trout and loons, known to use these areas for breeding. Little has been done to fully assess the overall ecological changes that dams have caused in Alaska, or to evaluate how mitigation and fish passage facilities typically installed for salmon and trout can benefit other wildlife, including invertebrates, amphibians, and nongame fish.

Urbanization

While the land area for community development is very small relative to the state's overall size, infrastructure needed for population growth does place pressure on local habitats. Urbanization eliminates some local habitats. It also encroaches on and often fragments remaining habitat. Food, trash, and habitat changes associated with human activities and communities can lead to increased predation on other species, such as nesting birds, and encourage invasive species. Through these means, even Alaska's smaller and more remote communities can have adverse effects on nearby wildlife habitat and populations, especially populations that are small in number (e.g., Bristle-thighed Curlew).

Because of long-term population growth trends, impacts to habitat from urbanization, while local in character, are likely to be permanent. Ongoing efforts to upgrade design/construction technology and practices are needed to support human population growth, while also minimizing environmental impacts. An additional need is to develop and apply advanced land use planning tools that can track and model community growth and its effects on wildlife. Elsewhere in the United States, satellite and GIS imagery are being used to measure and model urbanization and landscape or habitat change. The National Aeronautical and Space Association (NASA) website "Urban Sprawl; the Big Picture" (http://science.nasa.gov/headlines/y2002/11oct_sprawl.htm) describes how satellites are collecting valuable data that reveal the environmental impact of fast-growing cities. It also contains a series of animated time-series windows showing a visualized example of urban sprawl and forest fragmentation, and a reconstruction of Baltimore, Maryland's growth over the last 200 years as an example.

Many people correctly associate urbanization with urban sprawl: The term typically refers to the reduction of rural land due to increase in total size of the land areas of a city and its suburbs over a particular period of time; this definition is used as a standard quantitative measure of rural urbanization in cities across the country (www.sprawlcity.org). Knowing the actual amount of land that has been urbanized (i.e., converted) provides a key indicator of the threat to the natural environment, fish and wildlife, and to residents' quality of life.

Some residents believe that urbanization and habitat fragmentation are not a problem, given Alaska's large land base. However, studies show that land transformation and fragmentation affect the species composition of otherwise little modified ecosystems (Vitousek et. al. 1997)—like those outside Alaska's growing communities.

The challenge will be to plan Alaska's enclaves of urbanization in ways that address the needs of wildlife as well as people. As Sprawlcity.org notes: "Better planned sprawl is likely to keep its residents happier and less likely to decide later to move even further beyond the urban center."

Fortunately, Anchorage and surrounding communities, such as Palmer, have begun taking steps to address this. The Municipality of Anchorage has a number of green areas that help connect habitats and maintain wildlife diversity in Alaska's largest urban area. Existing zoning regulations, including greenbelts along riparian corridors and modern culvert installation standards, also help to maintain important terrestrial and aquatic habitats in urban areas.

In 2000, ADF&G, USFWS, DOD, and many other interested organizations and groups created a comprehensive wildlife planning document for Anchorage and its environs called "Living with Wildlife"[14] (ADF&G 2000). It recommends addressing wildlife needs in a holistic way, by understanding wildlife population dynamics and the types, amount, and connections between habitats, and by making informed land use and management decisions. This habitat assessment provides the basis for identifying prime habitat lands for protection, primarily through the use of targeted tax incentives or habitat conservation ordinances.

Since publication of Anchorage's urban wildlife plan, various planning organizations and committees in the Anchorage Bowl have become more vocal in promoting greenbelts and "node development," including requirements that developers include more parks and open spaces when platting new subdivisions (Municipality of Anchorage 2005). Partly for these reasons, Anchorage earned the highest rating in *Expansion Magazine*'s "Quality of Life Quotient" in 2002 and 2003. Increasingly, communities across the nation have come to understand that node development is an

[14] This plan did not address fisheries or marine mammals.

efficient and cost-effective urban development approach that helps safeguard nearby green spaces used by wildlife and children.

The community growth challenges facing Alaska are common to many areas of the country. Maine's fastest growing towns, for example, are new suburbs 10–25 miles distant from metropolitan areas. Recognizing the effects of this type of habitat loss, Maine recently prepared a brochure, entitled "Beginning with Habitat . . . A landscape approach to habitat conservation," that it makes available to interested community governments (see http://www.beginningwithhabitat.org/). Alaska will benefit from developing these same types of habitat and wildlife planning tools.

Providing decision-makers with tools to better plan needed growth can reduce impacts to fish and wildlife populations over the long term. Thus, a valuable result of Alaska's CWCS could be not only to build basic knowledge about Alaska's wildlife resources, but also to increase technological capacity so that interested communities can access up-to-date wildlife and habitat databases for planning purposes. These would include important habitat areas needed by wildlife, including migratory species that rely on the sources of food, resting areas, and other resources that local habitats provide during their migratory movements.

Wastewater effluent

Stormwater runoff into Eyak Lake, Cordova
B. McCracken, ADF&G

Wastewater that is discharged from the end of a pipe from domestic and industrial sources is known as a point source discharge. Point source water pollution primarily impacts aquatic life, but also affects upland species that depend on aquatic life as food sources. Pollution may affect any or all life stages, leading to increased mortality or reduced reproductive success and growth.

Domestic wastewater sources include on-site and community septage and sewage. Industrial sources include oil and gas, mining, seafood processing, timber harvesting, utilities and transportation, construction (stormwater runoff), and cruise ships. Improvement efforts focus on addressing higher-risk discharges and improving treatment and release practices.

Site-specific permitting conducted by DEC is a primary tool to ensure that discharges meet the state water quality standards that sustain fish and wildlife populations and their uses. The Alaska Water Quality Standards (AWQS; 18 AAC 70), adopted under the federal Clean Water Act, serve as the foundation for all water quality-related permitting in the marine and freshwater environments. As required under federal law, these state standards are reviewed and updated via a public process every three years to better reflect current scientific knowledge.

Nonpoint Source Water Pollution

Nonpoint sources are the primary cause of water pollution in Alaska. Nonpoint source water pollution generally results from land runoff, atmospheric deposition, water drainage, or seepage. Nonpoint water pollution sources in Alaska include urban development, construction activities, roads, timber harvesting, agriculture, harbors and marinas, and off-road vehicles; the most common sources are discharges from storm water drains and ditches and runoff from human and animal wastes. Nonpoint water pollution primarily impacts aquatic life; the impacts on wildlife are similar to those described above for wastewater effluents. Nonpoint source pollution also degrades habitat on which wildlife species depend.

Alaska works to control nonpoint source pollution by performing the following types of single- and multi-agency functions: ensure wetland fills do not adversely affect water quality; review timber harvest plans and perform related field inspections for forestry operations; review construction plans and pollution prevention plans for storm water discharges from industrial and construction sites; identify state water quality priorities and needs; develop recovery plans on impaired water bodies; and provide pass-through funding and technical assistance to municipalities, local groups, and other state agencies for water quality improvement projects. These activities are permitted by DEC, the agency responsible for the state's water quality. ADF&G also participates in project review in cases where these activities could affect legislatively designated state game refuges, sanctuaries, and critical habitat areas.

Pesticides

Pesticides are important in food and fiber production, forestry, public health, structure safety and maintenance, and general quality of life. Pesticides include fungicides, insecticides, herbicides, rodenticides, piscicides, sanitizers and disinfectants, wood preservatives, pet products, biocides, mosquito repellents, bear deterrents, marine antifouling paints, etc. All pesticides sold in Alaska must be state- and EPA-registered. These products may be used at a variety of commercial, institutional and residential sites, such as homes, farms, nurseries, hospitals, schools, water treatment plants, oil fields, restaurants and parks. Because of their potential to harm biota and the environment, pesticides are regulated by federal, state and local governments. The laws governing pesticide use are comprehensive, detailed and specific. Individuals using or recommending the use of a pesticide must strictly adhere to the product label and must comply with federal, state and local government laws. In certain situations pesticide applicators must also be trained and certified, and are required to obtain a permit. For example, in Alaska, DEC requires a permit when pesticides are applied by aircraft to water, or on state land. The permitting process adds additional safety precautions to specific pesticide applications.

The harmful effects of pesticides to birds and mammals can occur in a number of ways. Birds and mammals can mistakenly ingest pesticide granules, baits, or treated seeds; consume treated crops; drink or use contaminated water; feed on pesticide-contaminated prey; or be exposed directly to sprays. Fish kills are often a direct result of water contamination by a pesticide. Pesticides can enter water via wind drift, surface runoff, soil erosion, volatilization and atmospheric transport, leaching, and in some cases, deliberate or careless release (transport, disposal, application, or spills of the pesticide) directly into the water. Sometimes the effects can be seen at a great distance from the original application site.

Pesticides can directly or indirectly injure or kill animals, plants and other nontarget organisms. The subtle or less recognizable effects of long-term exposure to pesticides are also of concern in conserving wildlife. Chronic exposure can lead to reproductive failure, deformities and changes in behavior that cannot be documented until much later. Some pesticides can bioaccumulate and also be biomagnified in an ecosystem. For example, accumulations of pesticides (notably DDE) were linked to severe peregrine falcon population declines in the interior and northern parts of the state several decades ago. While DDT has been banned and peregrines have largely rebounded, DDE (and even DDT) is still detected in Alaska (e.g., Anthony et al. 1999, Rocque and Winker 2004). A number of migratory birds that nest in Alaska and winter in Central and South America carry a variety of organochlorine pesticides in their tissues.

Today pesticides are selectively used by government agencies in Alaska to control invasive species and to manage nuisance aquatic organisms. Several local communities also have permits to control mosquitoes and biting flies. Pesticides continue to be used in agriculture, forestry, oil fields, water and wastewater treatment, restaurants, hospitals, day cares, schools, food processing plants, airports and military installations, and other federal facilities. Many of these facilities have adopted Integrated Pest Management practices to reduce the amount of pesticides used and to switch to less toxic alternatives. However, one of the largest users of pesticides is the homeowner. The Alaska Railroad and the Alaska Department of Transportation and Public Facilities (DOT&PF) have not used pesticides in their vegetation management programs for well over a decade. Application of herbicides to state rights-of-way requires a permit from DEC. The permitting process would include a public notice, public comment period, and agency review. Alaska has adopted guidelines to reduce the chance of wildlife poisoning or other adverse effects resulting from pesticide application. The guidelines include consideration of need, storage and application methods, toxicity, and persistence in the environment.

Airborne Pollution

The federal Clean Air Act provides a legal structure for controlling air pollution in the United States. Under the Clean Air Act, states are obligated to control emission-generating activities to meet air quality standards. Like other states, Alaska administers a permitting program to regulate emissions from industrial, commercial or municipal operations; it regulates small sources, including automotive emissions, through actions outlined in a State Implementation Plan.

Alaska is meeting all ambient air quality standards except during natural pollution events such as large-scale forest fires, volcanic eruptions, and high wind events that scarify glacial fines from exposed riverbeds and gravel bars. To date there is no evidence of harm to fish or wildlife from air pollution produced in Alaska, but neither has there been much investigation of this subject in the state's urban or industrial areas. Meanwhile, long-range transport of contaminants to Alaska from other countries via air and water pathways has been and remains a significant concern.

Increased Access and Disturbance

Alaska's public road system is limited; most of the state's nonmunicipal highways (e.g., the Alaska Highway, earlier called the "Alcan Highway") were constructed during and shortly after World War II due to national security concerns. These military roads, and early resource roads in the state, often had significant negative impacts. Improper culvert placement frequently resulted in barriers to migration, water temperature changes, and altered streamflow regimes. Stream crossings also limited and sometimes eliminated fish passage. Landslides, debris flow, and other mass movement were common occurrences in early roads and can still occur when steep slopes become saturated during heavy rains.

Today, terrain challenges, long distances, small communities, and high construction and maintenance costs make publicly financed roads impractical for much of the state. Instead, outside of Alaska's population centers, aviation, river and marine transport, all-terrain vehicles, and snowmachines are the basic transportation systems.

Trail network across Anchor River channel and riparian area, Kenai Peninsula M. Wiedmer, ADF&G

Although it is larger than the states of Texas, California, Montana and Washington combined, Alaska has under 15,000 miles of public roads (DOT&PF 2003). Alaska also has railroads, an existing oil pipeline and proposed natural gas pipeline, public trails, and a growing network of unstructured recreation trails. These avenues and many thousands of miles of old mining and timber roads (e.g., see "Timber Harvest," above) provide access to Alaska's outdoors and its wealth of wildlife.

Although transport systems are essential to Alaska's economy, they are also one of the critical challenges for wildlife and land managers. By their nature, these systems increase the risk that wildlife, primarily species that are hunted, trapped or fished, may be overexploited.

Today transportation and resource agencies work to minimize project impacts to habitats near roads, including blockages to fish passage. Alaska proactively addresses project-specific concerns by having BMPs that guide permitting of major access projects. These practices are designed to reduce impacts to fish and wildlife, and their habitats. A step-wise progression of mitigation[15] is mandated for unavoidable effects, some of which are discussed below. Even with modern BMPs, however, risks to sensitive wildlife species compound as the density and scope of regional transportation systems expand.

The state's mitigation policy (DNR February 2005) does not address cumulative effects. However, cumulative effects for major transportation projects are addressed under the Federal Highway Administration National Environmental Policy Act (NEPA) guidelines. For state-funded projects, federal Corps of Engineers (COE) permits or other land use permits that require an environmental assessment (EA) or an environmental impact statement (EIS) also include a cumulative effects analysis. Most small-scale street or road rehabilitation projects do not require this analysis, and there is some concern that over time these projects can have areawide or regional impacts.

Wildlife Sensitivity and Response
Effects of increased access on wildlife depend on a number of factors, including types of disturbances to which wildlife are exposed, species-specific responses, overall species sensitivity, and available cover or escape terrain. Factors also include age (life stage), season and time of day, and species social structure, group size, and previous experience (Heuer 1997). Wildlife exhibit a spectrum of responses ranging from subtle responses that can have chronic, long-term effects, to extreme responses that put wildlife at risk of predation, injury, and separation from family unit.

Road, highway, trail, and railway impacts on wildlife include direct loss of habitat, degradation of habitat quality, habitat fragmentation, road avoidance, increased human exploitation, disruption of social structure, reduced access to vital habitats, splitting and isolation of populations, and disruption of processes that maintain

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[15] DNR's Statement of Policy on Mitigation says, in part: "Mitigation includes, in priority order of implementation: 1) avoid the impact altogether by not taking certain actions; 2) minimize impacts by limiting the degree or magnitude of an action or its implementation; 3) rectify the impact by repairing, rehabilitating, or restoring the affected environment; 4) reduce or eliminate the impact over time by preservation and maintenance operations during the life of the action; 5) compensate for the impact by replacing or providing substitute resources or environments. All land and water use activities will be conducted with proper planning and implementation to mitigate adverse effects on fish and wildlife, or their habitats. The department will enforce stipulations and measures as appropriate to their agencies and will require the responsible party to remedy any significant damage to fish and wildlife, or their habitats that may occur as a direct result of the party's failure to comply with applicable law, regulations, or the condition of the permit or authorization."

regional populations (Jackson 2000). Roads can also act as conduits for invasive species, which can displace native species.

Habitat Fragmentation

When roads, trails, railways, and other "disturbance corridors" have low permeability (i.e., serve as a filter or barrier), habitats and wildlife populations on either side of the corridor may become functionally separated, a process called "fragmentation" (Jalkotzy et al. 1997). Experts in the CWCS effort cited this phenomenon as a key challenge in maintaining Alaska's wildlife diversity and abundance. Habitat fragmentation occurs when the habitat elements used by a wildlife species are compromised in a way that is detrimental to the species' needs (Jalkotzy et al. 1997).

It can mean separation of one habitat into separate units of habitat lacking effective connectors. It can also mean reduction or elimination of a species' ability to move seasonally between crucial habitat types. When habitat becomes fragmented in ways that affect a species' temporal access to critical resources, it can cause the death of individuals or the loss of an entire population. As an example, amphibians that overwinter in forested habitats must be able to reach their spring breeding habitats in order to successfully reproduce.

Western toad P. Mooney, ADF&G

Habitat fragmentation can also result in loss of genetic diversity, reducing a population's collective genetic health, or biological "fitness." Studies using archived pelts and historic maps have shown that, for some species, high genetic diversity can be maintained even in fragmented habitats, as long as a sufficient network of "stepping stones" exists (Onaga 2001). If located within critical dispersal distances, these islands of intact habitat allow individuals to safely travel in search of mates, nesting/denning sites, or other needed resources.

The consequences of habitat fragmentation can be far-reaching. Altering the connectivity of habitats on the landscape can result in changes to the genetic structure of wildlife populations hundreds of kilometers away (Onaga 2001). This suggests that development could be planned in ways that retain important landscape connections. It also suggests that habitat restoration or "de-fragmentation" projects aimed at restoring wildlife diversity would benefit some species.

Effects of Disturbance Corridors on Wildlife
The effects of access corridors on wildlife are complex and can be influenced by the corridor shape, length, relationship to adjoining patches of matrix habitat, gap sizes and frequency, and the habitat suitability in and around gaps; essentially, these constitute the degree to which the ecosystem remains functionally connected or joined together. Depending on its structure, a corridor can provide food, shelter, other species requirements (e.g., breeding sites), and/or a route for movements or dispersal (e.g., rearing or migrating fish). A corridor may act as a "source," producing wildlife that then spreads into surrounding habitat, or a "sink," where wildlife are unable to survive or reproduce (Jalkotzy et al. 1997).

If designed poorly, transportation infrastructure can cause combined effects that have serious consequences for wildlife populations over time (Jackson 2000). However, many of the effects on wildlife populations from road, highway, and trail corridors are hard to document and can take decades to understand (Findley and Bourdages 2000). In addition, once the infrastructure is in place, impacts may be difficult to reverse. Population effects from factors including vehicle collisions, pollution, predation, and displacement by invasive species usually accumulate over time. In Alaska, changes in wildlife populations may be difficult to document because baseline data are often unavailable.

It is important for Alaska to plan road placement and construction in ways that minimize effects to wildlife. Road features can be designed to integrate habitat and corridor features in ways that preserve populations and complement wildlife management and fish passage and enhance wildlife viewing opportunities for all travelers. For instance, the Northwest Alaska Transportation Plan (DOT&PF 2004) mentions growing interest by birding enthusiasts as a consideration in designing potential road improvements near Nome. Such tasks will become easier for all agencies as Alaska gains the technical tools needed to better identify and spatially depict wildlife species' ranges and habitat use patterns.

Recreation Effects
Traditionally, recreational pursuits conducted responsibly were thought to have little effect on wildlife. However, recent studies show that recreation can have direct as well as indirect effects on species and their habitats. Working closely with stakeholders and the public, British Columbia recently prepared an analysis of commercial recreation impacts affecting its wildlife (see http://wlapwww.gov.bc.ca/wld/comrec/crecintro.html). The following table, from Chapter 6 of the analysis, illustrates the range and degree of potential impacts that, without careful planning, Alaska can also expect.

Table 33. Sources of Human-Caused Disturbance to Wildlife Resources

	Road	**Off-road**	**Water**	**Air**
Access Related Activities	• industrial traffic • cars/trucks • off-road vehicles • nonmotorized traffic	• ATVs • snowmachines • nonmotorized traffic	• motorized watercraft • nonmotorized watercraft traffic	• helicopters • fixed-wing aircraft
Habitat Impacts	• direct habitat loss • habitat fragmentation • reduced habitat effectiveness • loss of forest interior habitat conditions • human-induced fire • invasion by nonnative species • damage to soils & vegetation • spread of insects & disease	• invasion by non-native plants and animals • erosion and change in soil properties • human-induced fire • damage to soils and vegetation • spread of insects and disease	• biological invasions • riparian and wetland impacts • fuel deposits and spills	• industrial activities • fuel deposits and spills
Wildlife Impacts	• species displacement • barriers to movement and dispersal • reduced habitat use • harassment/ poaching • reduced reproductive success • population fragmentation • hunting pressure • human/wildlife conflicts • problem wildlife control • habitat loss	• species displacement • barriers to movement and dispersal • reduced habitat use • harassment • poaching • reduced reproductive success • population fragmentation • hunting pressure • human/wildlife conflicts • problem wildlife control	• harassment • habitat avoidance • hunting pressure • poaching • animal control	• harassment • poaching
Fisheries Impacts	• sedimentation and altered stream flows • debris flows and landslides • introduction of exotic species • restricted passages • fishing pressure • riparian and wetland impacts	• sedimentation • fishing pressure • riparian and wetland impacts • streambed and stream channel disturbances • introduction of exotic species	• water quality • fishing pressure • disturbance • fuel deposits and spills	• fishing pressure • fuel deposits and spills

Habitat impacts of roads and trails were detailed earlier in this section of the CWCS. The following pages provide some examples specific to Alaska conditions, sites and species. The bottom line for Alaska is that in little more than a generation, use of snowmachines, off-road vehicles (ORVs), and boats for hunting, fishing, local travel, and recreation has greatly increased, and with it the potential for unanticipated impacts to wildlife and fish populations. Wildlife managers are particularly concerned about habitat degradation and at-risk species, such as colony-nesting birds.

Off-Road Vehicles

Off-road vehicles or ORVs (also called all-terrain vehicles [ATVs]) are mechanized single- or multiperson vehicles. Impacts to wildlife habitat from their use varies by type, season of use, ground conditions, intensity of use, and distribution. Most ORV trails in Alaska are not "planned" but result from repeated use by riders seeking the shortest or easiest route to their destination. For many villages, the mainline snowmachine and ORV trails to favored hunting areas are destroying habitat, especially in areas with wet soils. This is because soils typically become unstable when wet, including at spring breakup and during rainy periods. Across the state, as ORV riders encounter wet or boggy terrain, they tend to detour around the wettest spots in widening arcs; this can cause the "trail" to expand to nearly a quarter mile wide in places. Much of the worst damage caused by ORVs, including sedimentation to fish streams, could be avoided if trails had been planned to primarily traverse the driest terrain, or to incorporate appropriate crossing structures. Although improving trails in villages and recreational use areas can reduce overall habitat damage, it does not eliminate access-related effects on wildlife.

ATV trail fanning in wetland habitat

M. Wiedmer, ADF&G

Some people have touted expanded use of ORVs as benefiting hunters and game populations by distributing hunting pressure over a broader area (ADF&G 1996). However, increased use of ORVs for hunting and other purposes has also caused concern about impacts to nontarget species, which have fewer places they can go to avoid disturbance. To date, relatively little data has been available with which wildlife or land management agencies could assess disturbance effects to wildlife, including habitat fragmentation from trails and trail use. Agencies and ORV user groups have held periodic summits and workshops over the past five to 10 years to elevate awareness, reduce user conflicts, and promote trail restoration efforts. Commitment to developing a coordinated management approach across multiple land ownerships has been elusive. Additional research to reduce ORV impacts and improve some ORV trails is important for maintaining plentiful wildlife and fish resources in Alaska.

Water Access

Increased water access can have significant effects on fish and wildlife species and their habitats, including pollution from vessel sewage dumped in marine waters and streambank erosion from boat wakes. For example, CWCS species experts expressed concern that increasing numbers of personal watercraft (e.g., ski-boats and jet skis) and motorized ecotourism excursions (inboard/outboard boats, jetboats, airboats) are causing adverse effects for some fish, bird, bear, and marine mammal populations. Species or life stages that have low tolerances for pollution (e.g., fish eggs and amphibians) or disturbance (e.g., cow/calf whale pairs and nesting loons) are at particular risk. So too are species such as shorebirds that use gravel shores, banks, and river bars for breeding and foraging. Increased frequency of boat visits to, or transit past, sensitive nesting areas can increase the incidence of nest flooding by wakes (Alaska Shorebird Working Group 2004).

Regardless of access method, heavy fishing pressure can cause physical effects on the habitat used by the target species and its prey and other species in the ecosystem. For instance, traversing streambanks can reduce bank stability (e.g., break down complex root wads) and eliminate riparian vegetation needed by juvenile fish and aquatic invertebrates for feeding and rearing cover. Some communities are taking action to alleviate the pressure and restore affected habitats. The Kenai Peninsula Borough, for example, enacted rules limiting development on the banks of the Kenai River (Peninsula Clarion 2000) and implemented building setbacks.


Riparian habitat restoration effort on the Kenai River B. McCracken, ADF&G

The Kenai River Joint State/Federal Matching Funds Program is a cooperative effort between ADF&G, USFWS and Kenai River landowners to conduct bank rehabilitation and protection projects. Under the program, ADF&G and USFWS provide successful applicants with financial assistance (50/50 cost share) and staff support for projects on private riverfront properties along the Kenai River that restore, protect, or promote fish habitat. Among examples of successful projects are: bank stabilization techniques including installation of rootwads, brush-layered banks, and cabled spruce trees; protection of existing bank vegetation by using light-penetrating materials for access structures such as boardwalks, decks, stairways and floating docks; revegetation of eroded banks; and the removal of structures detrimental to salmon habitats, such as jetties and bulkheads.

Since 1995, the program has rehabilitated 2,600 feet of riverbank by removing jetties, groins, bulkheads, riprap, gabion baskets and debris. The program has also stabilized or revegetated over two miles of riverbank with spruce tree revetments and constructed almost 10,000 feet of elevated light-penetrating walkways (Dean Hughes, ADF&G, personal communication). These types of efforts, integrated into new projects and retrofitted at old sites, are examples of how urban development and recreation access impacts can be reduced or avoided.

Other Recreation- and Community-related Concerns
Our close proximity or easy access to still-wild recreation lands is a big part of the Alaska challenge of conserving wildlife diversity, especially near the state's growing urbanized areas. When added to plentiful access opportunities, growth in our human population poses two additional challenges for conservation of wildlife: domestic pets, and increased risk of fires. Dogs and cats can expand the effects of human communities and activities on wildlife by causing disturbance, harassment, displacement, injury and direct mortality of wildlife (Sime 1999). For example, several studies have indicated domestic and feral cats are significant predators on birds and small mammals. The average number of animals each cat kills annually has been variously estimated from 14 and 26, to as many as 1,000 (Fitzgerald 1988; Churcher and Lawton 1987; Eberhard 1954; Bradt 1949; Coleman and Temple 1996). Domestic pets also have other, less direct, effects on wildlife, such as introducing diseases and transporting parasites into wildlife habitat (Sime 1999). To protect Alaska's Dall sheep, mountain goats, and musk oxen, ADF&G and DEC veterinarians have advised sheep hunters not to use domestic goats and llamas as pack animals.

Fire, too, can increase in frequency with more people recreating outside of core urban zones. Elevated fire risk offers opportunities for educating citizens about both climate change (increased intensity and frequency of wildfires) and biodiversity (e.g., which plant and animal species benefit after landscape-level fire, and which do not). For some species, fire suppression may be counterproductive to long-term species conservation.

Introduced, Nonindigenous, and Invasive Species

When human activity results in a species entering an ecosystem new to it, the species is classified as introduced or nonindigenous (Carlton 2002). Unfortunately, some introduced species cause harm to the economy, the environment, or humans. They are then classified as invasives (Mooney 1999). The cost of dealing with their impacts worldwide is enormous. In the United States alone, the costs associated with invasives are over $130 billion a year (Pimental et al. 1999). In addition, invasive species in the United States contribute to the listing of 42% of all federally recognized endangered species and were implicated in 68% of fish species extinctions (Stein and Flack 1996).

Alaska as a whole has been minimally affected by invasive species thanks to such factors as isolation, localized rather than widespread development, a colder climate, and restrictive species import/transport regulations. Locally, however, there have been significant effects, and the threat of biological disruptions and costly containment efforts is likely to grow. Roadway development, expanding ORV trail networks, and bank trampling—i.e., any activity that opens up new corridors into undeveloped terrain, denudes the soil, or significantly alters the vegetation—increases the risk of unintended species introductions. Whether it is hitchhiking plant seeds (e.g., dandelions) from an Anchorage airstrip or the larvae of a nonindigenous freshwater mussel brought here on a tourist's waders, Alaska's roadsides and backcountry are increasingly at risk from biological invaders.

Northern pike, a voracious predator
ADF&G

An example of the potentially damaging effect an invasive species can have on Alaska's relatively simple ecosystems is the Northern pike (*Esox lucius*). Native north, east and west of the Alaska Range, this species began appearing in the Matanuska-Susitna region in the 1970s. Since then it has spread, sometimes via human introduction, throughout the major drainages of the Southcentral region and onto the Kenai Peninsula, adversely affecting some trout and salmon populations. While the economic loss remains unquantified, it could be substantial if pike spread to the world famous Kenai River system. Ecological losses could also include possible loss of unique and scientifically valuable stickleback populations in the Anchorage area (Randy J. Brown, USFWS, personal communication).

Through ADF&G, the state has become proactive in dealing with one aspect of the invasive species threat by developing the *Alaska Aquatic Nuisance Species Management Plan* (ADF&G 2002). This plan focuses on nonindigenous aquatic nuisance species that have been, or could be, introduced into Alaska waters. It emphasizes preventing introductions and identifying and responding to the highest invasive threats.

Terrestrial nuisance species can be as ecologically damaging as those in the aquatic environment. For example, many seabird and shorebird populations on remote Alaskan islands have been devastated by foxes introduced for fur-farming and by Norway rats that escaped from ships.

Before the start of World War II, nearly every island with beach access south of the Alaska Peninsula and in the Aleutian Islands was stocked with foxes, either caged or free-roaming. Foxes and rats both prey heavily on birds, especially ground-nesting species. Experts are also concerned that endemic small mammals on some islands (e.g., the Pribilofs and some Alaska Peninsula islands) may be vulnerable to competition and predation by rats. Meanwhile, effects on native wildlife from past introductions of nonindigenous prey for farmed foxes (e.g., ground squirrels, voles, mice, hares, and marmots) are unknown.

Fox and rat control programs undertaken by USFWS have shown positive effects over the past 50 years in helping protect and restore the natural diversity of islands in the Alaska Maritime National Wildlife Refuge. For example, eradication of foxes and reintroduction of Aleutian Canada geese to their former nesting islands resulted in a 100-fold increase in population; this, in turn, allowed removal of the goose from the endangered species list in 2001. Where monitoring has occurred, it shows that removal of alien foxes has likely increased populations of 15 to 20 bird species on the refuge by more than 200,000, and that number should continue to rise for several decades.

Introduced Arctic fox with least auklet
A. DeGange, USFWS

Although good progress is being made in eradicating nuisance species from some of Alaska's remote islands, increased shipping in Arctic waters means the threat of new "rat spills" and other inadvertent introductions continues. Some of the shorebirds at highest risk of harm from such spills include Rock Sandpipers, Ruddy Turnstones, Red-necked Phalaropes, and Black Oystercatchers (Alaska Shorebird Working Group 2004). Many agencies now cooperate in conducting a rodent invasion prevention program in the state. This effort includes a shipwreck response plan and actions to increase harbor defenses against arriving stowaway rats.

Conservation of wildlife and fish diversity requires careful review of planned introductions for potential adverse effects. For example, some of the species experts in our process raised concerns with past stocking of no-inlet-no-outlet lakes in Southcentral Alaska. Others questioned prior introductions of populations of nonindigenous small mammals. Many such introductions were made by ADF&G in the 1930s to 1950s, either to improve trapping opportunities or to serve as food for other species being trapped (Burris and McKnight 1973).

Introductions of nonindigenous species can have several unintended effects: A nonindigenous species or nonindigenous genetic population (also called a "nonnative strain") can outcompete the indigenous population and either eliminate or significantly reduce it over time. In other cases, introduced populations can crossbreed with the original populations and "genetically swamp" them, effectively eliminating the prior genetic diversity and resiliency inherent in having completely separate populations located on different islands. Studies are needed to document the effects of prior introductions.

The growth of Alaska's livestock industry also poses concerns for wildlife. Whether it be common domestic animals, such as pigs, or domesticated wild animals, such as elk, concentrated populations usually have problems with disease, some of which can easily transmit to wild populations. For example, in the past year the state allowed importation of ranch-raised elk from Canada to an elk ranch in Alaska. Elk from the Lower 48 and Canada can carry chronic wasting disease, which is currently a serious problem for wildlife managers in many states. Whether species introductions are accidental, illegal, or sanctioned by the state, they pose unknown risks for fish and wildlife populations.

In order to ensure maximum health and diversity of Alaska's wildlife and fish resources, nonindigenous species introductions must be monitored. To do this, Alaska must develop and refine multipartner programs to gather basic information on existing ecosystem composition using not only tribal and government agencies, but also citizen volunteers. Alaska can then develop a comprehensive marine, terrestrial, and aquatic monitoring program. Such a program is fundamental to improved management and conservation of Alaska's species, including maintaining genetic diversity and sustainability.

Bycatch

Bycatch refers to species caught in a fishery intended to target another species, as well as reproductively immature juveniles of a target species. Bycatch is a serious issue that may significantly impact the populations harvested and may also have ecosystem-wide secondary effects. It was raised in our planning process by species experts for several marine taxa and some freshwater taxa groups.

Sorting the catch NOAA Fisheries

Commercial and sport fishermen harvest many species as bycatch in the freshwater and marine ecosystems. In freshwater systems, Bering cisco and various species of whitefish, including the larger whitefish (broad whitefish and humpbacks), are susceptible to bycatch in salmon fisheries as they return to spawn in summer and fall. Overall, bycatch in freshwater fisheries may be substantial, and it is not monitored consistently throughout the state. Recommended conservation actions include working with communities to monitor harvest and abundance of multiple species.

In the marine environment, some of the affected species are long-lived with very low reproductive rates. Rockfish, for example, grow slowly and can live more than 100 years. Because most suffer swim bladder damage when brought to the surface, they often remain floating and die soon after being released. Experts expressed concern that bycatch of rockfish, especially in habitats used as nursery areas, could affect recruitment and result in serious population declines. With ongoing commercial harvests of many species, growth in tourism-related charter fishing, and increasing numbers of people living and recreating along Alaska’s coast, the need to better monitor inadvertent “take” of nontargeted marine species is critical.

The waterbird experts identified various species of loons as vulnerable to being caught in commercial and subsistence fishing nets. They noted anecdotal evidence that Red-throated Loons and Yellow-billed Loons are bycatch in commercial and subsistence fishing, but said the extent of this problem is unknown. Incidental mortality in fishing gear was also identified as an issue or potential issue for piscivorous diving seabirds and for whales. Appendix 4 includes several specific conservation actions to alleviate bycatch of bird and whale species. These include performing surveys to document the extent of the problem, conducting education efforts aimed at reducing the problem, and developing new gear designs such as streamers that frighten birds away from baited fishing lines.

Overharvest

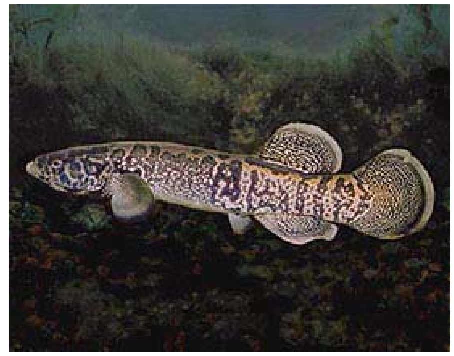
Experts identified overharvest as likely affecting some species featured in the Strategy. This issue has two elements to it: compliance with existing guidance or laws, if any; and the effectiveness of existing management frameworks in ensuring viability or sustainability of all species populations. In other words, as with bycatch, the issue affects not only a particular human-targeted species but also other species that rely on the target species in some way critical to their life history (e.g., as food).

One species group for which experts raised potential overharvest as a concern was the smelts. These forage fish form the base of the food chain for many marine and terrestrial species. Although the most significant smelt fisheries in the state are monitored, experts expressed concern that few studies have been conducted to evaluate trophic interactions or habitat requirements of Alaska’s smelt species.

Terrestrial mammal experts raised overharvest by trapping as a potential concern for several of Alaska’s small mammal species (e.g., marten, ermine). The experts felt that little attention is paid to these populations and their trophic relationships, and that there is a general lack of long-term monitoring. The Strategy calls for improving many aspects of the state’s monitoring capability; part of that challenge may be to compile and more effectively analyze existing harvest records.

Unknown/Unrecorded Level of Human Use

A similar recommendation was made with regard to unknown or unrecorded levels of human use. Many Alaska residents harvest a wide range of species for subsistence and personal use. While noncommercial human uses of some of the Strategy’s featured species is customary and traditional, in certain cases there is little or no monitoring by state or federal agencies to determine the magnitude of use. In raising this issue, experts were quick to point out that the degree of risk this may pose to particular species is unknown; it could, in fact, be negligible.



Alaska blackfish, often called "survival fish" by subsistence users in Interior, Western and Arctic Alaska

©John Brill, Pearlfish Press

Complicating efforts to collect more harvest data is the difficulty in obtaining consistent and accurate identification of the species being used by subsistence hunters, especially for species ranging throughout Alaska. As better information becomes available that addresses the degree of risk from human harvests faced by featured species, strategies based on cooperative efforts among rural and other hunters and government agencies may be developed for meeting these species' conservation needs.

The recently formed Alaska Migratory Bird Co-Management Council is addressing more active management of subsistence use of migratory birds. A primary function of this group, consisting of representatives from USFWS, ADF&G, and Alaska's indigenous peoples, is to develop recommendations for the subsistence spring/summer harvest, first legally recognized in July 2003. The subsistence harvest of migratory birds has been monitored in parts of the state for more than a decade using annual household surveys. Continuation and expansion of this monitoring enables tracking of any major changes or trends in levels of harvest. Harvest survey forms were approved by the federal Office of Management and Budget in October, 2003. More information on harvest surveys is available at http://alaska.fws.gov/ambcc/harvest.htm.

D. Maintaining Existing Conservation Areas

More than 50% of Alaska has been designated in federal or state conservation units. These units have differing levels of conservation and management for wildlife species and their habitats, offering varying challenges and opportunities for wildlife managers. In total, Alaska has 208 major state and federal land management units that can be considered as having been designated for, or otherwise engaged in some aspect of, wildlife conservation (Chris Smith, Alaska Public Lands Information Office, personal communication).

Many people think of Alaska's conservation lands as its state and national parks and preserves, forests, wildlife refuges, and recreation areas. However, there are surprises in the mix. For example, seven land units with very active wildlife habitat management programs are run by the DOD, making that agency—like many others—a valuable prospective partner in implementing the goals and objectives of Alaska's CWCS.

Regardless of their jurisdiction and management goals, managers of wildlife conservation lands face similar challenges; among them are:

a) growing numbers of visitors, whether residents or tourists;
b) increasing demand for, and effects from, public access (e.g., off-road vehicles, kayaks, aircraft);
c) insufficient fiscal resources for day-to-day management and/or long-term planning;
d) reduced connectivity among and between conservation lands (including shrinking numbers of safe stopover habitats for migratory bird populations);
e) fragmentation of habitats outside conservation areas; and
f) natural changes (e.g., climate change or isostatic uplift that reduce the wildlife values for which an area was originally designated.

Some of these challenges have become particularly acute for the land units designated by the Alaska Legislature for management by ADF&G as "Special Areas."

<u>State Special Areas</u>

Anticipating growth and change in the state, Alaska's early legislators began formally recognizing lands needed for the conservation of wildlife under the tenets of Article VIII, Section 7 of the Alaska Constitution: "The legislature may provide for the acquisition of sites, objects, and areas of natural beauty or of historic, cultural, recreational, or scientific value." Now evolved into a system of 32 individual state game refuges, critical habitat areas, and game sanctuaries, Alaska's special areas encompass nearly 3 million acres ranging from Cape Newenham State Game Refuge in the Bering Sea to Stan Price State Game Sanctuary in Southeast Alaska. See Figure 35, below.

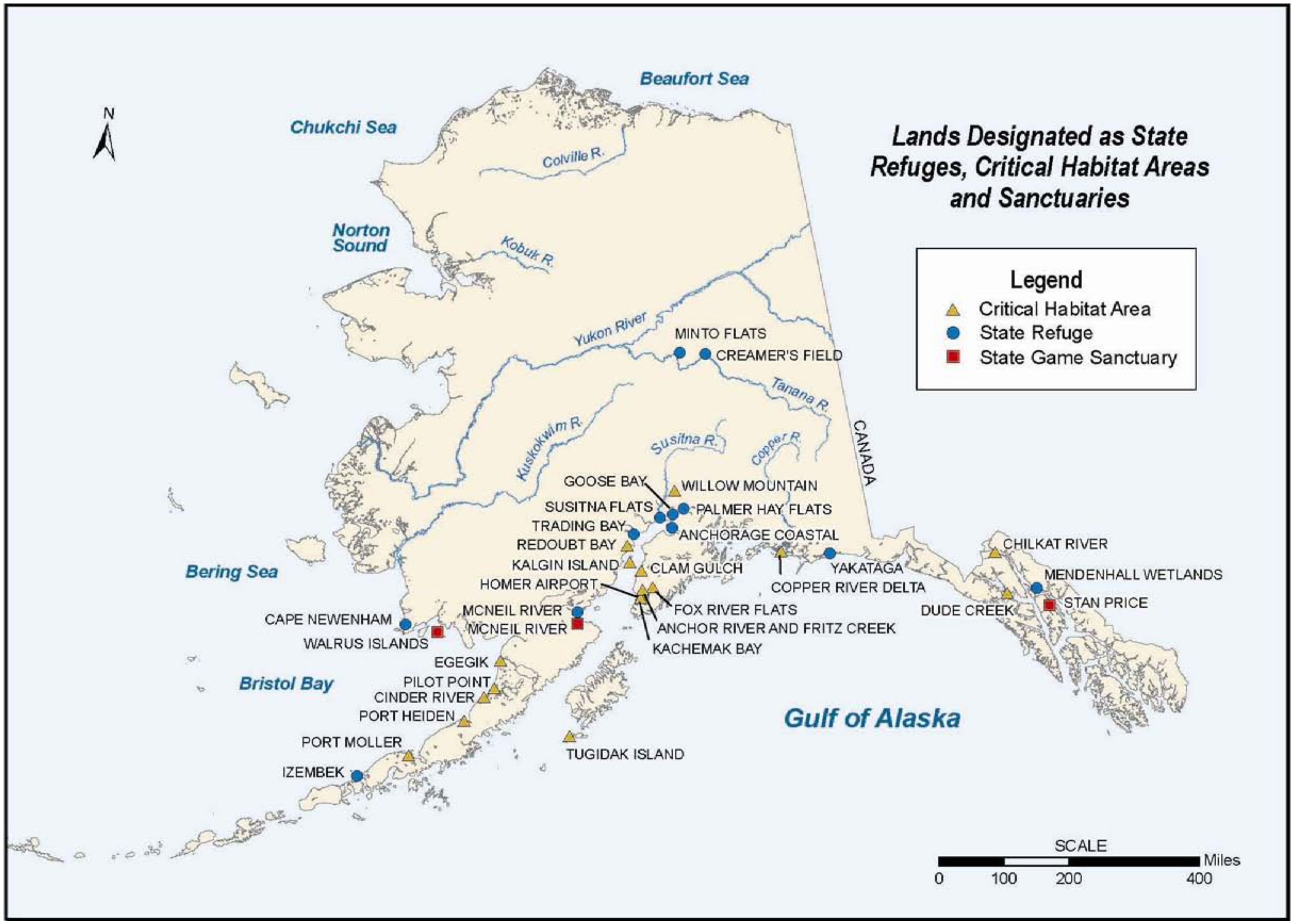


Figure 35. Lands Designated as State Refuges, Critical Habitat Areas and Sanctuaries

Each special area is characterized by a habitat that is optimal to a species or group of species. While some areas were set aside to benefit hunted species and ensure hunting opportunity, others were created to benefit multiple species.

Many of the areas were designated specifically because they contain rich wetlands, tidelands, and nearshore waters that are critical to waterbirds and shorebirds. For example, state critical habitat areas along the Bristol Bay side of the Alaska Peninsula are important staging and stopover sites for shorebirds dispersing to nonbreeding areas through the Americas, Oceania, and Australasia, and for breeding birds returning to arctic and subarctic habitats in the spring. Some species depend heavily on state-designated and other conservation units because they have specialized habitat needs. Examples include Brant and Emperor Goose use of Izembek State Game Refuge, and the Marbled Godwit, whose nesting appears restricted to the Egegik Bay and Port Heiden Critical Habitat Areas.

Background

Alaska's first special areas were established in 1960, immediately after statehood. One of the first was Walrus Islands State Game Sanctuary, created to protect a world-renowned haulout for walrus. The primary purpose of the sanctuary at the time of its creation was to protect the last remaining land haulout for walrus (*Odobenus rosmarus*) in North America. All other land haulouts had been abandoned, presumably due to harassment from commercial hunters and other disturbances. The sanctuary provides important habitat for walrus and now comprises one of four primary haulout sites used by walrus in Bristol Bay. The sanctuary also protects important habitats for many species of seabirds, Steller sea lions (*Eumetopias jubatus*), and other marine and terrestrial birds and mammals.

Walrus at Walrus Islands State Game Sanctuary

J. Hyde, ADF&G

The sanctuary protects a group of seven small islands and their adjacent waters in northern Bristol Bay, approximately 80 miles southwest of Dillingham. One of the islands, called Round Island, is known for extraordinary scenic views and wildlife watching: Each summer, 8,000 to 12,000 male walruses haul out on the exposed rocky beaches of Round Island. The department manages the sanctuary primarily to protect these important species and habitats, but also to foster opportunities for public use and enjoyment, including scientific and educational study, viewing, and photography.

McNeil River State Game Sanctuary, an area world-famous for its unique summer concentrations of feeding brown bears, was established in 1967. A population of 60 to 100 brown bears travels from up to 30 miles away to feed on migrating salmon at McNeil River Falls, providing premier wildlife viewing opportunities in relatively close proximity to Anchorage. A third sanctuary, Stan Price near Juneau, is also world-famous for bear photo and viewing opportunities.

In the 1970s and 1980s, additional refuges and critical habitat areas were created in rapid succession as citizen groups around the state became concerned about protecting their most productive hunting, fishing, and wildlife viewing areas.

The majority of the special areas were created for the protection of waterfowl and shorebirds. Spectacular concentrations of waterfowl and shorebirds stop to rest and feed in Alaska's coastal wetlands on their way to and from Arctic nesting grounds. Each spring and fall, these protected wetlands provide a critical stop for millions of migrants along the Pacific flyway. One of these areas, Izembek State Game Refuge, has been designated a Wetland of International Importance in recognition of its use by millions of migrating waterfowl and shorebirds. Four state critical habitat areas (CHAs)—Copper River Delta, Kachemak Bay, Homer Airport, and Fox River Flats—are included in units of the Western Hemisphere Shorebird Reserve Network because of their importance to shorebirds. In fact, the Copper River Delta Critical Habitat Area supports the largest gathering of shorebirds in the Western Hemisphere.

The Chilkat River CHA in Southeast Alaska was established for the protection of the largest known concentration of bald eagles in the world. Other special areas were established for moose, fish, and shellfish. A recent addition, the Dude Creek CHA, was established for the protection of an important sandhill crane staging area.

Chilkat River eagles J. Hyde, ADF&G

Kachemak Bay and Fox River Flats CHAs were legislatively designated in the early 1970s to protect natural habitat crucial for perpetuation of fish and wildlife, especially fish, crab, shellfish, shorebirds, and waterfowl. In 1999, Kachemak Bay was included in the national system of NERRs (National Estuarine Research Reserves); boundaries of the federally designated Kachemak Bay NERR include over 365,000 acres of lands and waters, mostly (228,000 acres) within the Kachemak Bay and Fox River Flats CHAs but with approximately 137,000 acres falling within the Kachemak Bay State Park and Wilderness Area.

Kachemak Bay has been identified by the World Bank as a regional priority for the conservation of marine biodiversity. The bay's protection and international designations have attracted researchers from around the world to study temperate marine ecosystems and climate change. Little research currently exists on temperate marine protected areas; thus, Kachemak Bay offers unique opportunities for understanding biological responses to special management and exogenous variables, such as climate change or fishing pressure.

Human Uses of Special Areas

As Alaska's population has increased, so has public use of special areas, many of which are among the most popular hunting, fishing, and wildlife viewing areas in the state. Besides the game sanctuaries and CHAs noted above, nine other special areas are within easy air or automobile access of Anchorage and Fairbanks: Anchorage Coastal Wildlife Refuge; Palmer Hay Flats, Susitna Flats, Minto Flats, and Trading Bay State Game Refuges; Kachemak Bay, Redoubt Bay, and Clam Gulch CHAs; and Creamer's Field Migratory Waterfowl Refuge. The pressures on these areas to provide for the sometimes competing needs of hunters, anglers, wildlife watchers, subsistence users, mushers and retriever training enthusiasts has increased tremendously in the past two decades. Meanwhile, the state budget dollars with which to prepare, update, and implement balanced management plans have withered. As shown in Appendix 10 (Alaska's Special Areas: Management Planning Status), over a dozen special areas remain without a site-specific management plan. With greater access and human use, degradation of these areas and increasing conflicts among user groups are likely.

Fishing, viewing, and brown bears at Wolverine Creek, Redoubt Bay Critical Habitat Area J. Meehan, ADF&G

Land Status and Regulatory Framework

State special areas are jointly administered by DNR and ADF&G. While DNR holds title to all state lands, including special areas, ADF&G has day-to-day management authority for most special areas and is responsible for managing uses of the land through the issuance of special area permits. Special areas are managed to minimize habitat alteration and species disturbance and to ensure recreational access. An ongoing challenge is to educate the public about the difference in requirements for use of general "multipurpose" state lands and state special areas. The latter are managed to a higher standard, expressly for the purpose of conserving unique wildlife resources and opportunities for their use.

Needs and Opportunities

Many of Alaska's conservation lands are highly valued internationally; indeed, Denali National Park is the most visited park or protected area in all of the Arctic. Alaska will benefit from enhanced monitoring of its conservation lands and waters, including with regard to impacts from site usage.

The CWCS is an important tool in identifying opportunities related to Alaska conservation lands and waters. For example, experts noted that such areas can serve as long-term monitoring and research sites to assess species population levels, detect and track effects of a warming climate on habitats, and flag encroachment by nonindigenous species. They also mentioned the need to expand public support by educating people about these unique areas' value to wildlife and to local economies, and providing avenues for local involvement in land use decision-making.

Another opportunity the CWCS provides is to increase the public's understanding and appreciation of the extent to which special areas and other conservation lands and waters can form a critical interlinked network for wildlife, especially migratory birds. Experts in our process strongly recommended identifying and protecting these linkages and partnering across jurisdictions to help maintain the values of Alaska's conservation areas for fish and wildlife. One model for doing so is CAFF's Circumpolar Protected Areas Network (CPAN) initiative. For over a decade, scientists and resource managers from USFWS, ADF&G, NOAA, USGS, and other organizations have participated in this Arctic Council working group, whose purpose is to support and promote protected areas, conserve key habitat throughout the Arctic, and better conserve all biogeographic zones in the circumpolar Arctic, including the marine environment. The Council's Protection of the Marine Environment (PAME) initiative follows a similar model, helping to focus attention on management of the circumpolar marine environment as a series of large marine ecosystems (LMEs), four of which include parts of Alaska (see http://www.edc.uri.edu/lme/clickable-map.htm).

Echoing CPAN and PAME participants, experts in Alaska's CWCS support working with fisheries managers and coastal communities to set aside geographic and/or temporal marine reserves to protect benthic habitats used as nursery and feeding areas for multiple species, including commercially important target species. In many cases, these areas need additional inventory to further identify important species, habitats and trophic relationships.

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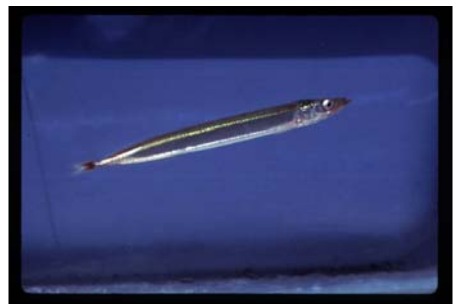
V. Conservation Action Plans

Alaska's CWCS process resulted in creation of conservation action plans for 74 species and species groups. To create these plans, the experts provided information on a standardized form, or "template." On it, they described distribution and abundance, listed key habitats and threats or concerns associated with those habitats, developed objectives with performance measures, and crafted specific conservation actions. They also worked to identify the most important species or species group recovery or management plans and extract findings and conservation actions relating to featured species. These templates constitute the action plan for Alaska's featured species or species groups.



Sand lance USFWS

Following is an example conservation action plan for an important species group—anadromous smelts—which was recommended by both the freshwater fish and marine fish expert groups. The latter addressed anadromous smelts in the marine environment as part of a conservation plan they created for "forage fish occurring in intertidal/shallow subtidal areas." Like all the other conservation action plans created for the CWCS, the forage fish plan can be found in Appendix 4. This extensive appendix forms the technical foundation of Alaska's Strategy and the basis for future collaborative efforts among the department and its partners.

Anadromous Smelts

A. Species Group description

Common name: anadromous smelt (i.e., longfin smelt, eulachon, rainbow smelt)

Scientific names: *Spirinchus thaleichthys*, *Thaleichthys pacificus*, *Osmerus mordax*

B. Distribution and abundance

Range:

Global range comments: Full extent unknown, but populations of some species occur in British Columbia, northwestern and northeastern United States (with introductions in Great Lakes areas), and northwestern Pacific Ocean and Bering Sea (Korea, Japan, Russia)

State range comments: Longfin smelt—Shelikof Strait, southwestern Gulf of Alaska, through Southeast Alaska; rainbow smelt—entire coast of Alaska, but less common along Gulf of Alaska; eulachon—Southwestern Alaska, Aleutians, through Southeast Alaska

Abundance:

Global abundance comments: Unknown

State abundance comments: Unknown

Trends:

Global trends: Declining trends for anadromous smelt species across parts of their range

State trends: Unknown

References: McPhail and Lindsey 1970; Mecklenburg et al. 2002; Morrow 1980.

C. Problems, issues, or concerns for species (or species group)

- Important forage fish for various marine predators, some of which have been identified in this Strategy as of conservation concern (e.g., Cook Inlet beluga whales) (See the Marine Fish template in Appendix 4 called “Forage Fish Occurring in Intertidal/Shallow Subtidal Areas.”)
- Alaskan populations of anadromous smelt species poorly documented
- Lack of information on these species, including life history, abundance, trophic ecology and instream flow needs
- Taken as a human food fish throughout their range
- Threats to freshwater and estuarine habitat and fish passage
- High interannual variability in populations suggested by saltwater trawl surveys

D. Identify location and condition of key or important habitat areas

- For all three species: lower reaches of streams and rivers and associated estuaries (e.g., Susitna River); also, eulachon are known to ascend ≥ 100 km up the Susitna (Yentna) system and rainbow smelt to enter Lower Ugashik Lake, likely spawning in tributaries to the lake (M. Weidmer, ADF&G, pers. comm.).
- On the North Slope, rearing also occurs in connected lakes in river deltas.
- Habitat condition overall thought to be very good to pristine
- Marine habitat and ecological conditions unknown

E. Identify concerns associated with key habitats

- Water diversion or impoundment could impact movements, spawning and rearing habitats, and survival.
- Nearshore chronic and acute pollution (such as oil spills, wastewater effluent)
- Broad-scale climate shifts affecting marine ecological conditions

F. Goal: Conserve and manage populations of Alaska anadromous smelt species throughout their natural range to ensure sustainable use of these resources

G. Conservation Objectives and Actions

Objective 1: Describe and maintain species distribution and population abundance throughout their distributions in Alaska

Target: Identify the distribution of anadromous smelt species in Alaska

Measure: Anadromous smelt distribution within Alaska as determined by literature review and surveys at river mouths to the limits of upstream spawning habitat

Target: Anadromous smelt species are within their natural variability of abundance in at least 90% of identified index areas.

Measure: Abundance of anadromous smelt species annually over a 10-year period in identified index areas

Issue 1: Anadromous smelt species are important prey for predators of conservation concern (e.g., beluga whales, loons).

Conservation action: Work with marine scientists (e.g., marine mammal biologists, waterbird and seabird biologists) and Native harvesters to document the significance of anadromous smelt species in the diet of target species; determine the trophic ecology of anadromous smelt species

Issue 2: Information is lacking on this species: life history (e.g., iteroparity vs. semelparity), population structure, migration patterns, distribution, trophic ecology, and habitat needs/use

Conservation actions:

a) Develop sampling and indexing protocols and implement sampling schedule across geographic range

b) Identify representative index areas

c) Identify the habitat types or categories used by anadromous smelts (e.g., as used in ADF&G's fish community inventory database)

d) Develop sampling techniques and document the migration and movement patterns of different species and life stages

e) Map current distribution and other similar habitats for future investigation

f) Develop a network of biologists/organizations to establish unified protocols, share data, leverage sampling efforts, and provide voucher specimens to museums (University of Alaska Fairbanks, etc.). AFS-Alaska Chapter might be a venue for organizing and consolidating information.

Issue 3: Habitat alteration, sufficient instream flow, fish passage, and water quality are potential concerns

Conservation actions:

a) Determine instream flow needs and habitat requirements for all life history phases of smelts

b) Consider these smelt species when there are issues of fish passage and habitat alteration (e.g., water diversions, dams, timber harvest, mining, sedimentation)

c) Develop a coordinated effort among governmental and nongovernmental agencies to collate and exchange information on the habitat and instream flow needs of these smelts

Issue 4: Anadromous smelt species are taken as a food fish; harvest levels are not monitored for all species in all locations.

Conservation actions:

a) Obtain local information and knowledge on local anadromous smelt distribution, relative abundance, and harvest
b) Develop sampling protocol to monitor locations, timing, magnitude and level of harvest
c) Collect biological samples (e.g., size, sex ratio, and if possible, species, age structure)
d) Involve communities in monitoring, and share information
e) Train local communities to monitor abundance and harvest effort

H. Propose plan and time frames for monitoring species and their habitats

Promote coordination with state agencies, federal agencies, universities, Native entities, and nongovernmental organizations to conduct monitoring every year for 10 years to establish the target indices. Possibly involve to administer the request for proposals process for monitoring.

I. Recommended time frame for reviewing and revising species status and trends

Review at five years.

J. Bibliography

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In selecting species to feature in the Strategy, and in generating conservation action plans for them, the experts raised significant points about some species and species groups in Alaska. For example, they pointed out that Alaska has many species or species groups for which one or more of the following is true:

- The species or group may be widely distributed, but so little is known that the experts did not have enough information to generate an initial planning objective.
- Significant verifiable, but unexplained, population declines have occurred in recent years; these species have not been officially listed as candidate, proposed, or threatened and endangered.
- The species is believed to be on the verge of extinction or is already extinct (e.g., Montague Island marmot).
- Concerns exist regarding imminent habitat loss, and the experts have included in the conservation action plan at least one conservation action to study or address that issue.
- Unmonitored or undermonitored human use or take is occurring, but the management/scientific community knows very little about the species' population level.
- Policy changes are believed needed in the next five years, and the experts proposed a conservation action that speaks to at least one such change.
- Collaborative monitoring efforts are not yet underway, but experts thought such efforts could be successfully undertaken in the next several years if funding were provided.
- The species is in need of restoration, and research and survey efforts on that species are needed to identify what factors may assist in its restoration.
- The species is widely considered a key species in an ecosystem, it makes use of a key habitat, and little is known about the species and/or its habitat use; baseline survey information is desirable.

Given how often these same concerns arose among all the featured species and species groups, we did not feel it beneficial to Alaska's conservation efforts to prioritize between or among species in the CWCS. In Appendix 3, featured species and groups are categorized by major ecosystem type (e.g., marine, freshwater aquatic, terrestrial). Meanwhile, in Appendix 4, species are presented in approximate taxonomic order, with species assemblages or groups placed in the order that seemed most logical.

We expect that these species- and group-specific plans will be posted to the department's CWCS website and periodically updated in coming years. This will ensure their availability to a wide audience of potential users, including students, decision-makers, and potential project investigators.

VI. Some Key Habitats of Featured Species

As noted elsewhere in the CWCS, Alaska lacks spatial and quantitative data on many of its species and habitats. What we do know is that habitat diversity in Alaska, as in other places in the Arctic, can be locally very high, including over short distances. What might look to the untrained eye like broad expanses of similar terrain can contain numerous microclimates and microhabitats exploited by species with quite different life requirements (CAFF 2002).

Because the planning team did not specify a standard format or classification for habitats, the scale at which experts identified habitats of concern varied. Some experts in our process identified specific geographic locations of the state, and sometimes even particular plant associations that need conservation action to benefit CWCS species. Others were able to address location, attributes and condition of key habitats for featured species in only very general terms.

For these and other reasons, teasing out what "key habitats" should be included in the Strategy was difficult. Based on a review of the conservation action plans and other material in Appendix 4, the planning team ultimately identified seven general habitat types in Alaska: forests, tundra, freshwater aquatic, wetlands, marine aquatic and coastline, sea ice, and karst caves. Table 34 lists these types and the standard subtypes for which experts identified concrete information regarding species' habitat requirements.

Table 34. Key Habitats of Featured Species

Forests
- Boreal
- Coastal Temperate Rain forest

Tundra
- Alpine
- Arctic
- Maritime

Freshwater aquatic

Glacial systems
- Lakes and Ponds
- Rivers and Streams

Non-glacial systems
- Lakes and Ponds
- Rivers and Streams

Riparian Zones

Wetlands
- Grass
- Sedge
- Bog
- Salt marsh

Marine and Coastline

Intertidal
- Rocky Intertidal
- Mudflats and Beaches
- Eelgrass Beds

Marine waters
- Nearshore
- Shelf
- Oceanic
- Benthic

Coastal Islands and Sea Cliffs

Sea Ice
- Fast
- Pack

Karst Caves
- Entrance Zone
- Twilight Zone
- Deep Cave Zone

The seven habitat types are complex in form and function, and in the unique and diverse biota that they support. Appendix 5 describes each habitat type and subtype; associated species; the habitat's ecological importance, status and threats; pertinent laws and regulations; and recommendations for conservation.

In addition to describing key habitats, participating CWCS species and habitat experts identified challenges that Alaska's fish and wildlife managers face in conserving these habitats. The following table highlights some of the primary concerns they raised.

Table 35. Synopsis of Fish and Wildlife Habitat-Related Concerns

Forests
- Decreased soil moisture and increased wildfire activity due to warming climate
- Insect infestation
- Fragmentation and loss

Tundra
- Rapid and widespread vegetation changes due to warming climate
- Habitat alteration due to ATV use
- Increased natural resource exploration and extraction activities

Freshwater Aquatic
- Increased temperatures and altered flow regimes due to warming climate
- Decreased instream flow and connectivity of waterways
- Nonpoint source pollution; stormwater runoff
- Streambank erosion from illegal fords and inadequate crossing sites
- Invasive species

Wetlands
- Desiccation, inundation, and vegetation changes due to warming climate
- Nonpoint source pollution
- Dredge and fill activities
- Habitat alteration due to ATV use

Marine Aquatic and Coastline
- Coastline development
- Dredging of shoreline habitat
- Oil spills
- Tourism pressure
- Invasive species
- Bycatch of coral and sponge
- Deepwater disposal of dredge spoils
- Tour ship increases; gray water disposal, solid waste management

Sea Ice
- Decreased quality, quantity and spatial occurrence due to warming climate
- Increased marine transportation and associated probability of oil spills

Karst Caves
- Silviculture practices that decrease the landscape integrity
- Tourism pressure

The Strategy identifies Alaska's marine, coastal, and Arctic tundra areas as being at particular risk of adverse impacts to wildlife, and various national and international initiatives have noted the importance of these habitats for subsistence purposes, their high overall biodiversity, and value to migratory species. As an example, the Arctic coastal tundra/North Slope and "Bering to Baja" coast are identified as key North American "regions of ecological significance" in *The Strategic Plan for North*

American Cooperation in the Conservation of Biodiversity (see http://www.cec.org/pubs_docs/documents/index.cfm?varlan=english&ID=1088). This plan was produced in 2003 by the North American Commission for Environmental Cooperation (CEC) to promote conservation of migratory and transboundary species, and other species identified by the parties (Canada, United States, and Mexico). Similar to Alaska's CWCS, the CEC strategy highlights needs for integrated monitoring and assessment, improved data and information sharing, and enhanced networking and collaboration.

In the CWCS, Alaska has purposely taken a very broad and general approach to classifying and describing habitats, in part to allow for flexibility in future statewide and North Pacific habitat classification efforts. Scientists and conservation planners have identified the lack of a comprehensive habitat classification system for Alaska as a data gap in the state's efforts to better manage its natural resources. With adequate funding, a subsequent iteration of the Strategy may demonstrate results from a scientifically rigorous review of Alaska's habitats.

Meanwhile, Alaska continues to implement programs that target protection and restoration of high priority habitats. An example is ADF&G's Habitat Conservation and Protection Program (HCPP), which works with private landowners, local, state, and federal government agencies, and nongovernmental organizations (NGOs), such as Ducks Unlimited, to develop approaches that help protect key fish and wildlife habitats, including habitats for at-risk species. This nonregulatory program emphasizes development of voluntary conservation easements and fee title acquisitions as a way to achieve long-term habitat and species population goals. HCPP is funded completely with federal dollars and private nonfederal (NGO) match. Federal grant sources include the National Coastal Wetlands Conservation Act and the USFWS Landowner Incentive Program.

Alaska also needs to continue addressing other habitat and land use issues that can affect production and management of fish and wildlife resources. These include the many issues shown in Table 35 and overall effects of a growing human population, such as the expansion and infilling of urbanized areas; invasive plants, such as Japanese knotweed in Southeast Alaska and European bird cherry in Anchorage (O'Harra 2005); and wildlife deaths from wind turbines, roadways, and improper trash management.

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O'Harra, D. "Plant specialists send out mayday over tree's spread." Anchorage Daily News 24 May 2005: A1.

VII. Primary Recommendations: Alaska's Greatest Wildlife Conservation Needs

In developing the CWCS, experts evaluated and discussed both the broad-scale needs relative to Alaska's wildlife and species- or group-specific needs. Many participants mentioned the value of taking an ecosystem-based approach to conservation planning and management for wildlife, one that encompasses the ecological relationships among multiple species and habitats. Potential benefits of this approach were highlighted recently when scientists announced study results showing a marked difference in plant communities between remote Aleutian Islands where introduced foxes decimated historic seabird colonies and those islands that remained fox-free. Lacking a seasonal infusion of guano, fox-infested islands transformed from lush grasslands to scrubland, affecting the habitats and populations of many wildlife species, some of them sensitive island endemics. For more information on ecosystem-based management and its elements, see:
http://www.esa.org/pao/esaPositions/Papers/ReportOfSBEM.php.

Experts generated hundreds of proposed conservation actions. Not surprisingly, many of the needs identified apply to all wildlife in Alaska; these include identifying and filling information and data gaps and conducting long-term monitoring of species and habitats.

Identifying and Filling Information Gaps

A serious impediment to the goal of better conserving broad arrays of species, and a central theme that quickly emerged in the CWCS development process, is the lack of information on most Alaskan species and their habitats. We've barely scratched the surface in terms of recording the diversity, abundance, distribution, and habitat relationships of most wildlife species in the state. To date, much of that effort has focused on game species that are important for commercial, recreational, and subsistence users. Little attention has been directed at the state's other wildlife resources, including invertebrates, fish, amphibians, the smaller mammals, and birds. In this first CWCS, the ability to use area- or species-specific spatial data (e.g., mapped species ranges) was hampered because information is incomplete or simply unavailable for many Alaska species.

For most species that have been well studied, populations and habitats are largely intact except in certain parts of the state. The exceptions generally include areas such as the Kenai Peninsula, Anchorage Bowl, and Matanuska-Susitna valleys, which are experiencing increased urbanization. Also, some areas have experienced significant industrial activity, including Southeast Alaska, where portions of the coastal forest are intensively managed for timber harvest, and the North Slope, where major oil and gas activity is occurring. For the hundreds of species about which little is known, we are unable to provide an accurate assessment of the health of populations or their habitats. A key need for Alaska is to complete a systematic statewide species ranking process in the next 18 months. This will help us prioritize efforts to fill information gaps and direct actions toward species of greatest conservation need.

Long-Term Monitoring

With its large, remote, and dynamic landscape, Alaska poses significant monitoring challenges. A growing but limited body of information is available on how habitats change naturally over time (e.g., in response to recurring wildfires, isostatic uplift, etc.). However, there is frequently no documented baseline against which to compare future population or habitat monitoring results. This makes it difficult to separate anthropogenic effects from natural effects, or even to gauge natural variability in loss, degradation, or gain of habitats. Enhanced GIS capability in the state would help present what is known, but GIS capability must be based on first having scientific control areas and the best available information or data to manipulate and compare. As new funds become available for wildlife and fish conservation, it will take a concerted effort to draft project selection criteria that give appropriate weight to monitoring projects. Reliability of long-term funding and net cost will be a critical issue for developing monitoring strategies.

A key recommendation from our process is to promote and facilitate meaningful participation by communities in monitoring and sharing information about the species and ecosystems they use. Traditional and other local user knowledge can also be very helpful to conservation efforts, e.g., by describing climate-related changes in northern species and habitats. Experts in our process noted possibilities for conducting basic species inventory in ways that contribute to future monitoring efforts. Monitoring to accomplish multiple purposes can help ensure that future conservation efforts are cost-effective and timely. For example, evaluating bycatch in marine and aquatic fisheries can help detect arrival of nonindigenous or invasive species.

List of CWCS Recommendations

The most significant and timely general recommendations for conserving Alaska's wildlife and fish diversity that arose during the CWCS planning effort are listed below. They fall into seven categories: Information and data gathering, data and classification systems, monitoring, species and habitat-related planning, funding and collaboration, education and outreach, and enforcement.

Information and Data Gathering

- Implement studies to collect baseline inventory and life history information on select species and their habitats; develop and implement management strategies for wildlife species of greatest conservation need.
- Implement a systematic approach such as Florida's (Millsap et al. 1990) for evaluating and quantitatively analyzing the state's wildlife and fish conservation needs.

- Conduct regional GAP analyses across Alaska as part of the National GAP; to help states maintain biodiversity, this program develops overlay maps showing land cover, stewardship, and species distribution.
- Integrate local knowledge into species and habitat data/information systems.
- Ensure that scientific data and pertinent traditional knowledge are available to decision-makers.
- Synthesize and distribute scientific information about species distribution, abundance and habitat use.

Data and Classification Systems

- Enhance mapping and GIS capability in resource management agencies.
- Develop and maintain coordinated data storage, retrieval, and management systems.
- Develop and implement uniform/complementary habitat classification systems.
- Develop procedures for contributing Alaska information to regional or national databases and conservation initiatives.

Monitoring

- Conduct long-term monitoring of selected species and their habitats, including in Alaska's existing conservation areas.
- Monitor the effects of climate change and invasive species on wildlife and their habitats.
- Evaluate the benefits and feasibility of establishing LTER sites in additional biomes in Alaska, especially the marine environment.
- Increase monitoring of water quality and quantity to support healthy aquatic ecosystems.

Species and Habitat-related Planning

- Support long-term land management planning that balances the needs of wildlife conservation with the need for community growth and responsible economic development.
- Develop wildlife habitat maps, including connectivity corridors, for use in designing and planning growth.
- Develop and implement effective conservation incentives for landowners and land management agencies.
- Identify and protect important habitats to help achieve long-term habitat or species population goals.
- Identify statutory and regulatory gaps that require attention to clarify responsibilities for conserving and managing species and their habitats.
- Develop protocols between agencies to better coordinate wildlife actions.
- Evaluate and establish a network of scientific control areas in representative habitats distributed across Alaska.
- Improve and maintain water quality in Alaska's estuaries and freshwaters, and water quantity in lakes, streams, and rivers.

- Support national/international efforts to reduce dumping, or loss at sea, of materials harmful to wildlife (e.g., nets, plastics, petroleum products).
- Ensure that existing conservation areas, including state special areas, are managed to maintain the wildlife values and use opportunities for which they were designated.

Funding and Collaboration

- Expand involvement of agencies, communities, industries and organizations, especially those that have species or habitat expertise or local knowledge, in conducting tasks related to CWCS conservation targets (e.g., research, inventory, and monitoring).
- Seek opportunities for funding source collaboration to meet the needs of species and habitats for which conservation concerns were noted in the CWCS planning process.
- Develop mechanisms for multiyear funding; this is especially important to long-term monitoring efforts.
- Identify opportunities to align proposal deadlines and selection criteria across funding sources to achieve shared wildlife and fish conservation goals and objectives.
- Consider establishing a dedicated funding source for the purchase of conservation easements important for restoring or maintaining at-risk wildlife populations.

Education and Outreach

- Foster public understanding of, and support for, maintaining and improving the diversity and health of Alaska's wildlife, fish, and habitat resources
- Use website development, citizen science programs, school programs, outreach through the media, and other techniques to reach and engage the public in actions that support wildlife goals outlined in the CWCS.

Enforcement

- Support law enforcement activities that help conserve wildlife and their habitats.

Literature Cited

Millsap, B.A., J.A. Gore, D.E. Runde, and S.I. Cerulean. 1990. Setting priorities for the conservation of fish and wildlife species in Florida. Wildlife Monographs. 111:1–57.

VIII. Monitoring of Species and Habitats

With its size, challenging logistics, and general lack of information on species and habitats, Alaska faces tremendous obstacles in improving the monitoring of its biodiversity. Yet nongame species can serve as important indicators of ecosystem health and resiliency (i.e., "the canary in the coal mine"). It is important and cost-effective to monitor and manage nongame species to avert the potential need for reactive, costly, and restrictive management. Some efforts have begun, and these can be strengthened and made more robust as a result of the CWCS. Implementation of additional monitoring efforts is needed, especially where anthropogenic effects are concentrated. For information about species-specific efforts and needs, please refer to Appendices 4 and 5. Once monitoring areas and control sites are established, the collection of local and traditional knowledge becomes a high priority.

Alaska has participated in various forums to rank conservation actions related to particular species (e.g., birds) and some habitats, especially the state's aquatic and estuarine areas. For example, through its Alaska's Clean Water Actions initiative (http://www.state.ak.us/dec/water/acwa/acwa_index.htm), DEC, DNR, and ADF&G annually set joint priorities for assessing and monitoring water quality, water quantity, and protecting aquatic habitats. ADF&G also has a long-term commitment to landbird monitoring efforts at the Creamer's Field Migratory Waterfowl Refuge. Along with the migration station at USFWS' Tetlin National Wildlife Refuge, the Creamer's station has been in operation since the early 1990s. It provides information on migration timing and changes in abundance of certain migratory landbird species. It also monitors change in the fattening and molt of migratory songbirds in response to environmental changes.

Banding a Yellow Warbler
K. Sowl, USFWS

At the international level, ADF&G has collaborated with the USFWS and other U.S. agencies in the Arctic Council's CAFF and AMAP initiatives. CAFF's website (http://www.caff.is/) contains information on conserving Arctic flora and fauna, ecosystems and habitat, and monitoring Arctic biodiversity and living resources. AMAP's website (http://www.amap.no/) describes efforts to monitor Arctic pollution, including airborne pollutants and contaminants carried by ocean currents.

Alaska also participates in the International Tundra Experiment (http://www.itex-science.net/), a circumpolar network focusing on impacts of climate change on Arctic vegetation. Some of the premier work on this topic is conducted at the University of Alaska's Toolik Field Station, located on the North Slope.

Through the activities of scientists from USFWS, ADF&G, and other organizations, Alaska participates in sampling networks for some of the animal species and groups selected for bi- or multilateral monitoring in the Arctic: Arctic char, seabirds, shorebirds, ringed seals, and polar bear. These marine mammals, and many of the seabirds and shorebirds monitored internationally (e.g., eiders), are also featured in the CWCS. For a description of the goals for monitoring biodiversity and a list of species for which circumpolar monitoring groups have been established, see http://www.caff.is/sidur/sidur.asp?id=9&menu=program and click on "Monitoring Arctic Biodiversity and Living Resources."

Monitoring is addressed through other key multidisciplinary efforts in Alaska such as the EVOS GEM program (http://www.evostc.state.ak.us/gem/how.html). What makes GEM unique is that it incorporates interagency cooperation and collaboration, public involvement, and accessible, informative data and information on the Gulf of Alaska ecosystem. The 1998 draft Bering Sea Ecosystem Research plan (BSER; http://www.afsc.noaa.gov/refm/reem/doc/sciencer.pdf) represents another excellent model for multidisciplinary efforts (Alaska Fisheries Science Center 1998). The BSER rates as its highest priority those monitoring approaches that:

- Respect the importance of traditional knowledge of Native peoples in understanding the Bering Sea.
- Provide opportunities for local involvement and communication.
- Foster cooperation among agencies and other stakeholders.
- Use and acquire information needed for adaptive management.
- Use a keystone or proxy species approach for monitoring.
- Provide opportunities for international cooperation and communication.
- Enhance technology transfer and communication among stakeholders.

Similar considerations feature prominently in the CAFF biodiversity monitoring model. The CAFF model also relies heavily on the use of standardized methods across the Arctic, so that data can be compared across regions. Using that model (as presented in the CAFF meeting report called "Monitoring Circumpolar Biodiversity Working Groups, Consolidated Results – April 29, 1999"), along with the GEM program and BSER plan as a basis for consideration, monitoring networks established to address needs of featured species and habitats in the CWCS should consider the following as objectives:

- Provide a means to share information, provide advice, and coordinate state monitoring efforts to be nationally and internationally compatible.
- Develop an ecologically based framework.
- Link to needs raised during the CWCS planning process, e.g.:
  a) Detect past and ongoing changes in Alaska's environment and biodiversity.
  b) Distinguish natural and short-term fluctuations from human-induced changes.
  c) Use monitoring as an early warning system that can trigger more specific and focused research and conservation measures.

    d) Provide independent information to test the validity of hypothesized changes.
    e) Implement and help to evaluate the effectiveness of conservation programs.
- Use monitoring results to update and prepare the next iteration of the CWCS.
- Build on existing state monitoring systems.
- Use community-based approaches to monitoring, including indigenous/traditional/local user knowledge.
- Identify indicator species as part of the monitoring framework.

Species and habitats must be monitored at appropriate scales and using appropriate indicators. For example, the draft BSER (Alaska Fisheries Science Center 1998) gives high priority to using a keystone or proxy species approach for monitoring in the Bering Sea. Meanwhile, the CAFF biodiversity monitoring plan takes a broader view as it seeks to promote monitoring across ecosystems and jurisdictions. Under that plan, useful considerations in selecting the desired scope for monitoring fish and wildlife diversity are:

- Incorporate an established ecosystem-based approach to allow for comparability between ecoregions.
- Design a monitoring process that is easily understood, sustainable, cost-effective, relevant to those involved, and paced appropriately.
- Incorporate cumulative impact assessment and an interdisciplinary approach.
- Include communications and public information as important features of a monitoring network.

To help states address USFWS guidance on CWCS monitoring requirements (see Section 1, page 3, Element No. 5), consultants under contract to Defenders of Wildlife worked with staff from several states to develop and make broadly available a "habitat monitoring framework." The full report is available on the web at http://www.biodiversitypartners.org/infomanage/monitoring/01.shtml. Relevant ideas for Alaska include:

- Tracking of long-term land use changes relative to habitat priorities at a statewide and/or ecoregional scale.
- Creating a statewide, interagency and private sector monitoring group to facilitate coordinated monitoring.
- Involving citizens in some elements of monitoring programs for practical and educational purposes.

CAFF's biodiversity monitoring plan also notes that because virtually everything can relate to biodiversity, it is important to be specific in what is to be monitored. Considerations would include such things as:

- Protocol for data collection and archiving of raw (not interpreted) data in the public domain.
- Involvement of multiple ecoregions where the phenomenon being monitored is common to each of them.

- Monitoring at intervals of a decade or longer to detect change, because Arctic floras grow slowly.
- Protection of sites being monitored for long-term change, perhaps for 100 years.

These recommendations are very similar to the findings generated by participants in Alaska's CWCS process. CWCS participants also raised several issues they felt were critical for improving monitoring efforts in Alaska. First, design programs to be integrative and coordinated with other research and monitoring efforts. For example, bycatch monitoring and monitoring of habitat changes in conservation areas could both be conducted in ways that help Alaska better detect invasive species. Experts also felt that funding recipients should be required to share results with others receiving similar funds. Successful examples included the EVOS GEM program and The Southern Oceans Convention on Antarctic Flora and Fauna. The latter monitors different ecosystem components of the Antarctic, and scientists in that effort specifically bring research together in a periodic report.

Live-trapping small mammals, Montague Island
E. Lance, USFWS

Interpreting historic data sets may provide unique and cost-effective insights into species diversity, abundance, and other characteristics. For example, ADF&G has annual furbearer sealing records dating back to 1977, and the University of Alaska Museum of the North houses a valuable collection of skin, bones, and frozen tissue of some 86,000 mammals. A researcher accessing data through the museum's website recently made an interesting discovery: The size of masked shrews in Alaska has significantly increased in the past 50 years as the state's climate has warmed (Anchorage Daily News 2005). This finding has intrigued scientists because it runs contrary to established biological theories on the relationship between climate and animal body size.

Experts also noted that recent concerns for fish and wildlife health issues, such as West Nile virus in birds or chytrid fungus in amphibians, may have significant effects on some wildlife populations. They felt it was important, therefore, to expand species monitoring efforts to include diseases, as well as potential contaminant-related pathologies like amphibian limb or bird bill deformities. Because birds from the North American and Asian flyways mingle here, Alaska is also a prime location to test for arrival of any avian influenza strains that could potentially affect humans.

Ecosystem Monitoring

Monitoring at the ecosystem level has potential to complement efforts to monitor species and habitats. It involves the analysis and monitoring of the cross-linkages between multiple species, species groups, humans, physical and climatic systems, and both the distinct and cumulative effects and interactions among them.

Currently, Alaska is home to two of the 24 LTER sites in the United States (see http://www.lternet.edu/). Both are terrestrial sites located in the northern part of the state (Toolik Lake in the North Slope foothills, and Bonanza Creek in Interior Alaska). Expanding the LTER program to include terrestrial sites in other parts of the state may be beneficial. Similarly, marine experts involved in CWCS development indicated that Alaska has much to gain from establishing one or more LTERs in its marine environment. The Alaska Maritime National Wildlife Refuge provides an example of a comprehensive approach to marine monitoring (Drew et al. 1996) that has led to a better understanding of the broad mechanisms of ecosystem functions and processes (Croll et al. 2005) and might be useful elsewhere.

Besides ongoing efforts described earlier in this section, experts identified several broad new initiatives related to biological monitoring programs, from regional to national in scope, that may help further the objectives of the Strategy. During implementation, efforts will be made to formally or informally integrate the conservation actions spelled out in this Strategy with these programs. One such program is the newly formed North Slope Science Initiative (NSSI), which focuses entirely on the inventory, monitoring, and research needed to inform the resource-management decisions of member agencies on the North Slope. Another is the National Ecological Observatory Network (NEON), the first national ecological measurement and observation system designed both to answer regional- to continental-scale scientific questions and to have the interdisciplinary participation necessary to achieve credible ecological forecasting and prediction.

Collaboration

Humans are an integral part of Alaska's ecosystems. In response to the experts' collective recommendations, the Strategy contains numerous conservation actions aimed at obtaining local knowledge and involving communities in monitoring (e.g., by sampling the stomachs of species taken for subsistence purposes). Some of the pioneering work on incorporating traditional knowledge in Alaska (Miraglia 1998) was done after the Exxon Valdez oil spill, as part of the GEM program. Overall, GEM has resulted in valuable collaborative working relationships and science-based models that can be applied in studying trophic interactions and ecosystems elsewhere in the state. Extensive community involvement is central to the GEM program. Citizen volunteers assist in observations and data gathering, and Alaska Natives are consulted for traditional ecological knowledge. Strong community involvement permits the program to compile a more extensive and expansive database.

Commercial fisheries can make valuable contributions to the conservation of nontarget species with which fishermen come in contact, and models now exist on how to incorporate ecological observations by small-scale, indigenous, and commercial fishermen. Information such as onboard observers' logbook records (e.g., of seabird activity and die-offs) can augment scientific studies and enhance species and ecosystem conservation efforts, including for at-risk species such as Steller's and Spectacled Eiders. A 2001 symposium at the University of British Columbia, entitled "Putting Fishers' Knowledge to Work," included presentations on methods for obtaining and accurately representing fishermen's knowledge. The fact that over 200 people from 23 countries and many representatives of North American indigenous groups attended this meeting testifies to a growing recognition of the value of traditional knowledge for managing fish and wildlife resources.


Recording information aboard a commercial fishing vessel
M. LaCroix, Fishery Observer

Alaska's land managers can offer valuable assistance to the CWCS implementation effort in coming years. For example, some existing conservation lands are well suited as long-term control sites for evaluating the effects of habitat fragmentation outside their boundaries. Other sites are ideally positioned to monitor effects of climate change, including northward encroachment of species from more temperate regions. Land managers can bring special expertise and assistance to monitoring efforts in Alaska. In addition, private landowners may gain public relations or other benefits by making their lands available as monitoring sites. The CWCS is an opportunity to provide strategies for helping them realize those benefits, and identify other mutually advantageous relationships.

As we move to expand data gathering and improve monitoring approaches in Alaska, incentives for participation and collaboration may or may not be needed. Much will depend on how well the public understands the basic ecological issues and the long-term value of its contributions. Some people may require little added incentive besides knowing they are helping to improve conservation of the species or ecosystems upon which their livelihoods or recreational enjoyment depend. Prospective "citizen monitor" volunteers may be energized by changes that affect their day-to-day lives (e.g., reduced snow cover, altered bird breeding and plant flowering dates) or in what they see happening to habitats over long periods (e.g., elimination of amphibian breeding ponds due to coastal isostatic uplift). Alaska's growing population of senior citizens may be receptive to the idea that contributing their time to monitoring efforts keeps them active and involved and leaves a legacy of much-needed baseline information for future generations.

Industries and nongovernmental organizations may find beneficial reasons and means to assist with Alaska's monitoring needs, including by providing matching funds, expertise, or in-kind services on multipartner projects. Where incentives to collaborate in monitoring and other CWCS efforts are needed, we can be both practical and creative. For example, with the right incentives, universities can encourage students in the sciences to devote a term's or summer's work to part of a long-term monitoring project in Alaska. In addition, the University of Alaska announced it is providing computer ownership and other incentives designed to promote greater participation in the sciences by Alaska Native high school and university students.

Cross-border collaborations have been especially effective for the management and monitoring of commercially important species. Experts noted that they also would be important for nongame species and ecosystem processes, especially collaborations with Canada, Mexico, Russia, and other countries associated with major flyways and dispersal routes.

Funding criteria related to monitoring priorities must help focus effort effectively. Experts warned of the "diluting" effects if, in the interests of being fair, decision-makers of agencies and conservation organizations spread funding across the state during each funding cycle. Instead, experts recommended that Alaska focus efforts in a way that advances priority work and then gradually revise priorities to begin focusing elsewhere.

Summary

Monitoring specifics will be developed as part of the CWCS implementation process. The descriptions of needs for each species in Appendix 4 provide substantial background and specific recommendations that should serve as a starting point. Specific steps to advance CWCS monitoring objectives include:

- Conduct an overview of existing monitoring activities in Alaska to identify gaps and deficiencies for key species, habitats and systems.

Monitoring water quality in Beaver Creek, a Kenai River tributary D. Palmer, USFWS

- Develop strategies for identifying new partners, strengthening existing relationships, and trying new methods of collaboration.
- Evaluate the need for different types of monitoring (populations, habitats, systems) across different scales (local, regional, statewide) with respect to the major causal factors of decline.
- Develop priority system(s) for addressing gaps and deficiencies and supplementing existing efforts.
- Design appropriate monitoring activities and programs.
- Coordinate meetings with partners and stakeholders to discuss ways of meeting monitoring priorities and to identify respective roles and responsibilities.

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IX. Strategy Monitoring

ADF&G has adopted the performance measurement system established by the state's Office of Management and Budget. These targets and measures provide a common understanding of purpose, direction and expected outcomes for state agency programs. They also provide for accountability through the federal and state budgeting processes. This structure will provide the basic framework for monitoring and evaluating progress under Alaska's CWCS. Interim progress (i.e., between CWCS iterations) will be reported periodically.

The department will evaluate CWCS performance at the overall strategy level and at the species or species group level. This approach will look at the performance of ADF&G and its partners in meeting identified performance indicators or "targets," as well as the effectiveness of conservation actions in attaining long-term outcomes.

The goal for the CWCS is to conserve the diversity of Alaska's fish and wildlife. Goals and objectives are also established for individual species and species groups. Efforts to document and manage habitats will also be monitored as they are implemented. All projects funded by ADF&G have specific project objectives that contribute to broader program objectives.

Red-throated Loon D. Menke, USFWS

Two sample frameworks, one for monitoring Alaska's overall performance under the CWCS (Table 36), and one for determining success in conserving a single species (Red-throated Loon; Table 37) are shown below.

Table 36: Sample Framework for Monitoring Overall Performance under the CWCS

CWCS OUTCOMES		**ACTIVITIES/OUTPUTS**	**INPUTS**
Long-term and End Results	Short-term/ Intermediate Results	Conservation Actions	What we invest
CWCS Goal: Conserve the diversity of Alaska's fish and wildlife Target: Decreasing trend in the ratio of species having SRANKs of S1, S2 compared to S3, S4, S5 over 5 years[17] Measure: Trend in the ratio of species having SRANKs indicating imperiled status (S1, S2) to those with less concern or considered secure (S3, S4, S5) Target: No loss of genetic diversity through extirpation or extinction of populations Measure: Number of populations lost in the state, over which the State of Alaska has management authority and for which human activities are believed to be primarily responsible.	Target: Establish new quantified targets for 10 species and 5 habitats[18] by 2015 Measure: The number of biological reference points established for CWCS featured species and key habitats Target: Meet the objectives (defined by targets) of 10 species by 2010 Measure: The number of objectives attained	Prioritize species for initial inventory and monitoring based on range-wide distribution factors such as endemism, limited, widespread, disjunct and peripheral and relative conservation concerns Define, inventory and map habitats at the ecoregional landscape level by patch communities and matrix-forming communities to identify relative vulnerability to destruction and degradation Map known populations and distributions of priority species within defined habitat communities Map expected populations and distributions based on habitat associations and predicted estimates Establish working groups, MOUs, and cooperative initiatives to facilitate collaboration among stakeholders and management agencies Explore market mechanisms that conserve the diversity of wildlife	Staff time Money Partnerships and donations of labor, equipment, and materials

[17] SRANKs are codes systematically applied to a state's species or populations by the National Heritage Network and The Nature Conservancy to indicate relative conservation status: e.g., S1 = critically imperiled, S5 = widespread, abundant, secure. For more information on SRANKs or global ranks (GRANKs), see Appendix 7, pages 4–6.

[18] Numbers here were picked arbitrarily, as examples; we expect that actual numerical targets for the CWCS will be selected within the first several years of CWCS implementation, with input from multiple divisions, agencies and partners.

Table 37: Sample Framework for Monitoring Success in Maintaining a Single Species, Red-throated Loon[19]

CWCS OUTCOMES		ACTIVITIES/OUTPUTS	INPUTS
Long-term and End Results	Short-term/ Intermediate Results	Conservation Actions	What we invest
Species Goal: Ensure Red-throated Loon populations remain sustainable throughout their range within natural population-level variation and historic distribution across Alaska	Species Objective: Maintain viable Red-throated Loon population levels Target: Maintain a population of at least 10,000 to 20,000 adult breeders Measure: Population number as indicated by Arctic Coastal Plain Survey and the Alaska Waterfowl Breeding Survey.	Conduct studies to evaluate phenology of birds' arrival and initiation of breeding relative to survey timing and climatic variations Evaluate detectability of breeders vs. nonbreeders and detection differences among observers Implement survey to evaluate current productivity surveys Institutionalize a contaminants monitoring program of loon tissues and prey Conduct studies to estimate survival and productivity simultaneously	Staff time Money Partnerships and donations of labor, equipment, and materials

[19]Particulars taken from Red-throated Loon Conservation Action Plan, found in Appendix 4

Evaluation and Reporting

The Strategy's success will be evaluated at various levels: first, whether the state and its partners are meeting the intermediate result targets at the species level, and then, whether we are conserving the diversity of wildlife in Alaska as indicated by the measures experts identified.

Tracking the conservation actions of ADF&G, partners supported by State Wildlife Grants, and other state, federal and nongovernmental organizations will be a monumental task. ADF&G hopes to convene a charrette-style meeting in 2005 to engage motivated and innovative resource managers in discussing particulars of plan implementation. Monitoring will be a big part of that challenge. We expect to begin developing the more detailed approach to implementation and monitoring, and securing commitments to follow through, at this meeting.

Until a more effective, comprehensive, and collaborative system of reporting is put in place, the planning team envisions that ADF&G staff in the Wildlife Conservation and Sport Fish Divisions will be responsible for staffing the charrette and other meetings and reporting on progress towards CWCS targets. Reports will be tailored to various interests including ADF&G policymakers, Strategy partners, USFWS Federal Assistance, Alaska Office of Management and Budget, the IAFWA, and the public.

Adaptive Management

Many of the specific conservation actions and strategies within the CWCS will be implemented in a manner consistent with the principles of adaptive management. These principles include closely monitoring the conservation actions to determine if the expected results take place, learning from these results, and making changes to specific conservation actions to maximize the intended conservation intent. Conversely, if a conservation action is shown to be ineffective, the Strategy is intended to be flexible enough to allow needed changes in emphasis or approach, without waiting for scheduled milestone reviews/revisions to occur. Many experts felt that reviews should take place as conditions warrant, and an adaptive management approach is consistent with this guidance.

X. Implementation

Implementing this Strategy will depend on coordinating conservation efforts among diverse partners. Such efforts will bring together expertise and funds from various sources and apply them to needs identified in the Strategy. As an example, see discussions on collaborative monitoring found in Section VIII (Monitoring of Species and Habitats). One of the needs identified by Congress, and broadly supported by experts and partners in the Alaska process, will be to align Alaska's existing programs to better achieve multispecies and ecosystem goals and ensure protection and management of wildlife diversity.

Alaska marmot ADF&G

The department's decisions about funding, timing, and cooperators will be directed according to budget cycles and federal processes associated with State Wildlife Grants and other funding sources. Since the charter establishing the CWCS Oversight Committee and Task Force (see Section II, Methodology and Approach) expires with Strategy submittal and approval in fall 2005, a new decision-making structure will be needed to guide implementation efforts. Meanwhile, partners will need to follow guidance and procedures unique to their own organizations and available fiscal resources. Cooperators may find it advantageous to formalize their working arrangements in memoranda of understanding.

Many potential CWCS partners are already involved with wildlife and fish conservation in this state, and many more will become involved as funding levels and sources increase. In Alaska, collecting, compiling and reporting data on species, including monitoring of trends, will be a big challenge. Data analysis and interpretation will require staffing increases. Timely evaluation and adjustment to species and habitat conservation actions will be of primary importance in the context of plan implementation.

This Strategy provides an impetus to improve existing cooperation and involve additional partners. By compiling state fish and wildlife conservation issues in a single document for the first time, it will now be possible to develop a coordinated approach ranging from individual species' concerns up to regional or broader habitat-level concerns. The Strategy is more than an outline for specific conservation actions; it can also serve as a framework for expanding partnerships and collaboration in support of these actions. A first step will be to identify individuals, land managers, and organizations that can contribute to and use CWCS information in a timely way.

XI. Strategy Review and Revision

Alaska's CWCS will be fully reviewed every 10 years, along with an interim five-year review for certain species carried out by expert groups. Guidance received from the species expert teams was split between conducting five- or 10-year review-and-revision exercises for the species featured in the Strategy. For example, the shorebird expert team recommends that a review of the CWCS's shorebird species be done in conjunction with the Alaska Shorebird Group and its five-year revision schedule for the Alaska Shorebird Conservation Plan. Conservation action plans for these species will be updated as new information is obtained from these reviews. Public involvement is an important part of CWCS development and implementation, and ADF&G expects to involve the public in any significant modifications, especially those that include changes to goals or objectives.

Four-spotted skimmer, Alaska's State Insect R. Armstrong

XII. Glossary

adaptive management: calls for designing the management of natural systems as replicable experiments in which participants are constantly learning and improving the management process

alluvial: of or relating to the sediment deposited by flowing water

anadromous fish: a fish or fish species that spends portions of its life cycle in both fresh and salt waters, entering fresh water from the sea to spawn; these include the anadromous forms of Pacific trouts and salmon of the genus *Onchorynchus* (rainbow and cutthroat trout and Chinook, coho, sockeye, chum, and pink salmon), Arctic char, Dolly Varden, sheefish, smelts, lamprey, whitefish, and sturgeon

anthropogenic: caused by humans

apex: the highest point; in biological terms it sometimes refers to an organism at the top of the food chain

aufeis: the ice formed when water from a stream freezes on top of previously formed ice

ballast: any heavy material placed at the bottom of a boat to stabilize it

benthic ecosystem: an ecosystem in which a collection of organisms attach, burrow, or rest on the bottom substrates

benthos: the bottom of the sea

bioaccumulate or **biomagnify:** to pass from tissues in one level of the food chain into tissues of the next higher trophic level; in this way pollutants can accumulate in the flesh of higher order organisms, including humans

biodiversity: the variety of life forms, the ecological roles they perform, and the genetic diversity they contain; often used to mean “species richness”

biogenic: produced by the actions of living organisms

biogeographic: relating to the science that deals with the location of a species on a regional or continental level

biomass: the total mass of the species in any ecological community

biome: a major regional biotic community characterized by the dominant forms of plant life and the climate

biota or **biotic**: living things; the adjective form means having to do with living things

bottomland: low-lying land near a body of water; the soil consists of sand, silt, and mud deposited by flowing water

bryophytes: a division of the plant kingdom that includes mosses and liverworts; plants with rhizoids rather than roots, and little or no vascular tissue

calcareous: containing calcium carbonate, calcium, or limestone

caldera: a large depression formed by a volcanic explosion or a volcanic collapse

canopy: the uppermost layer in a forest formed by the tops of trees

carrying capacity: number of individuals in a population that the resource of a habitat can support

charrette: an intensive brainstorming session involving any number of people and lasting anywhere from a few hours to a few days

chemosynthesis: process by which carbohydrates are made from carbon dioxide and water while using chemical nutrients as an energy source

circumpolar: surrounding or near one of the Polar Regions

cline: a gradual change in a character or feature across the distributional range of a species or population, usually associated with an environmental or geographic transition

cohort: a group of related families

colluvial: of or relating to a loose deposit of rock debris that accumulates through gravity at the bottom of a cliff or slope

colluvium: a loose deposit of rock debris at the base of a cliff or slope

colonization capacity: the capacity at which an invading species can settle in to a habitat

coniferous: of or having cones, (i.e. a coniferous tree would be a spruce)

conservation: the use of methods and procedures necessary or desirable to sustain healthy populations of wildlife, including all activities associated with scientific resources management, such as research, census, monitoring of populations; acquisition, improvement and management of habitat; live trapping and transplantation; wildlife damage management; and periodic or total protection of a species or population, as well as the taking of individuals within wildlife stock or population if permitted by applicable state and federal law

continental climate: climatic conditions under the influence of adjacent land masses

cyclic populations: animal populations that fluctuate drastically, with peak and low numbers tending to recur at regular intervals, and over large geographic areas. For example, 1960 was a "lemming year" for almost all of the Canadian Arctic. All sorts of reasons for the cycles have been suggested, from changes in the number of sunspots to snow conditions. Weather is a likely, but still unproven, trigger.

decadent: to be in a state of decline or decay

deciduous: losing foliage at the end of the growing season

decomposer: an organism, often a bacterium or fungus, that feeds on and breaks down dead plant or animal matter, thus making organic nutrients available to the ecosystem

depensatory: having a rate that increases as the size of a population decreases

detritivore: an organism that feeds on detritus, such as forest litter or leaf litter

detritus: loose matter resulting from the decay or erosion of rock or organic material

dimorphism: the existence of the same species with two different forms that can differ in size, color, or shape

ecoregion: large area of land and water that contains assemblages of vegetation communities that share species and ecological dynamics, environmental conditions, and interactions that are critical for their long-term persistence

ecotone: the transition between two adjacent ecological communities over a broad area

endemic species: a species that is restricted to, or native to, a particular area or region. Because of their limited geographic range, they are often, but not always, vulnerable to extinction.

ephemeral plant: any plant that lives only a very short time; short-lived, transitory, having a short life cycle

ephemeral stream: An ephemeral stream has flowing water only during, and for a short duration after, precipitation events in a typical year. Ephemeral stream beds are located above the water table year-round. Ground water is not a source of water for the stream. Runoff from rainfall is the primary source of water for stream flow.

epibiota: organisms living on the seafloor surface

epikarst: the upper surface of karst, consisting of a network of intersecting fissures and cavities that collect and transport surface water and nutrients underground. Epikarst depth can range from a few centimeters to tens of meters.

ericaceous: refers to the heath family, Ericaceae, e.g., blueberry; of, relating to, or being a heath or of the heath family of plants

estuaries or **estuarine:** refers to a coastal body of water that has a free connection with the open sea, where fresh water from land drainage is mixed with seawater. Estuaries are subject to tidal action.

eutrophication: the aging of a lake through the enrichment of its own water

extirpation or **extirpated**: means bringing a species to extinction within all or a part of its range; going or having gone extinct

fecundity: the state of being fertile; capacity for producing offspring

feeding guild: a group of species with similar foraging habits and similar roles in a community

fish wheels: a series of lift nets on a wheel frame that is rotated by the river current, catching migrating fish

fitness: the genetic contribution by an individual's descendants to future generations of a population

floodplain: the part of the river valley that is made up of unconsolidated, riverborne sediment and is occasionally flooded

fluvial: pertaining to rivers or streams; a product of flowing waters

food chain or **food web:** a succession of organisms in an ecological community that constitutes a continuation of food energy from one organism to another, as each consumes a lower member and in turn is preyed upon by a higher member of the chain

forbs: herbaceous ephemeral plants other than grasses, sedges or rushes

fructicose lichens: branched, shrub-like lichens that are attached to the twig by a single, sucker-like holdfast

fur sealing: process by which furbearer species are officially marked with locking tags and/or other means to record their harvest and biological information

game or **game species:** In common usage, this term refers to species that are commercially or recreationally hunted, trapped, or fished.

gelifluction lobes: a feature shaped by the process of soil movement over a permafrost layer in a periglacial environment

graminoid: grass or a grass-like plant

habitat: broadly defined, means all abiotic and biotic factors (temperature, humidity, precipitation, radiation, substrate, nutrient conditions, microbial communities, insect and plant communities, forage species, competitors, and predators) that describe the universe in which a given species can live and reproduce successfully over time

halophytic: of, or having to do with, a plant that grows naturally in soils having a high content of various salts

haulouts: dry land areas used by marine mammals, especially walrus and sea lions

hydrography: scientific description or analysis of the physical conditions, boundaries, flow, and related characteristics of the earth's surface waters

herbaceous: having little or no woody tissue. Most plants grown as perennials or annuals are herbaceous.

hydric: wet, excessive moisture, saturated

hydrology: scientific study of the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere

hypogean: growing or occurring underground

imperiled species: in the most general sense, typically includes species listed as Threatened or Endangered under the U.S. Endangered Species Act; species classified as critically endangered, endangered, or vulnerable by the World Conservation Union's (IUCN) Red List of Threatened Species; and those species classified as globally imperiled or critically imperiled (i.e., species global ranks of G1 – G2) by NatureServe

indigenous: existing, growing, or produced naturally in a region or country; native to an area

infauna: benthic organisms that dig into the seabed or construct tubes or burrows

infaunal: living within the sediment

instream flow: any quantity of water flowing in a natural stream channel at any time of year. The quantity may or may not be adequate to sustain natural ecological processes and may or may not be protected or administered under a permit, water right, or other legally recognized means.

interspecific interactions: interactions that occur *between* species

intraspecific interactions: interactions that occur between members of the *same* species

intertidal: the region between the high tide mark and the low tide mark

invasive species: a nonindigenous species whose introduction causes, or is likely to cause, economic or environmental harm or harm to human health. The term noxious or nuisance species is sometimes also used.

island biogeographic effects: the biological theory which says that, because of isolation, species located on islands are more subject to habitat change, the undiluted effects of natural selection and mutation, and extinction

island biogeography: the study of the distribution of living things, especially on islands

iteroparity: the condition of an organism that has more than one reproductive cycle in a lifetime

karst: a landscape topography found in any bedrock with internal drainage. The solubility of the bedrock produces fissures, underground streams, caverns, and sinkholes.

key species: important and significant species

keystone species: those species whose impact on their community or ecosystems is disproportionately large relative to their abundance. Where keystone species can be identified and used for conservation planning, they may be able to serve as surrogates for some ecological processes or ecosystems of high ecological integrity.

lentic: refers to slow-moving or standing waters typically associated with a lake or pond

life history: the life history of an organism can be described in terms of its capacity for producing offspring, growth and development, age at sexual maturity, parental care, and longevity

littoral: of or relating to the shore of a body of water

lotic: refers to fast-moving or flowing waters typically associated with a stream or river

macroalgal: of or relating to a nonvascular plant that can be seen with the naked eye

maritime climate: climatic conditions under the influence of an adjacent ocean

mesic: damp, moist, well-drained

microclimate: the climate within a small, distinct area, such as a forest or watershed, or an even more restricted space, such as a swale or cave

Native allottee: an Alaska Native who received title to a land parcel conveyed pursuant to the 1906 Alaska Native Allotment Act

necropsy: examination of an animal carcass to determine or confirm cause of death

nongame species: wildlife species that are not commonly hunted, trapped, or fished except by subsistence users

nonindigenous species: an alien species that is not native to a particular ecosystem. Alien species are also known as exotic, nonnative, or introduced, and the term noxious or nuisance species is sometimes used if the nonindigenous species can cause harm.

nonvascular plants: plants that lack the conductive tissue for the circulation of water and nutrients; moss and fungi

optimum sustainable population: population level targeted by the Marine Mammal Protection Act of 1972 as amended, which defines acceptable recovery at 60–100% of carrying capacity

overharvest: to allow harvest excessively, to the detriment of the resource

pack ice: solid sea ice; can be present only in winter, or as part of the permanent polar pack; the pack everywhere is floatable and breakable

paleoarctic: early or prehistoric Arctic

PCB: any of a family of industrial compounds produced by chlorination of biphenyl, noted primarily as an environmental pollutant that accumulates in animal tissue with resultant pathogenic or teratogenic effects

peat: partially decomposed organic matter

pelagic: of, relating to, or living in, open oceans or seas rather than waters adjacent to land or inland waters

periglacial: used to refer to geomorphic environments located at the periphery of past Pleistocene glaciers, where the landscape is dominantly influenced by frost action

phenology: the study of the impact of climate on the seasonal occurrence of flora and fauna and also the changing form of an organism and the way this affects its relationship with its environment

physiochemical: refers to the scientific analysis of the properties and behavior of chemical systems, including the earth's atmosphere and waters

physiognomy: outward appearance

physiographic: refers to natural features of the earth's surface, including land formation, climate, currents, and distribution of flora and fauna

pingo: an Arctic landform, shaped like a conical hill, that is created by the action of permafrost, contains a core of clear ice, and can be up to 75 meters high and 500 meters across

piscivorous: fish-eating

piscicide: any of a number of chemicals used to kill fish

plant community: any assemblage of plants found growing together

polynya: an area of open water surrounded by sea ice

pristine: remaining in a pure state; typical of earliest time or condition

prostrate: low growing; growing low to the ground

protist: a single-celled organism. Animal protists include naked and shelled amoebas, foraminiferans, zooflagellates, and ciliates.

proxy species: a species selected for management purposes that is intended to represent another species, group, or a habitat that will benefit from that management

radiation: species radiation refers to the diversification of a species or single ancestral type into several forms that are each adaptively specialized to a specific environmental niche; an adaptive process of species specialization

refugia: plural of "refugium," a place that a species will go seeking safe harbor from disturbance, injury, predation, etc.

rhizomes: underground stems that often send out roots

riparian: pertaining to a river and the corridor adjoining it (i.e., its banks and floodplain)

rodenticide: any of a number of chemicals used to kill small mammals such as rats

salinity: containing salt

scrub: A straggly, stunted tree or shrub; woody vegetation predominantly of shrubs, ranging between 8 inches and 10 feet in height

sedimentation: the act or process of depositing sediment (the solid fragments of inorganic or organic material that come from the weathering of rock and are carried and deposited by wind, water, or ice)

semelparity: the condition of an organism that has only one reproductive cycle during its lifetime

senescence: the complex deteriorative processes that naturally terminate the functional life of an organ or organism

septage: liquid or solid material removed from a septic tank, cesspool, portable toilet, Type III marine sanitation device, or similar domestic wastewater treatment system

shorefast ice or **landfast ice:** the part of pack ice that is firmly frozen to the shore

shrub: a woody plant of relatively low height, having several stems arising from the base and lacking a single trunk; a bush; a woody perennial plant differing from a tree by its low stature and by generally producing several basal stems instead of a single bole, and from a perennial herb by its persistent and woody stem(s)

soil creep: the slow downhill movement of surface soil and debris due to gravity

solifluction lobes: a form shaped by the movement of soil downslope in a freeze-thaw environment

spatial segregation: the separation of individuals or species by space

species: a fundamental category of taxonomic classification consisting of related organisms capable of interbreeding. In this document, use of the word “species” includes species, subspecies and distinct populations.

species pairs: morphologically, ecologically, and genetically distinct populations of the same “species” that are sympatric during some or all of their life cycle. Examples include kokanee and anadromous sockeye; dwarf and normal Arctic char; limnetic and benthic threespine stickleback; and giant and normal pygmy whitefish. Such “populations” generally show reproductive segregation and function as independent “species,” even though by traditional taxonomic means they are not differentiated.

speleologist: a scientist who studies caves

staging: refers to areas where migratory birds congregate. The staging areas provide food that enables the birds to accumulate fat to fuel their long flights.

stygobite: aquatic cave dweller; an organism that exclusively inhabits underground habitats, such as caves and subterranean waters

subalpine: of, or pertaining to, the mountain areas between the foothills and the alpine slopes

sub-Arctic: the region just south of the Arctic Circle

sublittoral: of or pertaining to the region in a body of water between the shoreline and the edge of a steeper drop-off; the benthic zone extending from the low tide mark to the outer edge of the continental shelf (about 200 meters)

subsistence: under federal law, defined as “the customary and traditional uses by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools or transportation; for the making and selling of handicraft articles out of non-edible byproducts of fish and wildlife resources taken for personal family consumption; and for the customary trade, barter or sharing for personal or family consumption”

substrate: a surface, such as where an organism grows or is attached

subtidal: the portion of the marine environment that is below the area exposed during low tides but still within the photic zone, the area of the seabed influenced by light

surface water: all water occurring above ground. This includes wetlands, lakes, rivers, and streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, wet meadows, or ponds.

sustainable or **sustainability:** the ability of an ecosystem to maintain ecological processes and functions, biological diversity, and productivity over time; also, use of resources in a manner that allows the resources to be replenished by natural systems in such a manner that they will never be exhausted

taxon: a taxonomic category or group, such as phylum, order, family, genus, or species. The plural form is "taxa."

taxonomic group: a classification of organisms in an ordered hierarchical system that indicates their natural relationships. Each species (a dog, for example) belongs to a genus (*Canis*), each genus belongs to a family (Canidae), each family belongs to an order (Carnivora), each order belongs to a class (Mammalia), each class belongs to a phylum (Chordata), and each phylum belongs to a kingdom (Animalia).

telemetry: the science and technology of automatic measurement and transmission of data by wire, radio, or other means from remote sources to receiving stations for recording and analysis

teratogenic: pertaining to substances that are suspected of causing malformations or serious deviations from the normal type, which cannot be inherited

thermokarst: a periglacial landscape that has enclosed depressions caused by the selective thawing of ground ice associated with thermal erosion by stream and lake water

traditional knowledge or **traditional ecological knowledge:** For the purposes of this document, traditional knowledge is broadly defined to include everything from raw notes, photographs, audiotapes and videotapes, and interviews with Native elders to formal databases organized on computer software; it also includes similar information gathered from others with long histories of observation about species and habitats, such as commercial and recreational fishermen, guides and charter operators.

troglobite: terrestrial cave dweller

troglophillic: cave-loving, dark-loving

trophic: pertaining to food or nutrition

trophic level or **trophic relationship:** position in the food chain determined by the number of energy-transfer steps to that level: 1 = producer; 2 = herbivore; 3, 4, 5 = carnivore

tundra scars: damage to tundra vegetation and the underlying tundra substrate

turbid or **turbidity:** having sediment stirred up or suspended

tussocks: a clump or tuft of growing grass

uplift: an increase in land elevation; sources of uplift include tectonic activities or isostatic changes due to glacial melting and crustal unloading

viable population: a population of sufficient numbers and reproductive potential to maintain its existence over time in spite of normal fluctuations in population levels; also, the ability of a population of a plant or animal species to persist for some specified time into the future. Viable populations are populations that are regarded as having the estimated numbers and distribution of reproductive individuals to ensure that their continued existence is well distributed in a given area.

Western science: the hypothesis-based method of scientific inquiry taught in academia

wildlife: all species in the kingdom Animalia except those considered domesticated

xeric: having very little moisture, tolerating or adapted to dry conditions

XIII. Acronyms

ACIA: Arctic Climate Impact Assessment

ACMP: Alaska Coastal Management Program

ACWA: Alaska's Clean Water Actions

ADF&G: Alaska Department of Fish and Game

AKNHP: Alaska Natural Heritage Program

ALMS: Alaska Landbird Monitoring System

AMAP: Arctic Monitoring and Assessment Program

AMBCC: Alaska Migratory Bird Co-Management Council

ANILCA: Alaska National Interest Lands Conservation Act

ANWR: Arctic National Wildlife Refuge

AOOS: Alaska Ocean Observing System

AORBBS: Alaska Off-Road Breeding Bird Survey

APOC: Arctic Peoples' Observation Center

ATVs: All-terrain vehicles

BCD: Biological Conservation Database

BLM: U.S. Department of the Interior, Bureau of Land Management

BMPs: Best management practices

BRI: Biodiversity Research Institute

BSER: Bering Sea Ecosystem Research

CAFF: Conservation of Arctic Flora and Fauna

CBC: Christmas Bird Count

CEC: Commission for Environmental Cooperation

CHAs: Critical Habitat Areas

CI: Confidence interval

CIB: Cook Inlet Beluga

CITES: Convention on International Trade in Endangered Species

COE: U.S. Army Corp of Engineers

COSEWIC: Committee on the Status of Endangered Wildlife in Canada

CPDB: Community Profile Database

CPUE: catch per unit effort

CRD: Copper River Delta

CWA: Clean Water Act

CWCS: Comprehensive Wildlife Conservation Strategy

DEC: Alaska Department of Environmental Conservation

DEMs: Digital Elevation Models

DLP: Defense of Life and Property

DNR: Alaska Department of Natural Resources

DOD: U.S. Department of Defense

DOF: Division of Forestry, DNR

DOI - MMS: Department of Interior, Minerals Management Service

DPO: Detailed plan of operations

EO: Education and outreach

EPA: U.S. Environmental Protection Agency

EPPR: Emergency Prevention, Preparedness and Response

EVOS: Exxon Valdez Oil Spill

FLUP: Forest Land Use Plan

FRPA: Alaska Forest Resources and Practices Act

GABA: gamma-aminobutyric acid

GAP: Gap Analysis Program

GEM: Gulf Ecosystem Monitoring

GIS: Geographic information system

GMU: Game management unit

GOA: Gulf of Alaska

IAFWA: International Association of Fish and Wildlife Agencies

IUCN: The International Union for the Conservation of Nature and Natural Resources

LTER: Long-term Ecological Research

LTFs: Log transfer facilities

LWD: Large woody debris

MAPS: Monitoring Avian Productivity and Survivorship

MPAs: Marine protected areas

NABBS: North American Breeding Bird Survey

NEON: National Ecological Observatory Network

NEPA: National Environmental Policy Act

NERR: National Estuarine Research Reserve

NGOs: Nongovernmental organizations

NHD: National Hydrography Dataset

NOAA: National Oceanic and Atmospheric Administration

NOAA ESI: National Oceanic and Atmospheric Administration Environmental Sensitivity Data

NPDES: National Pollution Discharge Elimination System

NPRA: National Petroleum Reserve - Alaska

NPRB: North Pacific Research Board

NRCC: National Research Committee Council

NSSI: North Slope Science Initiative

NWI: National Wetlands Inventory

OC: Oversight Committee

OHMP: Office of Habitat Management and Permitting, DNR

OPMP: Office of Project Management and Permitting, DNR

ORVs: Off-road vehicles

OSP: Optimum Sustainable Population

PAME: Protection of the Arctic Marine Environment

PARC: Partners in Amphibian and Reptile Conservation

PCB: Polychlorinated biphenyl

PIF: Partners in Flight

POPs: Persistent organic pollutants

PRISM: Program for Regional and International Shorebird Monitoring

SAR: Stock assessment report

SCALE: Shoreline Classification and Landscape Extrapolation

SDWG: Sustainable Development Working Group

SF: Sport Fish Division

SGCN: Species of Greatest Conservation Need

SWG: State Wildlife Grants

T&E: Threatened or Endangered

TEK: Traditional Ecological Knowledge

TLMP: Tongass Land Management Plan; officially the Tongass National Forest Land and Resource Management Plan 1997

TNC: The Nature Conservancy

UAF: University of Alaska Fairbanks

UAM: University of Alaska Museum

UAS: University of Alaska Southeast

UNESCO: United Nations Educational, Scientific, and Cultural Organizations

USFS: United States Forest Service

USFWS: United States Fish and Wildlife Service

USFWS - MBM: United States Fish and Wildlife Service, Migratory Bird Management

USGS: United States Geological Survey

WHSRN: Western Hemisphere Shorebird Reserve Network

Y-K: Yukon-Kuskokwim

YKD: Yukon-Kuskokwim Delta

XIV. Appendices

Appendix 1. Vertebrate Species of Alaska[1]

**** Threatened/Endangered***

Fishes

Scientific Name	Common Name
Eptatretus deani	**black hagfish**
Lampetra tridentata	**Pacific lamprey**
Lampetra camtschatica	**Arctic lamprey**
Lampetra alaskense	**Alaskan brook lamprey**
Lampetra ayresii	**river lamprey**
Lampetra richardsoni	**western brook lamprey**
Hydrolagus colliei	**spotted ratfish**
Prionace glauca	**blue shark**
Apristurus brunneus	**brown cat shark**
Lamna ditropis	**salmon shark**
Carcharodon carcharias	**white shark**
Cetorhinus maximus	**basking shark**
Hexanchus griseus	**bluntnose sixgill shark**
Somniosus pacificus	**Pacific sleeper shark**
Squalus acanthias	**spiny dogfish**
Raja binoculata	**big skate**
Raja rhina	**longnose skate**
Bathyraja parmifera	**Alaska skate**
Bathyraja aleutica	**Aleutian skate**
Bathyraja interrupta	**sandpaper skate**
Bathyraja lindbergi	**Commander skate**
Bathyraja abyssicola	**deepsea skate**
Bathyraja maculata	**whiteblotched skate**
Bathyraja minispinosa	**whitebrow skate**
Bathyraja trachura	**roughtail skate**
Bathyraja taranetzi	**mud skate**
Bathyraja violacea	**Okhotsk skate**
Acipenser medirostris	**green sturgeon**
Acipenser transmontanus	**white sturgeon**
Polyacanthonotus challengeri	**longnose tapirfish**
Synaphobranchus affinis	**slope cutthroat eel**
Histiobranchus bathybius	**deepwater cutthroat eel**
Avocettina infans	**blackline snipe eel**
Nemichthys scolopaceus	**slender snipe eel**
Alosa sapidissima	**American shad**
Clupea pallasii	**Pacific herring**

[1] This appendix lists the vertebrate species of Alaska, but it does not include subspecies, even though some of those are featured in the CWCS.

Sardinops sagax	**Pacific sardine**
Couesius plumbeus	**lake chub**
Catostomus catostomus	**longnose sucker**
Esox lucius	**northern pike**
Dallia pectoralis	**Alaska blackfish**
Nansenia candida	**bluethroat argentine**
Leuroglossus schmidti	**northern smoothtongue**
Lipolagus ochotensis	**popeye blacksmelt**
Pseudobathylagus milleri	**stout blacksmelt**
Bathylagus pacificus	**slender blacksmelt**
Macropinna microstoma	**barreleye**
Dolichopteryx parini	**winged spookfish**
Sagamichthys abei	**shining tubeshoulder**
Holtbyrnia latifrons	**teardrop tubeshoulder**
Holtbyrnia innesi	**lanternjaw tubeshoulder**
Conocara salmoneum	**salmon slickhead**
Mallotus villosus	**capelin**
Hypomesus olidus	**pond smelt**
Hypomesus pretiosus	**surf smelt**
Osmerus mordax	**rainbow smelt**
Thaleichthys pacificus	**eulachon**
Spirinchus thaleichthys	**longfin smelt**
Spirinchus starksi	**night smelt**
Stenodus leucichthys	**inconnu**
Coregonus sardinella	**least cisco**
Coregonus autumnalis	**Arctic cisco**
Coregonus laurettae	**Bering cisco**
Coregonus nasus	**broad whitefish**
Coregonus clupeaformis	**lake whitefish**
Coregonus nelsonii	**Alaska whitefish**
Coregonus pidschian	**humpback whitefish**
Prosopium cylindraceum	**round whitefish**
Prosopium coulterii	**pygmy whitefish**
Thymallus arcticus	**Arctic grayling**
Salvelinus fontinalis	**brook trout**
Salvelinus namaycush	**lake trout**
Salvelinus alpinus	**Arctic char**
Salvelinus malma	**Dolly Varden**
Salvelinus confluentus	**bull trout**
Salmo salar	**Atlantic salmon**
Oncorhynchus clarkii clarkii	**coastal cutthroat trout**
Oncorhynchus mykiss	**rainbow trout**
Oncorhynchus gorbuscha	**pink salmon**
Oncorhynchus kisutch	**coho salmon**
Oncorhynchus tshawytscha	**Chinook salmon**
Oncorhynchus keta	**chum salmon**

Oncorhynchus nerka	**sockeye salmon**
Sigmops gracilis	**slender fangjaw**
Cyclothone alba	**white bristlemouth**
Cyclothone signata	**showy bristlemouth**
Cyclothone atraria	**black bristlemouth**
Cyclothone pseudopallida	**phantom bristlemouth**
Cyclothone pallida	**tan bristlemouth**
Chauliodus macouni	**Pacific viperfish**
Tactostoma macropus	**longfin dragonfish**
Bathophilus flemingi	**highfin dragonfish**
Benthalbella dentata	**northern pearleye**
Benthosema glaciale	**glacier lanternfish**
Scopelosaurus harryi	**scaly waryfish**
Alepisaurus ferox	**longnose lancetfish**
Anotopterus nikparini	**North Pacific daggertooth**
Protomyctophum thompsoni	**bigeye lanternfish**
Tarletonbeania taylori	**taillight lanternfish**
Tarletonbeania crenularis	**blue lanternfish**
Diaphus theta	**California headlightfish**
Stenobrachius leucopsarus	**northern lampfish**
Stenobrachius nannochir	**garnet lampfish**
Lampanyctus jordani	**brokenline lanternfish**
Nannobrachium regale	**pinpoint lampfish**
Nannobrachium ritteri	**broadfin lanternfish**
Lampris guttatus	**opah**
Trachipterus altivelis	**king-of-the-salmon**
Percopsis omiscomaycus	**trout-perch**
Spectrunculus grandis	**giant cusk-eel**
Brosmophycis marginata	**red brotula**
Albatrossia pectoralis	**giant grenadier**
Coryphaenoides longifilis	**longfin grenadier**
Coryphaenoides leptolepis	**ghostly grenadier**
Coryphaenoides acrolepis	**Pacific grenadier**
Coryphaenoides cinereus	**popeye grenadier**
Coryphaenoides filifer	**threadfin grenadier**
Coryphaenoides armatus	**smooth abyssal grenadier**
Laemonema longipes	**longfin codling**
Antimora microlepis	**Pacific flatnose**
Merluccius productus	**Pacific hake**
Lota lota	**burbot**
Boreogadus saida	**Arctic cod**
Arctogadus glacialis	**polar cod**
Arctogadus borisovi	**toothed cod**
Eleginus gracilis	**saffron cod**
Microgadus proximus	**Pacific tomcod**
Theragra chalcogramma	**walleye pollock**

Gadus macrocephalus	**Pacific cod**
Gadus ogac	**Greenland cod**
Ceratias holboelli	**northern seadevil**
Oneirodes thompsoni	**Alaska dreamer**
Oneirodes bulbosus	**bulbous dreamer**
Cololabis saira	**Pacific saury**
Poromitra crassiceps	**crested bigscale**
Melamphaes lugubris	**highsnout bigscale**
Barbourisia rufa	**red whalefish**
Allocyttus folletti	**oxeye oreo**
Aulorhynchus flavidus	**tubesnout**
Gasterosteus aculeatus	**threespine stickleback**
Pungitius pungitius	**ninespine stickleback**
Syngnathus leptorhynchus	**bay pipefish**
Sebastolobus altivelis	**longspine thornyhead**
Sebastolobus alascanus	**shortspine thornyhead**
Sebastolobus macrochir	**broadfin thornyhead**
Sebastes helvomaculatus	**rosethorn rockfish**
Sebastes nigrocinctus	**tiger rockfish**
Sebastes babcocki	**redbanded rockfish**
Sebastes nebulosus	**China rockfish**
Sebastes maliger	**quillback rockfish**
Sebastes auriculatus	**brown rockfish**
Sebastes ciliatus	**dusky rockfish**
Sebastes brevispinis	**silvergray rockfish**
Sebastes entomelas	**widow rockfish**
Sebastes flavidus	**yellowtail rockfish**
Sebastes melanops	**black rockfish**
Sebastes polyspinis	**northern rockfish**
Sebastes paucispinis	**bocaccio**
Sebastes caurinus	**copper rockfish**
Sebastes elongatus	**greenstriped rockfish**
Sebastes variegatus	**harlequin rockfish**
Sebastes emphaeus	**Puget Sound rockfish**
Sebastes wilsoni	**pygmy rockfish**
Sebastes pinniger	**canary rockfish**
Sebastes miniatus	**vermilion rockfish**
Sebastes proriger	**redstripe rockfish**
Sebastes alutus	**Pacific ocean perch**
Sebastes reedi	**yellowmouth rockfish**
Sebastes crameri	**darkblotched rockfish**
Sebastes diploproa	**splitnose rockfish**
Sebastes saxicola	**stripetail rockfish**
Sebastes zacentrus	**sharpchin rockfish**
Sebastes ruberrimus	**yelloweye rockfish**
Sebastes aleutianus	**rougheye rockfish**

Sebastes borealis	**shortraker rockfish**
Anoplopoma fimbria	**sablefish**
Erilepis zonifer	**skilfish**
Oxylebius pictus	**painted greenling**
Ophiodon elongatus	**lingcod**
Pleurogrammus monopterygius	**Atka mackerel**
Hexagrammos stelleri	**whitespotted greenling**
Hexagrammos octogrammus	**masked greenling**
Hexagrammos decagrammus	**kelp greenling**
Hexagrammos lagocephalus	**rock greenling**
Rhamphocottus richardsonii	**grunt sculpin**
Synchirus gilli	**manacled sculpin**
Ascelichthys rhodorus	**rosylip sculpin**
Jordania zonope	**longfin sculpin**
Triglops xenostethus	**scalybreasted sculpin**
Triglops macellus	**roughspine sculpin**
Triglops forficatus	**scissortail sculpin**
Triglops scepticus	**spectacled sculpin**
Triglops metopias	**highbrow sculpin**
Triglops pingelii	**ribbed sculpin**
Scorpaenichthys marmoratus	**cabezon**
Hemilepidotus papilio	**butterfly sculpin**
Hemilepidotus spinosus	**brown Irish lord**
Hemilepidotus gilberti	**banded Irish lord**
Hemilepidotus zapus	**longfin Irish lord**
Hemilepidotus hemilepidotus	**red Irish lord**
Hemilepidotus jordani	**yellow Irish lord**
Icelinus tenuis	**spotfin sculpin**
Icelinus filamentosus	**threadfin sculpin**
Icelinus burchami	**dusky sculpin**
Icelinus borealis	**northern sculpin**
Archistes biseriatus	**scaled sculpin**
Radulinus taylori	**spinynose sculpin**
Radulinus asprellus	**slim sculpin**
Stelgistrum concinnum	**largeplate sculpin**
Stelgistrum beringianum	**smallplate sculpin**
Thyriscus anoplus	**sponge sculpin**
Icelus spiniger	**thorny sculpin**
Icelus canaliculatus	**blacknose sculpin**
Icelus euryops	**wide-eye sculpin**
Icelus uncinalis	**uncinate sculpin**
Icelus spatula	**spatulate sculpin**
Icelus bicornis	**twohorn sculpin**
Rastrinus scutiger	**roughskin sculpin**
Stlegicottus xenogrammus	**strangeline sculpin**
Artedius lateralis	**smoothhead sculpin**

Artedius fenestralis	**padded sculpin**
Artedius harringtoni	**scalyhead sculpin**
Ruscarius meanyi	**Puget Sound sculpin**
Gymnocanthus detrisus	**purplegray sculpin**
Gymnocanthus tricuspis	**Arctic staghorn sculpin**
Gymnocanthus pistilliger	**threaded sculpin**
Gymnocanthus galeatus	**armorhead sculpin**
Leptocottus armatus	**Pacific staghorn sculpin**
Cottus cognatus	**slimy sculpin**
Cottus asper	**prickly sculpin**
Cottus aleuticus	**coastrange sculpin**
Enophrys bison	**buffalo sculpin**
Enophrys diceraus	**antlered sculpin**
Enophrys lucasi	**leister sculpin**
Trichocottus brashnikovi	**hairhead sculpin**
Megalocottus platycephalus	**belligerent sculpin**
Myoxocephalus niger	**warthead sculpin**
Myoxocephalus quadricornis	**fourhorn sculpin**
Myoxocephalus scorpius	**shorthorn sculpin**
Myoxocephalus scorpioides	**Arctic sculpin**
Myoxocephalus stelleri	**frog sculpin**
Myoxocephalus jaok	**plain sculpin**
Myoxocephalus polyacanthocephalus	**great sculpin**
Micrcottus sellaris	**brightbelly sculpin**
Porocottus mednius	**Aleutian fringed sculpin**
Zesticelus profundorum	**flabby sculpin**
Bolinia euryptera	**broadfin sculpin**
Artediellichthys nigripinnis	**blackfin hookear sculpin**
Artediellus gomojunovi	**spinyhook sculpin**
Artediellus scaber	**hamecon**
Artediellus pacificus	**hookhorn sculpin**
Phallocottus obtusus	**spineless sculpin**
Sigmistes smithi	**arched sculpin**
Sigmistes caulias	**kelp sculpin**
Oligocottus rimensis	**saddleback sculpin**
Oligocottus maculosus	**tidepool sculpin**
Oligocottus snyderi	**fluffy sculpin**
Clinocottus acuticeps	**sharpnose sculpin**
Clinocottus embryum	**calico sculpin**
Clinocottus globiceps	**mosshead sculpin**
Hemitripterus bolini	**bigmouth sculpin**
Hemitripterus villosus	**shaggy sea raven**
Blepsias bilobus	**crested sculpin**
Blepsias cirrhosus	**silverspotted sculpin**
Nautichthys oculofasciatus	**sailfin sculpin**
Nautichthys pribilovius	**eyeshade sculpin**

Nautichthys robustus	**shortmast sculpin**
Dasycottus setiger	**spinyhead sculpin**
Eurymen gyrinus	**smoothcheek sculpin**
Malacocottus aleuticus	**whitetail sculpin**
Malacocottus zonurus	**darkfin sculpin**
Psychrolutes sigalutes	**soft sculpin**
Psychrolutes phrictus	**giant blobsculpin**
Psychrolutes paradoxus	**tadpole sculpin**
Percis japonica	**dragon poacher**
Hypsagonus quadricornis	**fourhorn poacher**
Pallasina barbata	**tubenose poacher**
Stellerina xyosterna	**pricklebreast poacher**
Chesnonia verrucosa	**warty poacher**
Occella dodecaedron	**Bering poacher**
Leptagonus decagonus	**Atlantic poacher**
Leptagonus frenatus	**sawback poacher**
Leptagonus leptorhynchus	**longnose poacher**
Agonopsis vulsa	**northern spearnose poacher**
Podothecus accipenserinus	**sturgeon poacher**
Podothecus veternus	**veteran poacher**
Bothragonus swanii	**rockhead**
Odontopyxis trispinosa	**pygmy poacher**
Bathyagonus nigripinnis	**blackfin poacher**
Bathyagonus pentacanthus	**bigeye poacher**
Bathyagonus alascanus	**gray starsnout**
Bathyagonus infraspinatus	**spinycheek starsnout**
Ulcina olrikii	**Arctic alligatorfish**
Aspidophoroides bartoni	**Aleutian alligatorfish**
Anoplagonus inermis	**smooth alligatorfish**
Aptocyclus ventricosus	**smooth lumpsucker**
Lethotremus muticus	**docked snailfish**
Eumicrotremus phrynoides	**toad lumpsucker**
Eumicrotremus barbatus	**papillose lumpsucker**
Eumicrotremus gyrinops	**Alaskan lumpsucker**
Eumicrotemus birulai	**Siberian lumpsucker**
Eumicrotremus derjugini	**leatherfin lumpsucker**
Eumicrotremus andriashevi	**pimpled lumpsucker**
Eumicrotremus orbis	**Pacific spiny lumpsucker**
Liparis pulchellus	**showy snailfish**
Liparis dennyi	**marbled snailfish**
Liparis gibbus	**variegated snailfish**
Liparis ochotensis	**Okhotsk snailfish**
Liparis catharus	**purity snailfish**
Liparis tunicatus	**kelp snailfish**
Liparis bristolensis	**Bristol snailfish**
Liparis megacephalus	**bighead snailfish**

Liparis fabricii	**gelatinous snailfish**
Liparis fucensis	**slipskin snailfish**
Liparis rutteri	**ringtail snailfish**
Liparis cyclopus	**ribbon snailfish**
Liparis mucosus	**slimy snailfish**
Liparis florae	**tidepool snailfish**
Liparis micraspidophorus	**thumbtack snailfish**
Liparis greeni	**lobefin snailfish**
Liparis callyodon	**spotted snailfish**
Gyrinichthys minytremus	**minigill snailfish**
Careproctus candidus	**bigeye snailfish**
Careproctus zachirus	**blacktip snailfish**
Careproctus canus	**gray snailfish**
Careproctus pycnosoma	**stout snailfish**
Careproctus abbreviatus	**short snailfish**
Careproctus rastrinus	**salmon snailfish**
Careproctus scottae	**peachskin snailfish**
Careproctus colletti	**Alaska snailfish**
Careproctus furcellus	**emarginate snailfish**
Careproctus cypselurus	**falcate snailfish**
Careproctus melanurus	**blacktail snailfish**
Careproctus spectrum	**stippled snailfish**
Careproctus phasma	**spectral snailfish**
Careproctus simus	**proboscis snailfish**
Careproctus bowersianus	**Bowers Bank snailfish**
Careproctus mollis	**everyday snailfish**
Careproctus opisthotremus	**distalpore snailfish**
Careproctus attenuatus	**attenuate snailfish**
Careproctus ectenes	**shovelhead snailfish**
Careproctus gilberti	**smalldisk snailfish**
Careproctus ostentum	**microdisk snailfish**
Crystallichthys cameliae	**elusive snailfish**
Crystallichthys cyclospilus	**blotched snailfish**
Elassodiscus tremebundus	**dimdisk snailfish**
Elassodiscus caudatus	**humpback snailfish**
Rhinoliparis barbulifer	**longnose snailfish**
Rhinoliparis attenuatus	**slim snailfish**
Paraliparis dactylosus	**polydactyl snailfish**
Paraliparis pectoralis	**pectoral snailfish**
Paraliparis holomelas	**ebony snailfish**
Paraliparis deani	**prickly snailfish**
Paraliparis ulochir	**broadfin snailfish**
Paraliparis cephalus	**swellhead snailfish**
Lipariscus nanus	**pygmy snailfish**
Nectoliparis pelagicus	**tadpole snailfish**
Trachurus symmetricus	**jack mackerel**

Brama japonica	**Pacific pomfret**
Taractes asper	**rough pomfret**
Caristius macropus	**bigmouth manefish**
Atractoscion nobilis	**white seabass**
Pseudopentaceros wheeleri	**North Pacific armorhead**
Brachyistius frenatus	**kelp perch**
Cymatogaster aggregata	**shiner perch**
Embiotoca lateralis	**striped seaperch**
Ronquilus jordani	**northern ronquil**
Bathymaster signatus	**searcher**
Bathymaster caeruleofasciatus	**Alaskan ronquil**
Bathymaster leurolepis	**smallmouth ronquil**
Opaeophacus acrogeneius	**bulldog eelpout**
Nalbantichthys elongatus	**thinskin eelpout**
Puzanovia rubra	**tough eelpout**
Gymnelus popovi	**Aleutian pout**
Gymnelus hemifasciatus	**halfbarred pout**
Gymnelus viridis	**fish doctor**
Lycenchelys crotalinus	**snakehead eelpout**
Lycenchelys jordani	**shortjaw eelpout**
Lycenchelys rosea	**rosy eelpout**
Lycenchelys alta	**short eelpout**
Lycenchelys camchatica	**Kamchatka eelpout**
Lycenchelys ratmanovi	**manypore eelpout**
Lycodes pacificus	**blackbelly eelpout**
Lycodes seminudus	**longear eelpout**
Lycodes mucosus	**saddled eelpout**
Lycodes turneri	**Polar eelpout**
Lycodes polaris	**Canadian eelpout**
Lycodes raridens	**marbled eelpout**
Lycodes rossi	**threespot eelpout**
Lycodes brunneofasciatus	**tawnystripe eelpout**
Lycodes brevipes	**shortfin eelpout**
Lycodes sagittarius	**archer eelpout**
Lycodes palearis	**wattled eelpout**
Lycodes pallidus	**pale eelpout**
Lycodes squamiventer	**scalebelly eelpout**
Lycodes eudipleurostictus	**doubleline eelpout**
Lycodes diapterus	**black eelpout**
Lycodes concolor	**ebony eelpout**
Bothrocara pusillum	**Alaska eelpout**
Bothrocara brunneum	**twoline eelpout**
Bothrocara molle	**soft eelpout**
Lycodapus parviceps	**smallhead eelpout**
Lycodapus psarostomatus	**specklemouth eelpout**
Lycodapus leptus	**slender eelpout**

Lycodapus mandibularis	**pallid eelpout**
Lycodapus endemoscotus	**deepwater eelpout**
Lycodapus fierasfer	**blackmouth eelpout**
Lycodapus dermatinus	**looseskin eelpout**
Lycodapus poecilus	**variform eelpout**
Eumesogrammus praecisus	**fourline snakeblenny**
Stichaeus punctatus	**Arctic shanny**
Gymnoclinus cristulatus	**trident prickleback**
Chirolophis tarsodes	**matcheek warbonnet**
Chirolophis nugator	**mosshead warbonnet**
Chirolophis decoratus	**decorated warbonnet**
Chirolophis snyderi	**bearded warbonnet**
Bryozoichthys lysimus	**nutcracker prickleback**
Bryozoichthys marjorius	**pearly prickleback**
Lumpenella longirostris	**longsnout prickleback**
Leptoclinus maculatus	**daubed shanny**
Poroclinus rothrocki	**whitebarred prickleback**
Anisarchus medius	**stout eelblenny**
Lumpenus fabricii	**slender eelblenny**
Lumpenus sagitta	**snake prickleback**
Acantholumpenus mackayi	**blackline prickleback**
Alectridium aurantiacum	**lesser prickleback**
Alectrias alectrolophus	**stone cockscomb**
Anoplarchus purpurescens	**high cockscomb**
Anoplarchus insignis	**slender cockscomb**
Phytichthys chirus	**ribbon prickleback**
Xiphister mucosus	**rock prickleback**
Xiphister atropurpureus	**black prickleback**
Cryptacanthodes giganteus	**giant wrymouth**
Cryptacanthodes aleutensis	**dwarf wrymouth**
Apodichthys flavidus	**penpoint gunnel**
Rhodymenichthys dolichogaster	**stippled gunnel**
Pholis fasciata	**banded gunnel**
Pholis clemensi	**longfin gunnel**
Pholis laeta	**crescent gunnel**
Anarrhichthys ocellatus	**wolf-eel**
Anarhichas orientalis	**Bering wolffish**
Ptilichthys goodei	**quillfish**
Zaprora silenus	**prowfish**
Scytalina cerdale	**graveldiver**
Trichodon trichodon	**Pacific sandfish**
Arctoscopus japonicus	**sailfin sandfish**
Ammodytes hexapterus	**Pacific sand lance**
Icosteus aenigmaticus	**ragfish**
Gobiesox maeandricus	**northern clingfish**
Rhinogobiops nicholsii	**blackeye goby**

Sphyraena argentea	**Pacific barracuda**
Scomber japonicus	**Pacific chub mackerel**
Sarda chiliensis	**Pacific bonito**
Thunnus alalunga	**albacore**
Thunnus orientalis	**Pacific bluefin tuna**
Icichthys lockingtoni	**medusafish**
Tetragonurus cuvieri	**smalleye squaretail**
Citharichthys sordidus	**Pacific sanddab**
Citharichthys stigmaeus	**speckled sanddab**
Lyopsetta exilis	**slender sole**
Eopsetta jordani	**petrale sole**
Hippoglossus stenolepis	**Pacific halibut**
Reinhardtius hippoglossoides	**Greenland halibut**
Atheresthes stomias	**arrowtooth flounder**
Atheresthes evermanni	**Kamchatka flounder**
Clidoderma asperrimum	**roughscale sole**
Hippoglossoides elassodon	**flathead sole**
Hippoglossoides robustus	**Bering flounder**
Psettichthys melanostictus	**sand sole**
Isopsetta isolepis	**butter sole**
Lepidopsetta bilineata	**rock sole**
Lepidopsetta polyxystra	**northern rock sole**
Pleuronichthys coenosus	**C-O sole**
Pleuronichthys decurrens	**curlfin sole**
Embassichthys bathybius	**deepsea sole**
Microstomus pacificus	**Dover sole**
Glyptocephalus zachirus	**rex sole**
Platichthys stellatus	**starry flounder**
Pleuronectes quadrituberculatus	**Alaska plaice**
Pleuronectes glacialis	**Arctic flounder**
Parophrys vetulus	**English sole**
Limanda proboscidea	**longhead dab**
Limanda aspera	**yellowfin sole**
Limanda sakhalinensis	**Sakhalin sole**
Mola mola	**ocean sunfish**

Amphibians

Scientific name	Common name
Rana aurora	**Red-legged Frog**
Pseudacris regilla	**Pacific Chorus Frog**
Bufo boreas	**Western Toad**
Rana luteiventris	**Columbia Spotted Frog**
Rana sylvatica	**Wood Frog**
Ambystoma gracile	**Northwestern Salamander**
Rana aurora	**Long-toed Salamander**
Taricha granulosa	**Rough-skinned Newt**

Reptiles

Scientific name	Common name
***Caretta caretta*	**Loggerhead Seaturtle**
***Chelonia mydas*	**Green Seaturtle**
***Lepidochelys olivacea*	**Olive Ridley Seaturtle**
***Dermochelys coriacea*	**Leatherback Seaturtle**

Birds

Scientific name	Common name	
Anser fabalis	**Bean Goose**	
Anser albifrons	**Greater White-fronted Goose**	
Anser erythropus	**Lesser White-fronted Goose**	Accidental
Chen canagica	**Emperor Goose**	
Chen caerulescens	**Snow Goose**	
Chen rossii	**Ross's Goose**	Casual
Branta canadensis	**Canada Goose**	
Branta bernicla	**Brant**	
Cygnus buccinator	**Trumpeter Swan**	
Cygnus columbianus	**Tundra Swan**	
Cygnus cygnus	**Whooper Swan**	Rare
Aix sponsa	**Wood Duck**	Casual
Anas strepera	**Gadwall**	
Anas falcata	**Falcated Duck**	Casual
Anas penelope	**Eurasian Wigeon**	
Anas americana	**American Wigeon**	
Anas rubripes	**American Black Duck**	Accidental
Anas platyrhynchos	**Mallard**	
Anas poecilorhyncha	**Spot-billed Duck**	Casual
Anas discors	**Blue-winged Teal**	
Anas cyanoptera	**Cinnamon Teal**	Casual
Anas clypeata	**Northern Shoveler**	
Anas acuta	**Northern Pintail**	
Anas querquedula	**Garganey Anas**	Casual
Anas formosa	**Baikal Teal**	Casual
Anas crecca	**Green-winged Teal**	
Aythya valisineria	**Canvasback**	
Aythya americana	**Redhead**	
Aythya ferina	**Common Pochard**	Casual
Aythya collaris	**Ring-necked Duck**	
Aythya fuligula	**Tufted Duck**	Rare
Aythya marila	**Greater Scaup**	
Aythya affinis	**Lesser Scaup**	
***Polysticta stelleri*	**Steller's Eider**	
***Somateria fischeri*	**Spectacled Eider**	
Somateria spectabilis	**King Eider**	
Somateria mollissima	**Common Eider**	
Histrionicus histrionicus	**Harlequin Duck**	
Melanitta perspicillata	**Surf Scoter**	
Melanitta fusca	**White-winged**	

Melanitta nigra	**Black Scoter**	
Clangula hyemalis	**Long-tailed Duck**	
Bucephala albeola	**Bufflehead**	
Bucephala clangula	**Common Goldeneye**	
Bucephala islandica	**Barrow's Goldeneye**	
Mergellus albellus	**Smew**	Rare
Lophodytes cucullatus	**Hooded Merganser**	
Mergus merganser	**Common Merganser**	
Mergus serrator	**Red-breasted Merganser**	
Oxyura jamaicensis	**Ruddy Duck**	Casual
Bonasa umbellus	**Ruffed Grouse**	
Falcipennis canadensis	**Spruce Grouse**	
Lagopus lagopus	**Willow Ptarmigan**	
Lagopus mutus	**Rock Ptarmigan**	
Lagopus leucurus	**White-tailed Ptarmigan**	
Dendragapus obscurus	**Blue Grouse**	
Tympanuchus phasianellus	**Sharp-tailed Grouse**	
Gavia stellata	**Red-throated Loon**	
Gavia arctica	**Arctic Loon**	Rare
Gavia pacifica	**Pacific Loon**	
Gavia immer	**Common Loon**	
Gavia adamsii	**Yellow-billed Loon**	
Podilymbus podiceps	**Pied-billed Grebe**	Rare
Podiceps auritus	**Horned Grebe**	
Podiceps grisegena	**Red-necked Grebe**	
Podiceps nigricollis	**Eared Grebe**	Accidental
Aechmophorus occidentalis	**Western Grebe**	
Thalassarche cauta	**Shy Albatross**	Accidental
Phoebastria immutabilis	**Laysan Albatross**	
Phoebastria nigripes	**Black-footed Albatross**	
***Phoebastria albatrus*	**Short-tailed Albatross**	Rare
Fulmarus glacialis	**Northern Fulmar**	
Pterodroma inexpectata	**Mottled Petrel**	
Pterodroma cookii	**Cook's Petrel**	Accidental
Puffinus creatopus	**Pink-footed Shearwater**	Rare
Puffinus gravis	**Greater Shearwater**	Accidental
Puffinus bulleri	**Buller's Shearwater**	Rare
Puffinus griseus	**Sooty Shearwater**	
Puffinus tenuirostris	**Short-tailed Shearwater**	
Oceanodroma furcata	**Fork-tailed Storm-Petrel**	
Oceanodroma leucorhoa	**Leach's Storm-Petrel**	
Pelecanus erythrorhynchos	**American White Pelican**	Accidental
Pelecanus occidentalis	**Brown Pelican**	Accidental
Phalacrocorax penicillatus	**Brandt's Cormorant**	Rare
Phalacrocorax auritus	**Double-crested Cormorant**	
Phalacrocorax urile	**Red-faced Cormorant**	
Phalacrocorax pelagicus	**Pelagic Cormorant**	
Fregata magnificens	**Magnificent Frigatebird**	Accidental
Botaurus lentiginosus	**American Bittern**	Rare
Ixobrychus sinensis	**Yellow Bittern**	Accidental
Ardea herodias	**Great Blue Heron**	

Ardea alba	**Great Egret**	Casual
Egretta eulophotes	**Chinese Egret**	Accidental
Egretta garzetta	**Little Egret**	Accidental
Ardeola bacchus	**Chinese Pond-Heron**	Accidental
Bubulcus ibis	**Cattle Egret**	Casual
Butorides virescens	**Green Heron**	Accidental
Nycticorax nycticorax	**Black-crowned Night-Heron**	Casual
Cathartes aura	**Turkey Vulture**	Casual
Pandion haliaetus	**Osprey**	
Haliaeetus albicilla	**White-tailed Eagle**	Casual
Haliaeetus pelagicus	**Steller's Sea-Eagle**	Casual
Circus cyaneus	**Northern Harrier**	
Accipiter striatus	**Sharp-shinned Hawk**	
Accipiter gentilis	**Northern Goshawk**	
Buteo swainsoni	**Swainson's Hawk**	Rare
Buteo jamaicensis	**Red-tailed Hawk**	
Buteo lagopus	**Rough-legged Hawk**	
Aquila chrysaetos	**Golden Eagle**	
Falco tinnunculus	**Eurasian Kestrel**	Casual
Falco sparverius	**American Kestrel**	
Falco columbarius	**Merlin**	
Falco subbuteo	**Eurasian Hobby**	Casual
Falco rusticolus	**Gyrfalcon**	
Falco peregrinus	**Peregrine Falcon**	
Rallus limicola	**Virginia Rail**	Casual
Porzana carolina	**Sora**	Rare
Fulica atra	**Eurasian Coot**	Accidental
Fulica americana	**American Coot**	Rare
Grus canadensis	**Sandhill Crane**	
Grus grus	**Common Crane**	Accidental
Pluvialis squatarola	**Black-bellied Plover**	
Pluvialis apricaria	**European Golden-Plover**	Accidental
Pluvialis dominica	**American Golden-Plover**	
Pluvialis fulva	**Pacific Golden-Plover**	
Charadrius mongolus	**Mongolian Plover**	Rare
Charadrius alexandrinus	**Snowy Plover**	Accidental
Charadrius hiaticula	**Common Ringed Plover**	Rare
Charadrius semipalmatus	**Semipalmated Plover**	
Charadrius dubius	**Little Ringed Plover**	Casual
Charadrius vociferus	**Killdeer**	
Charadrius morinellus	**Eurasian Dotterel**	Rare
Haematopus bachmani	**Black Oystercatcher**	
Himantopus himantopus	**Black-winged Stilt**	Accidental
Recurvirostra americana	**American Avocet**	Accidental
Tringa nebularia	**Common Greenshank**	Rare
Tringa melanoleuca	**Greater Yellowlegs**	
Tringa flavipes	**Lesser Yellowlegs**	
Tringa stagnatilis	**Marsh Sandpiper**	Accidental
Tringa erythropus	**Spotted Redshank**	Casual
Tringa glareola	**Wood Sandpiper**	
Tringa ochropus	**Green Sandpiper**	Casual

Tringa solitaria	**Solitary Sandpiper**	
Heteroscelus incanus	**Wandering Tattler**	
Heteroscelus brevipes	**Gray-tailed Tattler**	
Actitis hypoleucos	**Common Sandpiper**	Rare
Actitis macularia	**Spotted Sandpiper**	
Xenus cinereus	**Terek Sandpiper**	Rare
Bartramia longicauda	**Upland Sandpiper**	
Numenius minutus	**Little Curlew**	Accidental
***Numenius borealis*	**Eskimo Curlew**	Accidental
Numenius phaeopus	**Whimbrel**	
Numenius tahitiensis	**Bristle-thighed Curlew**	
Numenius madagascariensis	**Far Eastern Curlew**	Casual
Limosa limosa	**Black-tailed Godwit**	Casual
Limosa haemastica	**Hudsonian Godwit**	
Limosa lapponica	**Bar-tailed Godwit**	
Limosa fedoa	**Marbled Godwit**	
Arenaria interpres	**Ruddy Turnstone**	
Arenaria melanocephala	**Black Turnstone**	
Aphriza virgata	**Surfbird**	
Calidris tenuirostris	**Great Knot**	Casual
Calidris canutus	**Red Knot**	
Calidris alba	**Sanderling**	
Calidris pusilla	**Semipalmated Sandpiper**	
Calidris mauri	**Western Sandpiper**	
Calidris ruficollis	**Red-necked Stint**	
Calidris minuta	**Little Stint**	Casual
Calidris temminckii	**Temminck's Stint**	Casual
Calidris subminuta	**Long-toed Stint**	Rare
Calidris minutilla	**Least Sandpiper**	
Calidris fuscicollis	**White-rumped Sandpiper**	Rare
Calidris bairdii	**Baird's Sandpiper**	
Calidris melanotos	**Pectoral Sandpiper**	
Calidris acuminata	**Sharp-tailed Sandpiper**	
Calidris maritima	**Purple Sandpiper**	Accidental
Calidris ptilocnemis	**Rock Sandpiper**	
Calidris alpina	**Dunlin Calidris**	
Calidris ferruginea	**Curlew Sandpiper**	Casual
Calidris himantopus	**Stilt Sandpiper**	
Eurynorhynchus pygmeus	**Spoonbill Sandpiper**	Casual
Limicola falcinellus	**Broad-billed Sandpiper**	Casual
Tryngites subruficollis	**Buff-breasted Sandpiper**	
Philomachus pugnax	**Ruff**	Rare
Limnodromus griseus	**Short-billed Dowitcher**	
Limnodromus scolopaceus	**Long-billed Dowitcher**	
Lymnocryptes minimus	**Jack Snipe**	Accidental
Gallinago delicata	**Wilson's Snipe**	
Gallinago gallinago	**Common Snipe**	
Gallinago stenura	**Pin-tailed Snipe**	Accidental
Phalaropus tricolor	**Wilson's Phalarope**	Casual
Phalaropus lobatus	**Red-necked Phalarope**	
Phalaropus fulicarius	**Red Phalarope**	

Glareola maldivarum	**Oriental Pratincole**	Accidental
Stercorarius maccormicki	**South Polar Skua**	Casual
Stercorarius pomarinus	**Pomarine Jaeger**	
Stercorarius parasiticus	**Parasitic Jaeger**	
Stercorarius longicaudus	**Long-tailed Jaeger**	
Larus pipixcan	**Franklin's Gull**	Casual
Larus minutus	**Little Gull**	Casual
Larus ridibundus	**Black-headed Gull**	Rare
Larus philadelphia	**Bonaparte's Gull**	
Larus heermanni	**Heermann's Gull**	Casual
Larus crassirostris	**Black-tailed Gull**	Casual
Larus canus	**Mew Gull**	
Larus delawarensis	**Ring-billed Gull**	Rare
Larus californicus	**California Gull**	
Larus argentatus	**Herring Gull**	
Larus glaucoides	**Iceland Gull**	
Larus fuscus	**Lesser Black-backed Gull**	Casual
Larus schistisagus	**Slaty-backed Gull**	
Larus occidentalis	**Western Gull**	Casual
Larus glaucescens	**Glaucous-winged Gull**	
Larus hyperboreus	**Glaucous Gull**	
Larus marinus	**Great Black-backed Gull**	Accidental
Xema sabini	**Sabine's Gull**	
Rissa tridactyla	**Black-legged Kittiwake**	
Rissa brevirostris	**Red-legged Kittiwake**	
Rhodostethia rosea	**Ross's Gull**	
Pagophila eburnea	**Ivory Gull**	
Sterna caspia	**Caspian Tern**	Rare
Sterna hirundo	**Common Tern**	Rare
Sterna paradisaea	**Arctic Tern**	
Sterna aleutica	**Aleutian Tern**	
Sterna fuscata	**Sooty Tern**	Accidental
Chlidonias leucopterus	**White-winged Tern**	Casual
Chlidonias niger	**Black Tern**	Casual
Alle alle	**Dovekie**	Rare
Uria aalge	**Common Murre**	
Uria lomvia	**Thick-billed Murre**	
Cepphus grylle	**Black Guillemot**	
Cepphus columba	**Pigeon Guillemot**	
Brachyramphus perdix	**Long-billed Murrelet**	Accidental
Brachyramphus marmoratus	**Marbled Murrelet**	
Brachyramphus brevirostris	**Kittlitz's Murrelet**	
Synthliboramphus antiquus	**Ancient Murrelet**	
Ptychoramphus aleuticus	**Cassin's Auklet**	
Aethia psittacula	**Parakeet Auklet**	
Aethia pusilla	**Least Auklet**	
Aethia pygmaea	**Whiskered Auklet**	
Aethia cristatella	**Crested Auklet**	
Cerorhinca monocerata	**Rhinoceros Auklet**	
Fratercula corniculata	**Horned Puffin**	
Patagioenas fasciata	**Band-tailed Pigeon**	Rare

Streptopelia orientalis	**Oriental Turtle-Dove**	Casual
Zenaida asiatica	**White-winged Dove**	Accidental
Zenaida macroura	**Mourning Dove**	Rare
Cuculus canorus	**Common Cuckoo**	Casual
Cuculus saturatus	**Oriental Cuckoo**	Casual
Coccyzus americanus	**Yellow-billed Cuckoo**	Casual
Otus sunia	**Oriental Scops-Owl**	Accidental
Megascops kennicottii	**Western Screech-Owl**	Rare
Bubo virginianus	**Great Horned Owl**	
Bubo scandiacus	**Snowy Owl**	
Surnia ulula	**Northern Hawk Owl**	
Glaucidium gnoma	**Northern Pygmy-Owl**	Rare
Strix varia	**Barred Owl**	Rare
Strix nebulosa	**Great Gray Owl**	
Asio otus	**Long-eared Owl**	Casual
Asio flammeus	**Short-eared Owl**	
Aegolius funereus	**Boreal Owl**	
Aegolius acadicus	**Northern Saw-whet Owl**	
Chordeiles acutipennis	**Lesser Nighthawk**	Accidental
Chordeiles minor	**Common Nighthawk**	Rare
Caprimulgus vociferus	**Whip-poor-will**	Accidental
Caprimulgus indicus	**Jungle Nightjar**	Accidental
Cypseloides niger	**Black Swift**	
Chaetura pelagica	**Chimney Swift**	Accidental
Chaetura vauxi	**Vaux's Swift**	
Hirundapus caudacutus	**White-throated Needletail**	Casual
Apus apus	**Common Swift**	Accidental
Apus pacificus	**Fork-tailed Swift**	Casual
Archilochus colubris	**Ruby-throated Hummingbird**	Accidental
Calypte anna	**Anna's Hummingbird**	Casual
Calypte costae	**Costa's Hummingbird**	Casual
Selasphorus rufus	**Rufous Hummingbird**	
Upupa epops	**Eurasian Hoopoe**	Accidental
Ceryle alcyon	**Belted Kingfisher**	
Jynx torquilla	**Eurasian Wryneck**	Accidental
Sphyrapicus varius	**Yellow-bellied Sapsucker**	Casual
Sphyrapicus ruber	**Red-breasted Sapsucker**	
Dendrocopos major	**Great Spotted Woodpecker**	Casual
Picoides pubescens	**Downy Woodpecker**	
Picoides villosus	**Hairy Woodpecker**	
Picoides dorsalis	**American Three-toed Woodpecker**	
Picoides arcticus	**Black-backed Woodpecker**	
Colaptes auratus	**Northern Flicker**	
Contopus cooperi	**Olive-sided Flycatcher**	
Contopus sordidulus	**Western Wood-Pewee**	
Empidonax flaviventris	**Yellow-bellied Flycatcher**	Rare
Empidonax alnorum	**Alder Flycatcher**	
Empidonax traillii	**Willow Flycatcher**	Casual
Empidonax minimus	**Least Flycatcher**	Casual
Empidonax hammondii	**Hammond's Flycatcher**	
Empidonax oberholseri	**Dusky Flycatcher**	Casual

Empidonax difficilis	**Pacific-slope Flycatcher**	
Sayornis nigricans	**Black Phoebe**	Accidental
Sayornis phoebe	**Eastern Phoebe**	Rare
Sayornis saya	**Say's Phoebe**	
Myiarchus crinitus	**Great Crested Flycatcher**	Accidental
Tyrannus melancholicus	**Tropical Kingbird**	Rare
Tyrannus verticalis	**Western Kingbird**	Rare
Tyrannus tyrannus	**Eastern Kingbird**	Rare
Tyrannus forficatus	**Scissor-tailed Flycatcher**	Rare
Lanius cristatus	**Brown Shrike**	Casual
Lanius excubitor	**Northern Shrike**	
Vireo cassinii	**Cassin's Vireo**	Casual
Vireo gilvus	**Warbling Vireo**	
Vireo philadelphicus	**Philadelphia Vireo**	Casual
Vireo olivaceus	**Red-eyed Vireo**	Rare
Perisoreus canadensis	**Gray Jay**	
Cyanocitta stelleri	**Steller's Jay**	
Nucifraga columbiana	**Clark's Nutcracker**	Casual
Pica hudsonia	**Black-billed Magpie**	
Corvus brachyrhynchos	**American Crow**	Rare
Corvus caurinus	**Northwestern Crow**	
Corvus corax	**Common Raven**	
Alauda arvensis	**Sky Lark**	Rare
Eremophila alpestris	**Horned Lark**	
Progne subis	**Purple Martin**	Casual
Tachycineta bicolor	**Tree Swallow**	
Tachycineta thalassina	**Violet-green Swallow**	
Stelgidopteryx ruficollis	**Northern Rough-winged Swallow**	Rare
Riparia riparia	**Bank Swallow**	
Petrochelidon pyrrhonota	**Cliff Swallow**	
Hirundo rustica	**Barn Swallow**	
Delichon urbica	**Common House-Martin**	Casual
Poecile atricapillus	**Black-capped Chickadee**	
Poecile gambeli	**Mountain Chickadee**	Casual
Poecile rufescens	**Chestnut-backed Chickadee**	
Poecile hudsonica	**Boreal Chickadee**	
Poecile cincta	**Gray-headed Chickadee**	Rare
Sitta canadensis	**Red-breasted Nuthatch**	
Certhia americana	**Brown Creeper**	
Troglodytes troglodytes	**Winter Wren**	
Cinclus mexicanus	**American Dipper**	
Regulus satrapa	**Golden-crowned Kinglet**	
Regulus calendula	**Ruby-crowned Kinglet**	
Locustella ochotensis	**Middendorff's Grasshopper-Warbler**	Casual
Locustella lanceolata	**Lanceolated Warbler**	Accidental
Sylvia curruca	**Lesser Whitethroat**	Accidental
Phylloscopus trochilus	**Willow Warbler**	Accidental
Phylloscopus sibilatrix	**Wood Warbler**	Accidental
Phylloscopus fuscatus	**Dusky Warbler**	Casual
Phylloscopus inornatus	**Yellow-browed Warbler**	Accidental
Phylloscopus borealis	**Arctic Warbler**	

Ficedula narcissina	**Narcissus Flycatcher**	Accidental
Ficedula parva	**Red-breasted Flycatcher**	Casual
Muscicapa striata	**Spotted Flycatcher**	Accidental
Muscicapa sibirica	**Siberian Flycatcher**	Casual
Muscicapa griseisticta	**Gray-spotted Flycatcher**	Casual
Muscicapa dauurica	**Asian Brown Flycatcher**	Accidental
Luscinia calliope	**Siberian Rubythroat**	Rare
Luscinia svecica	**Bluethroat**	
Luscinia cyane	**Siberian Blue Robin**	Accidental
Tarsiger cyanurus	**Red-flanked Bluetail**	Casual
Oenanthe oenanthe	**Northern Wheatear**	
Saxicola torquatus	**Stonechat**	Casual
Sialia currucoides	**Mountain Bluebird**	Rare
Myadestes townsendi	**Townsend's Solitaire**	
Catharus fuscescens	**Veery**	Casual
Catharus minimus	**Gray-cheeked Thrush**	
Catharus ustulatus	**Swainson's Thrush**	
Catharus guttatus	**Hermit Thrush**	
Turdus obscurus	**Eyebrowed Thrush**	Rare
Turdus naumanni	**Dusky Thrush**	Casual
Turdus pilaris	**Fieldfare**	Casual
Turdus migratorius	**American Robin**	
Ixoreus naevius	**Varied Thrush**	
Dumetella carolinensis	**Gray Catbird**	Casual
Mimus polyglottos	**Northern Mockingbird**	Casual
Toxostoma rufum	**Brown Thrasher**	Casual
Sturnus vulgaris	**European Starling**	
Prunella montanella	**Siberian Accentor**	Casual
Motacilla flava	**Yellow Wagtail**	
Motacilla cinerea	**Gray Wagtail**	Casual
Motacilla alba	**White Wagtail**	Rare
Anthus trivialis	**Tree Pipit**	Casual
Anthus hodgsoni	**Olive-backed Pipit**	Casual
Anthus gustavi	**Pechora Pipit**	Casual
Anthus cervinus	**Red-throated Pipit**	
Anthus rubescens	**American Pipit**	
Bombycilla garrulus	**Bohemian Waxwing**	
Bombycilla cedrorum	**Cedar Waxwing**	
Vermivora peregrina	**Tennessee Warbler**	Rare
Vermivora celata	**Orange-crowned Warbler**	
Dendroica petechia	**Yellow Warbler**	
Dendroica pensylvanica	**Chestnut-sided Warbler**	Accidental
Dendroica magnolia	**Magnolia Warbler**	Rare
Dendroica tigrina	**Cape May Warbler**	Casual
Dendroica caerulescens	**Black-throated Blue Warbler**	Accidental
Dendroica coronata	**Yellow-rumped Warbler**	
Dendroica virens	**Black-throated Green Warbler**	Accidental
Dendroica townsendi	**Townsend's Warbler**	
Dendroica discolor	**Prairie Warbler**	Accidental
Dendroica palmarum	**Palm Warbler**	Casual
Dendroica striata	**Blackpoll Warbler**	

Mniotilta varia	**Black-and-white Warbler**	Casual
Setophaga ruticilla	**American Redstart**	
Seiurus aurocapilla	**Ovenbird**	Casual
Seiurus noveboracensis	**Northern Waterthrush**	
Oporornis philadelphia	**Mourning Warbler**	Accidental
Oporornis tolmiei	**MacGillivray's Warbler**	
Geothlypis trichas	**Common Yellowthroat**	
Wilsonia pusilla	**Wilson's Warbler**	
Wilsonia canadensis	**Canada Warbler**	Accidental
Piranga olivacea	**Scarlet Tanager**	
Piranga ludoviciana	**Western Tanager**	
Pipilo maculatus	**Spotted Towhee**	Casual
Sparrow Spizella arborea	**American Tree Sparrow**	
Spizella passerina	**Chipping Sparrow**	
Spizella pallida	**Clay-colored Sparrow**	Casual
Spizella breweri	**Brewer's Sparrow**	Rare
Chondestes grammacus	**Lark Sparrow**	Accidental
Passerculus sandwichensis	**Savannah Sparrow**	
Passerella iliaca	**Fox Sparrow**	
Melospiza melodia	**Song Sparrow**	
Melospiza lincolnii	**Lincoln's Sparrow**	
Melospiza georgiana	**Swamp Sparrow**	Casual
Zonotrichia albicollis	**White-throated Sparrow**	Rare
Zonotrichia querula	**Harris's Sparrow**	Casual
Zonotrichia leucophrys	**White-crowned Sparrow**	
Zonotrichia atricapilla	**Golden-crowned Sparrow**	
Junco hyemalis	**Dark-eyed Junco**	
Calcarius lapponicus	**Lapland Longspur**	
Calcarius pictus	**Smith's Longspur**	
Emberiza leucocephalos	**Pine Bunting**	Accidental
Emberiza pusilla	**Little Bunting**	Casual
Emberiza rustica	**Rustic Bunting**	Rare
Emberiza elegans	**Yellow-throated Bunting**	Accidental
Emberiza aureola	**Yellow-breasted Bunting**	Casual
Emberiza variabilis	**Gray Bunting**	Accidental
Emberiza pallasi	**Pallas's Bunting**	Casual
Emberiza schoeniclus	**Reed Bunting**	Casual
Plectrophenax nivalis	**Snow Bunting**	
Plectrophenax hyperboreus	**McKay's Bunting**	
Pheucticus ludovicianus	**Rose-breasted Grosbeak**	Casual
Pheucticus melanocephalus	**Black-headed Grosbeak**	Casual
Passerina caerulea	**Blue Grosbeak**	Accidental
Passerina amoena	**Lazuli Bunting**	Accidental
Passerina cyanea	**Indigo Bunting**	Casual
Dolichonyx oryzivorus	**Bobolink**	Casual
Agelaius phoeniceus	**Red-winged Blackbird**	
Sturnella neglecta	**Western Meadowlark**	Casual
Xanthocephalus xanthocephalus	**Yellow-headed Blackbird**	Casual
Euphagus carolinus	**Rusty Blackbird**	
Euphagus cyanocephalus	**Brewer's Blackbird**	Casual
Quiscalus quiscula	**Common Grackle**	Casual

Cowbird Molothrus ater	**Brown-headed Cowbird**	Rare
Icterus spurius	**Orchard Oriole**	Accidental
Fringilla montifringilla	**Brambling**	
Leucosticte tephrocotis	**Gray-crowned Rosy-Finch**	
Pinicola enucleator	**Pine Grosbeak**	
Carpodacus erythrinus	**Common Rosefinch**	Casual
Carpodacus purpureus	**Purple Finch**	Casual
Carpodacus cassinii	**Cassin's Finch**	Casual
Carpodacus mexicanus	**House Finch**	Casual
Loxia curvirostra	**Red Crossbill**	
Loxia leucoptera	**White-winged Crossbill**	
Carduelis flammea	**Common Redpoll**	
Carduelis hornemanni	**Hoary Redpoll**	
Carduelis spinus	**Eurasian Siskin**	Accidental
Carduelis pinus	**Pine Siskin**	
Carduelis tristis	**American Goldfinch**	Accidental
Carduelis sinica	**Oriental Greenfinch**	Casual
Pyrrhula pyrrhula	**Eurasian Bullfinch**	Casual
Coccothraustes vespertinus	**Evening Grosbeak**	Casual
Coccothraustes coccothraustes	**Hawfinch**	Casual
Passer domesticus	**House Sparrow**	Casual

Mammals

Scientific name	Common name
Sorex alaskanus	**Glacier Bay water shrew**
Sorex cinereus	**common shrew**
Sorex hoyi	**pygmy shrew**
Sorex hydrodromus	**Pribilof Island shrew**
Sorex jacksoni	**St. Lawrence Island shrew**
Sorex monticolus	**dusky shrew**
Sorex palustris	**water shrew**
Sorex tundrensis	**tundra shrew**
Sorex ugyunak	**barrenground shrew**
Sorex yukonicus	**tiny shrew**
Eptesicus fuscus	**big brown bat**
Lasionycteris noctivagans	**silver-haired bat**
Myotis californicus	**California myotis**
Myotis keenii	**Keen's myotis**
Myotis lucifugus	**little brown bat**
Myotis volans	**long-legged myotis**
Alopex lagopus	**Arctic fox**
Canis latrans	**coyote**
Canis lupus	**gray wolf**
Vulpes vulpes	**red fox**
Lynx canadensis	**lynx**
Puma concolor	**mountain lion**
**Enhydra lutris (*SW Alaska population only)*	**sea otter**
Lontra canadensis	**northern river otter**

Gulo gulo	**wolverine**
Martes americana	**marten**
Martes pennanti	**fisher**
Mustela erminea	**ermine**
Mustela nivalis	**least weasel**
Mustela vison	**mink**
Odobenus rosmarus	**walrus**
Callorhinus ursinus	**northern fur seal**
**Eumetopias jubatus*	**Steller's sea lion**
Zalophus californianus	**California sea lion**
Cystophora cristata	**hooded seal**
Erignathus barbatus	**bearded seal**
Mirounga angustirostris	**northern elephant seal**
Phoca fasciata	**ribbon seal**
Phoca groenlandica	**harp seal**
Phoca hispida	**ringed seal**
Phoca largha	**spotted seal**
Phoca vitulina	**harbor seal**
Procyon lotor	**raccoon**
Ursus americanus	**black bear**
Ursus arctos	**brown bear**
Ursus maritimus	**polar bear**
**Balaena mysticetus*	**bowhead whale**
**Eubalaena glacialis*	**northern right whale**
Balaenoptera acutorostrata	**minke whale**
**Balaenoptera borealis*	**sei whale**
**Balaenoptera musculus*	**blue whale**
**Balaenoptera physalus*	**fin whale**
**Megaptera novaeangliae*	**humpback whale**
Eschrichtius robustus	**gray whale**
Globicephala macrorhynchus	**short-finned pilot whale**
Grampus griseus	**Risso's dolphin**
Lagenorhynchus obliquidens	**Pacific white-sided dolphin**
Lissodelphis borealis	**northern right-whale dolphin**
Orcinus orca	**killer whale**
Delphinapterus leucas	**white whale**
Monodon monoceros	**narwhal**
Phocoena phocoena	**harbor porpoise**
Phocoenoides dalli	**Dall's porpoise**
**Physeter catodon*	**giant sperm whale**
Berardius bairdii	**Baird's beaked whale**
Mesoplodon stejnegeri	**Stejneger's beaked whale**
Ziphius cavirostris	**Cuvier's beaked whale**
Cervus elaphus	**wapiti**
Alces alces	**moose**
Odocoileus hemionus	**mule deer**
Rangifer tarandus	**caribou**

Bison bison	**bison**
Oreamnos americanus	**mountain goat**
Ovibos moschatus	**muskox**
Ovis dalli	**Dall's sheep**
Marmota broweri	**Alaska marmot**
Marmota caligata	**hoary marmot**
Marmota monax	**woodchuck**
Spermophilus parryii	**Arctic ground squirrel**
Tamiasciurus hudsonicus	**red squirrel**
Glaucomys sabrinus	**northern flying squirrel**
Castor canadensis	**American beaver**
Clethrionomys gapperi	**southern red-backed vole**
Clethrionomys rutilus	**northern red-backed Vole**
Dicrostonyx groenlandicus	**northern collared lemming**
Lemmus trimucronatus	**brown lemming**
Microtus abbreviatus	**St. Matthew Island vole**
Microtus longicaudus	**long-tailed vole**
Microtus miurus	**singing vole**
Microtus oeconomus	**tundra vole**
Microtus pennsylvanicus	**meadow vole**
Microtus xanthognathus	**yellow-cheeked vole**
Ondatra zibethicus	**muskrat**
Synaptomys borealis	**northern bog lemming**
Mus musculus	**house mouse**
Rattus norvegicus	**Norway rat**
Neotoma cinerea	**bushy-tailed woodrat**
Peromyscus keeni	**Keen's mouse**
Peromyscus maniculatus	**deer mouse**
Phenacomys intermedius	**heather vole**
Erethizon dorsatum	**porcupine**
Ochotona collaris	**collared pika**
Lepus americanus	**snowshoe hare**
Lepus othus	**Alaskan hare**
Oryctolagus cuniculus	**European rabbit**

Appendix 2. Road Map to the Eight Required CWCS Elements

This appendix was provided to help the National Acceptance Advisory Team (NAAT)[1] evaluate this document to determine whether Alaska's CWCS planning process met the eight congressionally required elements for a comprehensive wildlife conservation strategy. It lists the section, page, and appendix numbers in the CWCS that address each required element. Based on the NAAT's findings that all eight required elements were satisfactorily fulfilled, Alaska received formal approval of its CWCS from the Director of the USFWS in December 2005.

Element 1: Information on the distribution and abundance of species of wildlife, including low and declining populations as the state deems appropriate, that are indicative of the diversity and health of the state's wildlife:

NAAT Guidance	Section	Page #	Table Figure	Page #	Appendix	Page #[2]
A. The Strategy indicates sources of information (e.g., literature, data bases, agencies, individuals) on wildlife abundance and distribution consulted during the planning process.	IIC, E; V	9-14; 140-144			4, 8	In Appendix 4, see especially Boxes B & J
B. The Strategy includes information about both abundance and distribution for species in all major groups to the extent that data are available. There are plans for acquiring information about species for which adequate abundance and/or distribution information is unavailable.	IVB,VII, VIII	92-101, 148-151, 152-159			4	In Appendix 4, see especially Boxes B & G
C. The Strategy identifies low and declining populations to the extent data are available.					1 (T&E); 4, 7	App. 1 (pgs 12-13, 15, 21, 22). In Appendix 4, see especially Box Bs
D. All major groups of wildlife have been considered or an explanation is provided as to why they were not (e.g., including reference to implemented marine fisheries management plans). The State may indicate whether these groups are to be included in a future Strategy revision.	I; IIC, D; VII	5; 9-11, 13; 148-151			3, 4, 7	In Appendix 4, see especially Box B
E. The Strategy describes the process used to select the species in greatest need of conservation. The quantity of information in the Strategy is determined by the State with input from its partners, based on what is available to the State.	I, II	5, 9-13			1, 3, 4, 7	In Appendix 4, see especially Boxes B-E

[1] Chaired by the USFWS Assistant Director for Migratory Birds and State Programs, the NAAT consisted of the six USFWS Assistant Regional Directors for Migratory Birds and State Programs and the five state presidents of the nation's regional associations of fish and wildlife agencies.
[2] Each appendix is paginated individually; "box" refers to the templates for each species or group.

Element 2: Descriptions of locations and relative condition of key habitats and community types essential to conservation of species identified in (1):

NAAT Guidance	Section	Page #	Table Figure	Page #	Appendix	Page #
A. The Strategy provides a reasonable explanation for the level of detail provided: if insufficient, the Strategy identifies the types of future actions that will be taken to obtain the information.	IIC, D; V,VI, VII	12-14; 141-144, 145-147, 148-151			4, 5	In Appendix 4, see especially Box D
B. Key habitats and their relative conditions are described in enough detail such that the state can determine where (i.e., in which regions, watersheds, or landscapes within the state) and what conservation actions need to take place.	IV,VI, VII	83-139, 145-147, 148-151	Table 34	145	4, 5	In Appendix 4, see especially Box D

Element 3: Descriptions of problems which may adversely affect species identified in (1) or their habitats, and priority research and survey efforts needed to identify factors which may assist in restoration and improved conservation of these species and habitats:

NAAT Guidance	Section	Page #	Table Figure	Page #	Appendix	Page #
A. The Strategy indicates sources of information (e.g., literature, databases, agencies, or individuals) used to determine the problems or threats.	IIC,D; IV, VI	12-14; 83-139, 145-147	Table 35	146	4, 8	In Appendix 4, see especially Boxes C, E & J
B. The threats/problems are described in sufficient detail to develop focused conservation actions (for example, “increased highway mortalities” or “acid mine drainage” rather than generic descriptions such as “development” or “poor water quality”).	IV, esp.IVC; VI	83-139, esp. 102-129; 145-147			4	In Appendix 4, see especially Boxes C, E & G
C. The Strategy considers threats/problems, regardless of their origins (local, State, regional, national and international), where relevant to the State’s species and habitats.	IV, VI	83-139, 145-147	Table 35	146	4, 5	In Appendix 4, see especially Boxes C & E
D. If available information is insufficient to describe threats/problems, research and survey efforts are identified to obtain needed information.	VII	148-151			4	In Appendix 4, see especially Boxes C, E & G

Element 3 (continued)

NAAT Guidance	Section	Page #	Table Figure	Page #	Appendix	Page #
E. The priority research and survey needs, and resulting products, are described sufficiently to allow for the development of research and survey projects after the Strategy is approved.	VII, VIII	148-151, 152-159			4	In Appendix 4, see especially Boxes C, E & G

Element 4: Descriptions of conservation actions determined to be necessary to conserve the identified species and habitats and priorities for implementing such actions:

NAAT Guidance	Section	Page #	Table Figure	Page #	Appendix	Page #
A. The Strategy identifies how conservation actions address identified threats to species of greatest conservation need and their habitats.	IIC, V	12, 140-144			4	See especially Box Gs
B. The Strategy describes conservation actions sufficiently to guide implementation of those actions through the development and execution of specific projects and programs.	VII, VIII	148-151, 152-159			4	See especially Box Gs
C. The Strategy links conservation actions to objectives and indicators that will facilitate monitoring and performance measurement of those conservation actions (see Element #5)	IX	160-163			4	See especially Box Gs
D. The Strategy describes conservation actions (where relevant to the state's species and habitats) that could be addressed by federal agencies or regional, national or international partners and shared with other states.	VII	148-151			4	See especially Box Gs
E. If available information is insufficient to describe needed conservation actions, the Strategy identifies research or survey needs for obtaining information	VII	148-151			4	See especially Box Gs
F. The Strategy identifies the relative priority of conservation actions.	VII	148-151				

Element 5: Proposed plans for monitoring species identified in (1) and their habitats, for monitoring the effectiveness of the conservation actions proposed in (4), and for adapting these conservation actions to respond appropriately to new information or changing conditions:

NAAT Guidance	Section	Page #	Table Figure	Page #	Appendix	Page #
A. The Strategy describes plans for monitoring species identified in Element #1, and their habitats.	VII, VIII, IX	148-151, 152-159, 160-163			4	See especially Boxes G & H
B. The Strategy describes how the outcomes of the conservation actions will be monitored.	IX	160-163	Tables 36, 37	161, 162	4	See especially Boxes G & H
C. If monitoring is *not* identified for a species or species group, the Strategy explains why it is not appropriate, necessary or possible.	N/A				4	See especially Boxes G & H
D. Monitoring is to be accomplished at one of several levels including individual species, guilds, or natural communities.	VIII	152-159			4	See especially Boxes G & H
E. The monitoring utilizes or builds on existing monitoring and survey systems or explains how information will be obtained to determine the effectiveness of conservation actions.	VIII, IX	152-159, 160-163			4	
F. The monitoring considers the appropriate geographic scale to evaluate the status of species or species groups and the effectiveness of conservation actions.	VII, VIII, IX	148-151, 152-159, 160-163				
G. The Strategy is adaptive in that it allows for evaluating conservation actions and implementing new actions accordingly.	V,VII, IX, X, XI	143-144, 148-151, 160-163, 164, 165	Tables 36, 37	161, 162	4	See especially Box I

Element 6: Descriptions of procedures to review the Comprehensive Wildlife Conservation Strategy at intervals not to exceed 10 years:

NAAT Guidance	Section	Page #	Table Figure	Page #	Appendix	Page #
A. The State describes the process that will be used to review the Strategy within the next ten years.	XI	165				

Element 7: Plans for coordinating, to the extent feasible, the development, implementation, review, and revision of the Comprehensive Wildlife Conservation Strategy with Federal, State, and local agencies and Indian tribes that manage significant land and water areas within the state or administer programs that significantly affect the conservation of identified species and habitats.

NAAT Guidance	Section	Page #	Table Figure	Page #	Appendix	Page #
A. The State describes the extent of its coordination with and efforts to involve Federal, State and local agencies, and Indian Tribes in the development of its Strategy.	IIB	7-9			8	
B. The State describes its continued coordination with these agencies and tribes in the implementation, review and revision of its Strategy.	VIII, IX, X, XI	152-159, 160-163, 164, 165				

Element 8: Provisions to ensure public participation in the development, revision, and implementation of projects and programs. Congress has affirmed that broad public participation is an essential element of this process:

NAAT Guidance	Section	Page #	Table Figure	Page #	Appendix	Page #
A. The State describes the extent of its efforts to involve the public in development of its strategy.	IIB	7-9			6	
B. The State describes its continued public involvement in the implementation and revision of its strategy.	IX, X, XI	160-163, 164, 165				

Appendix 3. List of Featured Species and Groups

The Strategy highlights the conservation needs of a large number of species, species groups, and/or species assemblages, and the habitats that support them. For a subset of Alaska's species, the Strategy provides detailed natural history information and measurable conservation goals and strategies. These species and groups, which we've termed "featured species," are listed below. Species were selected based on criteria developed during the planning process. For a more detailed explanation of how species were selected, refer to CWCS Section II.

Experts worked on featured species by taxa group in order to develop the conservation action plans presented in Appendix 4. The taxa subgroupings were: amphibians and reptiles, marine fish, marine invertebrates, seabirds, marine mammals, terrestrial mammals, landbirds, raptors, terrestrial invertebrates, waterbirds, shorebirds, freshwater fish, and freshwater invertebrates.

Marine Ecosystem

Marine Invertebrates

Nearshore Soft Benthic Ecosystems

- Eelgrass Invertebrates
  - Eelgrass Shrimp
  - Hydroids
  - Snails (*Lacuna* spp.)
  - Caprellid Amphipods
  - Dungeness Crab
  - Helmet Crab
  - Kelp Crabs
  - Horse Clams
  - Sea Cucumbers
  - Spionid Polychaetes
  - Nudibranchs
- Intertidal and Shallow Subtidal Bivalves
  - Intertidal Clams
  - Subtidal Clams

Deep Benthic Ecosystems

- Corals, Tunicates, and Sponges
  - Cold Water Corals
  - Black Corals
  - Gorgonian Corals
  - Stony Corals
  - Sea Whips
  - Sea Pens
  - Sponges

Salt Marsh Ecosystems

- Salt Marsh-associated Invertebrates

Pelagic Ecosystems

- Zooplankton
  - Zooplankton
  - Jellyfish
  - Ctenophores
  - Larvae

Nearshore Rocky Reef Ecosystems

- Benthic Grazers
  - Black Katy Chiton
  - Gumboot Chiton

Shallow Rocky Reef Ecosystem

- Northern Abalone

Marine Fish

- Forage Fish Occurring in Intertidal/Shallow Subtidal Areas
  - Pacific Sand Lance
  - Capelin
  - Eulachon
  - Pacific Sandfish
  - Sculpins
  - Pricklebacks
  - Gunnels
- Nearshore Occurrence of Pelagic Forage Fish
  - Lanternfish
  - Prowfish
  - Arctic Cod

Reptiles

- Leatherback Seaturtle

Waterfowl

- Sea Ducks
  - Pacific Common Eider
  - King Eider
  - Black Scoter
  - Surf Scoter
  - White-winged Scoter
  - Long-tailed Duck

Seabirds

- Storm-Petrels
  - o Leach’s Storm-Petrel
  - o Fork-tailed Storm-Petrel
- Red-faced Cormorant
- Black-legged Kittiwake
- Red-legged Kittiwake
- Arctic Tern
- Aleutian Tern
- Murres
  - o Common Murre
  - o Thick-billed Murre
- Marbled Murrelet
- Kittlitz's Murrelet
- Auklets
  - o Least Auklet
  - o Crested Auklet

Marine Mammals

- Cook Inlet Beluga Whale
- Ice-associated Marine Mammals
  - Polar Bear
  - Walrus
  - Bearded Seal
  - Ringed Seal
  - Ribbon Seal
  - Spotted Seal
- Large Whales
  - Fin Whale
  - Sperm Whale
  - Sei Whale
  - Blue Whale
  - Gray Whale
- Bowhead Whale
- Humpback Whale
- Beaked Whales
  - Baird’s Beaked Whale
  - Cuvier’s Beaked Whale
  - Stejneger’s Beaked Whale
- North Pacific Right Whale
- Northern Sea Otter

Freshwater/Aquatic Ecosystem

Freshwater Invertebrates

- Dragonflies and Damselflies (Odonata)
- Cladocera (Water Fleas)
- Ephemeroptera (Mayflies), Plecoptera (Stoneflies) and Trichoptera (Caddisflies)
- Karst Cave-dwelling Aquatic Invertebrates
  - Scuds
  - Mites
  - Springtails
  - Beetle Larvae
  - Proboscis Worms
  - Flat Worms
  - Seed Shrimp
- Mollusca
  - Yukon Floater
  - Western Pearl Shell
  - Western Floater

Freshwater Fish

- Lampreys
  - Pacific Lamprey
  - Arctic Lamprey
  - River Lamprey
  - Western Brook Lamprey
  - Alaskan Brook Lamprey
  - Siberian Brook Lamprey
- Anadromous Smelts
  - Longfin Smelt
  - Rainbow Smelt
  - Eulachon
- Bering Cisco
- Broad Whitefish
- Pygmy Whitefish
- Trout-perch
- Alaska Blackfish
- Sticklebacks (Cook Inlet radiation)
  - Threespine Stickleback
  - Ninespine Stickleback

Amphibians

- Native Amphibians
  - Western Toad
  - Columbia Spotted Frog
  - Wood Frog
  - Northwestern Salamander
  - Long-toed Salamander
  - Rough-skinned Newt

Waterbirds

- Grebes
  - Red-necked Grebe
  - Horned Grebe
- Loons
  - Common Loon
  - Arctic Loon
  - Pacific Loon
- Red-throated Loon
- Yellow-billed Loon

Shorebirds

- Black Oystercatcher
- Lesser Yellowlegs
- Solitary Sandpiper
- Bristle-thighed Curlew
- Marbled Godwit
- Rock Sandpiper
  - Pribilof Rock Sandpiper
  - Northern Rock Sandpiper
  - Aleutian Rock Sandpiper
- Buff-breasted Sandpiper

<u>Terrestrial Ecosystem</u>

Terrestrial Invertebrates

- Terrestrial Invertebrates

Raptors

- Goshawks
  - Northern Goshawk
  - Queen Charlotte Goshawk
- Contaminant-affected Raptor Species
  - Bald Eagle
  - Peregrine Falcon
  - Osprey
  - Merlin
- Diurnal Migrants
  - Rough-legged Hawk
  - Sharp-shinned Hawk
  - Red-tailed Hawk
  - Short-eared Owl
  - Northern Harrier
  - Golden Eagle
- Black Merlin and Gyrfalcon
- Forest Owls
  - Northern Pygmy-Owl
  - Northern Hawk Owl
  - Barred Owl
  - Boreal Owl
  - Northern Saw-whet Owl
  - Great Gray Owl
  - Western Screech-Owl
  - Great-horned Owl
- Snowy Owl

Landbirds

- Landbirds with Long-term Population Declines
  - Rangewide Declines
    - Blue Grouse
    - Black Swift
    - Wilson's Warbler
    - Belted Kingfisher
    - Black-backed Woodpecker
    - Bank Swallow
    - Barn Swallow
    - Dark-eyed Junco
    - Pine Grosbeak
    - Red Crossbill
    - Pine Siskin
    - Rufous Hummingbird
  - Alaska Declines
    - Hermit Thrush
    - Violet-green Swallow
    - Cliff Swallow
    - White-crowned Sparrow
- Landbirds Sensitive to Forest Management
  - Upland Gamebirds
    - Blue Grouse
    - Prince of Wales Spruce Grouse
  - Canopy-Nesting Species
    - Pacific-slope Flycatcher
    - Golden-crowned Kinglet
    - Red Crossbill
    - White-winged Crossbill
    - Pine Siskin
    - Townsend's Warbler
    - Varied Thrush
  - Cavity-Nesting Species
    - Red-breasted Sapsucker
    - Hairy Woodpecker
    - Three-toed Woodpecker
    - Black-backed Woodpecker
    - Northern Flicker
    - Boreal Chickadee
    - Chestnut-backed Chickadee
    - Red-breasted Nuthatch
    - Brown Creeper
- Olive-sided Flycatcher
- Blackpoll Warbler
- Rusty Blackbird
- Aleutian and Bering Sea Island Endemic Landbirds

  Rock Ptarmigan
  Winter Wren
  Song Sparrow
  Gray-crowned Rosy Finch
  McKay's Bunting
- Smith's Longspur

Terrestrial Mammals

- Southcoastal Alaska Bats
  - Little Brown Bat
  - Keen's Myotis
  - California Myotis
  - Long-legged Myotis
  - Silver-haired Bat
- Southeast Alaska Endemic Small Mammals
  - Ermine
  - Marten
  - Flying Squirrel
  - Southern Red-backed Vole
  - Sitka Tundra Vole
  - Long-tailed Vole
  - Admiralty Island Meadow Vole
  - Forest Deer Mouse
  - Revillagigedo Island Meadow Jumping Mouse
  - Dusky Shrew
  - Glacier Bay Water Shrew
  - Admiralty Island Beaver
  - Glacier Bay Hoary Marmot
- Southwest Alaska/Bering Sea Insular Endemic Small Mammals
  - Voles
  - Lemmings
  - Shrews
- Montague Island Marmot
- Kenai Peninsula Endemic Mammals
  - Kenai Red Squirrel
  - Kenai Marten
- Alaska Marmot and Barrow Arctic Ground Squirrel

Cryptically colored, the eelgrass shrimp is a key species in eelgrass communities.
A. Baldwin

Appendix 4. Conservation Action Plans

Introduction

This appendix generally describes what is known about species and species groups featured in the CWCS. It establishes goals for their conservation and sets targets or milestones to be accomplished. The appendix includes conservation actions that experts believe will help overcome issues identified during the planning process. The appendix typically also includes an introduction to each taxonomic group. Length and content of these introductions varies.

For more than 40 of the featured species, the Alaska Natural Heritage Program (AKNHP) prepared detailed information, including on distribution and abundance, concerns, level of protection, conservation status, and potential conservation and management actions (see http://aknhp.uaa.alaska.edu/zoology/zoology_adfg.htm). Key habitats of featured species are described in Appendix 5.

Paddle-tailed Darner, *Aeshna palmata* M. Hopson

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Marine Invertebrates – Introduction

Marine ecosystems worldwide are being altered by human disturbances such as overfishing (Botsford et al. 1997; Jackson et al. 2001; Pauly et al, 2002; Myers and Worm 2003) coastal shoreline development, climate change, and eutrophication (Howarth et al. 2000; Rabalais et al. 2002), and these impacts are beginning to be felt in Alaska. Achieving sustainability of resources, economies, coastal communities and the ecosystems in which these are all embedded requires conservation strategies that acknowledge the complex social and ecological interactions that drive marine ecosystem dynamics (Scheffer et al. 2001; Walker et al. 2002). The focus of this template is on the approach that will be used for conservation planning, one that encompasses the ecological relationships among multiple species and habitats.

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Nearshore Soft Benthic Ecosystems

This ecosystem extends from the intertidal to the shallow subtidal (+ 6 m to –30 m) and includes eelgrass, mud, sand and gravel habitats. We identified 2 species assemblages of concern: 1) intertidal and shallow subtidal bivalves and 2) eelgrass-associated invertebrates. An ecosystem-based approach to the conservation of these assemblages would acknowledge the complex food web interactions between structure forming plants (e.g., *Zostera marina*), stabilizing algae (e.g., *Enteromorpha, Cladophora*, diatom films), nongame bivalves (e.g., *Macoma* spp., *Serripes* spp., *Clinocardium* spp., *Mactromeris* spp. Tellina *spp., Nucula* spp. and *Yoldia* spp.), harvested bivalves (e.g., *Protothaca staminea, Saxidomus giganteus, Panopea abrupta*), sediment bioturbators such as infaunal polychaetes and epifaunal gastropods, generalist predators (e.g., dungeness crabs and sunflower stars), bottomfish that inhabit this "nursery" ecosystem (e.g., sand lance, sand sole, starry founder, juvenile salmonids), shorebirds (e.g., sandpipers, ducks and geese) that depend on secondary consumers (shrimp, worms, small bivalves) as a primary source of food, and finally, marine mammals (e.g., harbor seals, sea otters and gray whales) that also forage in this ecosystem.

Some ecosystem dynamics to consider:

- Freshwater and nutrient inputs from upstream watersheds influencing nearshore water and sediment chemistry (i.e., hypoxia) and sediment grain size
- Oceanic nutrient inputs from offshore upwelling and marine derived nutrients from returning salmonid species
- Water filtration rates
- Sedimentation vs. erosion rates
- Bacterial activity and detrital cycling
- Benthic pelagic coupling and microbial decomposition
- Biofilms (diatoms) stabilizing nearshore sediments

Eelgrass Invertebrates

A. Species group description

Common name: eelgrass-associated invertebrates
Scientific names: a variety of invertebrates associate with eelgrass *Zostera marina* including: eelgrass shrimp *Hippolyte clarki*, hydroids *Obelia* spp., snails *Lacuna* spp., caprellid amphipods, Dungeness crab *Cancer magister*, helmet crab *Telmessus cheiragonus*, kelp crabs *Pugettia* spp., horse clams *Tresus capax,* sea cucumbers *Parastichopus californicus*, spionid polychaetes, nudibranches including *Melibe leonina* (Kozloff 1993; Ricketts et al. 1985)

Selection criteria: Eelgrass beds are among the most productive ecosystems on the planet. The invertebrates associated with eelgrass play a key role in transferring energy from the eelgrass to higher trophic levels (Nelson and Waaland 1997; Johnson et al. 2003).

B. Distribution and abundance

Range: (McRoy 1966; McRoy and Helfferich 1977)
Global range comments: *Zostera marina* is discontinuous from the Sea of Okhotsk and Japan, the Baltic Sea, the Mediterranean Sea, the North Pacific as far south as Agiopampo Lagoon, Mexico
State range comments: North to Port Clarence, west to Atka Island, the Gulf of Alaska including the Southeast Panhandle

Abundance:
Global abundance comments: Unknown
State abundance comments: Unknown

Trends:
Global trends: Generally declining
State trends: Unknown

C. Problems, issues, or concerns for species group

- Eelgrass invertebrates act as a crucial link in transferring energy from eelgrass production to higher trophic levels (Shirley 2003)
- The distribution of eelgrass across the state is poorly known and the associated invertebrate assemblages are also poorly documented
- Eelgrass is vulnerable to destruction from turbid water and fishing gear
- Pesticides used in mariculture can directly affect eelgrass-associated invertebrates (Thayer et al. 1975; Griffin 1997)
- Many of the associated invertebrates are dependent upon the eelgrass environment and are severely impacted by the disappearance of eelgrass beds (Stauffer 1937).
- Disease (Rasmussen 1977; Levinton 1982)

D. Location and condition of key or important habitat areas

Unknown. An evaluation of location and condition of this habitat is needed.

E. Concerns associated with key habitats

- Light availability is an important factor limiting eelgrass growth; the amount of light reaching eelgrass can be influenced by human activities, such as sediment loads caused by logging and streamside activities.
- Eutrophication is regarded as a major factor of eelgrass bed declines because it stimulates the overgrowth of epiphytic algae (Huges et al. 2004).
- High nutrient input from fertilizers, sewage, and fish waste can result in excessive epiphyte growth on eelgrass blades that can also deprive eelgrass of light.
- Pesticides used to control invertebrates in mariculture operations may also kill the invertebrates in nearby eelgrass beds (Thayer et al. 1975; Griffin 1997).
- Coastal development has been the primary cause of widespread seagrass loss (Short and Wyllie-Echeverria 1996).

- Physical disturbance via commercial fishing gear (Stephan et al. 2000; National Research Council 2002; Trush and Dayton 2002) has been identified as a significant source of seagrass habitat destruction. Trawling, dredging and raking for bay scallops (Fonseca et al. 1984), mussels (Neckles et al. 2005), and hard clams (Peterson et al. 1983) have been found to damage eelgrass beds (Johnson 2002).
- Other activities such as dredging (Thayer et al. 1984), and associated construction of boat docks and harbors (Burdick and Short 1999) significantly impact eelgrass habitats.
- On-bottom shellfish aquaculture in close proximity to eelgrass beds can lead to habitat destruction as farmers access their beds. Geoduck mariculture may also affect eelgrass beds.

F. Goal: Conserve and manage eelgrass-associated invertebrate populations throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective: Sustain species diversity, population density and size structure of eelgrass-associated invertebrate populations within historic levels throughout the natural range of eelgrass beds.

Target: Identify and then sustain a diversity of species, and density and size structure of eelgrass-associated invertebrate assemblages that is similar to historical conditions.

Measure: Species diversity and population density and size structure.

Issue 1: The distribution and population status of eelgrass beds and associated fauna is unknown in most parts of the state.

Conservation actions:

a) Identify remote sensing technologies, including advanced satellite imagery that may allow for large-scale mapping and monitoring of eelgrass beds statewide.
b) Train local community groups to monitor species.

Issue 2: There is a lack of information on species diversity associated with eelgrass habitats.

Conservation action: Select 2–3 representative eelgrass beds from across the state for intensive monitoring of the population status of the bed and species diversity of associated fauna assemblages. Beds would be selected based on the location of previous studies, such as Izembek Lagoon, Sitka Sound, and Kachemak Bay.

Issue 3: Future increased mariculture in the state may have a negative effect on eelgrass-associated invertebrates.

Conservation actions:

a) Locations selected for mariculture sites should continue to avoid areas of eelgrass.
b) Monitor pesticides used in mariculture areas to determine their persistence and potential for impacts to the surrounding environment.

H. Plan and time frames for monitoring species and their habitats

State and federal agencies, the university, industry, Native entities and NGOs should coordinate to establish a monitoring plan within the next 2 years that would begin annual monitoring with evaluation at 5-year intervals.

I. Recommended time frame for reviewing species status and trends

Evaluate the strategy after 3 years and then 5 years after that.

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Intertidal and Shallow Subtidal Bivalves

A. Species group description
Common name: intertidal and subtidal clams **Scientific names:** *Macoma* spp., *Serripes* spp., *Clinocardium* spp., *Tellina* spp., *Nucula* spp., *Yolida* spp. and *Mactromeris* spp. are several nongame species. Commercially and recreationally harvested clams found in the same habitat include the Pacific little neck clam, *Protothaca staminea* and butter clam *Saxidomus giganteus* and geoduck (*Panopea abrupta*). **Selection criteria:** This is an important group of invertebrates as they are abundant in soft sediment areas and are prey for many other higher trophic level invertebrates, birds, fishes, and mammals (Fukuyama and Oliver 1985; Bodkin et al. 2002; Dean et al. 2002). The loss of these animals may affect populations of many other species, including some commercially important and subsistence species.
B. Distribution and abundance
Range: Global range comments: State range comments: Present throughout most state waters intertidally and subtidally **Abundance**: Global abundance comments: Probably locally abundant in areas not affected by pollution, intense fishing pressure, or sea otter predation State abundance comments: Probably locally abundant in areas not affected by pollution, intense fishing pressure, or sea otter predation **Trends**: Global trends: Unknown State trends: Unknown
C. Problems, issues, or concerns for species group
• In general, lack of data within this group is a problem; better quantitative information on distribution and abundance is needed • Lack of reproductive information; there is some reproductive information for a few species available in the literature • This is an important group of animals since they are prey for many other invertebrates, birds, fishes, and mammals; the loss of these animals may affect populations of many other species, including some commercially important and subsistence species • Unknown impact of contaminants or of diseases • Effect of climate change through water temperature effects on clams and their prey unknown

D. Location and condition of key or important habitat areas

Intertidal and subtidal soft sediment areas. Key areas include upper Cook Inlet, Copper River Delta and other large tidal wetlands for *Macoma* spp., which are a key prey species for wintering or migrating shorebirds (Bob Gill, USGS, personal communication). Other key areas for clams include the Aleutian Islands, Bristol Bay, Prince William Sound, and for *Serripes* spp., areas of the Chukchi Sea.
An evaluation of location and condition of key habitats is needed—currently unknown.

E. Concerns associated with key habitats

- One potential threat is loss of intertidal habitat from commercial and residential development
- Another potential concern is pollution

F. Goal: Conserve and manage clam populations throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

State conservation and management objectives and actions:

<u>Objective</u>: Develop targets for and sustain species diversity, population density and size structure throughout its distribution.

Target: Identify and then sustain a diversity of species, and density and size structure of those species that are reflective of productive populations.

Measure: Species diversity and population density and size structure.

<u>**Issue 1**: Unknown spatial and temporal variability and extent of distribution.</u>

Conservation action: Assess spatial variability of habitat and populations.

<u>**Issue 2:** Trawling or other fishing gear impacts.</u>

Conservation actions:

a) In collaboration with federal agencies and coastal communities, set aside areas to protect this benthic habitat from on-bottom fishing impacts.
b) Promote development of innovative technologies and alternative fishing gears and methods to minimize destructive effects of fishing gear.

<u>**Issue 3:** Lack of information on life history (growth and longevity).</u>

Conservation action: Identify and apply methods to age and measure growth rates. May apply methods used on other clam species for this group of clams.

Issue 4: Trophic dynamics are unknown and may affect growth and survival.

Conservation action: Quantify and identify interaction strength with other components of ecosystem of other associated species (predator and prey).

H. Plan and time frames for monitoring species and their habitats

State and federal agencies, universities, Native entities and NGOs should coordinate to establish a monitoring plan within the next 2 years that would begin annual monitoring with evaluation at 5-year intervals.

I. Recommended time frame for reviewing species status and trends

Evaluate the strategy after 3 years and then 5 years after that.

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Deep Benthic Ecosystems

Deep benthic ecosystems extend from –30 m to the deep marine trenches found off the Alaskan shelf. Our featured species assemblage of deep sea corals, tunicates and sponges occur on both soft and hard substrates. As biogenic habitat, this species assemblage offers structure, an important ecosystem service, to a wide variety of juvenile bottomfish, shrimp, and crab species, many of which are commercially important in Alaska. Turnover rates of primary production and the dispersal of phytoplankton, governed by regional and local oceanic currents, have obvious ramifications given that phytoplankton is the primary food source for this filter feeding assemblage. Other key trophic interactions pertinent to this ecosystem include those between primary and secondary producers in the pelagic ecosystem above. Reciprocal relationships among benthic epifauna (e.g., crab, shrimp, scallops), infauna (e.g., polychaetes, bivalves) and demersal fish (e.g., sablefish, lingcod, Pacific cod, black rockfish, halibut) are also germane. Commercially harvested invertebrates in this ecosystem include the weathervane scallop *Patinopecten caurinus*, king crab, Dungeness crab, Tanner crab, snow crab and shrimp.

Some ecosystem dynamics to consider:

- Spatiotemporal dynamics between nutrient upwelling, phytoplankton and zooplankton production
- Shifts in oceanographic regimes (i.e., Pacific Decadal Oscillation)
- Benthic pelagic coupling and microbial decomposition
- Role of biogenic habitat in fish and invertebrate population dynamics

Corals, Tunicates, and Sponges

A. Species group description

Common names: cold water corals, black coral, gorgonian corals, stony corals, sea whips, sea pens, and sponges. A high diversity of species make up this assemblage, many of which are currently undescribed.
Scientific names: Phylum Cnidaria
Octocoral Families: Corallidae, Isididae, Paragorgiidae, Pennatulidae, Primnoidae
Hexacoral Families: Antipathidae, Oculinidae, Caryophylliidae
Hydrocoral Family: Stylasteriidae
Phylum: Urochordata class: Ascidiacea
Phylum: Porifera

B. Distribution and abundance

Range:
Global range comments: Temperate benthic habitats
State range comments: The regional extent of this species assemblage is unknown; however, in Alaska they have been documented in the Aleutian Islands (e.g., Andreanof Islands) (Heifetz 2002), Bering Sea, Gulf of Alaska and Southeast Alaska (Heifetz et al. 2003) and other areas (see Etnoyer and Morgan 2003).

Abundance:
Global abundance comments: Unknown
State abundance comments: Percent cover of corals ranged from 5% on low relief pebble substrate to 100% on high relief bedrock at depths of 150–350 m (Heifetz 2002). Other species are common on soft bottom substrate, and populations may be patchy, making it difficult to assess impacts (Heifetz et al. 2003).

Trends:
Global trends: Although quantitative assessment has not been done, assemblages of corals and sponges are likely to have become increasingly impacted since the onset of commercial benthic trawling.
State trends: same as above

C. Problems, issues, or concerns for species group

Known concerns and threats

- High potential for localized depletion due to mobile fishing gear impacts on the seafloor (e.g., trawling, longlining, pot fisheries). The species composing this assemblage are often slow-growing and very long-lived. Consequently, population recovery after impact is likely to be very slow.
- These organisms create biogenic habitat structure that has been documented to be very important habitat for variety of other organisms (e.g., flatfish, rockfish, cod, etc.). Their absence can reduce the survival rates and slow the recovery of commercially harvested species (Lindholm, Walters and Kitchell 2001).
- Many corals and sponges are a specific food source for rare nudibranchs (e.g. *Tochuina tetraquetra*) that feed on only one or several species of corals or sponges. Loss of the coral or sponge species would be detrimental to these nudibranchs.

- A lack of data exists on the range extent of corals and sponges and their associated species.
- Population dynamics are unknown.

Potential or suspected threats

- Climate change and how it alters oceanic temperature, salinity and circulation patterns (i.e., alteration of potential food sources and larval recruitment)
- Impact of disease is unknown
- Lack of information on the effects of natural disturbances
- Offshore dredging impacts

D. Location and condition of key or important habitat areas

These corals and sponges are found in benthic habitat on both soft and hard rock substrates. In areas impacted by fishing gear (heavily trawled areas) these habitats can be very degraded; however, in undisturbed areas, these habitats are often in very good condition.

E. Concerns associated with key habitats

- Habitat alteration due to trawling, longlining and pot fisheries
- Lack of information on the effects of natural disturbances

F. Goal: Conserve and manage assemblages of corals and sponges throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective A: Sustain species diversity, population density, and size structure throughout its natural range within historic levels.

Target: Identify and then sustain a diversity of species, and density and size structure of those species in known areas of population density that is similar to historical conditions.

Measure: Species diversity, population density and size structure of assemblages in known areas of population density across their natural range.

Target: Distribution of species is greater than 90% of the historical distribution within state waters (experts in this group recommend that it go beyond state waters).

Measure: Percentage of known historical distribution.

Objective B: Research the ecological role of corals and sponges in providing sufficient structural habitat for associated species (commercially important bottomfish species have higher survival rates in areas with complex bottom topography [Lindholm 2001]).

Target: Identify or develop a species association index, a measure of the utility of sponges and corals as habitat by key species.

Measure: Species association index.

Issues and conservation actions below apply to one or both objectives.

Issue 1: Habitat alteration and localized declines of corals due to trawling and or other mobile fishing gear impacts. In Alaska, anthropogenically induced disturbance to these benthic epifauna is most evident in heavily fished areas (Heifetz 2002; Heifetz et al. 2003).

Conservation actions:

a) In collaboration with federal agencies and coastal communities, set aside areas to protect this benthic habitat from on-bottom fishing impacts.
b) Support an international agreement between Canada, the United States and Russia to establish an international offshore protected area.
c) Promote development of innovative technologies and alternative fishing gears and methods to minimize destructive effects of fishing gear.

Issue 2: Lack of information on the taxonomy of corals and sponges.

Conservation actions:

a) Inventory and collaborate with government agencies, such as NOAA, universities, and local nongovernmental organizations.
b) Train observers and commercial fishermen in species identification and collection of unknown species for taxonomic identification (e.g., molecular methods).

Issue 3: Unknown spatial and temporal variability and extent of distribution of coral species.

Conservation actions:

a) Collect local ecological knowledge from trawl fishermen on the magnitude and extent of bycatch.
b) Assess spatial variability and distribution of habitat and populations.

Issue 4: Lack of information on life history (reproduction, growth, and longevity)

Conservation action: Identify and apply methods to age and measure growth rates in corals and sponges.

H. Plan and time frames for monitoring species and their habitats

Current efforts to designate Habitat Area of Particular Concern (HAPC) for living substrates, such as corals and sponges, through the Magnuson-Stevens Fishery Conservation and Management Act should be coordinated among management agencies and completed. Collaboration with federal agencies, universities, local coastal communities, and local NGOs is essential to effective monitoring of the resource.

I. Recommended time frame for reviewing species status and trends

Evaluate the strategy after 3 years and then 5 years after that.

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Salt Marsh Ecosystems

Coastal salt marsh ecosystems are tidal wetlands broadly defined by halophytes, plants that are adapted to saline soils (e.g., spike grass *Distichlis spicata*, salt marsh sand spurry *Spergularia marina*, creeping alkali grass *Puccinelia phryganodes*, Bear sedge *Carex ursina*, pickleweed). Salt marsh ecosystems occur at the mid point between high and low tides where the flood of seawater prevents the establishment of terrestrial vegetation. Low marshes may be inundated by each high tide, whereas high marshes are covered by seawater only a few times during the growing season. In this ecosystem we identified a very broad species assemblage: salt marsh-associated invertebrates. The extensiveness of this species group reflects the paucity of information on it yet our appreciation that it is a critical source of food to an incredibly wide variety of marine and terrestrial species. Migratory shorebirds use this ecosystem extensively, as do numerous land-based mammals, including bears, beavers, muskrats, river otters, raccoons and deer. Burrowing filter feeders that inhabit this ecosystem include many species of clams, cockles, and polychaete worms. Epifauna include gastropods, crabs, and oysters. Larval and juvenile stages of many fish and invertebrate species thrive in this protected system yet spend much of their adult life elsewhere. Consequently, these ontogenetic shifts in habitat associations suggest that there are strong ecological connections to the other marine ecosystems identified in this report. Furthermore, because this system represents a transition zone between land and sea, the ecological connections among species templates produced by the marine, terrestrial, and freshwater expert groups are likely very high for this ecosystem.

Some ecosystem dynamics to consider:

- Ontogenetic shifts in habitat associations
- Decomposition, detritus cycling, bacterial production
- Salt excretion and water storage
- Absorption of freshwater runoff
- Siltation rates vs. erosion rates
- Filtration and degradation of nitrogenous and phosphorous waste
- Land-based nutrient subsidies

Salt Marsh-Associated Invertebrates

A. Species group description

Common name: salt marsh-associated invertebrates
Scientific names: examples of salt marsh-associated invertebrates include marine annelid worms, such as the lugworm (*Arenicola pacifica*), and marine gastropods, such as the Sitka snail (*Littorina sitkana*).
Selection criteria: Salt marsh habitats are very productive systems (Mitsch and Gosselink 1993; Begon et al. 1996). The invertebrates associated with salt marshes play a key role in transferring energy from marshes to higher trophic levels (Graca et al. 2000; Peterson and Howarth 1987).

B. Distribution and abundance
(species assemblage unknown; therefore, range, abundance, trends unknown)

Range:
Global range comments:
State range comments:

Abundance:
Global abundance comments:
State abundance comments:

Trends:
Global trends: Generally declining
State trends: Unknown

C. Problems, issues, or concerns for species group

- In general, lack of data within this habitat is a major problem. An inventory of salt marsh-associated species, along with quantitative information on distribution and abundance, is needed.
- This is a very important habitat for variety of other plants and animals. The loss of this habitat with its associated organisms may affect populations of many other species, including some commercially harvested species.

D. Location and condition of key or important habitat areas

Unknown; an evaluation of location and condition of this habitat is needed.

E. Concerns associated with key habitats

- A key threat is loss of this habitat through commercial and residential development
- Loss from filling
- Pollution threats
- Alteration of habitat due to trawling in subtidal areas is a potentially important issue

F. Goal: Conserve and manage salt marsh species assemblages throughout their natural range to ensure sustainable use of these resources.

G. Conservation objective and actions

Objective: Develop targets for, and sustain species diversity, population density and size structure of, salt marsh-associated invertebrates throughout the natural range of salt marshes in Alaska state waters.

Target: Identify species and then attain the diversity of species, and density and size structure of those species, that is reflective of productive populations of invertebrates associated with salt marsh habitats.

Measure: Species identification, diversity, population density and size structure of salt marsh-associated invertebrate assemblages.

Issue 1: Unknown spatial and temporal variability and extent of distribution.

Conservation action: Assess spatial variability of salt marsh habitat and associated invertebrate populations.

Issue 2: There is a lack of information on the species that are associated with salt marsh habitats.

Conservation actions:

a) Inventory species.
b) Train observers in species identification and collection of unknown species for taxonomic identification (including using molecular methods).

H. Plan and time frames for monitoring species and their habitats

State and federal agencies, universities, Native entities, and NGOs should coordinate to establish a monitoring plan within the next 2 years that would begin biannual monitoring with evaluation at 5-year intervals.

I. Recommended time frame for reviewing species status and trends

Evaluate the strategy after 3 years and then 5 years after that.

J. Bibliography

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Pelagic Ecosystems

The pelagic ecosystem encompasses the water column beyond –30 m over both hard and soft substrates. We identified zooplankton species (euphausiids, copepods, jellyfish, ctenophores, invertebrate and fish larvae) as a primary invertebrate species assemblage of concern. Reciprocal relationships among phytoplankton, zooplankton, pelagic forage fish (e.g., herring), upper level fish predators (e.g., pollock), seabirds (e.g., shearwaters, albatross species, storm-petrels) and marine mammals (baleen and toothed whales) encompass some of the key trophic interactions of this system.

Ecosystem dynamics to consider:

- Spatiotemporal dynamics between nutrient upwelling, phytoplankton and zooplankton production
- Shifts in oceanographic regimes (i.e. pacific decadal oscillation)
- Benthic pelagic coupling and microbial decomposition

Zooplankton

A. Species group description **Common name**: zooplankton, jellyfish, ctenophores, larvae **Scientific names:** a variety of planktonic invertebrates including copepods *Neocalanus* spp., *Calanus* spp., *Acartia* spp., *Psuedocalanus* spp., *Oithona* spp., *Metridia* spp., *Podon* spp., *Evadne* spp., chaetognaths *Sagitta elegans*, euphausiids, amphipods, pteropods, cladocerans, cnidarian medusae, ctenophores, meroplankton (benthic invertebrate larvae, fish larvae), and others **Selection criteria:** Zooplankton are an essential link in the food chain and provide food for many seabirds, fishes, and marine mammals.
B. Distribution and abundance **Range**: Global range comments: Widely distributed State range comments: Widely distributed **Abundance**: Global abundance comments: Unknown State abundance comments: Unknown **Trends**: Global trends: Unknown State trends: Unknown

C. Problems, issues, or concerns for species group

- Great importance as food for invertebrates, fishes, seabirds, and marine mammals
- Dramatic seasonal, interannual and decadal-scale variability documented
- Importance of specific species unknown
- Lack of data on distribution and abundance, with the exception of studies conducted by UAF, Institute of Marine Science on some of the dominant copepods

Potential and/or suspected threats

- Pollution from oil spills, oil and gas platforms, sewage outfall, forestry and mining runoff, anthropogenic and natural heavy metals
- Contamination from pollution sources (oil spills, oil platform discharge)
- Pesticide introduction from forestry, agriculture, and mariculture activities
- Fish harvesting may alter trophic cascades and result in dramatic changes in plankton communities
- Climate change; changes in ocean temperature may affect distribution, abundance, and community composition

D. Location and condition of key or important habitat areas

Unknown; an evaluation of location and condition is needed.

E. Concerns associated with key habitats

- Pollution from oil spills, sewage discharge, mining and forestry runoff
- Fish harvest may alter community composition

F. Goal: Maintain the ecological function of zooplankton populations throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective: Sustain species diversity, population density and size structure within historic levels.

Target: Identify and then sustain a diversity of species, and density and size structure of those species that is similar to historical conditions.

Measure: Species diversity and population density and size structure.

Issue 1: There is a fundamental lack of information on importance of zooplankton in diets of seabirds, fishes, and marine mammals.

Conservation action: Compile existing information on role of zooplankton in diets of seabirds, fishes, and marine mammals. Assess temporal and spatial variation in the role of individual zooplankton species as diet.

Issue 2: Seasonal, interannual, and decadal-scale changes in zooplankton can impact the abundance of other species.

Conservation action: Develop a long-term monitoring program in various locations throughout the state. The California Cooperative Oceanic Fisheries Investigation (CalCOFI) program is one such model.

Issue 3: Increases in mariculture in the state could potentially have a negative effect on zooplankton diversity and abundance through the use of pesticides.

Conservation action: Monitor the use of pesticides in mariculture operations to determine their persistence and unintended impacts on the surrounding environment and zooplankton.

H. Plan and time frames for monitoring species and their habitats

Management agencies, university researchers, local coastal communities, and local NGOs will need to coordinate to ensure that a monitoring program is developed and deployed.

I. Recommended time frame for reviewing species status and trends

Evaluate the strategy after 3 years and then 5 years after that.

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Nearshore Rocky Reef Ecosystems

Nearshore rocky reef ecosystems include both intertidal and shallow subtidal rocky reef species assemblages (+4 m to –30 m). An ecosystem-based approach to the conservation of nearshore rocky reef ecosystems would include conservation actions that address the threats to food web dynamics among reef fish predators (greenlings, rockfish, lingcod, cabezon), marine invertebrates predators (octopus, sea stars, Muricidae gastropods), small cryptic reef fish (e.g., sculpins, warbonnets, pricklebacks, and gunnels), scavengers (red rock crabs), deposit feeders (sea cucumbers), grazers (urchins, chitons and limpets), filter feeders (mussels *Mytilus* spp., barnacles *Semibalanus and Balanus,* giant rock scallop *Crassadoma* once *Hinnites)*, structure-forming anemones such as *Metridium*, and primary producers (*Alaria* spp., *Nereocystis*, *Laminaria* spp.). Seabirds (Black Oystercatchers, guillemots, kittiwakes, Rock Sandpipers, Glaucous-winged Gulls, Herring and Mew gulls, Bald Eagles, Northwestern Crows, Common Ravens) and mammals that forage in this system (American mink, sea otters, river otters, American martens, black bears, harbor seals) can have direct and indirect effects on the species mentioned above, some of these interactions being more critical to system dynamics than others.

While stressing the importance of considering the complex associations among algal and animal rocky reef food web dynamics, we have identified the northern abalone, gumboot chiton and black leather chiton as 3 featured species of concern representative of this ecosystem. These specific species were identified because of known demographic limitations in the case of the northern abalone and localized declines in the case of the two chitons.

Some ecosystem dynamics to consider:

- Top-down effects of keystone predators
- Kelp production and its contribution to secondary consumers, both directly via invertebrate grazers and indirectly via filter feeders consumption of detritus
- Terrestrial subsidies via freshwater runoff
- Marine subsidies via upwellings, seabird colonies, sea lion and seal rookeries
- Interaction between upwellings, regional and local oceanographic currents, and larval dispersal and delivery

Benthic Grazers
Katharina tunicata and *Cryptochiton stelleri*

A. Species group description

Common name: black Katy chiton, black leather chiton, bidarki, Urriitaq in Alutiiq
Scientific name: *Katharina tunicata*
Selection criteria: This competitive dominant benthic grazer is known to govern the community dynamics and productivity of temperate rocky intertidal ecosystems (Detheir and Duggins 1984; Paine 1992, 2002). *K. tunicata* remains an important traditional subsistence food source for coastal Native Alaskans (Stanek et al. 1982; Fall and Utermohle 1999; Chugachmiut 2000) and is a prey item for sea otters and various seabirds (O'Clair and O'Clair 1998). As a result, there have been noticeable declines in the density and size structure of this chiton in some areas. Lastly, *K. tunicata* is representative of a broad array of other rocky intertidal benthic species located on surf-swept rocky shores.

Common name: gumboot chiton, giant Pacific chiton, Chinese slipper, lady slipper, Urriitarpak in Alutiiq
Scientific name: *Cryptochiton stelleri*
Selection criteria: Although primarily found in the subtidal, individuals found in the low intertidal are a subsistence food item for coastal Alaska Natives. Recruitment rates of *C. stelleri* are low, making this species vulnerable to overharvest (O'Clair and O'Clair 1998). Indeed, there have been noticeable declines in the density and size structure of *C. stelleri* in some areas.

B. Distribution and abundance

Katharina tunicata
Range:
Global range comments: Kamchatka, through the Aleutian Islands, Alaska, to Southern California (O'Clair and O'Clair 1998)
State range comments: *Katharina* have been documented to be present in the Aleutian Islands, Amchitka and Shemya Island (Estes and Palmisano 1974, Simenstad et al. 1978), Southcentral and Southeast Alaska.

Abundance:
Global abundance comments: Densities and sizes vary:
1) 15–30/m^2 Tatoosh Island, WA (Paine 2002)
2) 28–52/m^2 San Juan Island, WA (Dethier and Duggins 1988)
State abundance comments: Densities and sizes vary:
1) 21–57/m^2 Torch Bay, AK (Detheir and Duggins 1988)
2) 0–60/m^2 Nanwalek and Port Graham, AK (Salomon 2003)

Trends:
Global trends: Varies depending on localized impacts
State trends: Varies depending on localized impacts

Cryptochiton stelleri

Range:

Global range comments: Japan through Aleutian Islands, Alaska, to southern California

State range comments: Aleutian Islands southward

Abundance:

Global abundance comments: Unknown

State abundance comments: Unknown

Trends:

Global trends: Varies depending on localized impacts

State trends: Varies depending on localized impacts

C. Problems, issues, or concerns for species group

Known concerns and threats

- Localized depletion due to subsistence harvest
- Localized depletion due to predation by sea otters, sea stars and other subtidal predators
- Lack of demographic data
- Recruitment limitation (especially in *Cryptochiton*) makes these chitons more susceptible to overharvest

Potential and/or suspected threats

- Pollution from oil spills, oil and gas platforms, sewage outfall, forestry and mining runoff, anthropogenic and natural heavy metals
- Contamination from pollution sources (oil spills, oil platform discharge)
- Disease – unknown impact
- Climate change; changes in ocean temperature may effect chitons directly by altering their spawning period and length (Himmelman 1978) and/or indirectly by affecting the production of their algal food sources and/or local current patterns which influence their metapopulation structure

D. Location and condition of key or important habitat areas

Both chiton species live on surf-swept rocky shores, in low intertidal and shallow subtidal rocky reef habitats. *Cryptochiton* is generally found subtidally to 20 m on both rocky and muddy substrate (O'Clair and O'Clair 1998). Both chitons are more commonly found on exposed outer coasts. Generally, the condition of the habitats in which these chitons are found is very good, although shoreline development and pollution from oil spills, sewage discharge and forestry and mining runoff can degrade such habitats.

E. Concerns associated with key habitats

- Shoreline development
- Localized trampling
- Pollution from oil spills, sewage discharge, mining and forestry runoff

F. Goal: Conserve and manage chiton metapopulations throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective A: (*Katharina tunicata)* Sustain population density and size structure throughout its distribution at target levels.

Target: 20–30 reproductive chitons per square meter within its microhabitats (reproductive individuals are 35 mm and greater [Strathman 1987]).
Measure: Density of chitons in local population.

Target: Size structure distribution: maximum 130 mm – mininum 5mm, average 50 cm.
Measure: Size structure of chitons in local population.

Target: Sustain greater than 80% of known historical populations throughout natural range.
Measure: Percentage of known historical local populations sustained.

Objective B: (*Cryptochiton stelleri)* Sustain population density and size structure throughout its distribution.

Target: Identify and then sustain typical population density and size structure.
Measure: Density and size structure of chitons in local population.

Target: Sustain greater than 80% of known historical populations throughout natural range.
Measure: Percentage of known historical local populations sustained.

Issues and conservation actions for both *Katharina tunicata* and *Cryptochiton stelleri* appear below.

Issue 1: Because they are broadcast spawners, both *Katharina* and *Cryptochiton* require a minimum density for successful fertilization and reproduction. Consequently, these chitons are vulnerable to depensatory (Allee) effects. Furthermore, low densities of these grazers likely alter local macroalgal assemblages including gamma-aminobutyric acid (GABA) producing crustose coralline algae implicated with successful recruitment (Strathman 1987). Therefore, low densities of this species may indirectly impede local recruitment. Localized depletion due to harvest and interactions with other predators such as sea otters and seabirds has already been documented (Salomon 2003).

Conservation actions:

a) In collaboration with coastal communities, experiment with harvest policies (harvest and no harvest zones, seasonal harvest restrictions, minimum size limits, etc.) to estimate sustainable population sizes and population recovery rates for local habitats. Quantify interaction strength with other components of ecosystem.
b) In collaboration with coastal communities, establish areas where harvest of chitons is not allowed interspersed with areas where chiton harvest is allowed in order to maintain optimum density of reproductive individuals embedded within a functional ecosystem.

Issue 2: Intertidal and subtidal habitat degradation along with direct contamination can occur due to pollution from various sources. Watershed discharges, such as sewage (point and nonpoint sources), forestry, mining and agricultural runoff, may degrade chiton habitat.

Conservation actions:

a) Promote proper regulation of discharge from offshore oil and gas platforms.
b) Promote proper treatment of sewage to reduce nitrogen input levels and regulation of sewage flow rates to reduce particulates and turbidity levels that may be discharged during storm events.
c) Promote regulations and policies that ensure sewage settling fields/ponds in rural areas are located far enough away from streams to allow for adequate filtration to occur.
d) Document and promote regulations that limit elevated nutrient levels originating from the fish waste discharged by canneries and hatcheries.
e) Promote regulations that curtail or eliminate the commercial use of antifouling paint that contains tri-butyl tin.
f) Promote sustainable forestry and mining practices that reduce high turbidity and sediment flows.
g) Discourage the use of fertilizers and pesticides in reforestation and coastal agricultural and mariculture activities.

Issue 3: There is limited education and community involvement in research.

Conservation action: Community-based research should be prioritized for funding. Local communities can be trained to monitor chiton densities to ensure the sustainability of chiton populations and encourage local stewardship of the resource.

Issues 4: Growth rates, survival rates, and dispersal distances of both adults and larvae are unknown.

Conservation actions:

a) Conduct tagging studies on both adults and larvae; assess growth rate and recruitment patterns of *Katharina* and *Cryptochiton.*

b) Consider genetic studies and local current pattern research to help determine metapopulation dynamics.
c) Assess reproductive patterns relative to food resources and availability of food resources.

Issues 5: There is a high degree of spatial and temporal variability and an unknown extent of suitable habitat in Alaska.

Conservation action: Assess spatial variability of rocky reef habitat in Alaska.

Issue 6: Population trends are unknown in Alaska.

Conservation action: Collect local and traditional ecological knowledge to develop a time series of historical population dynamics. Archeological data from middens may also indicate how densities and sizes may have changes through time (Simenstad et al. 1978).

Issue 7: Trophic dynamics are unknown and may affect the growth and survival of these chitons. For example, predation on the gumboot chiton by predators such as sea otters, cabezon, and sunflower stars (*Pycnopodia helianthoides*) likely alters the distribution and abundance of *Cryptochiton* in conjunction with human harvest.

Conservation action: Research the relative role of natural predation versus fishing mortality in altering the density and size structure of *Katharina* and *Cryptochiton*. This mortality should be factored into the harvest policy experiments suggested above.

H. Plan and time frames for monitoring species and their habitats

State and federal agencies, universities, Native entities, and NGOs should coordinate to establish a monitoring plan within the next 2 years that would begin annual monitoring with evaluation at 5-year intervals.

I. Recommended time frame for reviewing species status and trends

Evaluate the strategy after 3 years and then 5 years after that.

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Shallow Rocky Reef Ecosystem (0–20 meters)
Species: *Haliotis kamtschatkana*

A. Species description

Common Name: Northern abalone, pinto abalone, Alaskan abalone, Japanese abalone
Scientific name: *Haliotis kamtschatkana*

Selection criteria: The northern abalone is vulnerable to overharvest and has become commercially extinct in parts of its range (Washington and British Columbia) (Wallace 1999; Jamieson 2001; Adkins 2000). In Alaska, this species is at the northern limit of its ecological range, increasing its vulnerability to potential impacts (e.g., harvest pressure or changes in ocean temperatures). In some areas, expansion in the range of sea otters, a major abalone predator, may be increasing natural mortality. A combination of these factors could lead to northern abalone recruitment failures in Southeast Alaska. This species has been declared a “species at risk” in British Columbia, Canada, by Environment Canada and a “species of concern” in Washington state by the Washington Department of Fish and Wildlife. The concern identified to the south should not stop across international borders, particularly given that this species is at the end of its ecological range in Alaska.

B. Distribution and abundance

Range:

Global range comments: Sloan and Breen (1988) suggest that the northern abalone ranges from Icy Strait at the northern tip of Sitka Island, Alaska (approximately ≅58^{o} North) to Baja California (approximately (≅27.5^{o}N). However, O’Clair and O’Clair (1998) indicate that northern abalone exist from Yakutat, Alaska to Point Conception, California. The northern abalone range is also said to extend to northern Japan and parts of Siberia.

State range comments: Yakutat southward

Abundance:

Global abundance comments: The northern abalone is patchily distributed, and densities vary spatially depending on human harvest pressure, sea otter predation, local recruitment rates, and hydrodynamics forces. The following are several reported density estimates from British Columbia, Canada (SL = shell length; see papers for estimates of error):

1) Denman Island, BC all sizes: $0.06/m^2$, 90–110 mm SL: $0.02/m^2$ (Lucas et al. 2002)
2) Barkley Sound, BC all sizes: $0.10/m^2$, 90–110 mm SL: $0.04/m^2$ (Lucas et al. 2002)
3) Kitkatla, BC all sizes: $0.16/m^2$ at McCauley Island, $0.05/m^2$ at Goschen Island, 90–110 mm SL: $0.05/m^2$ McCauley Island, $0.01/m^2$ Goschen Island (Lucas et al. 2002)
4) Bere Bay, Malcom Island, BC all sizes: $0.04/m^2$, Trinity Bay $0.03/m^2$, Cormorant Island, BC $0.05/m^2$
5) Higgins Pass, central coast of BC 0.43–$0.52/m^2$ (Cripps and Campbell 1998)

State abundance comments: Abundances vary spatially depending on human harvest pressure, sea otter predation, and local recruitment rates. No specific Alaskan abundance estimates are known.

Trends:

Global trends: The northern abalone is listed as “threatened” by COSEWIC (Jameison 2001) and is listed as “threatened” under the Canadian Species at Risk Act. In Washington state, the northern abalone is a candidate species for listing under the Endangered Species Act.

State trends: unknown

C. Problems, issues, or concerns for species

Potential and/or Suspected Threats

- Localized depletion due to harvest
  a) Mature individuals found in shallow water are easily accessible to harvesters, making abalone prone to localized depletion.
  b) Northern abalone larvae disperse over relatively short distances; this species may be particularly vulnerable to localized extirpations (Jamieson 2001).
- Recruitment limitation increases susceptibility to overharvest
  a) As a broadcast spawner, the northern abalone requires high densities to ensure successful fertilization. Consequently, it is susceptible to depensatory (Allee) effects.
  b) Food web dynamics may also hinder this species.
  c) GABA-producing coralline crusts induce settlement of larvae; therefore, a lack of browsing adults may reduce successful recruitment rates.
  d) Mucus trails of conspecifics may be an important cue to triggering settlement and metamorphosis (Sloan and Breen 1988).
- Pollution from oil spills, oil and gas platforms, sewage outfall, forestry and mining runoff, anthropogenic and natural heavy metals
- Pesticide introduction from forestry, agriculture, and mariculture practices

- Climate change; changes in ocean temperature may affect abalone directly by altering their spawning period and length and/or indirectly by affecting the production of their algal food sources and/or local current patterns, which influence their metapopulation structure
- Lack of demographic data
- Higher trophic level predation, range expansion of sea otters increasing natural mortality
- Disease
- Contamination from pollution sources (oil spills, oil platform discharge)

D. Location and condition of key or important habitat areas

Northern abalone are patchily distributed throughout their range on exposed and semiexposed coasts in close association with kelp beds (Sloan and Breen 1988). In its southern range, *H. kamtschatkana* is found strictly in the subtidal with most individuals located at 10–20 m depth; however, in its northern range it is found in the lower intertidal to 100 m depth (Sloan and Breen 1988). Juveniles are cryptic and are often found in habitats characterized by crustose coralline algae. Generally, these habitats are in good condition in Alaska.

E. Concerns associated with key habitats

- Kelp forest degradation due to pollution (sewage discharge, mining, forestry and agricultural runoff)
- Coastal development
- Shallow trawling

F. Goal: Conserve and manage northern abalone metapopulations throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

State conservation and management objectives and actions:

<u>Objective</u>: Develop targets for, and sustain the population density and size structure indicative of, sustainable northern abalone populations reflective of a viable metapopulation throughout their natural range in Alaska.

Target: Identify the population density and size structure indicative of sustainable northern abalone populations in Alaska.

Measure: Density and size structure of abalone in local populations.

<u>**Issue 1**: The northern abalone is vulnerable to overexploitation because of its sporadic recruitment, slow growth, longevity and late maturity, and sedentary nature.</u>

Conservation actions: In collaboration with coastal communities, establish “no harvest” areas (marine abalone reserves) interspersed with abalone harvest areas in order to sustain a minimum density of reproductive individuals embedded within a functioning ecosystem. Because juveniles are generally found deeper than adults, these marine reserve areas must encompass depths associated with juvenile rearing grounds (i.e. account for broader metapopulation dynamics). By maintaining egg production, genetic diversity, and functional food webs, marine abalone reserves could play an important role in abalone conservation (Shepard and Brown 1993).

Issue 2: Kelp forest degradation may be caused by "upstream," coastal and oceanic pollution. For example, watershed discharge such as sewage (point and nonpoint sources), forestry, mining and agricultural runoff may degrade abalone habitat (Tegner 1991).

Conservation actions:

a) Promote the regulation of discharge from offshore oil and gas platforms to reduce coastal habitat degradation and potential contamination of coastal food webs.
b) Promote regulation of sustainable forestry and mining practices in "upstream" watersheds to reduce the potential for high turbidity and sediment flows in aquatic ecosystems.
c) Promote proper reforestation practices to reduce the use of fertilizers and pesticides.
d) Promote the regulation of sewage treatment and flow rates to reduce particulates, turbidity levels and toxins that may be discharged during storm events; promote regulations that ensure that sewage settling ponds/fields in rural areas are located far enough away from streams to allow for proper filtration to occur.

Issue 3: Kelp forest degradation can be induced by shoreline development. Furthermore, abalone depend on high flow environments that are altered by shoreline development activities.

Conservation action: Promote regulations that reduce of the amount of shoreline hardening (e.g., sea walls), which can alter regional hydrodynamics.

Issue 4: Alaskan northern abalone die at a water temperature of 16–17^{o}C (Paul and Paul 1981).

Conservation action: Promote proper regulation and design of pulp and paper mills and steam power plants that use ocean water as a coolant.

Issue 5: Lack of demographic and trophic interaction information. Growth, survival, and recruitment rates, plus estimates on minimum viable population densities required for successful fertilization, are critical pieces of demographic information required to manage and conserve a species susceptible to depensatory effects.

Conservation actions:

a) Determine food web dynamics that contribute to natural mortality.
b) Estimate metapopulation dynamics with density and size structure surveys, plus tagging and local circulation pattern studies.

Issue 6: The species *Haliotis kamtschatkana* has not been entirely resolved (Sloan and Breen 1988) across its range; consequently, it remains unclear if we are dealing with one abalone species or a species complex.

Conservation action: Collaborate on research projects with international researchers on the genetic analyses of various northern abalone populations.

Global conservation and management objectives and actions:

Issue: Various concerns regarding northern abalone cross international borders. These animals are broadcast spawners subject to metapopulation dynamics, and the populations in Southeast Alaska may be dependent on Canadian recruits or visa versa. Additionally, scientists are interested in finding out how genetically unique the northern abalone species and populations are within the Pacific. A variety of other common concerns may be identified.

Conservation action: Collaborate with Japanese and Canadian government agencies and universities that are currently devising conservation strategies for the northern abalone.

H. Propose plan and time frames for monitoring species and their habitats

State and federal agencies, universities, Native entities and NGOs should coordinate to establish a monitoring plan within the next 2 years that would begin annual monitoring with evaluation at 5-year intervals.

I. Recommended time frame for reviewing species status and trends

Evaluate the strategy after 3 years and then 5 years after that.

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National Recovery Action Plan for Northern Abalone (*Haliotis kamtshctkana*) in British Columbia. 2003. http://www-comm.pac.dfo-mpo.gc.ca/pages/consultations/fisheriesmgmt/abalone/default_e.htm

http://www.speciesatrisk.gc.ca/search/speciesDetails_e.cfm?SpeciesID=603

Freshwater Invertebrates

Dragonflies and Damselflies

A. Species group description

Common names: dragonflies, damselflies
Scientific names: Order Odonata (dragonflies), Suborder Anisoptera (dragonflies) and Suborder Zygoptera (damselflies)

Few insects inspire as much awe and fascination among the public as do dragonflies and damselflies.

B. Distribution and abundance

Range: Both suborders are widely distributed across Alaska; however, individual species ranges are poorly understood due to limited collection data.
Global range comments: Worldwide distribution
State range comments: Ranges vary by species. All species now known to occur in Alaska also occur in other states and/or provinces.

Abundance:
Global abundance comments: Unknown
State abundance comments: Unknown

Trends:
Global trends: Kennedy's Emerald (*Somatochlora kennedyi*), a red-listed species (Canadian designation for endangered or threatened) in British Columbia, may occur in Alaska.
State trends: Unknown

C. Problems, issues, or concerns for species group

- The primary dragonfly conservation issue in Alaska is the lack of information on geographic distribution, abundance, and species diversity in this large, remote, and undersurveyed state. For example, 10 of Alaska's 31 dragonfly species are known from fewer than 4 locations. During the summer of 2003, a minimal collecting effort by a biologist found 3 new species previously not known to occur in Alaska.
- Dragonflies are an important component of freshwater/terrestrial food webs because they are prey for a large variety of invertebrates and vertebrates and certain carnivorous plants.

Dragonflies are also a top invertebrate predator in both aquatic and terrestrial environments. As such, they are likely to accumulate contaminants and transfer them to predators including migratory songbirds. Dragonflies can serve as barometers of environmental health and change in both the aquatic and terrestrial environments. Dragonfly larvae and adults are both predaceous, relying on diverse and productive invertebrate communities. Therefore, if the aquatic environment and food web that sustains dragonflies is impaired, dragonflies, and the fishes, amphibians, birds, and mammals that prey on them, will be impacted.

D. Location and condition of key or important habitat areas

Dragonfly larvae live in slow streams and rivers, marshes, lakes, ponds, wetlands, and springs. Adult dragonflies use a variety of terrestrial habitats, both near and far from aquatic habitats. Dragonfly habitat is generally abundant and widely distributed across the state. However, the condition of dragonfly habitat in Alaska is not known. Likewise, the specific habitat requirements of our species are poorly understood.

E. Concerns associated with key habitats

- Dragonflies are sensitive to a variety of stressors, including habitat alteration (e.g., air and water quality degradation, infilling, dams, acidification, pesticides and other chemical pollutants, erosion, eutrophication, and sedimentation), urbanization, shoreline development, collisions with vehicles, heavy metal contamination, fish and domestic duck introductions, commercial peat extraction, and invasive species. An invasive species in Southcentral Alaska, northern pike, feed heavily on dragonfly nymphs after all other prey species have been extirpated.
- Climate change will influence species distribution and habitat quality and quantity through melting of permafrost and drought, both of which eliminate lentic and lotic habitats.
- Dragonfly habitat can be adversely impacted by resource development activities including mining, logging, and oil and gas exploration and production.

F. Goal: Describe and manage dragonfly populations throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective: Describe current geographic distribution, abundance within existing range of variation, and species diversity of dragonflies in Alaska.

Target: Survey and map species presence/absence information at 10 sites in each region of Alaska within 5 years (regions correspond to the ADF&G joint board management regions).

Measure: Number of sites surveyed and documented in each region.

Target: Survey larval dragonfly habitat to determine species-specific habitat requirements and the physical, chemical, and biological characteristics of each habitat type within 5 years.

Measure: Develop a list of species-specific habitat requirements for dragonflies in Alaska.

<u>**Issue 1**: Dragonfly species diversity and distribution data in Alaska are currently insufficient for determining the conservation status of these insects. For example, our limited knowledge of species distributions prevents distinguishing truly rare species from undersurveyed species.</u>

Conservation actions:

a) Conduct a literature review to determine appropriate sampling techniques and protocols and sample sizes.
b) Establish an Alaska Odonata Survey to increase knowledge of dragonfly diversity and distribution.
c) Compile and synthesize existing distribution data and publications into an electronic database (preferably GIS or compatible).
d) Collect immature and adult dragonflies from key habitats and regions not represented in existing collections and literature.
e) Compare dragonfly species lists and distribution data from the Yukon. Territory and British Columbia with available Alaska data to determine what species might occur here.
f) Collaborate with Odonata researchers in neighboring Canadian provinces.
g) Develop a network of volunteer collectors.
h) Train volunteers to sort and label specimens keyed to family level.
i) Use recognized experts to identify specimens.
j) Preserve and archive specimen collections and associated data at the University of Alaska Fairbanks, Museum of the North, for future research and use.
k) Publish a peer-reviewed paper on the distribution of dragonflies in Alaska and present the findings at appropriate state, national, and international meetings.

Issue 2: Maintaining healthy dragonfly populations throughout Alaska requires baseline information on natural spatial and temporal variation in dragonfly abundance.

Conservation actions:

a) Use on the ground inventory and GIS technology to determine species-specific habitat availability and health by region over 3–5 consecutive years.
b) Focus on species/habitats that appear rare or have limited distributions.

Issue 3: Understanding dragonfly habitat requirements in Alaska is critical for protecting, conserving, and if necessary, restoring populations.

Conservation actions:

a) Identify species-specific habitat associations during surveys.
b) Use GIS to predict and map habitat.
c) Encourage school districts, Elderhostel, nonprofit organizations, universities, state and federal agencies, and interested individuals to participate in surveys.
d) An annual report including survey locations and maps of new and old distribution records by species and region should be produced.

Conservation actions:

a) Identify species-specific habitat associations during surveys.
b) Use GIS to predict and map habitat.

H. Plan and time frames for monitoring species and their habitats

Presence/absence surveys should begin as soon as funding allows. They should be conducted once per month during the flight season, which varies by area. Surveys should be conducted for 3–5 years.

I. Recommended time frame for reviewing species status and trends

Five years. This interval is necessary because conservation measures may change as data becomes available. Data may show that human development and climate change are affecting dragonfly habitat and populations.

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Other Information

Dragonfly species known from Alaska

Suborder Zygoptera: Common Spreadwing (*Lestes disjunctus)*, Emerald Spreadwing (*Lestes dryas)*, Subarctic Bluet (*Coenagrion interrogatum)*, Taiga Bluet (*Coenagrion resolutum)*, Boreal Bluet *(Enallagma boreale)*, Northern Bluet (*Enallagma cyathigerum)*, Sedge Sprite (*Nehalennia irene)*

Suborder Anisoptera: Lake Darner (*Aeshna eremite)*, Variable Darner (*Aeshna interrupta)*, Sedge Darner (*Aeshna juncea)*, Paddle-tailed Darner (*Aeshna palmate)*, Azure Darner (*Aeshna septentrionalis)*, Zigzag Darner (*Aeshna sitchensis)*, Subarctic Darner (*Aeshna subarctica)*, Common Green Darner (*Anax junius)*, Pacific Spiketail (*Cordulegaster dorsalis)*, American Emerald (*Cordulia shurtleffii)*, Ringed Emerald (*Somatochlora albicincta)*, Delicate Emerald (*Somatochlora franklini)*, Hudsonian Emerald (*Somatochlora hudsonica)*, Treeline Emerald (*Somatochlora sahlbergi)*, Mountain Emerald (*Somatochlora semicircularis)*, Whitehouse's Emerald (*Somatochlora whitehousei)*, Boreal Whiteface (*Leucorrhinia borealis)*, Crimson-ringed Whiteface (*Leucorrhinia glacialis)*, Hudsonian Whiteface (*Leucorrhinia hudsonica)*, Canada Whiteface (*Leucorrhinia patricia)*, Red-waisted Whiteface (*Leucorrhinia proxima)*, Four-spotted Skimmer (*Libellula quadrimaculata)*, Black Meadowhawk (*Sympetrum danae)*, Cherry-faced Meadowhawk (*Sympetrum internum)*; Spot-winged Glider (*Pantala hymenaea)*

Cladocera (Water Fleas)

A. Species group description

Common name: water fleas
Scientific name: Class: Crustacea; Order: Cladocera; Family: Daphniidae and Bosmina

B. Distribution and abundance

Range:
Global range comments: Order widespread globally, widespread in North America.
State range comments: Widespread where surveys have occurred.

Abundance:
Global abundance comments: Highly variable where documented
State abundance comments: Highly variable where documented

Trends:
Global trends: Unknown
State trends: Unknown

C. Problems, issues, or concerns for species group

- Group is highly sensitive to hydrocarbon, heavy metals, organic pollutant contamination, and turbidity
- Group distribution is limited by temperature and pH constraints
- This group also serves as the primary transfer of aquatic primary production to many vertebrate (waterfowl and fish) species

D. Location and condition of key or important habitat areas

Lakes, ponds, connected wetlands, and sloughs throughout the state. Habitat is mostly in very good or pristine condition. A small and unquantified amount of area damaged by urbanization, road construction, or other development.

E. Concerns associated with key habitats

Specific threats, limited to minor extent of range, are development-specific and include:

- nonpoint source hydrocarbon pollution in urbanized areas
- sedimentation from timber, mineral, or agricultural development
- water quality degradation (changes in pH, organic pollutants, eutrophication, or heavy metals) from industrial or agricultural development
- General threats (statewide) to group are related to water quality degradation (changes in pH, organic pollutants, or heavy metals) through airborne pollutants and water temperature or level changes related to climate change

F. Goal: Conserve and manage *Cladocera* spp. populations throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective: Maintain current Cladocera distribution, range of abundance, and species diversity throughout their natural range in Alaska.

Target: Document what species occur in each of Alaska's ecoregions by collecting and identifying specimens from 5 sites within each region over 5 years (regions correspond to the ADF&G joint board management regions).

Measure: Review existing literature and identify the species collected at each site.

Target: Obtain baseline data of normally occurring population densities in typical habitats at up to 5 survey sites in each region of Alaska for 5 consecutive years. (Regions correspond to the ADF&G joint board management regions.)

Measure: The population density estimates for Cladocera populations at selected survey sites within in each region of Alaska.

Issue: Alaska's Cladocera species, distribution, and range of normal abundance are unknown.

Conservation actions:

a) Compile any existing distribution and abundance data into an electronic database (preferably GIS-based).
b) Compare species lists of adjacent areas (Canada, Russian Far East) with available Alaska data to determine what species might occur here.
c) Establish survey protocols and identify possible survey sites.
d) Establish abundance estimation protocols and identify possible study sites.
e) Develop a network of volunteer collectors.
f) Collect individual specimens and document habitat associations.
g) Use recognized experts to identify individual specimens.
h) Create a peer-reviewed paper on the distribution of Cladocera in Alaska.
i) Preserve and archive specimen collections and associated data at the UAF Museum of the North for future research and use.
j) Convene an expert task force to review conservation plans of other jurisdictions.
k) Convene an expert task force to assess trends, critical habitats, threatened species, and to develop a featured species list and a conservation plan for these species.

H. Plan and time frames for monitoring species and their habitats

- Surveying should begin as soon as funding is available and be conducted yearly for 5 years.
- Monitoring for species baseline abundance and variance should begin as soon as funding is available and be conducted at selected sites every year for 5 consecutive years.
- Volunteer organization such as school districts, Elderhostels, nonprofit organizations, state and federal agencies, and interested individuals can collect and share specimen and habitat association information.

- Qualified taxonomists will conduct species identification; data and specimens would be housed at the UAF Museum of the North.
- Review the conservation plans of other jurisdictions concurrently with data and information collection; assessment and preparation of a featured species list would occur after the plan review and the Alaska data review.

I. Recommended time frame for reviewing species status and trends

Five years. This interval is necessary because conservation measures may change as data becomes available. Data may show that human development and climate change are affecting Cladocera habitat and populations.

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Ephemeroptera/Plecoptera/Trichoptera (Mayflies, Stoneflies, Caddisflies)

A. Species group description

Common name: mayflies, stoneflies, caddisflies
Scientific name: Class: Insecta, Orders: Ephemeroptera/Plecoptera/Trichoptera Alaska endemic mayfly *Rhithrogena n.* sp. (Randolf and McCafferty [in press]) Families: Numerous within each Order.

B. Distribution and abundance

Range:
Global range comments: Order are widespread globally, widespread in North America.
State range comments: Widespread (in flowing waters), where surveys have occurred. Diversity and abundance are higher in lower latitudes, but representatives of each order are found throughout the state.
Rhithrogena n. sp. is currently known only from adults taken at Yukon-Koyukuk region, Birch Creek, 10 miles upstream from mile 147 of the Steese Highway north of Fairbanks. Interestingly, it is most closely related to 2 Siberian species, and not North American species. (Email correspondence from P. McCafferty, 2004).

Abundance:
Global abundance comments: Highly variable where documented
State abundance comments: Highly variable where documented; undocumented in most regions of the state. High levels of abundance are often highly correlated with healthy fish stocks.
Rhithrogena n. sp.: unknown

Trends:
Global trends: Unknown
State trends: Unknown
Rhithrogena n. sp.: unknown

C. Problems, issues, or concerns for species group

- This group is highly sensitive to heavy metals, organic pollutant contamination, and sedimentation and turbidity.
- Ephemeroptera/Plecoptera/Trichoptera (EPT) species are important water quality indicators. The mere presence, abundance, and distribution of these species are indicative of the positive health of waters.
- The distribution of most representatives of the group is limited to flowing waters, and by temperature and pH constraints.
- The group also represents a major transfer of primary production to many vertebrates, including waterfowl and fish species, in flowing waters.

D. Location and condition of key or important habitat areas

Primarily found in flowing waters throughout the state. Habitat is mostly in very good, or pristine condition, although some localized habitat is threatened by water quality problems directly related to mining, logging, or other development.

E. Concerns associated with key habitats

Specific concerns, limited to minor extent of range, are development-specific and include:

- Nonpoint source hydrocarbon pollution in urbanized areas
- Sedimentation from timber, mineral, or agricultural development
- Water quality degradation (changes in pH, organic pollutants, eutrophication, or heavy metals) from industrial or agricultural development

General threats (statewide) to group are related to water quality degradation (changes in pH, organic pollutants, or heavy metals) through airborne pollutants and water temperature or level changes related to climate change.

F. Goal: Conserve and manage Ephemeroptera/Plecoptera/Trichoptera (EPT) populations throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective: Maintain current geographic distribution and species diversity of EPT species in Alaska.

Target: Document typical species assemblages (larval stages) that occur in Alaska by collecting and identifying specimens from 5 sites within each region over 5 years. (Regions correspond to the ADF&G joint board management regions.)

Measure: larval species assemblages within each region as determined by site survey and literature review.

Target: Obtain relative baseline data of normally occurring population densities. For example, compare annual densities or densities between habitat sites (Oswood et. al. 2001).

Measure: Obtain statistically valid population density estimates for EPT populations at up to 5 survey sites in each region of Alaska for 5 consecutive years. (Regions correspond to the ADF&G joint board management regions.)

Issue: There is limited information on EPT species in Alaska, their distribution, and their range of normal abundance.

Conservation actions:

a) Compile existing distribution and abundance data into an electronic database (preferably GIS-based).
b) Compare species lists of adjacent areas (Canada, Russian Far East) with available Alaska data to determine what species may occur here.
c) Establish survey protocols and identify possible survey sites.
d) Establish abundance estimation protocols and identify possible study sites.
e) Develop a network of volunteer collectors.

f) Collect individual specimens and document habitat associations.
g) Use recognized experts to identify individual specimens.
h) Create a peer-reviewed paper on the distribution of EPT in Alaska.
i) Preserve and archive specimen collections and associated data at the Museum of the North for future research and use.
j) Convene an expert task force of experts to review conservation plans of other jurisdictions.
k) Convene a task force to assess trends, critical habitats, threatened species, and to develop a featured species list and conservation plan for these species.
l) Develop species biological indices within regions.

H. Plan and time frames for monitoring species and their habitats

- Surveying should begin as soon as practical and be conducted yearly for 5 years.
- Monitoring for species baseline abundance and variance should begin as soon as practical and be conducted at selected sites every year for 5 consecutive years.
- Volunteer organizations, such as school districts, Elderhostels, nonprofit organizations, state and federal agencies, and interested individuals can collect and share specimen and habitat association information.
- Qualified taxonomists will conduct species identification; data and specimens would be housed at the UAF Museum of the North.
- Review the conservation plans of other jurisdictions concurrently with data and information collection; assessment and preparation of a featured species list would occur after the plan review and the Alaska data review.

I. Recommended time frame for reviewing species status and trends

Five years. This interval is necessary because conservation measures may change as data becomes available. Data may show that human development and climate change are affecting EPT habitat and populations.

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Karst Cave-dwelling Aquatic Invertebrates

A. Species group description

Common names: scuds, mites, springtails, beetle larvae, proboscis worms, flatworms, seed shrimp, water fleas and possible previously unconfirmed and unknown species
Scientific names: *Stygobromus quatsinensis, Stygobromus n.* sp. *A, Arrhopalites hirtus, Robustocheles occulta, Hydaticus larvae, Rhynchelmis* spp., *Polycelis* spp., *Candona* spp., *Acanthocyclops* spp., *Dacyclops* spp.

B. Distribution and abundance

Range:
Global range comments: Cave adapted invertebrates do not find favorable habitat in all cave systems, but instead occur in environmentally relatively stable cave systems that have a favorable glacial history and are large enough to have true troglobitic habitat. Human accessibility also further limits the systems from which invertebrate samples can be obtained. *Stygobromus* sp. has been described from Vancouver Island caves and may be relict populations from glacial refugial areas. The distributional ranges of many cave-adapted invertebrates are unknown. These species are often associated with cave habitats where subsurface waters are found predominantly within carbonate rock; vadose cave systems that have pirated surface streams and lakes; drip pools in mud and glacial marine outwash sediments, insurgent and resurgent springs, and subsurface groundwater systems.
State range comments: Cave-adapted invertebrate habitats within karst landscapes are scattered throughout Alaska but have been best studied in Southeast Alaska. *Stygobromus quatsinensis* has only been found on the outer islands of Southeast Alaska (Dall, Coronation, Heceta, Baker, and Suemez).

Abundance:
Global abundance comments: unknown
State abundance comments: limited abundance, unquantified

Trends:
Global trends: unknown

- Cavernicole species likely survived *in situ* during the last glaciation but re-radiative and re-immigrative mechanisms may also have resulted in the current distribution.

State trends: unknown

- In Southeast Alaska, one study of caverniculous invertebrate species abundance and diversity indicates that these parameters decrease from north to south; this trend may be an artifact of the sample site locations on the outer islands were also the southernmost islands, which could have been glacial refugia. Trends in distribution could also possibly be due to past glacial events and/or associated sea level changes (Carlson 1997).

- In Southeast Alaska, cavernicolous invertebrate migration from the inner islands to the outer islands is represented by a decrease in abundance and diversity from east to west, in the direction of decreasing probability of glacial coverage. (Carlson 1997).

C. Problems, issues, or concerns for species group

There is a very limited amount of information about this group.

Fauna will likely contain cave-adapted taxa that, due to the following characteristics, make them sensitive to anthropogenic impacts.

- Use a very limited habitat type
- Have a low reproductive rate
- Stenothermic
- Highly adapted to unique and harsh living conditions
- Require caves with temperature range equal to the mean annual ambient temperature
- Require low pH range
- Tolerance to contaminants is low
- Recruitment from outside the system is little to none
- Use a specific habitat that is easily degraded, rendering populations highly vulnerable to habitat destruction
- In cave ecosystems, a single species of amphipod may dominate a relatively simple food web based on fine organic particulates (Drost and Blinn 1997).
- Geographic isolation
    a) Chronic population genetics bottlenecks due to glaciation (Carlson 1997)
    b) Endemism, which can be highly localized
- Some populations endemic to a single cave or a small cluster of caves
- Some of the known cave habitats have been degraded by changes in hydrology and nutrient inputs as a result of timber harvest (including road construction, changes in forest structure, and impacts on local hydrology) and other extractive industries. On a global scale, karst landscapes are generally rare. Known karst landscapes exist in Africa, Australia and Oceania, Asia, Europe, North America and South America. Karst landscapes underlying temperate rain forests are even less common, occurring only in Tasmania and Chile.

D. Location and condition of key or important habitat areas

Karst landscapes in Southeast Alaska. Over 600 caves have been inventoried on northern Prince of Wales Island and several westerly islands (Dall, Coronation, Suemez, Heceta, Baker, and Kosciusko). Caves and karst are also present on Kuiu, Long, Etolin, Revillagigedo, Kupreanof and Chichigof Islands, as well as some parts of the mainland near Wrangell, areas of Lynn Canal and Haines, and in Glacier Bay National Park.

Thousands of caves are estimated to exist on Prince of Wales Island (USFS, 2004).

- El Capitan (in Southeast Alaska) is the largest cave in Alaska; over 2 miles of passage have been mapped from the main entrance. The El Capitan pit is the deepest vertical drop in the United States at 598 ft.
- Karst also occurs in Wrangell-St. Elias National Park. Extensive karst occurs in the Brooks Range. Smaller pockets are found in places such as the Lime Hills (Southcentral Alaska), and the White Mountains (Interior Alaska). Some of these karst blocks are similar in geologic age but have been accreted to the North American craton in differing positions due to differences in plate tectonics.
- Karst watersheds: water resources originating from lake or surface waters versus groundwater reserves greatly influence the species composition.
- Aquatic resurgence habitat: aquatic cave dwelling amphipods such as *Stygobromus quatsinensis* are associated with 37.4–46.4 degrees F freshwater cave or resurgence stream and pool habitats (Carlson 1997).
- Terrestrial entrance and deep cave habitats; terrestrial cave-dwelling amphipods such as *Robustocheles occulta* are associated with entrance as well as deep cave drip pools or organic debris. True aquatic "deep cave" habitats characterized by low organic matter, mud-limestone substrate, absolute darkness, a temperature profile resembling ground temperature, and pHs indicative of carbonate buffering host a fairly simple assemblage of invertebrates including: *Stygobromus quatsinensis, Stygobromus n.* sp., *Arrhopalites hirtus, Robustocheles occulta, Hydaticus larvae, Rhynchelmis* spp., *Polycelis* spp., *Candona* spp., *Acanthocyclops* spp., *Dacyclops* spp. (Carlson 1997).

Generally the condition of these cave habitats is pristine, although several caves have been degraded due to human visitation, timber harvest, and associated road construction.

E. Concerns associated with key habitats

- Hydrological:
  a) Silting, sediment and debris accumulation, and flooding associated with deforestation and logging, forest fires, and dam structures
  b) Geochemical changes to groundwater pH due to increased tannic acid outwash from runoff due to surface activities
  c) Overpumping of ground water and loss of watershed groundwater storage capacity due to removal of forest canopy and erosion of thin surface soils causing spring failure and dewatering
  d) Poorly planned road drainage causing groundwater contamination from roading outwash and sediment transport into karst systems
  e) Groundwater contamination from industrial sites, logging camps, and the application of pesticides

- Fire:
  Increased susceptibility to silting, changes in pH, loss of watershed storage capacity, increased flashiness of karst systems overlain with thin soils; resultant sedimentation eliminates microhabitats or introduces additional organics that support different epigean invertebrate species

- Land development:
  - a) Mineral mining and exploration—copper, gold, silver, zinc, lead, uranium and palladium
  - b) Quarrying of caves for limestone, other carbonate rock
  - c) Logging and road construction
    - Strong correlation between karst terrain and the presence of large trees; high volume karstland forests have been heavily harvested in the Tongass National Forest.
    - Many roads were originally built for log hauling
  - d) Timber industry is still a major employer; high volume karstland forests have been heavily harvested in the Tongass. Meteorological microclimate alterations, such as opening second entrances and sealing caves
- Nutrient stress:
  - a) Loss of fine particulate organic matter due to flooding or damming
  - b) Enrichment from sewage, slash, and sediments from logging road construction; fuel leakage from pipelines; nonpoint source pollution
- Exotic and pest species:

  Anthropogenically introduced species such as the collembolan *Willowsia* and Formicid ants may prove to have long-term detrimental effects on cavernicole populations.
- Chemical pollution:
  - a) Use of pesticides and herbicides, particularly along utility corridors, and more recently logging roads in close proximity to caves (The Associated Press 2003)
  - b) Non-point source contamination to the watershed
  - c) Hydrocarbon, heavy metal contamination of groundwater from abandoned logging camps
  - d) Military and federal toxic waste sites on Prince of Wales (ACAT 1998)
    - Formerly used defense sites
    - Groundwater contamination sites
    - Hazardous substances
- Killing, overcollecting, and disturbance of fauna:

  Most caves have vertical entrances, requiring technical climbing equipment and expertise for entry.
- Show caves:
  1. El Capitan, Prince of Wales Island, Tongass National Forest
     - Longest known cave in Alaska
     - Locked gate guards the cave entrance
     - Guided tours
  2. Cavern Lake Cave, Prince of Wales Island, Tongass National Forest

F. Goal: Conserve and manage karst cave-dwelling invertebrate populations to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective 1: Describe and maintain species distribution and diversity in karst systems in Southeast Alaska.

Target: Develop list of species and distribution maps within 5 years.

Measure: Survey aquatic invertebrates inhabiting karst systems in Southeast Alaska.

Target: Contact land managers at all Federal Conservation Units and State Special Designated Areas in Alaska within 5 years to provide educational information regarding cave habitats and invertebrate fauna.

Measure: Number of Federal Conservation Units and State Special Designated Areas in Alaska contacted and provided with educational information.

Target: Develop list of species and distribution maps within 5 years.

Issue 1: There is little or incomplete information about what species exist in these limited habitats, possibly including new species that have not been identified.

Conservation actions:

a) Compile existing data into an electronic database (preferably GIS).
b) Compare species lists of other karst regions with available Alaska data to determine what species might occur here.
c) Establish survey protocols and select survey sites.
d) Partner with the USFS and caving organizations (Glacier Grotto, Alaska statewide chapter of the National Speleological Society, and the Tongass Cave Project, a nonprofit caving organization) to develop a network of volunteer collectors.
e) Collect individual specimens and document habitat associations and physical and water quality parameters.
f) Use recognized experts to identify individual specimens.
g) Develop protocol for estimating densities.
h) Create a peer-reviewed paper on the distribution of cave-adapted species in Alaska.
i) Preserve and archive specimen collections and associated data at the Museum of the North for future research and use.
j) Convene an expert task force to review conservation plans of other jurisdictions.
k) Convene an expert task force to assess trends, critical habitats, and threatened species, and to then develop a featured species list and a conservation plan for these species.

Issue 2: Karst caves are easily degraded.

Conservation actions:

a) Develop best management practices for karst system watershed protection during land-altering activities.
b) Participate in watershed planning efforts.
c) Review existing management plans to assess provisions to protect invertebrate assemblages in karst caves and their watersheds, and include provisions in revised plans.
d) Identify which cave physical parameters are limiting factors for invertebrate assemblages and are easily degraded.
e) Create pamphlets and a PowerPoint presentation outlining the sensitivity and threats to cave habitats and associated invertebrate communities.
f) Distribute presentation to Public Land Information Centers, school districts, and conservation organizations.

Objective 2: Inventory cave resources throughout Alaska to quantify karst habitats.

Target: Contact land managers at all Federal Conservation Units and State Special Management Areas within Alaska to identify inventoried lands; cooperate with state and federal geologic agencies to identify likely cave-bearing geologic formations.

Measure: Develop a catalog (including maps) of cave resources and geologic formations likely to contain caves in Alaska.

Issue: Cave hydrogeography resources in Alaska are largely unknown.

Conservation actions:

a) Develop a list of persons, organizations, and agencies knowledgeable about cave locations in Alaska.
b) Collaborate with bat researchers and botanists conducting surveys in known karst areas.
c) Develop a GIS database of cave locations and geographic areas likely to contain caves.
d) Work cooperatively with other state and federal agencies and stakeholders to conduct hydrogeologic dye-tracing efforts in karst caves.
e) Produce maps of the karst cave hydrology to identify extent, distribution, flow and characteristics (springs, seeps, streams, etc.) of available aquatic invertebrate habitat.

H. Plan and time frames for monitoring species and their habitats

Objective 1:

Contract collectors, develop sampling protocol in 2005, begin surveys in 2006, and continue for 5 years.

Contact land managers in 2005, develop best practices “white paper” by 2007, distribute by 2007. Review existing land use/management plans by 2006, make recommendations to land managers as part of white paper by 2007.

Objective 2:
Contact land managers in 2005, develop list of caves or likely landforms by 2006.
Develop karst cave dye-tracing plan during 2007.
Implement dye-tracing during 2008–2010.

I. Recommended time frame for reviewing species status and trends

Five years (2011). This interval is necessary because conservation measures may change as data becomes available. Data may show that human development and climate change are affecting cave habitats and cave invertebrate populations.

J. Bibliography

Possible Resources:

USFS (Tongass National Forest, Jim Bachtal-Region 1 USFS geologist)
no longer in USFS now in Virginia
Glacier Grotto, statewide chapter of The National Speleological Society
Tongass Cave Project, a nonprofit caving organization
American Academy of Underwater Scientists, Alaska chapter (contact-Seward Sea Life Center)
Alaska bat researchers, UAS and UAF

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Mollusca

A. Species group description

Common names: freshwater clams/mussels; Western pearl shell, Yukon floater, Western floater
Scientific names: *Margaritifera falcata, Anodonta bergiana, Anodonta kennerlyi* and possibly previously unconfirmed/unknown species (Baxter [1987] suggested there may be 20 species of bivalves in Alaska)

B. Distribution and abundance

Range:
Global range comments: Poorly known; northwestern North America and pan-Arctic. Generally, mollusks have a widespread distribution but are declining in terms of area occupied and number of sites and individuals (NatureServe 2004). Mollusks possess limited abilities to disperse with present distributions often reflecting former (Pleistocene) drainage linkages.

State range comments: Poorly known.
a) *Anodonta beringiana* fairly well documented in many parts of the state, mainly north of 61 degrees latitude (Smith 2004); Kamchatka to central Alaska and into the upper Yukon drainage (Gustafson 1997).
b) Beringian species endemic to Alaska:
- *Anodonta kenneryli* and *Margaritifera falcata* are sparingly documented in Southeast Alaska (Smith 2004)
- *Margaritifera falcata* found on Revillagigedo Island (Southeast Alaska) and north to Naha Bay at 55 degrees latitude (Gustafson 1997).

Abundance:
Global abundance comments: Unknown
State abundance comments: Unknown

Trends:

Global trends: Unknown; fish host species are known for only about a quarter of the mussel species in North America (Watters 1994)

State trends: Unknown; conservation status not yet assessed (NatureServe 2004)

C. Problems, issues, or concerns for species group

As a water quality indicator species:

- Aquatic biomonitors; minute levels of some toxins or chronic environmental stressors can cause catastrophically significant losses in mussel communities long before they are noticed in fish populations
- Presence/absence, spatial distribution, population age structure, tissue and shell chemistry all relative to water quality
- They are bioaccumulator of contaminants with vertebrates (otter, muskrat, fish) relying on them for food
- Live over 100 years
- The spatial and temporal comparison of mussel population age structure may explain timing and causes of species population changes

Large aquatic filter feeder

- Are exposed to toxins or other deleterious environmental conditions at a more acute level than many higher trophic level organisms
- Their nutrient rich biodeposits (feces) provide an important trophic component of benthic community structure
- Easily identified/disturbed by the public
- Complicated biological and reproductive adaptations, requiring a host fish to brood glochidia (obligate parasites)
- Vital components of a number of intact salmonid ecosystems
- Important biomedical research implications for cancer (resistance to tumors)
- Are relatively late at maturing (6≥12 years old)
- Currently one of the most endangered faunal groups in North America
- Distribution and host fish information widely unknown
- Population health and numbers rely on the health of certain, but unknown, fish species and populations
- Can be an important subsistence food

D. Location and condition of key or important habitat areas

- *Anodonta beringiana* associated with slow-moving streams or lakes; prefers sand and gravel substrate
- *Anondonta kennerlyi* associated with lakes, ponds and slow-moving streams; visible in shallow areas
- *Margaritifera falcata* associated with rivers; prefers gravel substrate, often wedged between rocks

Locations of existing populations are limited to certain lakes, ponds, sloughs, slow-moving streams, and rivers. The condition of these habitats is mostly very good or pristine.

E. Concerns associated with key habitats

- Pollution; mussel larvae are more sensitive to pollutants than adults
- Mussels have a mandatory parasitic stage, thus are totally dependent on specific fish species, not all of which are known
  a) *Anodonta kennerlyi*: host fish currently unknown; associated unknown fish habitat closely linked to *A. kennerlyi* habitat
  b) *Anodonta beringiana*: 3 known host fish, sockeye salmon (*Onchorhynchus nerka),* Chinook salmon (*O. tshawytscha*) and threespine stickleback (*Gasterosteus aculeatus*) (Cope 1959; Hart and Fuller 1974)
  c) *Margaritifera falcata*: known host fish include Chinook salmon; rainbow, brook, and brown trout; possibly sockeye salmon

- Fish passage barriers
  Consumption of small mussels by fish and their subsequent elimination from fish's gut unharmed may be an important distribution mechanism; thus mussel populations are even more dependent on the distribution of certain unknown fish populations.

- Siltation
  Juvenile mussels must fall from the host fish onto suitable substrate for their adult life requirements or they will not survive; shifting sands, suspended fine mud, clays, and silt are considered harmful to juveniles and adult mussels.

- Climatic change may result in potentially dangerous falling water levels (due to longer ice-free periods, permafrost melting, and drought)

- Alterations in water temperature
  a) Spawning is stimulated by a change in water temperature.
  b) The duration of the parasitic glochidia stage (generally 5–120 days) is water temperature dependent.

- Water withdrawals due to human activities could threaten populations

- Invasive species: Species such as the zebra mussel (*Dreissena polymorpha)* and New Zealand mud snail (*Potamopyrgus antipodarum)* have driven a number of freshwater mussel species to extirpation in other states.

F. Goal: Conserve and manage freshwater mussel populations throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

<u>Objective 1</u>: Maintain current freshwater mussel distribution and species diversity.

Target: Document what species occur in each of Alaska's ecoregions by collecting adults (preferably shells) from numerous sites over 5 consecutive years (regions correspond to the ADF&G Board of Fisheries management regions); perform DNA and mitochondrial genetic assays.

Measure: The number of species and locations identified should not be increasing significantly by the fifth year of the study.

Issue: Species diversity and distribution in Alaska is unknown.

Conservation actions:

a) Conduct literature search/review of existing references and compile existing data into a database (electronic, preferably GIS or compatible).
b) Compare species lists of adjacent countries with available Alaska data to determine what species might occur here.
c) Establish survey protocols and identify possible survey sites.
d) Develop a network of volunteer collectors.
e) Collect individual specimens and document habitat associations.
f) Recruit recognized experts to identify individual specimens.
g) Create a peer-reviewed paper on the distribution of freshwater mussels in Alaska.
h) Preserve and archive specimen collections and associated data for future research and use.
i) Convene an expert task force to review conservation plans of other jurisdictions.
j) Convene an expert task force to assess trends, critical habitats, threatened species, and to develop a featured species list and a conservation plan for these species.

Objective 2: Maintain and maintain bivalve populations within existing range of variability.

Target: Obtain baseline data of normally occurring population densities at undisturbed key habitat types (for example, lake, pond, river).

Measure: Obtain statistically valid population density estimates for bivalve populations at up to 30 survey sites in each region of Alaska for 5 consecutive years. (Regions correspond to the ADF&G Board of Fish management regions.)

Issue 1: Population variance is unknown for any Alaska bivalve habitats.
Issue 2: Urbanization can create or destroy habitats.
Issue 3: Invasive species introductions may negatively impact habitats and kill individual bivalves.

Conservation actions:

a) Compare urban and undisturbed populations to understand which species benefit from, or are compromised by, disturbance.
b) Survey for invasive species when conducting bivalve fieldwork.

Objective 3: Describe the fish species/subpopulations required for larval obligate parasitic life stage.

Target: 100% of existing currently known whitefish, grayling, and salmon (host species) range information.

Measure: Distribution maps developed by fisheries researchers.

Issue: Variations in obligate fish host populations may affect mussel population maintenance.

Conservation actions:

a) Collect individual specimens and document habitat associations.
b) Survey for present resident and nonresident fish species (and life stages) to aid in identifying specific glochidia host species and life stage of host species.

Objective 4: Educate the public on bivalve conservation issues.

Target: An informed public that better understands the importance of bivalves and their habitat.

Measures:

a) Number of participants in bivalve distribution surveys.
b) Number of visits to bivalve website.
c) Number of public presentations and educational seminars including bivalve conservation information.

Issue: The public knows little about freshwater bivalves, thus cannot collaborate in their protection.

Conservation actions:

a) Prepare and distribute a general information publication suitable for laypersons and policymakers.
b) Give presentations to various forums, including symposia, outdoors shows, and conventions in Alaska, the Pacific Northwest, and elsewhere.
c) Post an article in the ADF&G Division of Wildlife Conservation electronic newsletter and newspapers.
d) Post information on bivalves on the ADF&G website.
e) Enlist volunteer organization, such as school districts, Elderhostels, nonprofit organizations, state and federal agencies, and interested individuals, to collect and share specimen and habitat association information.

H. Plan and time frames for monitoring species and their habitats

Surveying should begin immediately both at selected and opportunistic sites. It should be conducted once each year for at least 5 years or until a statistically adequate number of likely habitats have been surveyed, the number of new species found levels off, and all reports of mussel populations are investigated.

I. Recommended time frame for reviewing species status and trends

Five years. This interval is necessary because conservation measures may change as data becomes available. Data may show the need to develop conservations actions if human development, invasive species, and climate change are negatively affecting bivalve habitats and populations.

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Terrestrial Invertebrates – Introduction

Invertebrates, or animals without backbones, are a diverse group occupying marine, freshwater, and terrestrial habitats. Terrestrial invertebrates include all of the groups listed at the end of this introduction, in order from most primitive (worms) to highly evolved (insects). The list illustrates the incredible diversity of species represented by this group.

Currently, there are no federal or state listed terrestrial invertebrates in Alaska. Information from the coterminous United States indicates that invertebrate populations of concern—like many declining bird, mammal and amphibian populations—are affected by habitat degradation and habitat loss 87% of the time, and by pollution 45% of the time, among other factors (Stein et al. 2000). This is important because it tells us that the factors that cause species to become rare often operate in similar fashion for invertebrates as for the vertebrate species that humans tend to be more aware of and to value more highly. By the same token, management efforts that benefit an important bird species, for example, could also have positive benefits for the invertebrate species that share its habitat.

Invertebrates are often keystone components of the habitats and ecosystems of the more familiar vertebrate species that we value. It is perhaps difficult to appreciate the importance of microbes and worms, which are essential for the improvement of soil fertility. In the Arctic, large populations of mites, collembolans (springtails), enchytraeid worms, and insect larvae assist in decomposition by breaking down plant and animal material (CAFF 2001). Decomposition helps determine the amount of organic matter accumulated in the soil. Thus, it is essential to soil fertility and plant growth upon which all terrestrial animals ultimately depend.

Less difficult perhaps is some appreciation for bees, which are known to pollinate a wide diversity of domestic and wild plants. In the late 1980s, the value of insect- (that is, mostly bee-) pollinated crops in the United States was estimated as ranging between $4.6 billion and $18.9 billion (Daily and Ellison 2002). Plants that rely on pollinators include potatoes, almonds, soybeans, onions, carrots, and many greenhouse crops. The decline of native pollinators in many areas has had significant economic impacts on cash crops (Kevan and Phillips 2001). Therefore, it is no surprise that farmers and gardeners whose crops rely on native pollinators have begun to incorporate some common-sense conservation practices, including protecting natural habitat where native bees and other beneficial insects can thrive; leaving enough wildland to provide a functioning habitat; buffering these important areas from areas where pesticides are being used; mixing crops where possible and maintaining weedy borders, ground cover, and hedge-rows; and aiming for sequential flowering so that there will be nectar and pollen year-round for the beneficial insects. Many of these practices are intended to mimic what intact natural ecosystems already provide.

In Alaska, where farms are relatively few in comparison to the Lower 48, the economic importance of pollinators is best illustrated by their usefulness in natural systems and their vital role in maintaining sport and subsistence hunting. Most insect pollination in the Arctic is done by flies and by bumblebees (Pielou 1994). Many of the plants that benefit from their activity, such as the arctic willow (*Salix arctica*), are highly important to caribou, which in turn are highly important to humans for their meat and hides.

Invertebrates are important food sources for other species. A wide-ranging Alaskan species such as the Blackpoll Warbler, for example, eats aphids, flies, beetles, gnats, mosquitoes, wasps, ants and spiders (Hunt and Eliason 1999). The breeding seasons for many birds occur when insect populations are at their highest levels. Little is know about bats in Alaska, but elsewhere their diets depend heavily on both terrestrial and aquatic invertebrates. Spiders composed 15% of the estimated diet volume of the little brown bat (*Myotis lucifigus*) in Southeast Alaska (Parker 1996) and 16% in central Alaska (Whitaker and Lawhead 1992).

Many recent studies have considered the potential of invertebrates as reliable indicators of disturbance or degradation in terrestrial systems (Holliday 1991; Niemela et al. 1993; Anderson 1997; Blair and Launer 1997; Rodriguez et al. 1998). Terrestrial invertebrates are prevalent, have high species diversity, are easy to sample, and are important in ecosystem function (Rosenberg et al. 1986). They respond to environmental changes more rapidly than vertebrates and can provide early detection of ecological changes (Kremen et al. 1993). They also have diverse roles in natural environments that include functioning as decomposers, predators, parasites, herbivores, and pollinators, and these roles are affected by various perturbations.

Some studies have examined the responses of various taxa, including ground beetles (family Carabidae), ants (family Formicidae), and butterflies, to urbanization, logging, agricultural practices, and fire. More recently, studies have attempted to examine terrestrial invertebrate assemblages across a range of disturbance events, with the goal of selecting groups that respond in a consistent manner to various types of disturbance, and using those for developing a terrestrial index of biological integrity. Similarly to the aquatic indices now in use, terrestrial indices would provide an objective way to assess the biological condition of various sites, which is the ultimate key to successful restoration, mitigation, and conservation efforts.

Traditional management has taken a single-species perspective focusing on the activities that directly threaten declining species. It is not likely that we can successfully conserve invertebrate diversity if we try to survey, study, manage, and monitor invertebrates one by one. The loss of species interactions and their ecological functions may be of even greater consequence than the loss of one or more individual species (Levin and Levin 2002; Soule et al. 2003). Management that takes a broad multi-species and -systems perspective may be essential to the conservation of invertebrate species and the ecosystems of which they are a part. We are hampered by our lack of specific information about the various ecosystem functions of terrestrial invertebrates. As an ideal, however, we strive toward holistic and adaptive ecosystem-based management of Alaska's terrestrial systems to maintain functioning landscapes and natural communities.

Our knowledge of the status of terrestrial invertebrates is less than that of any other taxonomic group. For this reason, it is virtually impossible to come up with a list of species of invertebrates of concern that would be at all comparable to lists for vertebrates. In addition, vertebrate groups are split out much more finely than the tremendous and diverse group of animals lumped together here as "terrestrial invertebrates."

One logical starting point for terrestrial invertebrate conservation efforts would be to focus on the habitats for terrestrial invertebrates within the 7 general habitat types identified by the planning team: forests, tundra, freshwater aquatic, wetlands, marine aquatic and coastline, sea ice, and karst caves. Appendix 5 describes each of these complex habitat types and subtypes, associated species ecological importance, status, and recommendations for conservation. Table 34, Section VI, lists these types and the standard subtypes for which experts identified concrete information regarding species' habitat requirements. Forest (boreal, coastal temperate rain forest), tundra (alpine, arctic, maritime), wetland (grass, sedge, bog, salt marsh), and karst cave (entrance zone, twilight zone, deep cave zone) habitats would be especially important for terrestrial invertebrates.

In May 2003, a number of invertebrate experts participated in a Candidate Conservation Workshop, organized by USFWS (Judy Jacobs, pers. comm.). They identified a number of high priority activities; many of these are captured in the Terrestrial Invertebrates Template below. The group also identified several areas and specialized habitats that require survey. The potential to identify new and habitat-limited invertebrates, as well as plants and mammals, is high in these places. They include the isolated Nogahabara Dunes and Great Kobuk Dunes of northwest Alaska; the steppes and south-facing slopes of the southern Yukon River, which include rare plants and vegetation similar to western Beringia during the last glaciation; the 3000 feet of south-facing slopes associated with Castle Mountain; the Kenai Peninsula with its mix of maritime and continental climates; and the Aleutian Islands and the Seward Peninsula with its associated coastal islands, which were all connected at one time to Asia and the Russian paleoarctic as part of the Bering Land Bridge. Urbanizing areas, such as Anchorage, the Matanuska-Susitna valleys, and Fairbanks, also may require immediate study.

Based on limited information, we have included 2 groups of potentially rare invertebrates in Alaska: the western bumblebee and land snails. Concerns for their status are presented next.

The western bumblebee (*Bombus occidentalis*) once ranged from northern California northward along the Pacific Coast; it has declined precipitously from northern California to British Columbia. Very few if any specimens have been collected in California, Oregon, and Washington in the last few years. More recently, bees in British Columbia seem to be declining dramatically as well. The decline may be associated with a pathogen introduced by nonnative bees. We do not know if this species is waning in Alaska, or if it is already extirpated. There are two morphologically different forms of this bumblebee, an interior form, and a Pacific coastal form. Biologists speculate that the interior form is still abundant, but status of the coastal form is unknown.

Similarly, little information is available for the land snails of the Arctic and boreal habitats of North America. Baxter (1983) summarized the few earlier reports of Alaskan land snails at 31 species. Additional work by Brian Coles (2002, University of Arkansas for Medical Sciences, unpublished) in the Anchorage region added 10 species for the state, showing that some wetlands contain an undescribed (and perhaps endemic) *Vertigo* species, and that other species also are highly restricted in range and/or habitat, with a striking cline of species from Anchorage to Girdwood (boreal-Pacific north-west). Arctic Alaska is almost unexplored for land snails, yet they can be a common component of the Arctic tundra (e.g., *Vertigo hannai* is abundant in the tundra of Churchill, Manitoba; Jeff Nekola, University of Wisconsin – Green Bay, and Brian Coles, University of Arkansas for Medical Sciences, 2003, unpublished). Further work needs to be done to determine whether these snails are endemic to their type localities or more widely distributed.

Terrestrial Invertebrates

"Animals Without Backbones"

(Note: The following information was derived from BIOSIS; it is based on a simplified and somewhat abbreviated classification scheme for the animal kingdom following the Zoological Record indexing service.)

Phylum **Nematoda**: includes round, thread (some), whip, lung, hook, and eel worms
Many nematodes are free living and play critical ecological roles as decomposers and predators on microorganisms; also include parasitic species. One study reported around 90,000 individual nematodes in a single rotting apple. Another reported 236 species living in a few cubic centimeters of mud. The number of described species is around 12,000, but too little attention has been paid to these animals and the true number may be closer to 500,000 (Myers 2001).

Phylum **Annelida**: includes leeches, earthworms, terrestrial bristle worms
Currently, more than 830 species of annelids representing 27 families, 12 orders, and 5 classes (Oligochaeta, Aphanoneura, Branchiobdellae, Acanthobdellae, and Hirudinea) are recognized as occurring in the U.S. and Canada; these include both native and introduced species (Coates et al. 2003). Many species function as decomposers, and enhance soil properties.

Phylum **Mollusca**: includes slugs, land snails, and their relatives (gastropods)
Gastropods are by far the largest group of molluscs. Their 40,000 species comprise over 80% of living molluscs. Gastropod feeding habits are extremely varied. Some graze, some browse, some feed on plankton, some are scavengers or detritivores, and some are active carnivores (Myers and Burch 2001).

Phylum **Arthropoda**: includes crustaceans, arachnids, and insects; easily the largest phylum of all animals and of great economic importance

- Class **Malacostraca**: includes many marine, freshwater species; also terrestrial isopods
  - Order **Isopoda:** isopods, pill bugs, woodlice
- Class **Arachnida:** spiders, mites, ticks, scorpions
- Class **Pentastomida:** tongue worms, parasitic group
- Class **Chilopoda:** centipedes
- Class **Diplopoda:** millipedes
- Class **Entognatha:** minute arthropods mostly found in leaf litter and soil
  - Order **Collembola:** springtails
  - Order **Protura:** proturans
  - Order **Diplura:** diplurans
- Class **Insecta:** insects
  - Order **Anoplura:** sucking lice, true lice
  - Order **Coleoptera:** beetles
  - Order **Dermaptera:** earwigs
  - Order **Dictyoptera:** cockroaches, mantids
  - Order **Diptera:** true flies

Order **Hemiptera:** true bugs, aphids, plant lice, cicadas, mealy bugs, scale insects, jumping plant lice
Order **Hymenoptera:** wasps, ants, bees, sawflies
Order **Isoptera:** termites, white ants
Order **Lepidoptera:** butterflies and moths
Order **Mallophaga:** bird lice, biting lice
Order **Mecoptera:** scorpionflies
Order **Neuroptera:** dobsonflies, doodlebugs, lacewings
Order **Orthoptera:** leaf insects, stick insects, crickets, grasshoppers, groundhoppers, katydids, locusts
Order **Psocoptera:** bark lice, book lice
Order **Siphonaptera:** fleas
Order **Strepsiptera:** twisted wing insects
Order **Thysanoptera:** thrips
Order **Thysanura:** bristletails, silverfish

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Terrestrial Invertebrates

A. Species group description

Common name: terrestrial invertebrates
Scientific name:

B. Distribution and abundance

Range:
Global range comments: Ranges vary; many are only partially described or completely unknown.
State range comments: Ranges vary; many are only partially described or completely unknown.

Abundance:
Global abundance comments: Mostly unknown
State abundance comments: Mostly unknown

Trends:
Global trends: Mostly unknown
State trends: Mostly unknown

C. Problems, issues, or concerns for species group

- The primary issue for terrestrial invertebrates in Alaska is the lack of information on geographic distribution, abundance, habitat use, and species diversity in this large, remote, and under-surveyed state.
- Many common habitats and most unique habitats are under-surveyed. Little work has been conducted off the existing road system.
- Insects associated with rare plants need additional study.
- In many cases, the ability to identify species with appropriate taxonomic keys and species descriptions is lacking.
- Existing information is scattered and not compiled in a consistent, accessible fashion. Many specimen collections are outside of Alaska.
- Coordination of efforts could be improved. Communication among experts, interested managers, and general public also could be enhanced.
- The important roles of terrestrial invertebrates, even when known, are not appreciated and are undervalued by most people.
- Endemic species need to be identified and conservation status assessed.
- Response of various groups to climate change is uncertain.
- Establishment of baseline information on populations would permit proactive management.

D. Location and condition of key or important habitat areas

Habitat for many terrestrial invertebrates generally is assumed to be abundant and widely distributed across the state. The specific habitat requirements of many species, however, are poorly understood. An evaluation of habitat locations and conditions is needed.

E. Concerns associated with key habitats

- Unknown at present; since habitat loss and degradation are the most common causes of species' declines, it will be important to identify key, important, and unique habitats for future conservation efforts.
- Climate change will influence species distribution, habitat quality, and habitat quantity.

F. Goal: Ensure terrestrial invertebrates remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management objectives and actions:

<u>Objective</u>: Assess and describe current geographic distribution, abundance within existing range of variation, and species diversity of terrestrial invertebrates in Alaska.

Target: Survey unique, threatened, or representative habitats (at least 2 sites) for key or priority terrestrial invertebrates in each Alaska state region in the next 10 years.

Measure: Spreadsheet documenting baseline species presence/absence information, current state rank (SRANK) for priority species, and GIS distribution and range maps for priority species.

Target: Survey and assess habitats of 10 priority species to determine species-specific habitat needs, and the physical, chemical, and biological characteristics of each habitat type in the next 10 years.

Measure: Description of species-specific habitat requirements for priority species; maps of key, important, and unique habitats.

<u>Issue 1</u><u>: Terrestrial invertebrate species diversity and distribution data in Alaska are currently insufficient for determining their conservation status.</u> For example, our limited knowledge of species distributions prevents distinguishing truly rare species from under-surveyed species.

Conservation actions:

a) Compile and synthesize existing distribution data and publications into an electronic database (preferably GIS).
b) Work with experts and managers to identify information gaps.
c) Compare species lists and distribution data from the Yukon Territory and British Columbia with available Alaska data to determine what species might occur here.
d) Establish survey priorities to target rare, unique, threatened, or representative habitats.
e) Establish survey priorities to target rare, declining, keystone, or representative species, including species associated with rare plants.
f) Conduct a literature review to determine appropriate sampling techniques and protocols, and sample sizes.
g) Conduct inventories.
h) Establish an Alaska invertebrate survey, and employ bio-blitz or rapid bioassessment technology to increase knowledge of terrestrial invertebrate diversity and distribution.

i) Train observers in species identification and collection of unknown species for taxonomic identification (including using molecular methods); use recognized experts to identify specimens.
j) Develop a network of volunteer collectors. Encourage school districts, Elderhostels, nonprofit organizations, universities, state and federal agencies, public schools, and interested individuals to participate in surveys.
k) Collaborate with terrestrial invertebrate researchers in Canadian Provinces and Russia.
l) Develop a series of manuals to provide current information on the identification, distribution, and habitat of Alaska's rarer terrestrial invertebrate species.
m) Develop a general guide to Alaskan insects to raise public awareness and perhaps spur additional insect observations and reports.
n) Preserve and archive specimen collections and associated data at the University of Alaska Museum as feasible for future research and use.

Issue 2: Maintaining healthy terrestrial invertebrate populations throughout Alaska requires baseline information on natural spatial and temporal variation in species' abundance.

Conservation actions:
a) Use on-the-ground assessments, modeling and GIS technology to determine species-specific habitat availability and quality.
b) Focus on species/habitats that appear rare or have limited distributions.

Issue 3: Understanding species' habitat requirements in Alaska is critical for protecting and conserving populations.

Conservation actions:
a) Identify species-specific habitat associations during surveys.
b) Use GIS to predict and map habitat.
c) An annual report including survey locations and maps of new and old distribution records by species and region should be produced.

H. Propose plan and time frames for monitoring species and their habitats

Presence/absence surveys should begin as soon as funding allows and continue until all priority species and habitats have been addressed.

I. Recommended time frame for reviewing species status and trends

Five years. This interval is necessary because conservation measures may change as data become available.

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Marine Fish – Introduction

Species known as "forage fish" play a critical role in Alaska's marine ecosystems and coastal areas. They are the principal link between primary and secondary producers (e.g., phytoplankton and zooplankton) and apex predatory species (e.g., seabirds, marine mammals, and large fishes). These species often also constitute important dietary or ecological components for terrestrial-oriented species. Consumption of these marine fishes by terrestrial predators in the intertidal zone provides sustenance for those species (e.g., crows feeding on sand lance) and indirectly spreads nutrients into the terrestrial system. Consumption of forage fish by marine predators, such as seabirds that return to shore, helps sustain the birds, brings nutrients to coastal terrestrial systems, and plays a part in longer food chains that include species that prey upon seabirds and sea ducks or their young, including humans.

Critical habitat for forage fish species that are important in terrestrial ecosystems can be divided into intertidal habitats and shallow pelagic habitats. Intertidal habitats are used temporarily on a seasonal basis by embryonic, larval, juvenile and adult stages of some key forage fish species for shelter, feeding and rearing, and spawning. Meanwhile, shallow pelagic habitats are used year-round by other key forage species. Both habitats serve as important nursery areas for forage fish.

The CWCS features a suite of forage fish species known to be critical for healthy ecological function in each of these 2 habitat categories; these fish are regarded as indicator species. Prior research on forage fish shows that the species selected are either: a) the locally dominant prey biomass in many Alaska nearshore areas, or b) a frequent component of Alaskan predator diets. Their conservation needs are representative of the needs for many other nearshore and intertidal species. Since none of the featured forage fish species are commercially harvested, management actions will likely focus on habitat protection rather than on organism protection.

Habitat protection is especially crucial in forage fish nursery areas because the early life history stages of forage fishes are often more sensitive to a broad range of pollutants than are adult stages. In addition, for Alaskan waters, recirculation and nearshore vertical stratification (largely due to density differences from the input of freshwater) can result in concentration of terrestrial or nearshore-sourced pollutants. This is in contrast to areas with lower freshwater input where estuarine circulation helps remove or dilute pollutants.

Because human activity often concentrates in nearshore coastal areas, aquatic input of petroleum hydrocarbon compounds, sewage, and industrial or household chemical waste to these most sensitive of marine areas is also potentially high. Given the critical ecological role of forage fish, conservation actions designed to protect the key species and habitats shown on the following templates will likely benefit not only other species of forage fish, but also other marine species more widely recognized as valuable to human society.

Forage Fish Occurring in Intertidal/Shallow Subtidal Areas

A. Species group description

Common name: Intertidal/shallow subtidal forage fish (esp. Pacific sand lance, capelin, eulachon, Pacific sandfish; and intertidal fish [e.g., sculpins, pricklebacks, and gunnels]); some members of this group are also called small schooling fish (see definition found in *Forage Fishes in Marine Ecosystems*, 1997)
Scientific names: *Ammodytes hexapterus, Mallotus villosus, Thaleichthys pacificus, Trichodon trichodon,* and Cottid, Hemipterid, Rhamphocottid, Stichaeid, and Pholid families*)*

B. Distribution and abundance

Range:
Global range comments: Circumpolar (capelin, intertidal fishes); Northeast Pacific (intertidal fishes)
State range comments: Gulf of Alaska and Bering Sea (eulachon, Pacific sandfish), and throughout coastal Alaska (Pacific sand lance, capelin, sculpins, pricklebacks, and gunnels)

Abundance:
Global and state abundance comments: unknown
State abundance comments: unknown[1]

[1] Pacific sand lance and capelin may dominate local assemblages by biomass; the listed species and groups are key species serving important trophic roles in the transfer of energy to larger predators, such as marine birds and mammals and commercially important fish.

Trends: Much annual variation but trends unknown
Global trends: Capelin and Pacific sand lance trends variable with climate in North Atlantic; for other species, trends are unknown
State trends: Unknown for all

References: Alaska Sea Grant College (1997); Brown (2002); Mecklenburg et al. (2002); Robards et al (1999)

C. Problems, issues, or concerns for species group

- These are key species that play a critical role in Alaska's marine ecosystems. They are the primary link between primary and secondary producers (e.g., phytoplankton and zooplankton) and apex predatory species (e.g., seabirds, marine mammals, and large fishes); however, data on the forage fish species currently are sparse. This paucity of data and understanding of intertidal/shallow subtidal fish reduces the ability to link effects of climate change and other environmental changes on forage fishes with changes in the apex communities that are of both social and economic importance (e.g., whales, birds, commercially harvested fishes).
- Susceptible to adverse effects from degradation of subtidal and intertidal substrates or beaches (substrates used for spawning and burrowing habitat; exact substrate is species-specific).
- Susceptible to habitat modification (jetties, etc).
- Anthropogenic and natural changes to riverine and estuarine hydraulics and morphology can impact eulachon and many other forage fish species.
- Susceptible to subtidal, intertidal, estuarine and riverine pollution.
- Lack of swim bladder in some species, benthic orientation, and/or shallow water distribution makes standard acoustic survey and some net sampling techniques difficult.
- Capelin, Pacific sand lance, and Pacific sandfish have been and could again be considered for a possible commercial fishery in Alaska; the potential effects to these populations are unknown.
- Very little is known about distribution, abundance, and life history.

D. Location and condition of key or important habitat areas

- Pacific sand lance: For spawning and burrowing, subtidal areas as well as protected and semi-protected clean fine substrate beaches within their range; condition unknown but currently thought to be pristine over much of the range.
- Capelin: For spawning, subtidal areas as well as exposed or semi-protected clean fine substrate beaches within their range; condition unknown but currently thought to be pristine over much of the range.
- Eulachon: For spawning, rivers within their range; condition unknown but currently thought to be pristine over much of the range.
- Pacific sandfish: Juveniles and nonspawning adults prefer soft to sandy subtidal substrate; at the time of spawning, they deposit egg clusters on nearshore rocky areas or rock ledges with modest currents.
- Intertidal fish (e.g., sculpins, pricklebacks, gunnels): Need substrates (living or not) for nesting, brooding, rearing; pricklebacks may be a primary colonizer in periglacial environments that consist of high amounts of glacial silt.
- In general, status and condition of all these habitats is unknown.

References: Baxter (1997); Love (2002); Marliave (1981); Pahlke (1985); Robards et al. (1999); Robards and Piatt (2004).

E. Concerns associated with key habitats

- See Section C, above
- Anthropogenic and natural (e.g., earthquake, uplift) changes to shore habitats
- Pollution (including eutrophication, outfalls, sedimentation)
- Spilled pollutant (e.g. oil transport, toxic plume) pathways parallel the food pathway for these species; mechanisms that produce important spawning and rearing habitats are the same mechanisms that transport spills to them
- Climate change; change in storm patterns, sea level rises and change in sea ice distribution
- Interaction with exotic species (e.g., new predators, disease, parasites), including as a result of increased vessel traffic and associated ballast water discharge
- Dredge and fill

F. Goal: Conserve and manage intertidal/shallow subtidal forage fish populations throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective A: Sustain populations of the indicated intertidal/shallow subtidal forage fish species within their natural range of abundance.

Target: Level trend (recognizing potential for large inter-annual variability) in annual abundance of each sampled species as measured over a ten-year cycle.

Measure: Trend analysis of abundance in intertidal/shallow subtidal forage fish species using annual measurements over a ten-year cycle, based on information from the baseline survey sites.

Objective B: Maintain the quality and quantity of coastal habitat needed to sustain intertidal/shallow subtidal forage fish populations within their natural range of abundance.

Target: Maintain 100% of the very good-to-pristine condition habitat required to maintain viable sustainable populations of each intertidal/shallow subtidal forage fish stock.

Measure: A baseline map of available intertidal/shallow subtidal forage fish habitats against which to compare future monitoring results.

(Issues and conservation actions below apply to one or both objectives.)

Issue 1: There is a paucity of information about intertidal/shallow subtidal forage fish species and their habitats, and a lack of commitment to long-term monitoring.

- Generally, very little appears to be known about intertidal/shallow subtidal forage fish distribution, abundance, life history, and habitat requirements/use.
- Few documented baselines exist (especially outside Southcentral and Southeast Alaska) against which to compare future population or habitat monitoring results.
- There is limited information available on how habitats change naturally over time; difficult to separate anthropogenic from natural (climate, uplift, etc.) variability in loss/degradation/gain of habitats.
- Likely sources of “traditional knowledge” about intertidal/shallow subtidal forage fish abundance and habitat use have not been determined.

Conservation actions:

a) Establish a network of monitoring sites.
b) Determine minimum number of sites needed for statewide index (see draft network).
c) Annually survey forage fish populations by conducting recruitment surveys at index locations around the coast, and report decadal trends in the scientific and popular literature; conduct recruitment surveys via airplane or boat, or use beach seine and other net sampling techniques, and conduct intertidal transect surveys for intertidal species.
d) Determine the ecosystem function at the specific monitoring sites through collaboration with other agency projects (e.g., salmon, halibut, seabird, marine mammal diet surveys). (This entails evaluating the flow of energy through the system and what dictates or regulates that flow, as well as the stability and resiliency of the system [i.e., if perturbed will the system return to its former composition or resume a new state with different energy flow rates and forcing regulators].)
e) If there is extensive overlap among sites recommended by the different expert groups, consider putting together an LTER proposal at a designated site.
f) Develop ecological trophic interaction models for comparing among sites and over time based on data collected in Conservation Action (d), above. (This work delineates predator/prey relationships and defines feeding/predation/ consumption rates either in numeric or energetic currency. This is a critical and necessary part of mapping energy flow in ecosystem function.)
g) Establish a baseline map of available habitats used by intertidal/shallow subtidal forage fish against which to compare future monitoring results.
h) Add known forage fish habitat to NOAA's environmental sensitivity index maps.
i) Map known, and survey and map unknown, intertidal/shallow subtidal forage fish habitat.
j) Develop a trend analysis of habitat use by intertidal/shallow subtidal forage fish using annual measurements over a 10-year cycle, based on information from the baseline survey sites.
k) Develop a trend analysis of the amount and quality of habitat, using annual measurements over a 10-year cycle, based on information from the baseline survey sites.
l) Prioritize and link known habitat requirements for forage fish to existing coastal habitat maps; use literature values (densities, etc.) to extrapolate what potential population levels could be.
m) Measure and map the rate of change (loss/gain) of key habitats.
n) Measure and map the rate of change in percentage overlap of fish distribution with mapped habitat.
o) Develop multiple methods to link habitat use to abundance.
p) Collaborate with community leaders to identify and tap sources of local and/or traditional knowledge familiar with local forage fish abundance and habitat use.

Issue 2: There is a paucity of public knowledge and understanding about, or interest in, intertidal/shallow subtidal forage fish and their habitats.

- Little knowledge by the public about forage fish distribution, abundance, life history, and habitat (especially among those not traditionally using or observing forage fish species)
- Lack of public understanding of the importance of forage fish and forage fish habitat in the ecosystem

Conservation actions:

a) Develop a public citizenry in Alaska that is well educated about the importance of forage fish assemblages and their habitats as a key element in Alaska's marine ecosystems and understands how forage fish form a linkage between comprehensive research on climate change and trends in apex predator populations.
b) Establish information and education interchange mechanisms (active hands-on websites).
c) Establish citizen education and information exchange programs directed, at a minimum, to key monitoring sites.
d) Integrate intertidal/shallow subtidal forage fish and their habitat needs into existing fish curricula, including homeschooling.
e) Involve local residents in planning and conducting sampling and monitoring programs.
f) Mentor local leaders regarding benefits and importance of the program.

Issue 3: Education programs lack flexibility, with budget and time constraints limiting options to incorporate new material or customize it for the local area; outreach/start-up funding is needed (over and above the normal allocation for education) for field sampling equipment, travel, and salary for additional human resources needed to begin and maintain the program. Homeschooling curricula needs to be considered since homeschooling is widespread in Alaska, especially in more remote areas.

Conservation action: Integrate intertidal/shallow subtidal forage fish and their habitat needs into existing fish curricula, including home schooling.

Issue 4: Lack of public support can jeopardize efforts to implement conservation measures.

Conservation actions:

a) Involve local residents in planning and conducting sampling and monitoring programs.
b) Mentor local leaders regarding benefits and importance of the program.

Issue 5: Policies for better maintaining intertidal/shallow subtidal forage fish stocks and their habitats may be needed.

- The public appears to have a low awareness of how their activities can adversely affect the marine ecosystem; coastal communities with rocky intertidal zones accessible by road are especially hard hit by beach foragers, algae gatherers and school educational groups during low tide periods.
- Capelin, Pacific sand lance, and Pacific sandfish have been and could again be considered for a possible commercial fishery in Alaska, and the potential effects to these populations from fishing are unknown; future fisheries would need to be regulated in a way that incorporates ecosystem considerations, such as considering predator needs in quota decisions.

Conservation actions:

a) Develop approaches to mitigate adverse impacts from beach foragers and educational groups to beaches, road-accessible rocky intertidal zones, and rocky reef habitats used by rockfish juveniles (regulations, enforcement, coastal zone planning, beach preserve designations).
b) Develop standards for managing vessel ballast water to avoid introduction of nonindigenous species (see state's Invasive Species plan for overlapping strategies that would benefit forage fish).
c) If fisheries are begun on capelin, Pacific sand lance, or Pacific sandfish, ensure that harvest regulations are based on broader ecosystem considerations such as predator needs.

H. Plan and time frames for monitoring species and their habitats

Within the next 2 years, state and federal agencies in coordination with appropriate partners (e.g., universities, NGOs, tribal governments, village councils) to develop an annual monitoring plan with evaluation at 5-year intervals; see objectives above.

I. Recommended time frame for reviewing species status and trends

Review at 3, 7, and 12 years.

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Nearshore Occurrence of Pelagic Forage Fish

A. Species group description

Common name(s): Myctophids, prowfish, and Arctic cod
Scientific names: Myctophidae, *Zaprora silenus*, and *Boreogadus saida*

B. Distribution and abundance

Range:
Global range comments: Circumpolar (Arctic cod); North Pacific (myctophids, prowfish)
State range comments: Coastal glacial fjords and shelf edge (myctophids); broadly distributed (prowfish); associated with jellyfish aggregations as juveniles (Arctic cod; possible associations for myctophids, prowfish); North Bering, Chukchi and Beaufort Seas (Arctic cod)

Abundance:
Global abundance comments: Unknown
State abundance comments: Unknown (myctophids, prowfish, Arctic cod); Myctophids may dominate local assemblage by biomass; in the Beaufort Sea region, Arctic cod are locally the most abundant marine species; occurrence of any or all 3 species may represent a healthy marine ecosystem; prowfish are commonly caught in the juvenile fish assemblage near shore.

Trends: Unknown
Global trends: Arctic cod trends in the North Atlantic are better understood than those in the North Bering, Chukchi, Beaufort, and Bering Seas; trends in the Chukchi and Bering Seas are variable and generally related to recruitment events.
State trends: Unknown for all

References: Abookire et al. (2002); Alaska Sea Grant College (1997); Bradstreet and Cross (1982); Mecklenburg et al. (2002); Roseneau and Herter (1984); Springer et al. (1984)
C. Problems, issues, or concerns for species group • These are key species that play a critical role locally at local sites in Alaska's marine ecosystems; in glacial fjords, myctophids are a critical food source for many species; in the Arctic, Arctic cod play a critical role in the marine ecosystem and for human consumption. • These species are susceptible to subtidal pollution (all 3 species) and, for Arctic cod, waste products from offshore drilling. • These species are susceptible to climate change in regards to changes in sea ice (Arctic cod) and glacial ice (myctophids). • Whatever may adversely affect jellyfish (*Cyanea* and *Chrysaora*) in the Chukchi and Beaufort Seas may in turn have a detrimental effect on *Boreogadus*. • In general, recovery time for Arctic and/or ice-dependent species and their habitats may be much longer than in more temperate climates; however, a population rebound could be very rapid in the Arctic for a species such as cod (B. Wilson, personal communication). • Effective oil spill cleanup in ice-affected waters is still unproven. • The presence of ice, affinity to ice structure (for Arctic cod, myctophids), and/or shallow water distribution make(s) standard acoustic survey and some net sampling techniques difficult. • A lack of harvest data (Arctic cod) exists and potential impacts of harvest on the population are unknown. • Very little is known about distribution, abundance, life history, and habitat use and requirements.
D. Location and condition of key or important habitat areas For all, habitat requirements are largely unknown. Prowfish may need living cover (e.g., jellyfish aggregations) for rearing (i.e., refuge from surface feeders); juvenile Arctic cod may require jellyfish aggregations when ice cover is limited. In general, status and condition of these habitats is unknown. **References:** Alaska Sea Grant College Program (1997); Brodeur et al (1999); Purcell et al. (2000)
E. Concerns associated with key habitats • See Section C, above • Concentration of pollutants from anthropogenic sources (e.g., in the Arctic for Arctic cod) • Pollution (including increased ship traffic, cruise ship dumping and offshore oil development) • Spilled pollutant (e.g. oil transport, toxic plume) pathways parallel the food pathway for these species; mechanisms that produce important spawning and rearing habitats may be the same mechanisms that transport oil spills to them

- Climate change; change in storm patterns, sea level rises and change in sea ice distribution
- Interaction with exotic species (e.g., new predators, disease, parasites)
- Dredge and fill (Arctic cod)

F. Goal: Conserve and manage nearshore pelagic forage fish populations to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective A: Maintain populations of the indicated nearshore pelagic forage fish species at their current levels.

Target: Level trend in annual abundance variation from the mean of each sampled species as measured over a 10-year cycle.

Measure: Trend analysis of abundance in nearshore pelagic forage fish species, using annual measurements over a 10-year cycle, based on information from the baseline survey sites.

Objective B: Maintain the quality and quantity of coastal habitat resources needed to sustain nearshore pelagic forage fish populations at their current levels.

Target: 100% of the very good-to-pristine condition habitat required to maintain viable populations of each forage fish stock.

Measure (1): Establish habitat requirements for species (e.g., salinity, temperature, prey) and produce a baseline map of available habitats used by nearshore-occurring pelagic forage fish against which to compare future monitoring results.

Measure (2): Trend analysis of the amount and quality of habitat, using annual measurements over a 10-year cycle, based on information from the baseline survey sites. For myctophids and Arctic cod this would focus first on defining optimal habitat conditions (oceanographic conditions that produce optimal plankton and food resources), then connecting these conditions to the forcing factors such as storm frequency, water temperature, salinity and timing/frequency of water stratification; for adult prowfish, it would focus on rocky, bouldery areas with cover.

(Issues and conservation actions below apply to one or both objectives.)

Issue 1: There is a lack of harvest data for Arctic cod, and potential impacts on the population from harvest are unknown.

Conservation action: Develop and conduct harvest assessment for Arctic cod.

Issue 2: There is a paucity of information about nearshore-occurring pelagic forage fish species and their habitats, and a lack of commitment to long-term monitoring.

- Very little is known about nearshore-occurring pelagic forage fish distribution, abundance, life history, and habitat requirements/use.
- With some notable exceptions (e.g., industry-sponsored work in the nearshore Beaufort Sea, near Prudhoe Bay), little documented baseline exists against which to compare future population or habitat monitoring results.

- There is limited information available on how habitats change naturally over time; it is difficult to separate anthropogenic from natural (climate, uplift, etc.) variability in loss/degradation/gain of habitats.
- Sources of "traditional knowledge" about forage fish abundance and habitat use have not been determined.

Conservation actions:

a) Establish a network of monitoring sites.
b) Determine minimum number of sites needed for statewide index.
c) If there's extensive overlap among sites recommended by the different expert groups, consider putting together an LTER proposal at a designated site.
d) Annually survey forage fish populations by conducting recruitment surveys via net sampling techniques and acoustics at index locations around the coast, and report decadal trends in the scientific and popular literature.
e) Determine the ecosystem function at the specific monitoring sites through collaboration with other agency projects (e.g., salmon, halibut, seabird, marine mammal diet surveys). (This entails evaluating the flow of energy through the system and what dictates or regulates that flow, as well as the stability and resiliency of the system [i.e., if perturbed will the system return to its former composition or resume a new state with different energy flow rates and forcing regulators].)
f) Develop ecological trophic interaction models for comparing among sites and over time based on data collected in Conservation Action (e), above; addresses first Issue bullet in template box C. (This work delineates predator/prey relationships and defines feeding/predation/consumption rates either in numeric or energetic currency. This is a critical and necessary part of mapping energy flow in ecosystem function.)
g) Establish a baseline map of available habitats used by nearshore-occurring pelagic forage fish against which to compare future monitoring results.
h) Map known, and survey and map unknown, nearshore-occurring pelagic forage fish habitat.
i) Develop a trend analysis of habitat use by nearshore-occurring pelagic forage fish using annual measurements over a 10-year cycle, based on information from the baseline survey sites.
j) Prioritize and link known habitat requirements for myctophids to existing coastal habitat maps; use literature values (densities, etc.) to extrapolate what potential population levels could be.
k) Measure and map the rate of change (loss/gain) of key habitats.
l) Measure and map the rate of change in percentage overlap of fish distribution with mapped habitat.
m) Develop multiple methods to link habitat use to abundance.
n) Collaborate with community leaders to identify and tap sources of local and/or traditional knowledge familiar with local Arctic cod abundance and habitat use.

Issue 3: There is a paucity of public knowledge and understanding about, or interest in, pelagic forage fish species occurring near shore and their required habitats.

- Little public knowledge about forage fish distribution, abundance, life history, and habitat (especially among those not traditionally using or observing forage fish species).
- Lack of public understanding of the importance of forage fish and forage fish habitat in the ecosystem.

Conservation actions:

a) Develop a public citizenry in Alaska that is well educated about the importance of forage fish assemblages and their habitats as a key element in Alaska's marine ecosystems, that has a higher awareness of how their activities can adversely affect the marine ecosystem, and that understands how information on forage fish can form a linkage between comprehensive research on climate change and trends in apex predator populations.
b) Establish information and education interchange mechanisms (active hands-on websites).
c) Establish citizen education and information exchange programs directed, at a minimum, to key Arctic cod monitoring sites.
d) Integrate nearshore pelagic forage fish and their habitat needs into existing fish curricula, including for home schooling.
e) Involve local residents in planning and conducting sampling and monitoring programs for Arctic cod (possible diet composition of subsistence harvest species such as seals); more difficult to involve locals for myctophids and prowfish.
f) Mentor local leaders regarding benefits and importance of the program.

Issue 4: Policies for sustaining forage fish stocks and their habitats is lacking.

- Arctic cod harvest could become an issue; it may need to be regulated in a way that incorporates ecosystem considerations such as predator needs in quota decisions.

Conservation actions:

a) Develop approaches to mitigate adverse anthropogenic impacts to nearshore waters (regulations, enforcement, coastal zone planning).
b) Develop standards for shipping regarding pollution, docking facilities, and transport/introduction of nonindigenous species (see state's Invasive Species Plan for overlapping strategies that would benefit forage fish).

H. Plan and time frames for monitoring species and their habitats

Within the next 2 years, state and federal agencies in coordination with appropriate partners (e.g., universities, NGOs, tribal governments, village councils) to develop an annual monitoring plan with evaluation at 5-year intervals; see objectives above.

I. Recommended time frame for reviewing species status and trends

Review at 3, 7, and 12 years.

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Freshwater Fish – Introduction

Freshwater fish species play an important role in the social and economic fabric of Alaska. Many are important for subsistence. Recreational and commercial fishing for many species, such as Arctic char, pike, rainbow trout, Dolly Varden, sheefish, and the 5 species of Pacific salmon, account for millions of dollars in commerce annually in Alaska. However, Alaska's "nongame" fish species—species that are *not* recreationally or commercially harvested—play a crucial role in aquatic ecosystems and, through predation by terrestrial, avian, and marine species, in other ecosystems as well. Some freshwater fish species constitute an important element of the food chain for many other species including species of potential conservation concern, such as loons and beluga whales.

In April 2004, ADF&G convened a diverse group of freshwater fish experts and asked these scientists to develop a short list of species and/or species groups to feature in the CWCS, including specific conservation actions that could be started in the next decade. The group reviewed a complete list of freshwater and anadromous candidate species that excluded species routinely harvested in sport or commercial fisheries in Alaska. By mutual agreement, the group then excluded species (e.g., sturgeon) that occur only incidentally in Alaska. The experts compared the status of the remaining 25 species against 15 criteria; these included the 11 "species selection criteria" listed in Section II(D), plus other criteria the group generated, including whether a species is used by humans, is important prey for another "at-risk" species, or is of demonstrated special scientific importance.

Based on these criteria and the limited time available at the meeting, the group elected to prepare templates on 8 featured species or species groups: lampreys (species group), broad whitefish (*Coregonus nasus),* Bering cisco (*Coregonus laurettae),* pygmy whitefish (*Prosopium coulteri),* Alaska blackfish (*Dallia pectoralis),* trout-perch (*Percopsis omiscomaycus),* anadromous smelts (species group), and stickleback (Cook Inlet radiation). Conservation actions designed to protect the fish species and habitats shown on the following templates will likely benefit not only the human users of these species, but also the populations of game fish species inhabiting the same lakes and drainages.

Failure of a species to be selected through this process as a featured species does not mean a species is unimportant or not in need of further study. For example, round whitefish, longnose sucker, slimy sculpin and ninespine stickleback are widely distributed in Alaska and common, while prickly sculpin and coastrange sculpin have a more restricted distribution; all have been virtually unstudied. Lake chub has a restricted distribution in Alaska but populations are contiguous with other North American populations; it is an abundant and important forage species but unstudied in Alaska. The remaining whitefish species are all very important because of human use for subsistence. The USFWS Office of Subsistence Management has recently funded studies on whitefish, but genetic and taxonomic studies, particularly of the humpback whitefish species complex, remain to be addressed.

There are huge data gaps regarding life history, abundance, and trophic structure for all these species. Overall they are poorly understood, especially in terms of Western science. However, the ecological role they perform is undoubtedly very important in aquatic, and for anadromous species, estuarine and marine ecosystems. In June 2005, the ADF&G Sport Fish Division, with partial funding from SWG monies developed an Alaska freshwater fish community and habitat database with interactive mapping capabilities. This database is located at http://www.sf.adfg.state.ak.us/statewide/SF_home.cfm and includes the list of freshwater species found in Alaska, maps indicating where species have been collected or observed, and a link to general biological information on species. These data do not represent exhaustive inventories, but are compilations of existing knowledge from field biologists that are updated periodically as knowledge improves.

Lampreys

A. Species group description

Common names: lampreys (often colloquially/locally referred to as "eels" in Alaska and elsewhere)

Scientific names:

- Pacific lamprey – *Lampetra tridentate* (Richardson 1836)
- western brook lamprey – *Lampetra richardsoni* (Vladykov and Follett 1965)
- river lamprey – *Lampetra ayresii* (Gunther 1870)
- Arctic lamprey – *Lampetra camtschatica* (Tilesius 1811), *(*Mecklenburg et al. 2002)*; Lampetra japonica* (Berg 1948*); Lentheron camtschatica* (Kottelat 1997*)*
- Alaskan brook lamprey – *Lampetra alaskense (*Vladykov and Kott 1978)
- Siberian (brook) lamprey – *Lethenteron kessleri; Lampetra kessleri; Lampetra japonica kessleri* (Anikin 1905)

B. Distribution and abundance

Range:

Global Range Comments: Poorly known, particularly in and across northerly areas/countries

- Pacific lamprey: Eastern Pacific drainages from very northern Mexico to Alaska, across the Aleutian Island chain into the western Pacific and north to Hokkaido, Japan
- western brook lamprey: Eastern Pacific from the Sacramento River in California to just north of Juneau, Alaska
- river lamprey: Eastern Pacific from California to southeastern Alaska
- Arctic lamprey: Bering Sea and Arctic drainages to Anderson River (Canada) and south to Japan/Korea
- Alaskan brook lamprey: Range is considered the same as for Arctic lamprey, but perhaps most often with a more inland range; this species in particular is not consistently recognized or understood.

State Range Comments: Distributions and relationships very poorly known in Alaska

- Pacific lamprey: Pacific drainages up to at least the Bering Sea with records into lower Yukon/Kuskokwim
- western brook lamprey: southern Southeast Alaska north to approximately 20 mi north of Juneau, Alaska
- river lamprey: Southeastern Alaska north to approximately Tee Harbor, Alaska

- Arctic lamprey: Bering Sea and Arctic drainages, and possibly into northern north Pacific river basins
- Alaskan brook lamprey: Range considered same as for Arctic lamprey, but perhaps most often with a more inland range

Abundance:

Global abundance comments: Serious conservation concern throughout ranges

State abundance comments: Unknown, but often found in Alaska with some local abundance

Trends:

Global trends: Declining across ranges outside of Alaska in North America and globally

State trends: Unknown

References: Beamish and Northcote 1989; Klamath-Siskiyou Wildlands Center (and other petitioners) 2003; Larson and Belchik 1998; Maitland 2003; Mecklenburg et al. 2002; Weeks 1991

C. Problems, issues, or concerns for species group

There is a paucity of information about lamprey species in Alaska and their habitats**.**

- We lack much basic information on such topics as abundance, age structure, diet, trophic ecology, homing/migration, species identification, range, instream flow/water volume and habitat needs (Beamish and Levings 1991; Beamish and Youson 1987; Vladykov and Follett 1965; Young et al. 1990).
- The systematics of Alaska's diverse lamprey species is difficult to determine.
  a) Lamprey species can be hard to identify, especially in juvenile stages (McPhail and Carveth 1994).
  b) Systematics of lamprey is very incomplete and poorly understood; needs research and inventory.
  c) Lampreys are classically thought of as occurring in "species pairs" or "satellite pairs" (Mecklenburg et. al. 2002) with one species parasitic (and anadromous) and its "congener species" nonparasitic derivative (and a freshwater resident) (Beamish 1987, Beamish and Neville 1992; Vladykov and Kott 1979; Vladykov 1985). Examples:
     - river lamprey (parasitic) and western brook lamprey (nonparasitic) (Mecklenburg et. al. 2002) (Also see "distribution" info)
     - Arctic lamprey (parasitic) and Alaskan brook lamprey (nonparasitic)
  d) Populations that are isolated or with unusual life histories are described as distinct species elsewhere in the Pacific (Docker et al. 1999; Haas 1998; Klamath-Siskiyou et al. 2003; Kostow 2002).

e) Lamprey diversity in Alaska is poorly documented and understood (McPhail and Lindsey 1970; Morrow 1980); although lampreys are usually listed as fish, there is currently some debate about it; their overall group is superclass Agnatha, class Cephalaspidormphi, order Petromyzontiformes.

f) The taxonomic status of lamprey species is unresolved due to differing viewpoints on significance of life history types, and the complexities of relationships between species (Mecklenburg et al. 2002).

- Alaska likely has many populations with possibly rare or unique life-history characteristics.

a) Confusing parasitic and non-parasitic "paired species" relationships exist due to unresolved genetic analyses, and degenerative changes with maturation resulting in inconsistent taxonomic identification (McPhail and Lindsey 1970, Mecklenburg et. al. 2002; Morrow 1980).

b) Non-parasitic freshwater forms are believed to have evolved from parasitic anadromous forms, but unusual "intermediates," such as freshwater parasitic forms, exist.

c) Geological isolates are not uncommon and are found in Alaska (Hastings and Haas 2002).

- Serious lamprey conservation/management issues exist elsewhere; extent and nature of issues to be expected in Alaska are unknown but may include:

a) Lampreys are described as having serious conservation concern throughout most of their natural range (Renaud 1997).

b) Lampreys (particularly Pacific lamprey) have been petitioned for listing as endangered species in the contiguous United States under the U.S. Endangered Species Act (Klamath-Siskiyou et al. 2003).

c) There has been a collapse of Native subsistence and commercial fisheries outside of Alaska (e.g., Close et al. 2002).

d) Lampreys are of considerable cultural and food importance for Native Americans (Close et al. 2002).

e) Similar conservation/management/extinction issues are recognized elsewhere in the range (Beamish and Northcote 1992, Frissel 1993, Haas 1998, Kostow 2002).

f) Lamprey are taken as a food fish in the lower Kuskokwim and Yukon Rivers and possibly elsewhere in Alaska.

g) Subsistence harvest locations, levels, species, etc., are poorly documented or unknown.

h) An emerging commercial fishery is possible in at least some regions, with unknown impacts.

i) Lampreys are possibly an important forage fish for species of conservation concern.

j) Anadromous lampreys appear to have similar life history and habitat needs to salmonids; it is unknown whether factors causing decline of salmon stocks also cause declines in lamprey populations within the same drainages.

D. Location and condition of key or important habitat areas

Key or important habitat areas are largely undescribed and unknown in Alaska; lampreys may occur in other habitat types than listed here.

While it is believed that adult lampreys have similar habitat/spawning needs as salmon (e.g., Vadas 2000), a 2003 Bristol Bay inventory found adult Alaskan brook lamprey in locations not occupied by salmon. Alaskan brook lamprey appear to have greater tolerance for streams with low gradient, fine substrate, and low dissolved oxygen than do salmon (M. Wiedmer, pers. comm.).

Rearing habitat for all juvenile lampreys (ammocoetes) is different from that used by the adults. Juvenile lampreys prefer slow-flow freshwater areas/sloughs with silt/mud bottoms (Sugiyama and Goto 2002). In the 2003 Bristol Bay inventory mentioned above, juvenile lamprey were often found in headwater habitats, if suitable habitat (soft bottoms) was available (M. Wiedmer, pers. comm.).

Resident nonparasitic lampreys use freshwater habitat for their entire life cycle; their ammocoetes only mature into adults for reproduction. Resident parasitic lampreys mature into adults, and feed as adults, in fresh water; some may spawn in lakes.

E. Concerns associated with key habitats

Lampreys seem to have similar habitat requirements as salmon (e.g., Vadas 2000); concerns for habitat destruction and degradation include effects originating instream (channelization, instream flow/water volume alteration, temperature, impoundment, passage, sedimentation) and those influences originating from outside the stream (pollution, riparian zone loss, ocean [or lake] conditions, and climate change).

F. Goal: Conserve and manage populations of Alaska lamprey species throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective: Maintain species distribution, population abundance, and life history variability indicative of viable lamprey species complexes throughout their native habitats in Alaska.

Target: Identify the distribution of lamprey species in Alaska.

Measure: Document lamprey distribution within Alaska as determined by literature review and surveys for ammocoetes in potential habitat.

Target: Lamprey ammocoetes are present in at least 90% of identified index areas.

Measure: Presence of lamprey ammocoetes in index areas (to be determined).

Target: Density of ammocoetes is within natural variability in at least 90% of selected lamprey rearing areas.

Measure: Density of ammocoetes annually over a 10-year period in selected index areas.

Issue 1: Identification of species is difficult.

Conservation action: Develop criteria and an approach for identification of ammocoetes and adult lampreys.

Issue 2: Unknown distribution of lamprey.

Conservation actions:

a) Document the freshwater distribution of the various species of lampreys in Alaska by sampling for ammocoetes and adults in a representative selection of drainages.

b) Develop sampling protocols and implement sampling schedule across geographic range in Alaska.

c) Identify representative index areas.

d) Identify and describe the habitat types or categories used by various species and their life forms (e.g., as used in ADF&G's freshwater fish inventory database); develop and conduct sampling in rearing areas for ammocoetes to document distribution.

e) Develop sampling techniques and document the migration and movement patterns of different species and life stages.

f) Develop a network of biologists/organizations to establish unified protocols, share data, leverage sampling efforts, and provide voucher specimens to museums (UAF, etc.). AFS-Alaska Chapter might be a venue for organizing and consolidating information.

Issue 3: Habitat alteration, sufficient instream flow/water volume, fish passage, and sedimentation are potential concerns.

Conservation actions:

a) Determine instream flow/water volume needs and habitat requirements for all life history phases of lampreys.

b) Consider lamprey species when there are issues of fish passage and habitat alteration (e.g., water diversions, dams, timber harvest, mining, sedimentation).

c) Develop a coordinated effort among government and nongovernment agencies to coalesce and exchange information on the habitat and instream flow/water volume needs of lampreys.

Issue 4: Lampreys are taken as a food fish (e.g., lower Yukon/Kuskokwim, possibly other areas); harvest levels are not monitored.

Conservation actions:

a) Obtain local information and knowledge on local lamprey distribution, relative abundance, and harvest.

b) Develop sampling protocol to monitor locations, timing, magnitude, and catch per unit effort (cpue) of harvest.

c) Involve communities in monitoring, and share information.

d) Train local communities to monitor abundance and harvest effort.

Issue 5: Emerging commercial fishery for lamprey on the Yukon River with a lack of assessment.

Conservation action: Document the number and magnitude of the commercial fisheries for lampreys that are occurring in the state; collect biological samples of lampreys (e.g., size, sex ratio, and if possible, species, age structure).

Issue 6: Lampreys may be important forage fish for various freshwater and marine predators, some of which have been identified in this Strategy as of conservation concern.

Conservation action: Determine the trophic ecology of lampreys.

H. Plan and time frames for monitoring species and their habitats

Promote coordination with state agencies, federal agencies, universities, industry, Native entities, and NGOs to conduct monitoring every year for 10 years to establish the target indices. Wherever possible, make use of any existing fisheries to collect data and information.

The University of Alaska Fairbanks, Museum of the North is interested in coordinating and undertaking inventory and research in general for nongame (and game) fish in Alaska. The Museum of the North would provide expertise, training, and resources for proper collections, as well as storage in perpetuity and curation. ADF&G's ongoing statewide fish inventory program should coordinate with the Museum of the North to ensure proper preparation and submittal of voucher specimens for curation.

I. Recommended time frame for reviewing species status and trends

Review within 5 years, and then at such frequency in the future to ensure progress.

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Anadromous Smelts

A. Species group description

Common name(s): anadromous smelts (i.e., longfin smelt, eulachon, rainbow smelt)

Scientific names: *Spirinchus thaleichthys, Thaleichthys pacificus, Osmerus mordax*

B. Distribution and abundance

Range:

Global range comments: Full extent unknown, but populations of some species occur in British Columbia, northwestern and northeastern United States (with introductions in Great Lakes areas), and northwestern Pacific Ocean and Bering Sea (Korea, Japan, Russia)

State range comments: Longfin smelt: Shelikof Strait, southwestern Gulf of Alaska, through Southeast. Rainbow smelt: entire coast of Alaska, but less common along Gulf of Alaska. Eulachon: Southwestern Alaska, Aleutians, Southcentral Alaska through Southeast Alaska.

Abundance:

Global abundance comments: Unknown

State abundance comments: Unknown

Trends:

Global trends: Declining trends for anadromous smelt species across parts of their range

State trends: Unknown

References: McPhail and Lindsey 1970; Mecklenburg et al. 2002; Morrow 1980

C. Problems, issues, or concerns for species group

- Anadromous smelt species are an important forage fish for various marine predators, some of which have been identified in this Strategy as of conservation concern (e.g., Cook Inlet beluga whales). (See the Marine Fish template called "Forage Fish Occurring in Intertidal/Shallow Subtidal Areas.")
- Alaskan populations of anadromous smelt species are poorly documented.
- There is a lack of information on these species, including life history, abundance, trophic ecology and instream flow/water volume needs.
- They are taken as a human food fish throughout their range.
- Threats exist to freshwater and estuarine habitat and fish passage.
- There is a high interannual variability in populations suggested by saltwater trawl surveys.

D. Location and condition of key or important habitat areas

For all 3 species: Lower reaches of streams and rivers and associated estuaries (e.g., Susitna River); also, eulachon are known to ascend ≥ 100 km up the Susitna (Yentna) system and rainbow smelt to enter Lower Ugashik Lake, likely spawning in tributaries to the lake (M. Wiedmer, pers. comm.). Significant eulachon runs also occur in the Kenai, Twenty-mile, and Eyak Rivers.

- On the North Slope, rearing also occurs in connected lakes in river deltas
- Habitat condition overall is thought to be very good to pristine
- Marine habitat and ecological conditions are unknown

E. Concerns associated with key habitats

- Potential impacts of water diversion or impoundment on movements, spawning and rearing habitats, and survival
- Nearshore chronic and acute pollution (such as oil spills, wastewater effluent)
- Broad-scale climate shifts affecting marine ecological conditions

F. Goal: Conserve and manage populations of Alaska anadromous smelt species throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective: Maintain species distribution and population abundance within natural variation throughout their distributions in Alaska.

Target: Identify the distribution of anadromous smelt species in Alaska.

Measure: Anadromous smelt distribution within Alaska as determined by literature review and surveys at river mouths to the limits of upstream spawning habitat.

Target: Anadromous smelt species are within their natural variability of abundance in at least 90% of identified index areas.

Measure: Abundance of anadromous smelt species annually over a 10-year period in identified index areas.

Issue 1: Anadromous smelt species are important prey for predators of conservation concern (e.g., beluga whales, loons).

Conservation action: Work with marine scientists (e.g., marine mammal biologists, waterbird and seabird biologists) and Native harvesters to document the significance of anadromous smelt species in the diet of target species. Determine the trophic ecology of anadromous smelt species.

Issue 2: Lack of information on this species: life history (e.g., iteroparity vs. semelparity), population structure, migration patterns, distribution, trophic ecology, and habitat needs/use.

Conservation actions:

a) Develop sampling and indexing protocols and implement sampling schedule across geographic range.
b) Identify representative index areas.
c) Identify the habitat types or categories used by anadromous smelts (e.g., as used in ADF&G's freshwater fish inventory database).
d) Develop sampling techniques and document the migration and movement patterns of different species and life stages.
e) Map current distribution and other similar habitats for future investigation.
f) Develop a network of biologists/organizations to establish unified protocols, share data, leverage sampling efforts, and provide voucher specimens to museums (UAF, etc.). AFS-Alaska Chapter might be a venue for organizing and consolidating information.

Issue 3: Habitat alteration, sufficient instream flow/water volume, fish passage, and water quality are potential concerns.

Conservation actions:

a) Determine instream flow/water volume needs and habitat requirements for all life history phases of smelts.
b) Consider these smelt species when there are issues of fish passage and habitat alteration (e.g., water diversions, dams, timber harvest, mining, sedimentation).
c) Develop a coordinated effort among government and nongovernment agencies to coalesce and exchange information on the habitat and instream flow/water volume needs of these smelts.

Issue 4: Anadromous smelt species are taken as a food fish; harvest levels are not monitored for all species in all locations.

Conservation actions:

a) Obtain local information and knowledge on local anadromous smelt distribution, relative abundance, and harvest.
b) Develop sampling protocol to monitor locations, timing, magnitude, and level of harvest.
c) Collect biological samples (e.g., size, sex ratio and species, age structure).
d) Involve communities in monitoring, and share information.
e) Train local communities to monitor abundance and harvest effort.

H. Plan and time frames for monitoring species and their habitats

Promote coordination with state agencies, federal agencies, universities, Native entities, and NGOs to conduct monitoring every year for 10 years to establish the target indices. Possibly involve AKNHP to administer the RFP process for monitoring.

I. Recommended time frame for reviewing species status and trends.

Review at 5 years.

J. Bibliography

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Morrow, J. E. 1980. The freshwater fishes of Alaska. Alaska Northwest Publishing Company, Anchorage, AK.

Bering Cisco

A. Species description

Common name: Bering cisco
Scientific name: *Coregonus laurettae*

B. Distribution and abundance

Spawning populations are known to be in the Yukon, Kuskokwim, and Susitna river drainages. All Bering ciscos are considered anadromous, and no subadult fish have been documented in fresh water. In the Yukon River, spawning migrations extend at least 1700 km upstream, into the upper region of the Yukon Flats; the farthest upstream record is from Dawson City in Yukon Territory, over 2000 km from the sea. Marine distribution in the Bering Sea extends from Bristol Bay to Kotzebue Sound, and some individuals have been identified across the Beaufort Sea coast to Prudhoe Bay. Bering cisco have been reported from nearshore waters of the Chukotsk Peninsula, north of the Bering Straight, but these were probably migrants from Alaska, as no spawning populations have been reported from Asia. The marine distribution of the Susitna River population is unknown, but presumably they range throughout Cook Inlet waters and perhaps even farther. Abundance of the 3 identified Bering cisco populations are unknown, but Bering cisco are not rare where they are found.

Range:
Global range comments: Spawning populations known to be in Yukon, Kuskokwim, and Susitna Rivers; marine distribution includes Bering, Chukchi, and Beaufort Seas, and Cook Inlet
State range comments: same as previous

Abundance:
Global abundance comments: Bering cisco essentially endemic to Alaska
State abundance comments: Unknown

Trends:
Global trends: Unknown
State trends: Unknown

References: ADF&G 1983; Alt 1973; Bickham et al. 1992; Brown 2000; Chereshnev 1985; DeGraaf 1981

C. Problems, issues, or concerns for species

- Lack of information on spawning area locations in the Kuskokwim and Yukon Rivers; spawning populations are not known elsewhere in Alaska
- In freshwater systems, fisheries bycatch of returning spawners in the salmon fishery in summer/fall (Yukon/Kuskokwim Rivers) in the fish wheels
- Localized human harvest (very abundant in river and coastal regions: potential for fishery development though not currently exploited)

- Spawning areas very confined/localized and thus vulnerable to localized habitat disturbance (true for Susitna River population; situation unknown for Kuskokwim and Yukon Rivers)
- Major ecological changes in the Bering Sea could impact population levels

D. Location and condition of key or important habitat areas

- Only known to spawn in 3 large river systems in Alaska—Yukon, Kuskokwim, Susitna
- Freshwater phase(s): egg development, emergence and spawning; thought to have highly confined/localized spawning areas; spring increase in flow triggers egg hatch in early spring and subsequent flush of larvae to salt water
- Marine phase: coastal/nearshore environment from Bristol Bay to Pt. Barrow, and Cook Inlet; also present (but rare) in nearshore Beaufort Sea at least as far east as Prudhoe Bay region. Males live in coastal environment 5–7 years, females 6–9 years

<u>Condition of coastal areas in Alaska salt water</u>: very good to pristine
<u>Condition of large freshwater river systems</u>: very good to pristine

E. Concerns associated with key each habitats

Water diversion or impoundment could impact movements toward spawning and other habitats (low probability).

F. Goal: Conserve and manage populations of Bering cisco throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

<u>Objective</u>: Maintain current spawning distribution and abundance within natural variation of Bering cisco populations in Alaska.

Target: Current level of abundance within natural variation.
Measure: Use cpue as determined by random fish wheel or gillnet sampling or other means on the Yukon, Kuskokwim, and Susitna Rivers as abundance index.

Target: 100% of known spawning locations/areas identified.
Measure: Presence of spawning Bering cisco on known spawning locations in spawning season (September/October).

<u>**Issue 1**: Lack of information on spawning area locations in the Kuskokwim, and Yukon Rivers.</u>

Conservation action: Document the spawning distribution, e.g., by using radio telemetry.

<u>**Issue 2:** Localized human harvest as bycatch in salmon fisheries and no monitoring of the catch is occurring; potential for fishery development, though not currently exploited.</u>

Conservation actions:

a) Establish a system for estimating total harvest by randomly sampling fish wheel harvest on the Yukon and Kuskokwim Rivers; use cpue as an index of abundance for Bering cisco.
b) Estimate the size of Bering cisco stocks in Alaska using mark-recapture methods to evaluate the impact of bycatch and potential development of commercial fisheries.
c) Obtain local information and knowledge on Bering cisco distribution, relative abundance, age structure of the population, and harvest.
d) Develop sampling protocol to monitor locations, timing, magnitude and cpue of harvest.
e) Involve communities by training local individuals to monitor abundance and harvest, and by sharing information with affected villages.

Issue 3: Bering cisco are an important forage fish for various freshwater and marine predators, some of which have been identified in this Strategy as of conservation concern (e.g., loons).

Conservation action: Determine the trophic ecology of Bering cisco.

Issue 4: Habitat alteration, sufficient instream flow/water volume, fish passage, and water quality are potential concerns.

Conservation actions:

a) Determine instream flow/water volume needs and habitat requirements for all life history phases of Bering ciscos.
b) Consider Bering cisco when there are issues of fish passage and habitat alteration (e.g., water diversions, dams, timber harvest, mining, sedimentation).
c) Develop a coordinated effort among government and nongovernment agencies to coalesce and exchange information on the habitat and instream flow needs of Bering ciscos.

H. Plan and time frames for monitoring species and their habitats

State and federal agencies, universities, industry, Native entities, and NGOs should coordinate to conduct monitoring every year for 10 years to establish the target indices.

I. Recommended time frame for reviewing species status and trends

Review at 5 years.

J. Bibliography

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Broad Whitefish

A. Species description

Common name: broad whitefish
Scientific name: *Coregonus nasus*

B. Distribution and abundance

Broad whitefish are widely distributed in Alaska fresh water from the Kuskokwim River drainage north to the Beaufort Sea drainages of the North Slope. Diadromous individuals frequent brackish water estuaries throughout their range, but they are not thought to venture far out to sea. Freshwater resident individuals are present in some systems. Broad whitefish are also widely distributed along the northern coasts of Canada and Russia. In Alaska, few spawning areas have been identified. Known spawning areas are in the lower reaches of large rivers, but upstream from the influence of marine water. In northern Alaska, full maturity is reached by age 12. This species uses lakes connected to river systems as major feeding areas, sometimes remaining in lakes until maturity. Abundances of broad whitefish populations are unknown, but broad whitefish are generally not rare where they are found.

Range:

Global range comments: Northern regions of Asia and North America
State range comments: Widely distributed in brackish and fresh water from the Kuskokwim River drainage north and east to the Beaufort Sea coastal region and the Canadian border

Abundance:

Global abundance comments: Unknown
State abundance comments: Unknown

Trends:
Global trends: Unknown
State trends: Unknown

References: Alt 1976; Bendock and Burr 1984, 1985; Berg 1948; Bond and Erickson 1985; Fechhelm et al. 1995a, 1995b; Kline et al. 1998; McPhail and Lindsey 1970; Mecklenburg et al. 2002; Morrow 1980; Reist and Bond 1988; Tallman and Reist 1997

C. Problems, issues, or concerns for species

- Spawning areas have not been located in many systems.
- Instream flow/water volume needs for broad whitefish are unknown.
- In freshwater systems, a limited amount of fisheries bycatch of spawners occurs in the salmon fisheries in summer and fall (Yukon River particularly); no monitoring of bycatch is occurring and population effects, if any, of bycatch are unknown.
- Localized human harvest (abundant in river and coastal regions, actively sought in food fisheries; a preferred fish for subsistence users along the Arctic Coastal Plain and an important fresh food source during the spring and fall in the Lower Kuskokwim and lower Yukon Rivers); no monitoring of the catch or bycatch is occurring.
- Major ecological changes in marine waters could impact population levels.

D. Location and condition of key or important habitat areas

- Spawning, egg development, and emergence are thought to occur in localized areas; spring increase in flow triggers egg hatch in early spring with subsequent larvae flush to lower drainage habitats and to estuaries.
- Freshwater feeding occurs in widely dispersed lentic and lotic habitats.
- Coastal environments and lakes connected to rivers or coastal regions are utilized throughout the species' range.
- Overwintering in Beaufort Sea drainages in Alaska occurs in deep pools in lower reaches; elsewhere in Alaska, overwintering habitats are poorly understood.
- Summer feeding in nearshore waters of the Beaufort Sea in/near deltas of larger rivers.

Condition of saltwater coastal areas in Alaska: very good to pristine
Condition of large freshwater river systems: very good to pristine

E. Concerns associated with each habitat

- Instream flow/water volume alteration, water diversion, or impoundment could impact movements toward spawning and other habitats.
- Mining in spawning habitats could impact entire populations.
- Drier climatic trends, an increase of beavers noted through local traditional knowledge, and reduced or altered instream flows/water volume in Interior Alaska may cause reduced access to off-channel feeding habitats.

F. Goal: Conserve and manage broad whitefish populations throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective: Maintain current spawning distribution and abundance within natural variation of broad whitefish populations in Alaska

Target: Current level of abundance within natural variation

Measure: Use cpue and age distribution as determined by random fish wheel sampling on the Yukon River, fish wheel or gillnet sampling on the Kuskokwim River, and standardized net sampling in a selection of other drainages as abundance indices

Target: 100% documentation of drainages known to support spawning populations

Measure: Number of drainages surveyed and mapped for presence of broad whitefish spawners in known or likely spawning drainages during late fall season (September/October)

Issue 1: Lack of information on spawning area locations throughout the state

Conservation action: Document the spawning distribution using radiotelemetry.

Issue 2: Localized human harvest and bycatch in salmon fisheries is large in places; no monitoring of the catch or bycatch is occurring; commercial harvest has occurred in the past; potential exists for additional commercial fishery development in some locations.

Conservation actions:

a) Establish a system for estimating total harvest of select populations by randomly sampling regional harvests; use cpue and age distribution as an index of abundance for monitoring large changes.
b) Estimate the size of certain broad whitefish stocks in Alaska using mark-recapture methods to evaluate the impact of bycatch and potential development of commercial fisheries.
c) Obtain local information and knowledge on broad whitefish distribution, relative abundance, age structure of the population, and harvest.
d) Develop sampling protocol to monitor locations, timing, magnitude, and cpue of harvest.
e) Involve communities by training local individuals to monitor abundance and harvest, and by sharing information with affected villages

Issue 3: Habitat alteration, sufficient instream flow/water volume, fish passage, and water quality are potential concerns.

Conservation actions:

a) Determine instream flow/water volume needs and habitat requirements for all life history phases of broad whitefish.

b) Consider broad whitefish when there are issues of fish passage and habitat alteration (e.g., water diversions, dams, timber harvest, mining, sedimentation).
c) Develop a coordinated effort among government and nongovernment agencies to coalesce and exchange information on the habitat and instream flow/water volume needs of broad whitefish.

H. Plan and time frames for monitoring species and their habitats

State and federal agencies, universities, industry, Native entities, and NGOs should coordinate to conduct monitoring every year for 10 years to establish the target indices.

I. Recommended time frame for reviewing species status and trends

Review at 5 years.

J. Bibliography

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Pygmy Whitefish

A. Species description

Common name: pygmy whitefish
Scientific name: *Prosopium coulteri*

The pygmy whitefish is a small whitefish in which parr marks persist in all but the largest adults. It inhabits deep habitats of large postglacial lakes and has a disjunct distribution in North America and in a small area of Russia.

B. Distribution and abundance

Range:

Global range comments: Only known from North America and 3 locations in arctic Russia; disjunct range (Lake Superior and northwestern North America); generally in large postglacial lakes

State range comments: Only known from some large postglacial lakes: Alaska Peninsula/Bristol Bay (Chignik, Becharof, Ugashik, Brooks, Naknek, and Aleknagik Lakes); Copper River drainage (Tonsina, Tazlina, and Klutina Lakes); Lake George in the Cook Inlet watershed (M. Wiedmer, pers. comm.)

Abundance:
Global abundance comments: Unknown, but locally abundant in some areas
State abundance comments: Locally abundant, but not in all locations

Trends:
Global trends: Unknown, likely stable
State trends: Unknown, likely stable

References: McPhail and Lindsey 1970; Morrow 1980; Reshetnikov 2003; Scott and Crossman 1974

C. Problems, issues, or concerns for species

- Incomplete information on this species including life history, abundance, and trophic ecology
- Alaskan populations poorly documented, may occur in other lakes
- Species pairs are rare; need to protect the 2 known species pairs (giant and normal pygmy whitefish) and any others discovered. (Taylor 1999)

D. Location and condition of key or important habitat areas

Deep areas of large postglacial lakes.

E. Concerns associated with key habitats

None that are known.

F. Goal: Conserve and manage pygmy whitefish populations throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective: Maintain abundance, size, and age structure within natural variation throughout its native distribution in Alaska.

Target: Fully documented distribution of pygmy whitefish in Alaska.
Measure: Maps of distribution within Alaska as determined by literature review (see bibliography) and surveys in potential native habitat (e.g., prioritized locations would be other large [deep] glacial lakes).
Target: Identify and obtain size and age structure indices of pygmy whitefish populations in Alaska.
Measure: Size and age structure of pygmy whitefish populations in index areas to be determined.
Target: Sampling for, and presence of, reproducing populations noted in all known localities.
Measure: Presence and sexual maturity as determined by surveys
Target: Sampling for, and occurrence noted, in all other potential habitats used by

pygmy whitefish in Alaska.

Measure: Occurrence noted in habitat(s) other than large (deep) glacial lakes.

Issue 1: Species pairs are rare; need to conserve the 2 known species pairs and any others discovered.

Conservation action: Prevent the introduction of nonindigenous species into habitats with species pairs.

Issue 2: Distribution of pygmy whitefish in Alaska may not be completely documented.

Conservation actions:

a) Map current distribution and survey other similar habitats.
b) Develop a network of biologists/organizations to establish unified protocols, share data, leverage sampling efforts, and provide voucher specimens to museums (UAF, etc.). AFS-Alaska Chapter might be a venue for organizing and consolidating information.
c) Obtain local information and knowledge on pygmy whitefish.

H. Plan and time frames for monitoring species and their habitats

Promote coordination with other state agencies, federal agencies, universities, industry, Native entities, and NGOs to conduct monitoring every 5 years to confirm occurrence and relative abundance.

I. Recommended time frame for reviewing species status and trends

Review at 10 years.

J. Bibliography

McPhail, J.D. and C.C. Lindsey. 1970. Freshwater fishes of northwestern Canada and Alaska. Fisheries Research Board of Canada, Bulletin 173, Ottawa, Canada.

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Trout-perch

A. Species description

Common name: trout-perch
Scientific name: *Percopsis omiscomaycus*

The trout-perch is the only percopsid found in Alaska, and it has a very limited distribution. This species likely invaded the Yukon River relatively recently via the Peel and Porcupine Rivers.

B. Distribution and abundance

Range:
Global range comments: Across most of North America from Maryland northward to Hudson Bay, west through Tennessee and the Mississippi drainage, through the prairie provinces northward. The Mackenzie drainage, upper Porcupine and mainstem Yukon River.
State range comments: Mainstem Yukon River from Tatonduk and Kandik River downstream to the Yukon Delta (only reported from mainstem Yukon River).

Abundance:
Global abundance comments: Relatively abundant within its range in Canada and Lower 48 states.
State abundance comments: Not abundant; only captured intermittently.

Trends:
Global trends: Unknown
State trends: Unknown

References: Mecklenburg et al. 2002; McPhail and Lindsey 1970; Morrow 1980; Reshetnikov 2003; Scott and Crossman 1974

C. Problems, issues, or concerns for species

Unknown, but may be positively affected by climate change and warming temperatures since this species thrives in milder climates.

D. Location and condition of key or important habitat areas

Key habitats in Alaska are slow-moving portions of the mainstem Yukon River.

E. Concerns associated with key habitats

None that are known; however, specific habitat requirements are unknown. Water diversion or impoundment and pollution are potential threats.

F. Goal: Conserve and manage Alaskan trout-perch populations throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

<u>Objective</u>: Maintain abundance, size, and age structure throughout its native distribution in Alaska.

Target: Identify the native distribution of trout-perch in Alaska.
Measure: Native distribution within Alaska as determined by literature review and surveys in potential native habitat (e.g., Yukon River mainstem and tributaries, near margins of previously documented distributions).

Target: Identify and obtain size and age structure indices indicative of native trout-perch populations in Alaska in index areas.
Measure: Size and age structure of native trout-perch populations in index areas of Alaska to be determined.

Target: Abundance within the natural variability of known populations.
Measure: Native abundance estimates (relative or absolute as determined by cpue or mark-recapture) in Alaska within the bounds of 10-year cycles as determined by literature review and surveys in index areas to be determined.

<u>**Issue**: Lack of information on this species: life history, population structure, migration patterns, distribution, trophic ecology, and habitat and instream flow/water volume needs.</u>

Conservation actions:

a) Develop sampling protocols and implement sampling schedule across geographic range of trout-perch populations in Alaska.
b) Identify representative index areas.
c) Identify the habitats used by trout-perch (.e.g., as used in ADF&G's freshwater fish inventory database).
d) Map current distribution and habitats for future investigation.
e) Develop a network of biologists/organizations to establish unified protocols, share data, leverage sampling efforts, and provide voucher specimens to museums (UAF, etc.). AFS-Alaska Chapter might be a venue for organizing and consolidating information.
f) Obtain local information and knowledge on local trout-perch distribution and relative abundance.

H. Plan and time frames for monitoring species and their habitats

State and federal agencies, universities, industry, Native entities, and NGOs should coordinate to conduct monitoring every 2 years for 10 years to establish the target abundance index.

I. Recommended time frame for reviewing species status and trends

Review at 5 years.

J. Bibliography

McPhail, J.D. and C.C. Lindsey. 1970. Freshwater fishes of northwestern Canada and Alaska. Fisheries Research Board of Canada, Bulletin 173, Ottawa, Canada.

Mecklenburg, C.W., T.A. Mecklenburg and L.K. Thorsteinson. 2002. Fishes of Alaska. American Fisheries Society, Bethesda, MD.

Scott, W. B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada, Bulletin 184. Ottawa, Canada.

Morrow, J.E. 1980. The freshwater fishes of Alaska. Alaska Northwest Publishing Co., Anchorage, AK.

Reshetnikov, Y.S. 2003. Atlas of Russian freshwater fish. Vol. 1, Nauka. Moscow.

Alaska Blackfish

A. Species description

Common name: Alaska blackfish
Scientific name: *Dallia pectoralis*

Alaska blackfish is endemic to Beringia. Blackfish populations are also known from Chukotsk Peninsula in the far east of Russia. Alaska blackfish are known for their hardiness and their ability to survive low oxygen levels and partial freezing. They are the only Umbrid (mudminnow) in Alaska.

B. Distribution and abundance

Range:
Global range comments: Alaska and eastern Chukotka
State range comments: Naturally from Colville River delta to Chignik on the Alaska Peninsula, mostly in lowland waters; also on St. Lawrence Island and Nunivak Island; introduced on the Pribilof Islands and to upper Cook Inlet near Anchorage

Abundance:
Global abundance comments: Relatively abundant within its restricted range in Eastern Chukotka
State abundance comments: Abundant in lowland lakes and interconnected waterways, especially in Yukon-Kuskokwim Delta area

Trends:
Global trends: Unknown
State trends: Unknown

References: Berg 1962; Everman and Goldsborough 1907; McPhail and Lindsey 1970; Morrow 1980; Reshetnikov 2003; Scott and Crossman 1974; Walters 1955

C. Problems, issues, or concerns for species

- Lack of information on this species, including life history, maturity, and population dynamics for management actions
- Taken as a food fish (mostly for dog food and/or traditional reasons) in the lower Yukon/Kuskokwim; human use not monitored

D. Location and condition of key or important habitat areas

- Key habitats are low-lying lakes and low velocity waterways in southwestern, western, and northern Alaska.
- Habitats are likely in near pristine conditions except near villages, where village growth and water treatment impoundments may have affected some localized habitats.

E. Concerns associated with key habitats

Water treatment impoundments, water withdrawals, and pollution; natural and anthropogenic filling of shallow lakes are potential threats

F. Goal: Conserve and manage blackfish populations throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

Objective: Maintain abundance, size, and age structure within natural variability throughout its native distribution in Alaska.

Target: Identify the native distribution of blackfish in Alaska.
Measure: Native and nonnative distribution within Alaska as determined by literature review and surveys in potential native habitat (e.g., Beringia, near margins of previously documented distributions) and nonnative habitat (e.g., Matanuska-Susitna valleys, Anchorage bowl, etc.).

Target: Identify and obtain size and age structure indices indicative of native blackfish populations in Alaska in index areas.
Measure: Documented size and age structure of native blackfish populations by surveys in index areas of Alaska to be determined.

Target: Abundance within the natural variability of known populations.
Measure: Native abundance estimates (as determined by cpue or mark-recapture) in Alaska within the bounds of 10-year cycles as determined by literature review and surveys in index areas to be determined.

Issue 1: Lack of information on this species: life history, population structure, migration patterns, distribution, trophic ecology, habitat characterization information (georeferenced).

Conservation actions:

a) Develop sampling protocols and implement sampling schedule across geographic range in Alaska.
b) Identify representative index areas.
c) Identify the habitat types or categories used by blackfish (e.g., as used in ADF&G's freshwater fish inventory database).
d) Map current distribution and other similar habitats for future investigation.
e) Develop a network of biologists/organizations to establish unified protocols, share data, leverage sampling efforts, and provide voucher specimens to museums (UAF, etc.); AFS-Alaska Chapter might be a venue for organizing and consolidating information.

Issue 2: Lack of harvest information.

Conservation actions:

a) Obtain local information and knowledge on local blackfish distribution, relative abundance, and harvest.
b) Develop sampling protocol to monitor magnitude and age structure of harvest.
c) Involve communities in monitoring, and share information.
d) Train local communities to monitor abundance, size structure, and harvest effort.

Issue 3: Alaska blackfish may be an important forage fish for various freshwater predators, some of which have been identified in this Strategy as of conservation concern (e.g., loons).

Conservation action: Determine the trophic ecology of Alaska blackfish.

Issue 4: Habitat alteration, sufficient water quantity and quality are potential concerns.

Conservation actions:

a) Determine habitat requirements and water quantity needs for all life history phases of blackfish.
b) Consider blackfish species when there are issues of habitat alteration (e.g., water withdrawals, wetland fills, pollution).
c) Develop a coordinated effort among government and nongovernment agencies to coalesce and exchange information on the habitat and water quantity needs of blackfish.

H. Plan and time frames for monitoring species and their habitats

State and federal agencies, universities, industry, Native entities, and NGOs should coordinate to conduct monitoring every year for 10 years to establish the target abundance index.

I. Recommended time frame for reviewing species status and trends

Review at 5 years to assess progress.

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Stickleback (Cook Inlet radiation)

Threespine stickleback and ninespine stickleback are both species complexes with many unique and reproductively isolated “species” (i.e., populations or potential subspecies) throughout their range. The threespine stickleback is a model species in the fields of evolutionary biology, developmental genetics, animal behavior, ecology, and environmental toxicology. Although neither species complex is in danger of decline (stickleback are often the most abundant species in an area), many unique populations and “species” are in serious decline or already extinct (Foster et al. 2003).

One of the most studied and remarkable threespine stickleback radiations exists in the Cook Inlet watershed in Southcentral Alaska. Stickleback scientists have studied this radiation intensively for the past 20 years and a large database has been built, including detailed information for over 200 populations on body armor, morphometrics, life history, behavior, trophic ecology, parasitology, and genetics. Populations in this radiation are now being used to study the genetic and behavioral mechanisms of rapid evolution and speciation, loss of skeletal elements (which has human medical implications, for example, for osteoporosis), evolution of development and developmental abnormalities, behavioral evolution, life history evolution, parasitism, genetic structure and function, and the effects of environmental contaminants. This database (and hence the populations under study) represents the most extensive stickleback database in the world, with important contributions in all of these fields of study. The threespine stickleback genome is currently being sequenced. The individual fish selected for sequencing came from Bear Paw Lake in the Cook Inlet watershed (F. von Hippel, personal communication). Therefore the scientific importance of these populations will increase greatly in the future. Additionally, a number of unique and important ninespine stickleback populations that have been studied exist in the Cook Inlet watershed.

In order to protect the scientific investment in these radiations and the future utility of these populations for ongoing scientific investigations, unique populations from both species complexes should be sustained. Many of these populations may be threatened by invasive northern pike (*Esox lucius*), human impacts on water quality, and salmonid stocking or introductions in isolated lakes (no inlet or outlet streams). Lessons learned from the conservation of threespine and ninespine stickleback radiations in Alaska may be applied to the conservation of similar radiations (e.g., Arctic char [*Salvelinus alpinus*], sockeye salmon [*Oncorhynchus nerka*], lake whitefish [*Coregonus clupeaformis*], rainbow smelt [*Osmerus mordax*], and lampreys [*Lampetra and Lenthenteron* spp.]) when their phenotypic diversity becomes better understood. Additionally, sticklebacks play an important role in the food webs of lakes and streams; they are, for example, a major source of prey for fish-eating birds, including species of conservation concern (e.g., loons).

A. Species group description

Common name: threespine stickleback
Scientific name: *Gasterosteus aculeatus*

Common name: ninespine stickleback
Scientific name: *Pungitius pungitius*

B. Distribution and abundance

Range: (Bell and Foster 1994)

Global range comments: Threespine stickleback: Marine, brackish and fresh waters in the Northern Hemisphere along both coasts of the Pacific and Atlantic Oceans, as well as in scattered populations along the Arctic Ocean and inland seas of Europe Ninespine stickleback: Marine, brackish and fresh waters throughout the high latitude Holarctic

State range comments: Threespine stickleback: Marine, brackish and fresh waters along the Gulf of Alaska, Bering Sea, and low-gradient rivers and lakes; a few populations occur on the North Slope

Ninespine stickleback: Marine, brackish and fresh waters from the Kenai Peninsula and Mat-Su Valleys west along the Gulf of Alaska, as well as along the Bering Sea and North Slope

Abundance:

Global abundance comments: Both species complexes are abundant through most of their ranges. One potential sub-“species” in the threespine stickleback species complex (the “unarmored threespine stickleback”) is a U.S. federally listed endangered species (in southern California). A number of other populations/“species” are in serious decline or extinct in certain parts of their range; for example, all 3 remaining benthic-limnetic species pairs in Canada are now listed as endangered (introduced brown bullheads [*Ameiurus nebulosus*] caused the extinction of the Hadley Lake species pair in the 1990s), and numerous unique populations in North America, Europe, and Japan are now extinct or threatened (Foster et. al. 2003).

State abundance comments: Abundant in lowland lakes and streams, as well as marine and brackish waters; some unique populations are in decline within the Cook

Inlet watershed due to invasive northern pike, human impacts on water quality, and stocking of salmonids in isolated lakes (no inlet or outlet streams).

Trends:

Global trends: Still abundant in most of range, but an increasing number of unique populations in decline or extirpated in parts of Europe, North America and Asia (Foster et. al. 2003).

State trends: Still abundant in most of Alaska, but an increasing number of unique populations or "species" that are in decline as part of the Cook Inlet radiation are in decline in Southcentral Alaska due to invasive northern pike, human impacts on water quality, and stocking or introduction of salmonids in isolated land-locked lakes (Patankar et al., in review).

C. Problems, issues, or concerns for species group

The conservation concerns are specifically for lakes and streams containing unique populations of threespine or ninespine sticklebacks in the Cook Inlet watershed.

- Lack of information on the lakes and streams with unique populations
- Lack of information on the distribution/occurrence of unusual stickleback populations
- Predation by invasive northern pike may be leading to population declines and possible loss of unusual forms of the radiation (Patankar 2004)
- Human impacts on water quantity and quality
- Stocking or other introduction of predatory fish species (e.g., salmonids) in lakes without inlet or outlet streams (isolated land-locked lakes), whether that stocking be an official program by ADF&G or inadvertent or intentional introductions by the public
- Sticklebacks are not taken for commercial or recreational fisheries

D. Location and condition of key or important habitat areas

- Key habitats are low-lying lakes and streams. Many of the unique populations exist in lakes without inlets/outlets (and hence no native salmonids).
- Habitats are likely in near pristine condition except in developed areas of Southcentral Alaska.
- Unique populations of the Cook Inlet radiation that merit conservation attention are known to exist in a number of lakes and streams throughout the Cook Inlet watershed. Authors of this template can provide a detailed list of such lakes upon request.

E. Concerns associated with key habitats

Predation by invasive northern pike

- Human impacts on water quantity and quality
- Stocking or other introduction of predatory fish species (e.g., salmonids) in lakes without inlet or outlet streams (isolated lakes), whether that stocking be an official program by the ADF&G or inadvertent or intentional introductions by the public

F. Goal: Conserve and manage unique populations of the threespine stickleback radiation and the ninespine stickleback radiation in the Cook Inlet watershed throughout their natural range to ensure sustainability of these resources.

G. Conservation objectives and actions

Objective: Maintain abundance within natural variability of threespine and ninespine stickleback populations in key lakes and streams (with unique populations) throughout the Cook Inlet watershed.

Target: Abundance within the natural variability for unique Cook Inlet populations.

Measure: Abundance estimates (as determined by cpue, mark-recapture or other methods) in unique populations in the Cook Inlet watershed within the bounds of 10-year cycles as determined by literature review and surveys.

Issue 1: Lack of information on the abundance indicative of viable populations for these lakes and streams with unique populations. Information for these lakes and streams is needed for life history, population structure, migration patterns, distribution, trophic ecology, and habitat characterization (georeferenced). Some of this information is known for each lake and stream known to contain a unique population, but much data still need to be collected; missing information varies by lake/stream.

Conservation actions:

a) Develop sampling protocols and implement sampling schedule for these unique populations.
b) Develop a network of stickleback biologists/organizations to establish unified protocols, share data, leverage sampling efforts, and provide voucher specimens to museums. Much of this network is already in place and simply needs to be formalized.

Issue 2: Lack of information on the distribution/occurrence of unusual stickleback populations. The Cook Inlet watershed contains numerous lakes, and although well over 200 lakes have been sampled, many hundreds have not; some may contain unique and important stickleback populations. Unusual populations of threespine and ninespine sticklebacks occur where conditions are unusual (e.g., lakes with low ionic strength water and lacking inlet or outlet streams). It is not practical to sample every lake and stream in the Cook Inlet watershed, but it is important to know where and how common these unusual populations are.

Conservation action:

a) Develop a series of proxies to identify candidate lakes for unusual stickleback populations, such as isolated lakes (especially with no outlet stream) as a proxy for evolutionary loss of body armor, relative area above the euphotic zone depth as a proxy for trophic form, and deep steep-sided lakes as a proxy for limnetic or highly variable populations. Other proxies could be developed to rapidly identify potential unusual populations. This can lead to an efficient sampling strategy designed to locate and count unusual populations. One criterion could be areas at risk (e.g., lakes that may experience or have experienced invasion by northern pike, lakes near towns or other types of developments, or lakes that might be stocked by ADF&G).

b) As soon as possible, develop and implement a lake stocking policy designed to protect nongame species of unique scientific interest or of conservation concern, such as some stickleback populations in the Cook Inlet watershed.

Issue 3: Predation by invasive northern pike in many of these lakes and streams may lead to declines in stickleback populations and may cause extinctions of populations (e.g., armor-reduced populations of threespine stickleback, such as in Prator Lake); such predation could also quickly lead to major changes in the phenotype of some populations (e.g., the evolution of more robust body armor), reducing the scientific value of those populations (Patankar 2004).

Conservation actions:

a) Develop a public education element (e.g., curriculum for high school biology classes, poster at ADF&G offices) that provides information on the importance of Alaskan sticklebacks as model systems in scientific investigations.
b) Implement strategies to rid key stickleback lakes of invasive northern pike (e.g., unlimited fishing on northern pike, seining for northern pike, etc.); avoid use of poisons, which would also rid lakes of their unique stickleback populations.
c) Implement strategies to prevent pike from invading additional lakes with unique stickleback populations.
d) Conduct public education on the importance of pike elimination and the need to stop illegal introductions of pike.

Issue 4: Humans are impacting water quantity and quality in many of these lakes and streams where unique stickleback reside (e.g., sedimentation, eutrophication, pollution, water withdrawal, etc.) due to road construction, housing development, mining, timber harvest practices, pollution from military installations, etc. Global climate change, the spruce bark beetle outbreak, and fire may also influence water quantity and quality.

Conservation actions:

a) Identify water quality problems in these lakes and streams and implement remedies.
b) Take preventative measures to avoid sedimentation in these lakes and streams from road construction and logging operations.
c) Ensure sufficient water quantity in lakes and streams where stickleback reside
d) Develop additional remedies for known threats to water quality and reassess as needed.

H. Plan and time frames for monitoring species and their habitats

Promote coordination with other state agencies, federal agencies, universities, industry, Native entities, and NGOs to conduct monitoring every year for 10 years to establish the target abundance index for these unique populations.

I. Recommended time frame for reviewing species status and trends

Review at 5 years.

J. Bibliography

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Native Amphibians – Introduction

Six species of amphibians are considered native to Alaska. These are the Western Toad (*Bufo boreas*), Wood Frog (*Rana sylvatica*), Columbia Spotted Frog (*Rana luteiventris*), Rough-skinned Newt (*Taricha granulosa*), Long-toed Salamander (*Ambystoma macrodactylum*) and Northwestern Salamander (*Ambystoma gracile*). Only two of these species have been documented outside the southeast regions of the state. The Wood Frog, which is the most hardy and widespread species of frog in North America, has been found from the mainland of Southeast Alaska northward to the Brooks Range. Alaska's single toad species, the Western Toad, has been recorded throughout the southeast Panhandle and along the mainland coast to Prince William Sound.

Many large islands in Southeast Alaska have never been surveyed for amphibians, and only rudimentary species range maps are available for this region. Western Toad and Rough-skinned Newts are thought to be widely distributed throughout the mainland and islands of the Alexander Archipelago. Wood and Spotted Frog and Long-toed Salamander are reported chiefly in areas with transmontane river systems, such as the Taku and Stikine that connect Southeast Alaska to major portions of their distribution in Canada. Northwestern Salamanders are known from only a handful of locations in Southeast Alaska. Southeast Alaska populations of all but Wood Frog are near the northern edges of their geographic ranges.

In addition to these native species, two frogs from the Pacific Northwest have been introduced: Pacific Chorus Frog (*Pseudacris regilla*) and Red-legged Frog (*Rana aurora*). They apparently have viable but restricted populations in the Alexander Archipelago of Southeast Alaska on Revillagigedo Island and Chichagof Island. These populations are the result of unauthorized translocations from outside the state.

Alaska's amphibians require ponds or other still water for breeding. But the ecology of small ponds, particularly those lacking connections to fish streams, has received almost no scientific study. Effective conservation will require a better understanding of pond morphology, function, origin, and diversity.

Populations of some amphibians have declined dramatically around the world in recent decades. A variety of possible causes have been cited, including habitat loss, increased UV-B radiation, fungal infection, intensified predation by introduced fish and nonnative frogs, climate change, increased risk of disease, damage to immune systems resulting from pollutants such as pesticides, and combinations of these factors.

Amphibians are good indicators of significant environmental changes. They are sensitive to environmental factors such as habitat destruction and others listed above. Anecdotal reports from Ketchikan to Haines point to a dramatic drop in numbers of Western Toad, a species with well-documented declines outside of Alaska. Amphibians in many parts of North America including some areas in Alaska have unusually high occurrences of malformed limbs. In light of these growing amphibian conservation concerns and the importance of their habitats for other fish and wildlife species, there is a need for basic information in Alaska. This will require an understanding of amphibian taxonomy, as well as the distribution, habitat needs, life history, current status, and population trends of specific species.

A. Species group description: Six native amphibian species occur in Alaska.

Common names: Northwestern Salamander, Long-toed Salamander, Rough-skinned Newt, Western Toad, Columbia Spotted Frog, Wood Frog

Scientific names: *Ambystoma gracile, Ambystoma macrodactylum, Taricha granulosa, Bufo boreas, Rana luteiventris, Rana sylvatica*

B. Distribution and abundance

Range:

Global range comments:

Northwestern Salamander – Pacific coast of North America from northern Southeast Alaska south through western Canada and northwestern United States to Gualala River, California. Sea level to about 10,200 ft (3110 m).

Long-toed Salamander – Southeastern Alaska southward to Tuolumne County, California, east to Rocky Mountains (east-central British Columbia, west-central Alberta, western Montana, and central Idaho). Isolated populations in Santa Cruz and Monterey counties, California. Sea level to about 10,000 ft.

Rough-skinned Newt – Pacific coast from Southeast Alaska through western Canada (including Vancouver Island but not the Queen Charlotte Islands) to Santa Cruz County, California. Records from the Rocky Mountains, including 3 populations in Latah County, Idaho, in 1997. Sea level to about 9200 ft.

Western Toad – Pacific Coast from Prince William Sound in Alaska to Baja California, east through the Rocky Mountains in west-central Alberta, Montana, Wyoming, Utah, Colorado, and (formerly) northern New Mexico; absent from most of the desert Southwest. Sea level to at least 11,939 ft.

Wood Frog – Widespread throughout northern North America and ranges farther north than any other American amphibian. Northern Alaska to Labrador, south to New Jersey, northern Georgia, and northern Idaho; spotty distribution south to northern Colorado in Rocky Mountains; also disjunct populations in Arkansas and Missouri.

Columbia Spotted Frog – Southeast Alaska, southwestern Yukon, northern British Columbia, and western Alberta south through Washington east of the Cascades, eastern Oregon, Idaho, and western Montana. Disjunct populations found in Nevada, southwestern Idaho, Utah, and western and north-central Wyoming. Elevation range is from sea level to about 10,000 ft.

State range comments:

Northwestern Salamander – Found in coastal forests of Southeast Alaska. Collected in 2 localities only: southeast of Ketchikan on Mary Island, and on northwest Chichagof Island near Pelican. A globular egg mass, presumably of this species, was found in Figure Eight Lake, Stikine River. Recently, a single northwestern salamander was reported from the outer coast of Glacier Bay National Park in Graves Harbor.

Long-toed Salamander – Alaska distribution restricted to southeastern coastal forests adjacent to the Stikine and Taku River watersheds. Reported near the mouth of Stikine River at Figure Eight Lake (Twin Lakes), Mallard Slough, Cheliped Bay, Andrew Slough, Farm Island and Sokolof Island. Also collected on the Alaska side of the Coast Range in the Taku River Valley.

Rough-skinned Newt – Found throughout Southeast Alaska as far north as Juneau, and on the Alexander Archipelago on Admiralty Island, Shelter Island, and on many islands south of Fredrick Sound. They have also been reported on Bamdoroshni Island, and more recently on Rockwell Island in Sitka Sound. Newts on mainland near Juneau and Bamdoroshni and Rockwell islands may be the result of transplants from Shelter Sound around 1980 and Ketchikan in the 1960s respectively. Unverified and questionable reports from farther north along Gulf Coast and perhaps as far west as Cook Inlet.

Western Toad – This species as the widest distribution of all amphibians in Southeast Alaska. Found in coastal rain forests on the mainland and islands throughout Southeast Alaska, northward along Gulf Coast to Prince William Sound (PWS). In PWS, they have been documented on Montague and Hawkins islands, on the mainland as far west as the Columbia Glacier and as far north as the Tasnuna River, a tributary of the Copper River.

Wood Frog – Widely distributed throughout Alaska and is the only amphibian found above the Arctic Circle. Documented on the mainland in Southeast Alaska, throughout Central Alaska to at least Anaktuvuk Pass with unverified reports farther north and east on the North Slope, westward to Kobuk River valley, southward to the base of the Alaska Peninsula, and the Kenai Peninsula. Apparently, absent from Prince William Sound, though reported near Valdez, and the Copper River basin (Anderson 2004). A localized population of wood frogs on Douglas Island near Juneau are suspected transplants.

Columbia Spotted Frog – Present in coastal forests of Southeast Alaska, although range limits are not precisely known. Present distribution confined to coastal transboundary river corridors of continental mainland, such as Salmon, Taku, Stikine and Unuk Rivers and the Agassiz Peninsula. Have been documented on Mitkof, Sergief and Vank Islands within the adjacent Alexander Archipelago. Mitkof Island population (in and near the city of Wrangell) possibly introduced. Report in 2003 of frogs at one location along the Juneau road system suspected to be an introduction. Also reported but not confirmed in Haines area. Its regular presence on the Chilkoot Trail and within the White Pass areas lake system on the Canadian side of the border indicates high potential for the species to be found in nearby Alaska.

Abundance:

<u>Global abundance comments</u>:

Northwestern Salamander – Total adult population size unknown but likely exceeds 10,000 and possibly exceeds 100,000.

Long-toed Salamander – Total adult population size is unknown but expected to exceed 10,000.

Rough-skinned Newt – Total adult population size unknown but likely exceeds 100,000.

Western Toad – Total adult population size unknown but likely exceeds 100,000.

Wood Frog – Total adult population unknown but is likely more than 1,000,000.

Columbia Spotted Frog – Total adult population size unknown but surely exceeds 100,000.

State abundance comments:

Northwestern Salamander – Unknown, but suspected rare.

Long-toed Salamander – Alaska population size unknown but considered relatively small. Waters (1992) surveyed the Stikine River Basin during summer 1991 and failed to observe this species.

Rough-skinned Newt – The most common tailed amphibian in Alaska; fairly common throughout Southeast Alaska.

Western Toad – Overall population unknown. Formerly considered abundant and widespread in Southeast Alaska; more recently, reports of long-time residents from Haines to Ketchikan have noted sharp declines.

Wood Frog – Wood frogs are the most common amphibian in Alaska. Apparently more abundant on the mainland than in Southeast.

Columbia Spotted Frog – Current population size unknown.

Trends:

Global trends:

Northwestern Salamander – Unknown.

Long-toed Salamander – Unknown.

Rough-skinned Newt – Likely stable in extent of occurrence and probably stable to slightly declining in population size, proportion of sites occupied and number/condition of occurrences.

Western Toad – Rocky Mountain populations in Colorado and Wyoming have undergone a drastic decline since the 1970s. Declining in coastal southern British Columbia and questionable status in lower Pacific Northwest of United States. Has declined greatly in the Yosemite area of the Sierra Nevada, California, where surveys in 1915 and 1919 described them as "exceedingly abundant." Apparently declining in Yellowstone National Park, Montana, and locally elsewhere.

Wood Frog – Population trend is unknown but probably stable to slightly declining.

Columbia Spotted Frog – Relatively stable in most of the range, but populations in the arid southern portion of the range have declined.

<u>State trends</u>:

Northwestern Salamander – Unknown.

Long-toed Salamander – Unknown.

Rough-skinned Newt – Unknown.

Western Toad – Formerly considered abundant and widespread in Southeast Alaska; more recently, reports of long-time residents from Haines to Ketchikan suggest declines.

Wood Frog – Population trend is unknown but probably stable to slightly declining. Numerous reports from the Kenai Peninsula, the Anchorage Bowl, and Talkeetna area that indicate wood frogs are no longer present at historical breeding sites.

Columbia Spotted Frog – Unknown.

References: Carstensen et al. 2003, MacDonald 2003, Anderson 2004

C. Problems, issues, or concerns for species group

- Lack of information on taxonomic/evolutionary relationships, distribution, abundance, trends, habitat associations, and life history in Alaska
    - a) existing data are not compiled and field inventories are not completed
    - b) data are not available in a centralized database where they can be made available to managers, planners and developers
    - c) amphibian populations are not monitored in a systematic fashion.
    - d) little is known about requirements of amphibians outside of the breeding phase
- Potential loss of endemic taxa, distinct populations, and unique lineages (potential units of evolutionary significance—ESUs)
- Lack information about occurrence, frequency, causation, and magnitude of amphibian deformities
- Lack of information to understand the impacts of climate change on population viability
    - a) diminishing snow pack
    - b) increased depth of ground freeze
    - c) increased UV radiation affecting unprotected skin of amphibians
    - d) possible occurrence and spread of chytrid and other pathological fungi
    - e) effect of drought on precipitation regime and ponds/wetlands
    - f) expansion of the ranges of other amphibian species; some may expand their territories and thus affect the survival of extant species
    - g) glacial uplift eliminating some wetland habitats in Southeast Alaska

- Habitat loss and degradation
    a) loss of wetlands due to draining, filling, pollution
    b) potential direct and indirect effects from timber harvest
    c) herbicide use; application of toxics
- Habitat fragmentation reduces ability of dispersal to/from breeding sites, colonization dynamics, expansion potential, and metapopulation dynamics and gene flow
    a) timber harvesting (clearcutting)
    b) roads cause significant mortality (i.e. roadkill) and may impair dispersal
    c) development/wetland loss
    d) loss of stream functionality as dispersal corridors
- Pollution
    a) oil and chemical spills, PCBs (example: Kenai National Wildlife Refuge), and other contaminants
    b) potential for atmospheric pollution and associated precipitation
    c) road dust
    d) runoff from agricultural and lawn care chemicals
- Accelerated eutrophication
    a) direct fertilization of aquatic systems could change the allevin components in lakes (agencies have history of fertilizing lakes for fish growth; recently in Sitka, Redoubt Lake fertilization is ongoing)
    b) runoff from urban and agricultural use of fertilizer
- Predation
    a) fish introduction, although several species have adaptations to reduce this threat
    b) increased predator populations in developed areas, such as concentration of ravens around landfills
- Collecting
    a) potential to eliminate breeding individuals from populations
    b) reintroduction of collected individuals to the wild could spread diseases and negatively affect native populations
    c) lack of coordination sometimes causes duplication of collection for scientific purposes

- Disease; lack information about occurrence, frequency, and magnitude of this threat
    a) exotic amphibian species introductions may introduce fungi
    b) release of pets or captive animals
    c) disease transmission by humans (on gear/boots)
    d) parasitic infections
    e) Ribeiroia is fairly common in normal frog populations, but is thought to cause malformations if other stressors are present
    f) potential for unknown diseases (i.e. Ranaviruses)
    g) lack of information on the elements affecting the immune system
    h) lack of information on disease pathology
- Taxonomic and genetics concerns
    a) Unknown taxonomic and genetic relatedness of mainland and specific island populations
    b) Potential for genetic bottlenecks
    c) Unknown genetic relatedness for Wood Frogs, Western Toads, and Rough-skinned Newts (e.g., are there separate Wood Frog subspecies or evolutionary significant units [ESUs] north and south of the Alaska Range?)
    d) Need to further assess conservation priorities:
        i. Island versus mainland populations
        ii. Gene pool contamination
- Natural Succession
    a) Extent of natural change in important habitats, especially changes in pH and dissolved organic carbons (DOC) in the water, and natural succession of riparian areas affecting temperature, and other important environmental indicators at breeding sites is unknown
    b) Degree of impact for each species is unknown
    c) Conservation strategies to mitigate these impacts are not evaluated
    d) Acceleration of wetland succession to upland due to climatic changes

D. Location and condition of key or important habitat areas

- *Northwestern Salamander* – Eggs are laid in ponds, lakes, and slow-moving streams; usually attached to vegetation in shallows. During the breeding season, they often are found under rocks and logs. In Alaska, known breeding sites include muskeg ponds and freshwater lakes that supply a permanent water source.

This species may have an affinity for forested areas of glacial refugia. This species probably returns to its natal ponds for breeding.

- *Long-toed Salamander* – Found in a wide variety of habitats, including dry woodlands, humid forests, subalpine meadows, and rocky shores of mountain lakes. Common elements appear to be well-drained areas with thick litter on the forest floor and close to relatively permanent water bodies. Adults are subterranean except during the breeding season. Salamanders also were found in seral stages ranging from 3-year-old clearcuts to 180-year-old forests and occurred in active logging areas. Breeds in temporary or permanent ponds, or in quiet water at the edge of lakes and streams. During the breeding season adults may be found under logs, rocks, and other debris near water. Eggs are attached to vegetation or loose on bottom.
- *Rough-skinned Newt* – Uses forested cover adjacent to aquatic habitat for breeding and overwintering. Found in and about small permanent bodies of water (ponds, lakes, reservoirs, and slow-moving streams) with abundant vegetation. On Wrangell Island, species found using backwater lakes and muskegs. Lays eggs singly on aquatic plants or submerged twigs.
- *Western Toad* – Broad range of habitat use. Can be found from sea level to well up in the mountains. Primarily terrestrial, they enter water to breed in a variety of shallow ponds, lakes, streams, backwaters, ephemeral and sometimes brackish pools warmed by the sun. Hibernates in burrows below frostline in forested cover up to several kilometers from aquatic habitat. Tolerant of, and possibly prefers, young landscapes and disturbed areas near forest cover, such as riverine oxbows, ponds recently created due to glaciation, and gravel extraction ponds for breeding.
- *Wood Frog* – This species is closely associated with Alaska's Interior forests. Inhabits a diversity of vegetation types from grassy meadows to open forest, muskeg, and even tundra. Breeds in early spring in shallow bodies of permanent or ephemeral water. Hibernates under the snow in shallow depressions of compacted forest litter.
- *Columbia Spotted Frog* – Highly aquatic. Closely associated with permanent water. Found predominantly in outwash ponds and backwater lakes, beaver ponds, muskeg ponds, river channels, and streams. Emerges and breeds very early and in colder conditions compared to other species.

E. Concerns associated with key habitats

- Climate change and warming (See fourth bullet in C above)
  - a) Also affects water depth, temperature, and permanence of wetlands
  - b) Expect changes in seral patterns and vegetation types.
- Habitat loss, fragmentation and degradation (See C above)
- Natural succession (See C above)

F. Goal: Conserve and manage native amphibian populations, assemblages, and metapopulations throughout their natural range to ensure sustainable use of these resources.

G. Conservation objectives and actions

State conservation and management needs:

<u>Objective 1</u>: Maintain local amphibian distributions within natural variability.

Target: Establish and maintain occupancy rate (proportion of sites occupied) at baseline levels for native amphibians in selected areas within their ranges within 5 years.

Measure: Occupancy rate for selected areas and species.

<u>**Issue 1:** Historical information is currently dispersed and must be used to inform the development of occupancy-based protocols.</u>

Conservation actions:

a) Synthesize existing published and unpublished data on amphibian locations.
b) Initiate a Traditional Ecological Knowledge project to collect and summarize anecdotal amphibian information from Native and other long-time residents.
c) Assemble existing Alaska-based publications (articles, final reports, etc.) in a centralized location and make it accessible for education/research.

<u>**Issue 2:** Occupancy-based protocols for monitoring and supporting data systems are not in place for Alaska.</u>

Conservation actions:

a) Develop a central, statewide amphibian database to track historical, contemporary, and future observations, genetic samples, voucher specimens, changes in occupancy, malformation locations, and temporal/spatial data gaps in real time. Develop quality control standards for inclusion of future data.
b) Develop, promote, and initiate a stratified, regional amphibian inventory project using shared protocols that allow data to be pooled and analyzed across jurisdictions (regionally/statewide). Protocols would include the preservation of scientific samples for future morphological, genetic, epidemiological and other studies, and ideally also be consistent with national efforts (i.e., USGS Amphibian Research and Monitoring Initiative).
c) Support a statewide "Citizen Science" effort to collect and validate public reports on amphibian distribution, threats, and other appropriate issues. Develop standards for credibility of reports.

<u>**Issue 3:** Many threats are hypothesized, but few have been fully investigated and documented.</u>

Conservation action: Identify which potential threats or stressors may be influencing observed changes in occupancy in a given area. Design future inventory and monitoring efforts to test the validity of these potential hypotheses.

Issue 4: Native amphibians may be susceptible to declines due to known factors (introduced species, wetland loss) before all threats are fully understood.

Conservation actions:

a) Support implementation of the Alaska Amphibian Working Group to promote collaboration at regional, statewide, and international levels.

b) Promote development of outreach and educational information to inform state, federal, and tribal land management agencies of the serious deleterious effects of the factors currently identified as responsible for declines in occupancy.

c) Limit habitat fragmentation through the use of buffer zones and around breeding habitats and planning road construction to protect connectivity of populations.

d) Initiate active monitoring of known exotic amphibians in Southeast Alaska. Study feasibility of eradication methods.

e) Promote development of outreach and educational information to inform the public and school teachers on the effects of introduced nonnative (store bought) amphibians into natural systems, the illegality and dangers of the collection of endemic amphibians as pets, and the harmful effects of reintroduction of endemic amphibians collected as pets.

Issue 5: Habitat destruction and degradation in key areas could threaten the sustainability of amphibian populations.

Conservation actions:

a) Identify specific locations that appear to be of particular importance for survival/productivity.

b) Investigate and document the effects of potential threats, including clearcutting and other logging practices, siltation, and fish introductions.

c) Use plans, information on pending land exchanges, and personal interviews with local residents and land managers to assess potential threats to key local areas, including road building, settlement, development, logging, dumping fertilizer discharge, and fish introduction.

d) Support the protection of any areas identified as being of key importance to any amphibian species from overt anthropogenic change.

Objective 2: Monitor and maintain low malformation rates for Alaska amphibians.

Target: Maintain a malformation rate for Alaskan amphibians that approaches the suggested natural background malformation rate of 3%.

Measure: Rate of malformations of native amphibian species.

Issue 1: The current statewide malformation rates are not currently documented.

Conservation actions:

a) Determine the statewide proportion of malformations due to simple trauma or injury and initiate statewide surveys of amphibian malformations and their types.

b) Initiate/continue statewide surveys of amphibian malformations to determine if there are "malformation hotspots."

Issue 2: The proportional contributions of each of the potential causal agents to the malformation rate statewide are unknown.

Conservation actions:

a) Support laboratory research on the actual effects of the various hypothetical causes for amphibian malformation. Thoroughly test the natural background rate for various populations and species across the state.

b) Initiate studies to determine which potential causes may be operating in different malformation hotspots. If no hotspots exist, initiate studies to determine which of the potential causes is likely the greatest contributor to malformation.

Issue 3: The effects of malformations on population dynamics are unknown.

Conservation action: Support field studies to determine what level of malformations result in population losses.

H. Plan and time frames for monitoring species and their habitats

State and federal agencies, universities, Native entities and NGOs should coordinate to establish a monitoring plan within the next 2 years that would begin bi-annual monitoring with evaluation at 5-year intervals.

I. Recommended time frame for reviewing species status and trends

Review at 5 years.

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Reptiles – Introduction

Only 4 species of reptiles, all marine turtles representing 2 families, have been documented within the state's borders. Marine turtles are uncommon to casual visitors to Alaska's Gulf Coast waters (Wing 2004), and are considered a natural part of the state's marine ecosystem. Based on occurrences since 1960, Leatherback Seaturtles are considered uncommon (19 reports), Green Seaturtles are rare (15 reports), and Olive Ridley Seaturtles (3 reports) and Loggerhead Seaturtles (2 reports) are casual visitors to Alaska waters (Wing 2004; Wing and Hodge 2002). Currently, all 4 species are listed as threatened or endangered under the U.S. Endangered Species Act.

Prior to 1993, marine turtle sightings were mostly of live Leatherback Seaturtles; since then, most observations have been of Green Seaturtle carcasses (Wing 2004). At present it is not possible to determine if this is related to changes in oceanographic conditions or to changes in population size and distribution.

Reports of Garter Snakes from the mainland of Southeast Alaska have not been substantiated and thus remain hypothetical. Targeted surveys and specimens are needed to document their occurrence.

Leatherback Seaturtle

A. Species description

Common name: Leatherback Seaturtle
Scientific name: *Dermochelys coriacea*

B. Distribution and abundance

Range:
Global range comments: Wide ranging in Atlantic, Indian, and Pacific Oceans; generally forage in temperate waters, nest on beaches in tropical and subtropical latitudes; cold-tolerant species, nonbreeders often seen at high latitudes.
State range comments: Marine turtles are associated with the North Pacific Ocean and the interface between these waters and the shoreline of Alaska. Leatherbacks probably occur here as part of their normal habits, because they are a cold-water species that feeds on jellyfish (B. Wing, NOAA, personal communication).

Abundance:
Global abundance comments: Unknown, listed as critically endangered by IUCN, and endangered under the U.S. Endangered Species Act
State abundance comments: Uncommon, 19 records from 1960 to 2003

Trends:
<u>Global trends:</u> Declining throughout its range
<u>State trends:</u> Few records from the state make it difficult to establish trends, but probably similar to global trends. Historically, occurrences in high latitudes of the North Pacific Ocean were associated with warm-water years; however, occurrences since 1960 do not reflect this connection. From 1960 to 1983, most sightings were of live leatherbacks; however, since 1983, few have been documented.

References: Eckert 2003; Hodge and Wing 2000; MacDonald 2003; Wing 2004

C. Problems, issues, and concerns for species

- Very little is known about any aspect of Leatherback Seaturtle ecology in Alaska.
- Concerns in Alaska are unknown but outside the state include: habitat loss, incidental catch in commercial fisheries, and harvest of eggs and adults.

D. Location and condition of key or important habitat areas

Alaska marine waters – pristine

E. Concerns associated with key habitats

- Lack of information concerning occurrence and habitat use in Alaskan waters.
- Several live turtles were caught in commercial fishing gear and subsequently died.

F. Goal: Ensure Leatherback Seaturtle populations remain sustainable throughout their range within natural population-level variation and historical distribution in Alaska.

G. Conservation objectives and actions

State conservation and management needs:

<u>Objective</u>: Maintain Leatherback Seaturtle populations that occur within Alaskan waters.

Target: Stable trend in annual occurrences of Leatherbacks in Alaskan waters over 25-year period.

Measure: Documented occurrences of Leatherback Seaturtles in Alaska.

<u>Issue</u><u>: Little is known about Leatherback Seaturtle ecology in Alaskan waters.</u>

Conservation actions:

a) Continue to monitor presence of Leatherbacks and other turtles in Alaska.
b) Gather information on turtle sightings from fishermen and residents of coastal communities.
c) Develop protocol for persons who find or capture live turtles.
d) If numbers increase, attempt to learn about habitat use in Alaska.
e) Develop and distribute educational materials about marine turtles in Alaska, specifically Leatherback Seaturtles; permit requirements to handle turtles; and what to do if a turtle is seen alive or found dead.

Global conservation and management needs:

Participate and assist, to the degree appropriate, in national and international efforts to conserve these species.

H. Plan and time frames for monitoring species and their habitats

The USFWS Service has jurisdiction over marine turtles on land, while NOAA Fisheries has jurisdiction over marine turtles in water. In the past, B.L. Wing, NOAA, has monitored occurrences of marine turtles in Alaskan waters and hopefully will continue to do so and serve as a clearinghouse for additional data on seaturtle occurrences in Alaskan waters. A report on additional information should be submitted prior to the revision of this plan in 10 years.

I. Recommended time frame for reviewing species status and trends

Review at 10 years.

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Waterfowl – Introduction

Alaska’s waterfowl resources include 2 species of swans (in 3 populations), 5 species of geese (14 subspecies or populations), and 27 species of ducks. Of Alaska’s 365 million-acre surface, 50–60% is considered suitable waterfowl habitat, made up of rich coastal lagoons and river deltas, large inland valleys, and vast areas of wet tundra and boreal muskegs. Production of waterfowl in Alaska results not only from expansive and stable wetlands, but also from dynamic physical processes (floods, fires, coastal interfaces) that enrich habitats, and bursts of productivity from long summer days. The fall flight of waterfowl from Alaska provides 120,000 swans, 1 million geese, and 10–12 million ducks to all 4 North American flyways. Annually, Alaska produces or seasonally hosts waterfowl that are shared with Canada, Mexico, Russia, and Japan.

Alaskans depend on an annual harvest of about 400,000 migratory game birds for nutritional, economic, cultural, and recreational benefits. In addition, harvest and other benefits from many Alaska-breeding populations are realized most in Canada and the Lower 48 states.

Because Alaska's migratory game bird populations range internationally across many jurisdictions, management of these resources is governed by federal authority. However, they provide substantial benefits to culturally and geographically diverse public interests that are best engaged at state and regional levels. The utility of multilevel management and the valuable capabilities of state wildlife agencies led to the formation of flyway councils in the 1950s. Councils, made up of state wildlife agencies, provide the necessary cooperation to efficiently coordinate management efforts and balance the interests of agencies and user groups. The state of Alaska is a member of the Pacific Flyway Council, but also interacts with the Central, Mississippi, and Atlantic Councils on shared populations. Management efforts are aimed primarily at monitoring distribution and trends of breeding bird populations, assessing annual production and factors that influence populations of concern, measuring and managing harvest, and promoting habitat conservation through land use planning.

Waterfowl are not treated at length in this iteration of the CWCS because there is an extensive research and management network at regional, national, and continental levels. Research and management needs of nearly all populations of swans and geese that occur in Alaska are addressed by individual flyway management plans. Most duck populations are managed under programs of the North American Waterfowl Management Plan, national harvest strategies, and some flyway and regional plans. Thus, pages 58–65 of this appendix focus primarily on a group of sea duck species that breed in Arctic and sub-Arctic regions, have undergone substantial population declines, and for which there is neither adequate information about their status and biology nor a cohesive management plan.

Using criteria shown in Section II(C) (CWCS page 10), CWCS expert participants also selected Spectacled and Steller’s Eiders (both listed as Threatened), and Tule White-fronted Geese, as being of major conservation concern. These are populations for which existing information and management plans do not currently provide means to secure long-term conservation. Information on each of these species follows.

Tule White-fronted Goose (Anser albifrons gambeli)
Tule geese are one of two subspecies of greater white-fronted geese in North America. Since the early 20th century, they were recognized as a larger and darker bird wintering with Pacific White-fronts (*A. a. frontalis*) in California (Swarth and Bryant 1917), but their breeding grounds were unknown until 1979. Nesting Tule geese were first located in the Redoubt Bay and Susitna Flats areas of Cook Inlet, Alaska (Timm et al. 1982). Periodic aerial surveys of Cook Inlet coastal marshes indicate that the use of Redoubt and Trading Bays by Tule geese declined significantly some time between 1983 and 1992 (Campbell et al. 1992); few Tule geese have been seen there in recent years. Telemetry studies since 1994 indicate that most Tule geese now nest in the Kahiltna and Susitna River valleys, and as far north as the Tokositna River (USGS and ADF&G, unpubl. data). The coincident decline of Tule geese at Redoubt Bay and discovery of nesting in valleys north of Cook Inlet may reflect displacement of the breeding population from a major eruption of the Redoubt Volcano in December 1989. Telemetry also indicates that one-third to half of the population crosses the Alaska Range to molt in the Innoko River basin during midsummer.

Since the early 1980s, various methods have been used to enumerate Tule geese at 7000–9000 birds, making them one of the smallest populations of geese in North America. For over 20 years, management has been focused on basic research and protection of this vulnerable population; the Pacific Flyway plan (Pacific Flyway Council 1991 [revision in progress]) summarizes needs for fundamental information. Although this plan is currently under revision, there is insufficient information to guide management actions for the long-term conservation of this population: (1) To date, no reliable method has been established to estimate population size on the breeding grounds where they are dispersed in boreal forest habitats, or on the wintering grounds where they are obscured among 380,000 Pacific White-fronts. (2) Tule goose breeding grounds are almost entirely on state lands that are subject to timber sales, oil and gas leases, and increasing recreational activity. (3) Although Tule geese largely evade harvest through seasonal and spatial segregation, and harvest strategies in the Pacific Flyway are designed to avoid them, some Tule geese are taken.

Spectacled Eider (Somateria fischeri)
Spectacled Eiders primarily breed in one of three geographic areas: Arctic Russia, the Yukon-Kuskokwim Delta (YKD) in western Alaska, and Alaska’s Arctic Coastal Plain. The rapid decline in Spectacled Eiders on the YKD was the primary reason for listing this species as threatened in 1993 (USFWS 1993). Between the 1970s and 1990s, Spectacled Eiders on the YKD declined by about 96 percent, from 48,000 pairs to fewer than 2,500 pairs in 1992 (Stehn et al. 1993; USFWS 1999). Since then, the population on the YKD has increased slightly (Fischer et al. 2004; Platte and Stehn 2003). The vast majority of the worldwide population, mostly composed of Russian breeding birds, winters in the Bering Sea, where estimates range up to 363,000 birds (Larned and Tiplady 1999; Peterson et al. 1999).

The focus of the 1996 recovery plan (USFWS 1996) is to provide strategies for the recovery of Spectacled Eiders; assess potential threats from socioeconomic, political, biological, and ecological mechanisms; develop strategies to mitigate or alleviate these threats; and monitor population change. Specific mechanisms causing the decline or limiting recovery, however, remain unknown. Primary hypotheses that continue to be implicated in the decline of the eiders, mostly affecting adult survival, include lead poisoning on the YKD, changes in food supply at sea, exposure to marine contaminants, overharvest, increased predation on the YKD breeding ground, and disturbance of nesting birds by researchers (USFWS 1993; Stehn et al. 1993). The current recovery plan does not adequately provide for the long-term conservation of Spectacled Eiders because: (1) the cause(s) for the decline in numbers and distribution of the YKD breeding population are unknown; (2) there are no historical trends from the Arctic Coastal Plain from which to verify a decline or establish realistic recovery objectives; (3) recovery strategies largely address mitigating potential threats that may be impediments to recovery; and (4) without knowledge of the causes of population declines, the efficacy of strategies to actively increase the population is largely speculative.

Steller's Eider (Polysticta stelleri)
Three breeding population segments have been designated for Steller's Eiders, two in Arctic Russia (Atlantic and Pacific) and one in Alaska. The Alaska breeding population occurs in 2 separate regions: the Yukon-Kuskokwim Delta (YKD) in western Alaska and the North Slope, primarily near Barrow (USFWS. 2002). The Alaska breeding population of Steller's Eiders was listed as threatened in 1997 (USFWS. 1997), largely because of a reduction in its breeding range as it became extremely rare on the YKD (Kertell 1991). Although there are few quantitative data from the region, Steller's Eiders on the YKD historically composed the largest number of this species breeding in Alaska. Up to a few thousand eiders may nest irregularly on the North Slope (Quakenbush et al. 2004), where long-term changes in numbers and distribution are poorly known (Quakenbush et al. 2002).

The majority of the Pacific population (over 100,000 birds) nests in Russia, and winters in Alaska from the eastern Aleutian Islands east to lower Cook Inlet. Although Russia-breeding birds are not included in the ESA listing, they intermingle with Alaska breeders for most of the year, which complicates recovery efforts. The Russian Pacific breeding population of Steller's Eiders was recognized as a category 3 ("rare") species in the Red Book for the Yakutia Republic because of reduced breeding range, declining numbers, and illegal harvest (Solomonov 1987). In addition, there has been a declining trend in birds wintering along the Alaska Peninsula (Larned 2003).

The focus of the 2002 recovery plan (USFWS 2002) is to provide strategies for the recovery of Alaska-breeding Steller's Eiders; assess potential threats from socioeconomic, political, biological, and ecological mechanisms; develop strategies to mitigate or alleviate these threats; and monitor population change. Specific mechanisms causing the decline or limiting recovery in Alaska, however, remain unknown. Primary hypotheses include lead poisoning, overhunting, nest predation, and changes in the marine environment (USFWS 2002). The current recovery plan does not adequately provide for the long-term conservation of Steller's Eiders because: (1) the magnitude and cause(s) for the decline in numbers and distribution of breeders on the YKD are unknown; (2) there are no historical trends from the Arctic Coastal Plain from which to verify a decline or establish realistic recovery objectives; (3) recovery strategies largely address mitigating potential threats that may be impediments to recovery; and (4) without knowledge of the causes of population declines, the efficacy of strategies to actively increase the population is largely speculative.

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Sea Ducks

A. Species group description

Common names: Diminished sea duck species in Alaska (selected species that are largely endemic to Alaska, and have experienced significant declines); these include Pacific Common Eider, King Eider, Black Scoter, Surf Scoter, White-winged Scoter, and Long-tailed Duck
Scientific names: *Somateria mollissima v-nigra, Somateria spectabilis, Melanitta nigra americana, Melanitta perspicillata, Melanitta fusca deglandi, Clangula hyemalis*

B. Distribution and abundance

Range:

Global range comments:

Breeding range: Circumpolar in Arctic, sub-Arctic, and boreal habitats

Nonbreeding range: Principally coastal marine waters of Bering Sea and northeastern and northwestern Pacific Ocean

State range comments:

Breeding: Alaska's coastal tundra and Interior wetlands. Alaska wintering birds include some that breed in Russia and Canada

Nonbreeding: Coastal marine waters for winter, migration, staging, and molting; Alaska breeding birds also use coastal waters of Russia and Canada for migration, staging, molting, and wintering

Abundance:

Global abundance comments: Population estimates (current and historical) are considered unreliable for most species. In general the lack of comprehensive surveys and knowledge of distribution and movements allows for gross estimates only ("best guesses") of population size (Sea Duck Joint Venture 2003; Savard et al. 1998; Brown and Fredrickson 1997; Bordage and Savard 1995). Surveys often combine species groups, especially scoters.

Pacific Common Eider: Estimates of 100,000 in North America and 22,000 minimum in Siberia.
King Eider: Western Arctic: Possibly up to 470,000 including 100,000 in Russia.
Black Scoter: Historic estimates up to 550,000 (Savard et al. 1998). Currently unknown.
Surf Scoter: Estimates range from 257,000 to 765,000.
White-winged Scoter: Historic estimates of up to 675,000 birds. Currently unknown.
Long-tailed Duck: Historically up to 4 million. Currently unknown, 500,000 minimum.

State abundance comments: Estimates not reliable. Generally little information on seasonal distribution and abundance; survey data seldom comparable. Estimates during breeding, molting, and wintering vary greatly and may not represent population units, as birds migrate long distances to vast and remote regions for various life history events, often across international borders, (see Alaska status summary [USFWS 1999])

Pacific Common Eider: Estimate up to 67,000 in winter. Many fewer breeding.
King Eider: Arctic Coastal Plain breeding population about 7750. Up to 370,000 during migration from wintering areas primarily in Russia and Alaska.
Black Scoter: Winter unknown. Breeding population estimates of 102,000.
Surf Scoter: Winter population estimates up to 275,000. Breeding unknown.
White-winged Scoter: Winter estimates greater than 100,000. Breeding unknown.
Long-tailed Duck: Currently unknown. Winter population greater than 220,000. Greater numbers during migration.

Trends*:

Global trends: (Sea Duck Joint Venture 2003) In general, a lack of comprehensive surveys and standardized methods makes it difficult to extrapolate regional trend data to a global scale. The North American Waterfowl Breeding Population Survey was not designed to coincide with the life history patterns of sea ducks. Surveys often combine similar species, especially scoters.

Pacific Common Eider: Downward trend. Possible 50% decline of spring migrants since 1976.
King Eider: Declines of 40–75% since 1960s.
Black Scoter: Declining about 1% annually.
Surf Scoter: Possibly declined up to 2% annually since 1950s. May have stabilized.
White-winged Scoter: Possibly declined up to 2% annually since 1950s. May have stabilized.
Long-tailed Duck: Western North American population declined 70% since 1960s.

State trends: (Sea Duck Joint Venture 2003; USFWS 1999).

Pacific Common Eider: Breeding population declined 4.5% annually from 1976 to 1994. May be stable or increasing since late 1980s. Currently below historic levels.
King Eider: Stable or increasing slightly on Arctic Coastal Plain since 1990. Declines in winter/migrants of 55% from 1976 to 1996.
Black Scoter: Breeding populations declined about 2% annually from 1977 to 1998 in western Alaska, otherwise stable or increasing since 1988. Currently below historic levels.
Surf Scoter: Possibly declined up to 2% annually since 1950s. May have stabilized or increased since late 1980s.
White-winged Scoter: Possibly declined up to 2% annually since 1950s. May have stabilized or increased since late 1980's.
Long-tailed Duck: Declines of 5.5% annually since 1977 in breeding population. May have stabilized on Arctic Coastal Plain since 1986 and increased on Yukon Delta since 1988.

*Trends primarily reference breeding populations. Little time-series data is available to quantify changes in numbers of wintering or molting birds. For most species, sea ducks are most abundant in Alaska during winter from October through May.

References: Bordage and Savard (1995); Brown and Fredrickson (1997); Savard et al. (1998); Sea Duck Joint Venture (2003); USFWS (1999)

C. Problems, issues, or concerns for species group

Overview of problems: Sea ducks congregate in large dense flocks during migration, molting, and winter. This makes large numbers vulnerable to oil spills, other marine contaminants, disturbance, or habitat changes in areas where birds concentrate. Migrate over vast and remote regions under various governmental jurisdictions. Relatively little knowledge of population delineation, trends, life history, and ecology.

- Lack of good baseline information on population status, trends, and distribution
- Climate change
- Marine pollution
- Changes in prey abundance
- Avian and mammalian predation
- Overharvest/lead poisoning
- Off- and onshore mineral and energy development
- Commercial fishing and mariculture interactions

D. Location and condition of key or important habitat areas

Breeding habitat (Savard et al. 1998; Brown and Fredrickson 1997; Bordage and Savard 1995; Goudie and Reed 2000; Suydam 2000): Generally very good with exceptions, although overall conditions are largely unknown.

- Pacific Common Eider: Along marine coasts, mostly on barrier islands, river deltas, spits
- King Eider: Arctic tundra near lakes and ponds
- Black Scoter: Deltas, tundra and taiga lakes and ponds
- Surf Scoter: Boreal forest lakes, rarely on tundra
- White-winged Scoter: Boreal forest lakes, rarely on tundra
- Long-tailed Duck: Coastal and interior tundra

Non-breeding habitat (Savard et al. 1998; Brown and Fredrickson 1997; Bordage and Savard 1995; Goudie and Reed 2000; Suydam 2000): Generally very good with exceptions (includes molting and wintering areas), although overall conditions are largely unknown.

- Pacific Common Eider: Shallow offshore marine waters
- King Eider: Offshore marine waters and edge of sea ice
- Black Scoter: Nearshore marine waters
- Surf Scoter: Nearshore marine waters
- White-winged Scoter: Near- and offshore marine waters
- Long-tailed Duck: Near- and offshore marine waters

E. Concerns associated with key habitats

See Section C.

F. Goal: Ensure sea duck populations remain sustainable throughout their range within natural population-level variation and historic distribution throughout Alaska.

G. Conservation objectives and actions

Objective: Conserve and manage sea duck population levels at a sustainable level within their historic range.

Target: Specific population objectives have not been set because available inventory data are not reliable and a geographic regime for management has not been established; establishing population goals and objectives is one of the primary management needs for each species.

Measure: Population indices are currently based on several standard and special surveys:

a) Alaska-Yukon Waterfowl Breeding Population Survey (not designed for sea ducks).
b) Arctic Coastal Plain survey.
c) Miscellaneous regional surveys.

Establishing survey methods and protocols at a local, regional, and continental scale is a primary management need (see below).

Issue 1: Lack of reliable information to delineate populations and ranges.

Conservation actions:

a) Improve population delineation through increased banding, marking, telemetry, and genetic studies.
b) Expand existing level of research/monitoring.

Issue 2: Lack of effective survey methods to produce abundance and trend data.

Conservation actions:

a) Develop and implement effective population survey and monitoring techniques at continental, regional, and local scales (Sea Duck Joint Venture 2001) during breeding, molting, staging, and wintering periods.
b) Expand existing level of monitoring.

Issue 3: Important coastal habitats for staging, molting, and wintering are not identified or inventoried.

Conservation actions:

a) Identify, inventory, and assess attributes of important coastal habitats for staging, molting, and wintering.
b) Develop statewide sea duck GIS.
c) Identify potential impacts from development activities, vessel traffic, oil spills, commercial fishing, and subsistence activities.

Issue 4: Lack of baseline data on the prevalence and effects of diseases, parasites, and contaminants on sea duck populations.

Conservation actions:

a) Implement field and laboratory studies to screen for diseases, parasites, and contaminant exposure and assess effects.
b) Continue and expand programs to reduce exposure to lead shot.
c) Monitor contaminant levels in prey.

Issue 5: It is not known if climate change is negatively impacting these sea ducks.

Conservation action: Monitor sea duck population trends, abundance, and distribution, and test for correlations with climate change on a regional basis.

Issue 6: Changes in prey abundance may be affecting sea duck populations.

Conservation actions:

a) Identify primary prey species at key winter, staging, and molting sites.
b) Monitor prey intake and changes over time.

Issue 7: Lack of baseline data on the prevalence and effects of predators and unknown population effects of avian and mammalian predation.

Conservation actions:

a) Identify and evaluate abundance and effects of predator populations during breeding, molting, and winter on a regional basis.
b) Identify situations where human activities may enhance predator/scavenger populations.

Issue 8: Lack of knowledge on sea duck population age and sex structure makes it difficult to understand their population dynamics.

Conservation actions:

a) Identify population age and sex structure and age-specific survival rates to improve understanding of population dynamics.
b) Expand existing level of research/monitoring.

Issue 9: Unknown levels of harvest over range of species makes it difficult to understand mortality rates and effect of harvest on population.

Conservation actions:

a) Improve surveys of recreational and subsistence harvest over the range of species in the United States and Canada.
b) Expand existing level of research/monitoring.

H. Plan and time frames for monitoring species and their habitats

Plan proposal: A 10-year time frame is proposed to implement conservation and management needs. A comprehensive survey and monitoring program will be developed at continental and regional scales over the next few years. Surveys will be conducted at index locations on a predetermined schedule of once every 1–5 years.

Planning and implementation of monitoring programs will involve partnerships within the Sea Duck Joint Venture (an international program of the North American Waterfowl Management Plan), USFWS divisions of Migratory Bird Management and Refuges, the USGS, Alaska Native village and regional corporations, National Audubon Society, Ducks Unlimited, Inc., Canadian Wildlife Service, flyway councils, and other state and federal agencies with regulatory or management authority within a species range. The lead agency will be determined on an individual project basis.

I. Recommended time frame for reviewing species status and trends

Review every 5 years, or at more frequent intervals in response to additional information.

J. Bibliography

Bordage, D. and J.P.L. Savard. 1995. Black Scoter (*Melanitta nigra)*. In: A. Poole and F. Gill, editors. The Birds of North America, No. 177. The Academy of Natural Sciences, Philadelphia, PA, and the American Ornithologists' Union, Washington, DC. 20 p.

Brown, P.W. and L.H. Fredrickson. 1997. White-winged Scoter (*Melanitta fusca*). In: A. Poole and F. Gill, editors. The Birds of North America, No. 274. The Academy of Natural Sciences, Philadelphia, PA, and the American Ornithologists' Union, Washington, DC. 28 p.

Goudie, R.I., G.J. Robertson, and A. Reed. 2000. Common Eider (*Somateria mollissima*). In: A. Poole and F. Gill, editors The Birds of North America, No. 546. The Birds of North America, Philadelphia, PA. 31 p.

Savard, J.P.L., D. Bordage, and A. Reed. 1998. Surf Scoter (*Melanitta perspicillata*). In: A. Poole and F. Gill, editors. The Birds of North America, No. 363. The Birds of North America, Philadelphia, PA. 28 p.

Sea Duck Joint Venture. 2001. Sea Duck Joint Venture strategic plan 2001–2006. [Appendix B – Information needs and strategies]. c/o USFWS Migratory Bird Management, Anchorage, AK. http://www.seaduckjv.org/

Sea Duck Joint Venture. 2003. Species status reports. Unpubl. Rept. SDJV Continental Technical Team. c/o USFWS Migratory Bird Management, Anchorage, AK. http://www.seaduckjv.org/meetseaduck/species_status_summary.pdf /

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Suydam, R.S. 2000. King Eider (*Somateria spectabilis*). In: A. Poole and F. Gill, editors The Birds of North America No. 491. The Birds of North America, Philadelphia, PA. 28 p.

USFWS. 1999. Population status and trends of sea ducks in Alaska. Unpubl. Rept. USFWS., Migratory Bird Management, Anchorage, AK. 137 p.

Waterbirds – Introduction

For development of this plan, "waterbirds" does not include waterfowl or shorebirds, as both of those groups are dealt with separately. Nor does it include Osprey (dealt with by the Raptors group) or Belted Kingfisher or American Dipper (dealt with by the Landbird group). Aside from loons and grebes, the only other waterbird we therefore felt fell within our purview was Great Blue Heron. This species is continentally abundant and widespread, and without any obvious conservation concern within Alaska, we elected not to dwell on this species. Thus, our Waterbirds group developed templates just for loons and grebes.

Four templates were developed: one for Yellow-billed Loons, one for Red-throated Loons, one for all loons, and one for grebes. The rationale for the 2 species-specific treatments was that good abundance and/or trend information exists for loons, and for 2 species—Yellow-billed and Red-throated Loons—significant conservation concern at a state and national level is warranted. A group was made for all loons because (a) some type of threats to populations are common to all loon species, due to their similar life history, and (b) the other 3 loon species in Alaska are of less immediate conservation concern, but nonetheless, some localized concerns exist and this grouping provided the forum to identify issues. Alaska's 2 grebe species were grouped into a single template primarily because so little is known about their populations and ecology to usefully develop unique, species-specific templates.

Grebes

A. Species group description

Common name(s): Grebes: Red–necked Grebe and Horned Grebe

Scientific names: *Podiceps grisegena* and *Podiceps auritus*

B. Distribution and abundance

Range:

Global range comments (both Red-necked Grebe and Horned Grebe):

Breeding range: Circumpolar in sub-Arctic and boreal habitats.

Non breeding range: Coastal marine waters of northeast and northwest Pacific, and northeast and western Atlantic; occasionally winters on the Great Lakes in the United States; Horned Grebe winters locally on inland lakes, rivers, and reservoirs, mainly south of latitude 38°N.

State range comments (both Red-necked Grebe and Horned Grebe):

Breeding: South of the Brooks Range; absent from the Aleutian Islands and Southeast Alaska.

Nonbreeding: Coastal marine areas from the Aleutian Islands to Southeast Alaska.

Abundance:

Global abundance comments (Red-necked Grebe): Lack of information to indicate; 45,000 + individuals estimated in North America (Stout and Nuechterlein 1999).

State abundance comments (Red-necked Grebe): 12,000 (individuals) (R. Platte, USFWS, personal communication) estimated for Alaska.

Global abundance comments (Horned Grebe): Lack of information to indicate; 200,000+ individuals estimated in North America (Stedman 2000).

State abundance comments (Horned Grebe): Lack of information to indicate.

Trends:

Global trends (Red-necked Grebe): Lack of information to indicate.

State trends (Red-necked Grebe): Aerial survey data collected annually from 1988 to 1998 in the coastal zone of Yukon Delta National Wildlife Refuge suggests that the local breeding population is declining at a rate of 10% a year (R. Platte, USFWS, personal communication). No clear trend for the rest of the state.

Global trends (Horned Grebe): Lack of information to indicate. In North America, breeding range has shown slow, long-term contraction northwestward and NABBS data show significant negative trend continentwide from 1966 to 1996 (Stedman 2000).

State trends (Horned Grebe): Lack of information to indicate.

C. Problems, issues, or concerns for species group

- Little is known about either population in Alaska for all aspects of breeding and nonbreeding populations
- Horned Grebe breeding range has shown slow, long-term contraction northwestward and NABBS data show significant negative trend for North America from 1966 to 1996 (Stedman 2000)
- Unknown molting locations may pose a conservation concern to both species populations because of their tendency to aggregate in one spot
- Commercial and subsistence gillnets are potentially important sources of mortality for grebes
- Position at the top of the food chain makes grebes susceptible to biomagnification of contaminants
- Lake dynamics and changing phenology associated with global climate change may have effects on populations
- Invasive and introduced fish, e.g. northern pike, can alter the composition and abundance of prey and have negative effects on productivity
- Hazards associated with development:
    a) Increase in predation of eggs and chicks due to increase in predator numbers
    b) Increase in predation and nest failure due to increase in lake traffic and recreational disturbance

c) Toxic contamination
d) Oil spills
e) Draining of potholes for road-building and development (Horned Grebe)
f) Destruction of emergent vegetation near lakefront properties
g) Decreasing water levels as result of deforestation around wetlands
h) Eutrophication of lakes from fertilizers (runoff from lawns) degrades prey base

D. Location and condition of key or important habitat areas

Breeding habitat:

- Red-necked Grebe: (very good to pristine habitats, with local differences)
  - Mainly on shallow, freshwater lakes (>2 ha.) or shallow, protected marsh areas and secluded bays of larger lakes, usually with at least some emergent vegetation
- Horned Grebe: (generally pristine, with local differences)
  - Small to moderate sized (0.5–10 ha) fairly shallow, freshwater ponds and marshes with beds of emergent vegetation and substantial areas of open water
  - Secluded bays of larger lakes, usually with at least some emergent vegetation

Nonbreeding habitat: (concern that some are degraded)

- Red-necked Grebe:
  - Coastal marine waters from Yellow Sea to central California
- Horned Grebe:
  - Coastal marine and inshore freshwater habitats from the Yellow Sea to Baja Peninsula

E. Concerns associated with key habitats

See above.

F. Goal: Ensure Red-necked Grebe and Horned Grebe populations remain sustainable throughout their range within natural population-level variation and historic distribution across Alaska.

G. Conservation objectives and actions

Objective: Maintain healthy and viable grebe population levels.

Target: Combined grebe populations in Alaska of ≥ 30,000 (based on 13 years of aerial surveys[2]); species difficult to differentiate during aerial surveys.

Measure: population numbers for the different species as indicated by the Alaska Waterfowl Breeding Population survey.

Issue 1: Vulnerable to direct human disturbance (presence and activity at nest and brood sites), traffic, aircraft, pets.

[2] Data from 2 surveys flown by USFWS-Migratory Bird Management (MBM): the Alaska-Yukon Waterfowl breeding population survey.

Conservation actions:

a) Conduct education/outreach about human disturbance and ways to mitigate it.
b) Reduce or mitigate human disturbance by housing/domestic development. Develop management plans for housing development around lakes (Red-necked Grebe) with guidelines for developments and make them available to developers and permitters/regulators.
c) Develop better restrictions for industry development.
d) Develop lake activity management plans to control lake-borne disturbance (Red-necked Grebe) with guidelines and make them available to key agencies and users.

Issue 2: During aerial surveys, it is difficult to determine species.

Conservation action: Coordinate air-ground surveys to determine species ratios and different populations.

Issue 3: Currently unable to predict distribution of grebes where aerial surveys do not occur.

Conservation actions:

a) Develop habitat models to predict lake or habitat preferences.
b) Determine grebe distribution by working with local communities and field biologists to identify species during other studies.

Issue 4: Unknown molt and winter locations for breeding populations inhibits risk assessment.

Conservation actions:

a) Implement marking studies.
b) Coordinate with appropriate agencies to assure conservation of important molting areas.

Issue 5: Previous history of contaminant exposure creates concern for current exposure.

Conservation actions:

a) Implement contaminant monitoring program.
b) Conduct information, outreach, and education efforts.
c) Work with industries, NGOs and agencies to reduce emissions harmful to grebes that would affect grebe habitat.

Issue 6: Grebes are potentially vulnerable to being caught in commercial and subsistence fishing nets (bycatch).

Conservation actions:

a) Conduct surveys to determine how many grebes are caught in nets and how many hours the nets are fished.
b) Conduct outreach efforts to reduce bycatch.

Issue 7: Grebes are highly vulnerable to oil spills in coastal marine waters.

Conservation actions:

a) Determine molting areas (see Issue 4).
b) Coordinate and provide information on grebe use areas to agencies responsible for oil spill contingency planning and response.

Issue 8: Increase in nest and chick predation due to human-influenced increases in predator numbers.

Conservation actions:

a) Evaluate if nest and chick predation is a problem.
b) Conduct outreach and education.
c) Implement management actions to reduce human impacts that encourage predators.

Issue 9: Uncertain knowledge about basic breeding biology inhibits risk assessment

Conservation action: Conduct studies to answer life history questions that would aid in assessing risk.

Issue 10: Invasive and introduced fish, e.g., northern pike, alter the composition and abundance of prey.

Conservation actions:

a) Evaluate whether introduction of fish is a problem.
b) Conduct outreach and education.

H. Plan and time frames for monitoring species and their habitats

Plan proposal: select agencies in partnership

	Time Frame	**Lead Agency**	**Partners**	**Comments**
Grebe Watch	Annual	USFWS-ADF&G	Communities	New (2005) state-funded citizen science project
Arctic Coastal Plain/Alaska Yukon Survey, North Slope Eider Survey	Annual	USFWS-MBM		
Bycatch of grebes	Annual	ADF&G	USGS, USFWS, AMBCC, NOAA, local Native community	
Invasive species	Annual*	ADF&G-USFWS	Local community	

* In coordination with other agencies.

I. Recommended time frame for reviewing species status and trends

Review every 5 years because of changing conditions and gaps in information.

J. Bibliography

Stedman, S.J. 2000. Horned Grebe (*Podiceps auritus*). In: A. Poole and F. Gill, editors. The Birds of North America, No. 465. The Birds of North America, Inc., Philadelphia, PA.

Stout, B.E. and G.L. Nuechterlein. 1999. Red-necked Grebe (*Podiceps grisegena*). In: A. Poole and F. Gill, editors. The Birds of North America, No. 465. The Birds of North America, Inc., Philadelphia, PA.

Loons

A. Species group description

Common name(s): Loons (all 5 species that occur in Alaska [and the world]; these are Yellow-billed Loon, Red-throated Loon, Common Loon, Pacific Loon, and Arctic Loon)
Scientific names: *Gavia adamsii*, *G. stellata*, *G. immer*, *G. pacifica*, and *G. arctica*

B. Distribution and abundance

Range:
Global range comments:
Breeding range: Circumpolar in Arctic, sub-Arctic, and boreal habitats.
Non breeding range: Principally coastal marine waters of northeast and northwest Pacific, and northeast and northwest Atlantic.
State range comments:
Breeding: Alaska's coastal tundra areas and interior wetlands.
Nonbreeding: All coastal marine areas of Alaska south of the Yukon-Kuskokwim Delta.
Abundance:
Global abundance comments: Lack of information.
State abundance comments: 90,000 to 100,000 (breeders) (Groves et al. 1996).
Yellow-billed Loon: 3,500
Red-throated Loon: 10,000
Pacific Loon and Arctic Loon combined: 69,000 (mostly Pacific Loons; Arctic Loons cannot be distinguished from Pacific Loons during surveys)
Common Loon: 9,000
Trends:
Global trends: Lack of information to indicate.
State trends: See Yellow-billed Loon and Red-throated Loon templates for those species. Common Loon and combined Pacific Loon-Arctic Loon population approximately stable since 1977 (Groves et al. 1996; USFWS survey data[3]).

[3] Data from 2 surveys flown by USFWS-Migratory Bird Management: the Arctic Coastal Plain survey and the Alaska-Yukon Waterfowl breeding population survey

C. Problems, issues, or concerns for species group

- Due to a life history of high adult survival and low productivity, loon populations would be strongly impacted by unusually high levels of adult/mortality, and their low productivity would make it difficult to recover if a decline were to occur
- Their high trophic level predisposes them to bioaccumulation of contaminants
- Wintertime threats unknown, but concern about Asian waters where habitats may be degraded (contaminants, particularly mercury; overfishing; bycatch of loons)
- Breeding area threats include bycatch of loons in commercial and subsistence fishing nets, contaminants, and changes in lake dynamics, breeding season length, and marine fish communities associated with global climate change
- Invasive and introduced fish, e.g., northern pike, can alter the composition and abundance of prey and have negative effects on productivity
- Hazards associated with development:
    a) Increase in egg and chick predation due to increase in predator numbers
    b) Increase in predation and nest failure due to increase in air and ground traffic disturbance
    c) Toxic contamination
    d) Oil spills
    e) Eutrophication of lakes from fertilizers (runoff from lawns) degrades prey base

D. Location and condition of key or important habitat areas

See Yellow-billed Loon and Red-throated Loon templates for those species.

Breeding habitat:
- Common Loon: Lakes in forested areas statewide; vary from pristine to degraded
- Pacific Loon: Lakes (smaller than Common Loon, on average) in coastal tundra, and to a lesser extent, in forested areas statewide; vary from pristine to degraded
- Arctic Loon: Similar to coastal tundra habitats used by Pacific Loon, but restricted to northwest Alaska; very good to pristine habitats

Nonbreeding habitat: (concern that some are degraded)
- Coastal marine habitats from the Yellow Sea to Baja Peninsula

E. Concerns associated with key habitats.

See above.

F. Goal: Ensure loon populations remain sustainable throughout their range within natural population-level variation and historic distribution across Alaska.

G. Conservation objectives and actions

Objective: Maintain healthy and viable loon population levels.

Target: (See specific templates for Yellow-billed Loon and Red-throated Loon)
- Common Loon: Maintain a population of 10,000.
- Pacific Loon/Arctic Loon: Maintain a population of 70,000.

Measure: Population numbers as indicated by the Arctic Coastal Plain Survey and the Alaska-Yukon Waterfowl Breeding Population survey.

Issue 1: Vulnerable to direct human disturbance (presence and activity at nest and brood sites), traffic, aircraft, pets.

Conservation actions:

a) Conduct education/outreach.
b) Reduce human disturbance in residential and recreational areas by promoting creation of lake management plans (Common Loon, Pacific Loon).
c) Work with agencies and industry to create appropriate restrictions/guidelines for areas experiencing industrial development.
d) Lake activity management plans to control lake-borne disturbance (Common Loon, Pacific Loon).

Issue 2: Vulnerable to contaminants because of their high trophic level.

Conservation actions:

a) Implement contaminant monitoring program (e.g., mercury).
b) Conduct information outreach and education.
c) Work with industries and NGOs and agencies to reduce emissions.

Issue 3: Vulnerable to mortality due to lead poisoning by ingesting lead fishing sinkers during foraging in some areas (Common Loon, Pacific Loon).

Conservation actions:

a) Conduct outreach/education.
b) Promote use of nontoxic alternatives to lead fishing sinkers.
c) Monitor the mortality rate due to lead poisoning in Alaska.

Issue 4: Loons are vulnerable to being caught in commercial and subsistence fishing nets as bycatch.

Conservation actions:

a) Conduct surveys for bycatch on breeding areas related to fishing patterns and intensity
b) Conduct outreach and education to reduce bycatch.

Issue 5: Loons are highly vulnerable to oil spills in coastal marine waters.

Conservation actions:

a) Work with industry, NGOs, and agencies to minimize and mitigate these risks.
b) Conduct marking studies to determine the distribution of the large nonbreeding segment of the population.

Issue 6: Invasive and introduced fish, e.g., northern pike, alter the composition and abundance of prey (Common Loon, Pacific Loon).

Conservation actions:

a) Evaluate if introduction of fish is a problem.
b) Conduct outreach/education.

Issue 7: Vulnerable to nest and chick predation due to human-influenced increases in predator numbers.

Conservation actions:

a) Evaluate if nest and chick predation is a problem.
b) Conduct outreach/education.
c) Implement management actions to reduce human impacts that encourage predators.

Issue 8: Human perturbations in water level and water quality may impact productivity (Common Loon, Pacific Loon, Yellow-billed Loon).

Conservation actions:

a) Recognize where it might be a problem.
b) Determine the cause and source where there is a problem.
c) Conduct education/outreach.
d) Work with industry, communities and ADF&G instream flow program to minimize water level fluctuations on nesting lakes.

Issue 9: Status of Arctic Loon is unknown because of its rare and uncertain distribution in Alaska.

Conservation actions:

a) Determine their distribution by working with local communities and field biologists to identify species.
b) Assess genetic differences between Arctic Loon and Pacific Loon.

H. Plan and time frames for monitoring species and their habitats

Plan proposal: select agencies in partnership

	Time Frame	Lead Agency	Partners	Comments
Alaska Loon Watch	Annual	USFWS	Communities	
Southcentral Loon Survey	Annual	USFWS	Fairwinds	
Arctic Coastal Plain/Alaska Yukon Survey, North Slope Eider Survey	Annual	USFWS-MBM		
Contaminants	Biannual*	USFWS-USGS	Alaska Biological Research (ABR), Conoco-Phillips, Biodiversity Research Institute (BRI), EPA, DEC, AMBCC, local and Native community	Rotated among populations
Bycatch of loons	Annual	ADF&G	USGS, USFWS, AMBCC, NOAA, local Native community	
Invasive species	Annual**	ADF&G-USFWS	Local community	

***** After initial 5-yr period, conduct productivity, contaminant and fish-prey studies on a rotational basis.
**In coordination with other agencies

I. Recommended time frame for reviewing species status and trends

Review every 5 years because of changing conditions.

J. Bibliography

Groves, D.J., B. Conant, R.J. King, J.I. Hodges, and J.G. King. 1996. Status and trends of loon populations summering in Alaska, 1971–1993. Condor 98:189–195.

Red-throated Loon

A. Species description

Common name: Red-throated Loon
Scientific name: *Gavia stellata*

B. Distribution and abundance

Range:

Global range comments:

Breeding range: Circumpolar in Arctic and sub-Arctic habitats; primarily coastal.
Nonbreeding range: Coastal marine waters of northeast and northwest Pacific, and northeast and northwest Atlantic.

State range comments:

Breeding: Alaska's coastal tundra areas and small numbers in the Interior wetlands.
Nonbreeding: All coastal marine areas of Alaska south of the Seward Peninsula.

Abundance:

Global abundance comments: 300,000+ (breeders) (Barr et al. 2001).
State abundance comments: 10,000 (breeders).[4]

Trends:

Global trends: Lack of information to indicate.
State trends: Population survey data suggests a greater than 50% decline south of the Brooks Range since 1977 (Arctic Coastal Plain data was not collected prior to 1985).[5]

C. Problems, issues, or concerns for species

- Designated by USFWS as a bird of conservation concern (USFWS 2002)
- Wintertime threats unknown, but concern about Asian waters where habitats may be degraded (contaminants, particularly mercury; overfishing; bycatch of loons)
- Breeding area threats include bycatch of loons in commercial and subsistence fishing nets; contaminants; and changes in lake dynamics, breeding season length, and marine fish communities associated with global climate change
- Hazards, particularly for the North Slope, associated with development:
  a) Increase in predation of eggs and chicks due to increase in predator numbers
  b) Increase in predation and nest failure associated with increases in air and ground traffic disturbance
  c) Toxic contamination
  d) Oil spills

D. Location and condition of key or important habitat areas

Breeding habitat (Barr et al. 2001; USFWS survey data[6]): (generally pristine, with local differences)

- Small, low-lying tundra lakes less than 2 m deep
- Small lakes less than 5 ha
- Within 20 km of the ocean

[4] Data from 2 surveys flown by USFWS-Migratory Bird Management: the Arctic Coastal Plain survey and the North Slope Eider survey.
[5] Ibid.
[6] Ibid.

Nonbreeding habitat (Barr et al. 2001; Schmutz, J., unpublished data) : (concern that some are degraded)

- Coastal marine habitats from the Yellow Sea to Baja Peninsula

E. Concerns associated with key habitats

See above.

F. Goal: Ensure Red-throated Loon populations remain sustainable throughout their range within natural population-level variation and historic distribution across Alaska.

G. Conservation objectives and actions

Objective: Maintain viable Red-throated Loon population levels.

Target: Maintain a population of at least 10,000 to 20,000 adult breeders.

Measure: Population number as indicated by the Arctic Coastal Plain Survey and the Alaska Waterfowl Breeding Population survey.[7]

Issue 1: Surveys not well-designed for loons. Don't know how well surveys measure population; surveys are not designed specifically for loons relative to timing and stratification. The two North Slope waterbird surveys give very disparate views on population trend for this species (greater disparity than for all other species).[8]

Conservation action: Conduct studies to evaluate phenology of birds' arrival and initiation of breeding relative to survey timing and climatic variations. Also, evaluate detectability of breeders vs. nonbreeders and detection differences among observers.

Issue 2: Inadequate survey to monitor.

Conservation action: Implement survey to evaluate current productivity surveys.

Issue 3: Anecdotal evidence indicates that Red-throated Loons are bycatch in commercial and subsistence fishing, but the extent of this problem is unknown.

Conservation actions:

a) Conduct a survey for Red-throated Loon bycatch on breeding area rivers
b) Conduct surveys to determine how many loons are caught in nets and how many hours the nets are fished.
c) Outreach and collaboration (education to reduce bycatch)

Issue 4: Contaminants may reduce productivity and other aspects of demography in Red-throated Loon populations, based on precedence of common loons (Evers 2004).

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[7] Ibid.

[8] Data from 2 surveys flown by USUSFWS-Migratory Bird Management: the Arctic Coastal Plain survey and the Alaska-Yukon Waterfowl breeding population survey.

Conservation actions:

a) Institutionalize contaminants monitoring program of loon tissues and prey.
b) Identify sources of contaminants.
c) Compare levels observed in loons to other bird populations in the local area.
d) Identify an acceptable level of contamination for Red-throated Loon; data is available for common loons.

Issue 5: Changes in fish prey abundance may reduce the productivity of loons.

Conservation action: Targeted study areas to conduct sampling, on regular basis, to determine fish abundance (e.g., Alaska blackfish, and rainbow smelt; see both marine and freshwater fisheries strategies).

Issue 6: Concerns about inadequate productivity levels and other life table parameters, particularly in survival rates.

Conservation action: Conduct studies to estimate survival and productivity simultaneously.

Issue 7: North Slope Red-throated Loon may be distinct population and be exposed to higher risk of oil spill/contaminant and other risks, based on knowledge that they winter in East Asia (Schmutz, J., unpublished data).

Conservation actions:

a) Determine if North Slope population is different (genetically unique) from rest of Alaska population.
b) If unique, conserve that population.

Issue 8: Summertime distribution of nonbreeders is unknown, which limits adequate assessment of risks posed by oil spills and other disturbances.

Conservation actions:

a) Conduct marking studies.
b) Develop conservation measures in identified areas.

Issue 9: Development activity may impact reproductive success (productivity), either through an increase in predation of eggs and chicks due to increase in predator numbers, or through an increase in predation and nest failure due to increase in air and ground traffic disturbance.

Conservation actions:

a) Measure behavior and demographic parameters in areas likely to be developed. Do in an experimental context to enable ascribing variation in demography to predators or other disturbance.
b) Monitor predator numbers in newly developed areas.
c) Implement management actions to reduce human impacts that encourage predators.

H. Plan and time frames for monitoring species and their habitats

Plan proposal: select agencies in partnership

	Time Frame	Lead Agency	Partners	Comments
Arctic Coastal Plain/Alaska Yukon Survey	Annual	USFWS-MBM		
Productivity/Demographic Studies	Annual (for 5 yrs)*	USFWS-USGS	ABR, Conoco-Phillips	
Contaminants	Biannual*	USFWS-USGS	ABR, Conoco-Phillips, BRI, EPA, DEC, AMBCC, local and Native community	Rotated among populations
Bycatch of Red-throated Loon	Annual	ADF&G	USGS, USFWS, AMBCC, local Native community	
Fish-Prey abundance	Annual (tied to productivity studies)*	USGS	ADF&G, USFWS**	Targeted areas
Predator monitoring	Every 3 years	USFWS-USGS	Industry, local Native community	

***** After initial 5-yr period, conduct productivity, contaminant and fish-prey studies on a rotational basis if funding is limited.
** Check with fish experts.

I. Recommended time frame for reviewing species status and trends

Review every 5 years, because Red-throated Loons are a species of concern. Individual strategies can be reviewed and modified as needed.

J. Bibliography

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Evers, D.C. 2004. Status assessment and conservation plan for the Common Loon in North America. USFWS, Hadley, MA.

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USFWS (U.S. Fish and Wildlife Service). 2002. Birds of conservation concern 2002. Division of Migratory Bird Management, Arlington, VA. 99 p.

Yellow-billed Loon

A. Species description

Common name: Yellow-billed Loon
Scientific name: *Gavia adamsii*

B. Distribution and abundance

Range:
Global range comments:
Breeding range: High Arctic in United States, Canada, and Russia
Nonbreeding range: Coastal marine waters of northeast and northwest Pacific, and northeast Atlantic.

State range comments:
Breeding: 80% Arctic coastal plain (of these breeders, 91% are within the National Petroleum Reserve-Alaska [NPRA]), 20% in Seward Peninsula.[9] May also be on St. Lawrence Island (North 1994).
Nonbreeding: Coastal marine in Southeast and Southcentral, possibly Southwest Alaska.

Abundance:
Global abundance comments: 16,000 (breeders) (Fair 2002).
State abundance comments: 3,500 (breeders).[10]

Trends:
Global trends: Lack of information to indicate.
State trends: Data being analyzed by USFWS-MBM, likely to be level or slight decline.

C. Problems, issues, or concerns for species

- USFWS was petitioned to list Yellow-billed Loons as a threatened species, due to the small population size, geographically restricted breeding grounds, and their perceived vulnerability to human impact. Breeding range is expected to experience an increase in disturbance associated with energy development.
- Wintertime threats uncertain but possibly significant; use Asian waters where capture of loons in fishing nets, reduced foraging options for loons due to fishing effects, and contaminants are all factors that are not currently well known but are suspected to potentially be significant to this species. Mercury is a contaminant of particular concern.
- Accidental bycatch of loons in fishing nets (commercial and subsistence) also may be an issue on breeding grounds.

[9] Data from 2 surveys flown by USFWS-Migratory Bird Management: the Arctic Coastal Plain survey and the Alaska-Yukon Waterfowl breeding pair survey.
[10] Ibid.

- Lake dynamics and changing phenology associated with global climate change
- Hazards associated with development:
    a) Increase in predation of eggs and chicks due to increase in predator numbers
    b) Increase in predation and nest failure due to increase in air and ground traffic disturbance
    c) Toxic contamination
    d) Oil spills
    e) Lake draw-downs

D. Location and condition of key or important habitat areas

Breeding habitat: (currently they are pristine)

- Large, low-lying tundra lakes greater than 2 m deep (Earnst et al. 2004).
- Large lakes greater than 10 ha (Earnst et al. 2004).
- Lakes that are connected to other water bodies (ultimately to creeks and rivers) (Earnst et al. 2004).
- Localized pockets of higher concentrations (USFWS survey data[11]).

Nonbreeding habitat: (concern that some are degraded)

- Coastal marine habitats. In Asia these are southeast Chukotka Peninsula, Kamchatka Peninsula and other areas in southeast Russia, northern Japan, North and South Korea, and northern China (J.A. Schmutz, USGS, unpublished data). In North America, these are St. Lawrence Island, and Southeast and Southcentral Alaska (North 1994).

E. Concerns associated with key habitats

See above.

F. Goal: Ensure Yellow-billed Loon populations remain sustainable throughout their range within natural population-level variation and historic distribution across Alaska.

G. Conservation objectives and actions

Objective: To maintain the current adult breeding population and sufficient productivity to maintain it.

Target: 3500 adult breeders[12] and mean productivity rate (0.45 young in late summer/nest [ABR, unpublished data]).

Measure: Population number as indicated by the Arctic Coastal Plain Survey. Target productivity rate from surveys around Colville River Delta,[13] and in future may be based on a more geographically expansive Productivity Survey.[14]

[11] Arctic Coastal Plain Survey, flown annually by USFWS (E. Mallek, USFWS-Migratory Bird Management, Fairbanks Office)
[12] Ibid.
[13] Surveys flown by ABR, Inc. (Fairbanks), with funding from Conoco-Phillips.
[14] Newly initiated survey in 2004; flown by USFWS (E. Mallek) with funding from USGS.

Issue 1: Unsure how well surveys measure population; surveys are not designed specifically for loons relative to timing and stratification. Inadequate information on Seward Peninsula populations.

Conservation action: Conduct studies to evaluate phenology of birds' arrival and initiation of breeding relative to survey timing and climatic variations. Also, evaluate detectability of breeders vs. nonbreeders and detection differences among observers.

Issue 2: Inadequate survey to monitor productivity.

Conservation action: Implement survey that is representative of the Arctic coastal plain population.

Issue 3: Development activity may impact reproductive success (productivity), either through an increase in predation of eggs and chicks due to increase in predator numbers, or through an increase in predation and nest failure due to increase in air and ground traffic disturbance.

Conservation actions:

a) Measure behavior and demographic parameters in areas likely to be developed. Do in an experimental context to enable ascribing variation in demography to predators or other disturbance.
b) Monitor predator numbers in newly developed areas.
c) Implement management actions to reduce human impacts that encourage predators.

Issue 4: Inadequate knowledge of lake-specific nesting distribution within potential development areas.

Conservation actions:

a) Conduct additional lake circling surveys to identify additional nesting lakes in areas likely to be developed.
b) Work with industry and agencies to promote specific conservation and mitigation measures for identified nesting lakes.

Issue 5: Lake drawdowns are likely to negatively impact Yellow-billed Loons' reproductive success (Evers 2004).

Conservation actions:

a) Encourage industry to avoid significant drawdown of Yellow-billed Loon nest lakes during nesting season, either known or predicted.
b) Refine habitat models to enable better prediction of nest lakes.

Issue 6: Anecdotal evidence indicates that Yellow-billed Loon are bycatch in commercial and subsistence fishing, but the extent of this problem is unknown.

Conservation actions:

a) Conduct a survey for bycatch on breeding area rivers.
b) Conduct surveys to determine how many loons are caught in nets and how many hours nets are fished.
c) Conduct outreach.

Issue 7: Vulnerability of Yellow-billed Loon to oil spills, and other development impacts, is believed to be important, but the effect on nonbreeding adult populations is unknown.

Conservation actions:

a) Conduct marking studies to understand distribution of nonbreeders
b) Ensure oil companies have contingency plans for spill response that address needs of wildlife and loons.

Issue 8: Contaminants may reduce productivity and other aspects of demography in Yellow-billed Loon populations, based on precedence of common loons (Evers 2004).

Conservation actions:

a) Institutionalize a contaminants monitoring program of loon tissues and prey.
b) Identify sources of contaminants.
c) Compare levels observed in loons to other bird populations in the local area.
d) Identify an acceptable level of contamination for Yellow-billed Loon; data is available for common loons.

Issue 9: Lack of knowledge regarding what fish species Yellow-billed Loons use or prefer, thus difficult to predict impact of natural or anthropogenic effects on fish populations on Yellow-billed Loons.

Conservation actions:

a) Conduct study to identify fish prey selection.
b) Monitor relevant fish populations.

Issue 10: Uncertain if Yellow-billed Loons breeding in Alaska are demographically and genetically distinct from those elsewhere in the world (central Canada and Russia).

Conservation actions:

a) Conduct additional satellite tag studies and initiate a population genetic study.
b) Promote conservation of genetically distinct population segment if warranted.

H. Plan and time frames for monitoring species and their habitats

Plan proposal: select agencies in partnership

	Time Frame	Lead Agency	Partners	Comments
Arctic Coastal Plain Survey	Annual	USFWS-MBM		
Productivity Survey	Annual	USFWS-USGS	ABR, Conoco-Phillips	
Habitat modeling	By 2006	USFWS-USGS		
Lake Circling survey	annual	USFWS-BLM	USGS	Until all effected areas covered
Industrial effects on loon demographics	3 yrs pre, 3 yrs post	BLM-USFWS	Industry, Fairwinds, BRI	

I. Recommended time frame for reviewing species status and trends

Review every 5 years or more frequently as needed.

J. Bibliography

Earnst, S.L., R. Platte, and L. Bond. 2004. A landscape-scale model of Yellow-billed Loon habitat preferences in northern Alaska. Hydrobiologia (in press).

Evers, D.C. 2004. Status assessment and conservation plan for the Common Loon in North America. USFWS, Hadley, MA.

Fair, J. 2002. Status and significance of Yellow-billed Loon (*Gavia adamsii*) populations in Alaska. The Wilderness Society and Trustees for Alaska. 56 p.

North, M.R. 1994. Yellow-billed Loon. In A. Poole, and F. Gill, editors. The birds of North America. The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, DC. No. 121.

Schmutz, J.A., USGS, unpublished data (http://www.absc.usgs.gov/staff/WTEB/jschmutz/Gavia_adamsii_36404.jpg)

Seabirds – Introduction

Alaska's productive seas and isolated islands provide habitat for one of the largest and most diverse assemblages of marine birds in the world. The marine ecosystems that sustain marine birds also support some of the world's largest commercial marine fisheries and support numbers of coastal communities through economics related to fisheries or by providing subsistence food. Marine birds are indicators of the health of the marine ecosystem. Because various species of seabirds use different portions of the marine food web, they provide insight into changes in both the plankton and forage fish communities.

In April 2004, ADF&G convened a group of marine bird experts and asked these scientists to develop a short list of species and/or species groups to feature in the CWCS, including specific conservation actions that could be started in the next decade. More than 40 species of seabirds occur in Alaska, but the group decided to select species based on 2 types of criteria. One group was selected because Alaska has the majority of the world's populations and/or there is concern because they have declining populations. The group included: Red-faced Cormorant, Red-legged Kittiwake, Aleutian Tern, Arctic Tern, Kittlitz's Murrelet, and Marbled Murrelet. The second group included species that are recognized indicators of change in marine ecosystem. Species included to represent plankton feeders were Fork-tailed and Leach's Storm-Petrels (surface feeders) and Least and Crested Auklets (divers). Species that prey on forage fish included Black-legged Kittiwake, and Common and Thick-billed Murres.

The Short-tailed Albatross was first listed under the federal Endangered Species Act on June 2, 1970. It is currently designated as endangered throughout its entire range. A draft formal recovery plan is expected to be completed by the USFWS in mid 2005. NOAA – Fisheries actively engages the commercial fishing industry to minimize take in longline fisheries. Japan provides legal protection for the species, and actively manages its nesting habitat. Commercial import, export, or trade across international borders is prohibited by the CITES. Additional information on the Short-tailed Albatross can be found at http://alaska.fws.gov/fisheries/endangered/pdf/STALfactsheet.pdf

Conservation actions designed to protect marine birds and their habitats shown on the following templates will likely benefit seabirds, but also provide insight into processes that cause change in the marine ecosystem, thereby assisting managers in long-term conservation of these important areas.

Leach's and Fork-tailed Storm-Petrels

Rationale for selection:

These species were selected because:

- Species are endemic (i.e., occur primarily in Alaska or occur entirely within an ecoregion found in Alaska). *O. furcata furcata* is endemic in southwest Beringia and the Kuril region of Russia.
- Species are sensitive to environmental disturbance.

Species are representative of broad array of other species found in a particular habitat type (surface-feeding planktivore).

Species are important internationally (e.g., targeted for cross-jurisdictional action and/or recognized in bi- or multilateral agreements; or useful for cross-jurisdictional monitoring), and will require cooperative monitoring with Canadian Wildlife Service.

Human uses: none known

A. Species group description

Common names: Fork-tailed Storm-Petrel and Leach's Storm-Petrel

Scientific names: *Oceanodroma furcata* and *Oceanodroma leucorhoa*

B. Distribution and abundance (see maps pages 225–226, Appendix 4)

Range:

Fork-tailed Storm-Petrel: (*O. furcata*):

Global range:

Breeding: Alaska and Eastern Russia (to Kuril islands) (Boersma and Silva 2001).

Winter: at sea near breeding areas (Boersma and Silva 2001).

State range:

Breeding: Western Aleutians to Southeast Alaska to Northern Gulf of Alaska (Boersman and Silva 2001). *O. f. plumbea* breeds in Southeast Alaska

Winter: near breeding areas (Boersma and Silva 2001).

Leach's Storm-Petrel (*O. leucorhoa leucorhoa)*

Global range:

Breeding: Holarctic

Wintering: Offshore central Pacific, usually south of 35°north (Huntington 1996)

State range:

Breeding: Southern coast from Western Aleutians to Southeast Alaska

Wintering: Outside Alaska (Huntington 1996)

Abundance:

O. furcata:

Global abundance: 4 million individuals (Boersma and Silva 2001)

State abundance: 3.2 million individuals (USFWS 2003)

O. leucorhoa leucorhoa:

Global abundance: 8 million individuals (Huntington 1996)

State abundance: 3.5 million individuals (USFWS 2003)

Trends:

O. furcata:

Global trends: Stable or increasing since mid 1970s (Dragoo et al. 2003)

State trends: Stable or increasing since mid 1970s (Dragoo et al. 2003)

O. leucorhoa leucorhoa:

Global trends: Declines on Atlantic coast prior to 1900 (Huntington 1996) but apparently stable in 20th century.

State trends: Stable or increasing since mid 1970s (Dragoo et al. 2003)

C. Problems, issues, or concerns for species group

- Populations are sparsely monitored
- Specific winter range is not well defined

Existing

- Human disturbance at particular times
- Introduced predators (e.g, rats, foxes)
- Prey abundance variability
- Oil pollution, including chronic oiling (maybe bilge dumping)
- Light pollution (from fishing vessels anchored near colonies and in forage areas)

Potential

- Oil spills
- Highly susceptible to disturbance at nesting sites due to collapse of earthen burrows (humans, ungulates, dogs, etc.)
- Contaminants
- Rat spills
- Heavy predation (gulls and Northwestern Crows) (supplemental food from fish processing and community landfills near nesting colonies could artificially increase avian predator populations)

D. Location and condition of key or important habitat areas

Summer:

Breeding: Earthen burrows and rock crevices on oceanic islands. Degraded in some locations due to introduced mammals (Boersma and Silva 2001).

Foraging: Inshore and offshore waters relatively near breeding sites. (Boersma and Silva 2001). Condition not known.

Winter:

Foraging: over deep waters in North Pacific, usually north of 40°. Condition unknown.

Areas of significance: Buldir, Chagulak and Petrel Islands

E. Concerns associated with key habitats

Threat of rat spills, chronic oiling, climate change (changes in the food web), attraction/collisions with fishing vessels and platforms in the ocean due to light pollution

Attributes surrounding species success: Most of the nesting habitat lies within federal conservation system units; no commercial harvest currently occurs for forage species; oil discharge regulations; lack of human disturbance; foxes removed from certain islands.

F. Goal: Ensure storm-petrel populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska**.**

G. Conservation objectives and actions

State conservation and management needs:

<u>Objective</u>: Restore storm-petrel populations and distribution to pre-mammal introduction conditions (i.e. reestablish populations on islands after introduced mammals are removed).

Target: Maintain Alaska-wide populations at least at levels existing in year 2000.

Measure: Populations at index locations would be surveyed (e.g., Buldir, Ulak, Aiktak, East Amatuli, St. Lazaria Islands) at least once every 3 years for 20 years; monitor islands where introduced mammals have been removed to detect reestablished populations.

<u>**Issue 1**: Populations are sparsely monitored; specific winter range is not well-defined.</u>

Conservation actions:

a) Determine wintering locations.
b) Maintain a monitoring program.
c) Complete a nesting inventory.

<u>**Issue 2**: Introduced predators, such as rats and foxes, cause increased mortality by consuming eggs and killing adults and young. This results in effectively eliminating or greatly reducing the population size of many seabirds.</u>

Conservation actions:

a) Prevent additional rat introductions.
b) Educate ship crews about rat introduction.
c) Evaluate reestablishment on islands where introduced mammals have been removed.

<u>**Issue 3**: Human disturbance at particular times may contribute to mortality rates through such things as “seabird wrecks” (where large numbers of seabirds are attracted to a fishing boat in bad weather and then are injured or killed while landing on the boat).</u>

Conservation actions:

a) Evaluate disturbance at index colonies.
b) Monitor and evaluate instances of “seabird wrecks” with fishing boats from fishery observer notes; then seek ways to minimize them (Rojek 2001).

<u>**Issue 4**: Prey abundance variability</u>

Conservation action: Monitor foraging species status and trends (state-managed waters, 0–3 miles).

<u>**Issue 5**: Contaminants, oil pollution, including chronic oiling (maybe bilge dumping)</u>

Conservation actions:

a) Conduct research to measure contaminants in eggs.
b) Ensure compliance with discharge regulations for oil and other contaminants.

Issue 6: Light pollution (from fishing vessels working near colonies or in major foraging areas) may attract or disorient seabirds, leading to collisions and mortality, which is known as a type of "seabird wreck" (see Issue 3).

Conservation actions:

a) Educate (ship crews) about light pollution issue and care and release of birds that come aboard.
b) Encourage efforts to shield lights laterally.

Issue 7: Climate change (changes in the food web).

Conservation action: Monitor foraging species status and trends (state-managed waters, 0–3 miles).

Global conservation and management needs:

Conservation action: Add an index location site in Russia for monitoring within 5 years.

H. Plan and time frames for monitoring species and their habitats

- Surveys would be conducted at index locations once every 3 years for 20 years.
- Add a site in Russia within 5 years.
- Colony surveys would be conducted at the index locations (all within the federal refuge system). USFWS is a potential partner.
- TNC to take a lead on adding Russian site.

I. Recommended time frame for reviewing species status and trends

Ten years, or at more frequent intervals in response to additional information.

J. Bibliography

Dragoo, D.E., G.V. Byrd, and D.B. Irons. 2003. Breeding status, population trends and diets of seabirds in Alaska, 2001. USFWS. Report AMNWR 03/05.

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Huntington, C.E., R.G. Butler, and R.A. Mauck. 1996. Leach's Storm-Petrel (*Oceanodroma leucorhoa*). In: A. Poole and F. Gill, editors. The Birds of North America, No. 233.

Rojek, N. 2001. Biological Rationale for Artificial-Lighting Concerns in the Channel Islands. Unpublished report. California Department of Fish and Game, Marine Region, Monterey, California.

Red-faced Cormorant

Rationale
This species was selected because:

- Species[1] has noticeably declined in abundance or productivity from historical levels outside the range of natural variability.
- Species is rare (i.e., small/low overall population size/density).
- Species is designated as at risk (threatened, candidate, or endangered under ESA; state endangered or species of concern; depleted under Marine Mammal Protection Act).
- Species is endemic (i.e., occurs primarily in Alaska or occurs entirely within an ecoregion found in Alaska).
- Species makes seasonal use of a restricted local range (breeding, wintering, and migration).
- Species is sensitive to environmental disturbance.
- Species is representative of broad array of other species found in a particular habitat type.
- Species is important internationally (e.g., targeted for cross-jurisdictional action and/or recognized in bi- or multilateral agreements; or useful for cross-jurisdictional monitoring).

Human Uses
Viewing, ceremonial/subsistence

A. Species description

Common name: Red-faced Cormorant
Scientific name: *Phalacrocorax urile*

B. Distribution and abundance (see map page 227, Appendix 4)

Range:
Global range comments: Southern Alaska, Prince William Sound, Aleutian Islands, Commander Islands, Kuril Islands (USFWS 2003)
Breeding: Russia, northern Sea of Japan and Kuril Islands (Causey 2002).
Winter range: Dispersed throughout breeding range (Causey 2002).
State range comments: Thought to be largely resident
Breeding: Gulf of Alaska extending throughout the Alaska Peninsula and Aleutian Islands. (Causey 2002).
Wintering range: Dispersed throughout breeding range (Causey 2002).

Abundance:
Global abundance comments: 155,000 individuals (as of 1993) (Causey 2002, USFWS 2003)
State abundance comments: 20,000 individuals (USFWS 2003)

[1] Use of the word "species" includes species, subspecies and distinct populations.

Trends:
Global trends: Generally declining, unknown for Russian populations (Causey 2002)
State trends: Declining (Dragoo et al. 2003)

C. Problems, issues, or concerns for species

Existing

- Incidental mortality in fishing gear (Manly et al. 2003; 2 were taken in Kodiak setnet fishery, which extrapolated to ~ 28/year; this was high relative to local population)
- Exotic mammals (e.g., rats, foxes)
- Habitat change, such as the kelp forest changing and warming temperatures
- Prey abundance variability
- Oil pollution, including chronic oiling (maybe bilge dumping)

Potential

- Oil spills
- Highly susceptible to disturbance at nesting sites (commercial fishing, tourism near to shore)
- Contaminants
- Disease
- Localized overharvests

D. Location and condition of key or important habitat areas

Nesting and roosting: Cliff ledges on oceanic islands or the mainland coast, the majority of which lie within designated conservation lands. These areas are generally pristine, but some have introduced predators.

Foraging: Inshore marine waters, generally less than 50 m deep (Causey 2002): some areas are degraded by chronic oiling; this habitat includes kelp forests that will decline as sea otter populations decline. May also be subject to effects of bottom trawling and derelict fishing gear.

The Near Islands are a particularly high concentration area, probably due to the large expanse of shallow feeding areas. This area is subject to chronic oiling and substantial changes in the kelp forest due to changes in sea otter populations.

Areas of significance: Attu, Agattu, and Semichi Islands.

E. Concerns associated with key habitats

Summer

Nesting: threat of rat spills, change in land management and/or status, land use regulations.
Foraging: chronic oiling, climate change (changes in the food web), gillnet mortality and entanglement in derelict fishing gear.

Winter

Foraging: chronic oiling, climate change (changes in the food web), gillnet mortality and entanglement in derelict fishing gear.

Attributes surrounding species success: Most of the nesting/roosting habitat lies within conservation units; no commercial harvest currently occurs for forage species such as capelin, sand lance, small demersal fishes, but cormorants also eat juveniles of rockfish, cod, pollock, flatfish, and herring, all of which are fished commercially; oil discharge regulations; lack of human disturbance; foxes removed from certain islands.

F. Goal: Ensure Red-faced Cormorant populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

Objective: Restore Red-faced Cormorant population levels to those of the late 1970s by 2025. (1970s represent first "comprehensive" baseline numbers).

Target: Alaska-wide population of 50,000 individuals.

Measure: Populations at index locations would be surveyed (Near Islands, Kodiak, Amak, Rat Islands, Pribilofs) once every 5 years for 20 years.

Issue 1: Cause of the population decline is unknown; issues preventing population recovery are unknown.

Conservation actions:

a) Measure shifts in nesting colonies, adult mortality, reproductive success, and other vital rates to evaluate conservation status using demographic models.
b) Evaluate disease and gillnet mortality as a factor in population declines.
c) Evaluate preferred habitat features and changes in nearshore, benthic habitats, and fishes.

Issue 2: Incidental mortality in fishing gear.

Conservation actions:

a) Reduce mortality related to fishing and fishing gear – learn more about fisheries occurring in Red-faced Cormorant habitat and extent of interactions (temporal and spatial overlap and factors associated with entanglement).
b) Conduct studies to devise bird-safe gillnet gear and practices.

Issue 3: Predation by or impacts from exotic mammals (e.g., rats or foxes).

Conservation actions:

a) Conduct additional predator removal programs.
b) Prevent rat introductions.
c) Conduct rat response program.

Issue 4: Habitat or climate change, such as the kelp forest changing and warming temperatures (concerns with changes in the food web).

Conservation action: Monitor changes in nearshore marine habitats in selected areas to evaluate the status and trends of forage fish species used a prey by cormorants (state-anaged waters, 0–3 miles).

Issue 5: Prey abundance variability.

Conservation action: (see above, Habitat or Climate change)

Issue 6: Contaminants, oil pollution, including chronic oiling (maybe bilge dumping).

Conservation actions:
a) Bilge control (chronic oiling); monitor/improve oil spill planning and response (product shippers).
b) Evaluate contaminants in Red-faced Cormorant eggs.
c) Conduct regular beach bird surveys in selected areas.

Issue 7: Human disturbance at nesting sites (tourism near shore, commercial fishing).

Conservation action: Monitor increase of ecotourism at or near cormorant nesting areas; educate to avoid disturbance of Red-faced Cormorants.

Issue 8: Localized overharvest.

Conservation actions:
a) Monitor harvest or other human use.
b) Educate subsistence users to identify different cormorant species and teach them about population problems of this species, its rarity and uniqueness to Alaska, and ecotourism interest.

Global conservation and management needs:

Objective: Determine global population trends outside Alaska and interchange between Russian and U.S. populations.

Target: 5-year review and update of available data and use of genetics and telemetry to evaluate interchange.

Measure: Maps, population estimates and trends for key areas.

Issue: Consolidate bycatch information available outside Alaska and determine whether Russian populations are unique genetically compared to Alaska populations.

Conservation action: Education; provide our products to international lists.

H. Plan and time frames for monitoring species and their habitats

Surveys would be conducted at index locations once every 5 years for 20 years. Colony surveys would be conducted at the index locations (all within the federal refuge system). USFWS is a potential partner.

I. Recommended time frame for reviewing species status and trends

Ten years, or at more frequent intervals in response to additional information.

J. Bibliography

Causey, D. 2002. Red-faced Cormorant (*Phalacrocorax urile*). In: A. Poole and F. Gill, editors. The Birds of North America, No. 617.

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USFWS. 2003. Beringian Seabird Colony Catalog–computer database and Colony Status Record archives. Anchorage: USFWS Migratory Bird Management.

Manly, B.F.J., A.S. Van Atten, K.J. Kuletz, and C. Nations. 2003. Incidental catch of marine mammals and birds in the Kodiak Island set gillnet fishery in 2002. Final report by Western EcoSystems Technology, Inc., Cheyenne, WY, for NMFS, Juneau, AK.

Black-legged Kittiwake

Rationale
This species was selected because:
Species is sensitive to environmental disturbance.
Species is representative of broad array of other species found in a particular habitat type. (For marine environment: fisheries, maybe other seabird habitat and surface fish feeders).
Species is important internationally (e.g., targeted for cross-jurisdictional action and/or recognized in bi- or multilateral agreements; or useful for cross-jurisdictional monitoring).

Human Uses
Subsistence egging, and viewing.

A. Species description

Common name: Black-legged Kittiwake
Scientific name: *Rissa tridactyla*

B. Distribution and abundance (see map page 228, Appendix 4)

Range:
Global range comments: circumpolar, sub-Arctic and Arctic regions
Breeding: Baffin Island, Jones Sound, Prince Leopold Island, Barrow Strait, Newfoundland, Nova Scotia, New Brunswick, Northwest Territories (Baird 1994), Greenland, and Alaska.
Winter range: range extends widely from breeding areas (Baird 1994).

State range comments:
Breeding: in Alaska: Southeast through Gulf of Alaska and Aleutian Islands, north to Point Hope (Baird 1994).
Winter range: pelagic, south of ice edge, Gulf of Alaska, Aleutians and Southeast Alaska (Baird 1994).

Abundance for ***Rissa tridactyla pollicaris***:
Global abundance comments: 2.6 million (Pacific region) (Baird 1994).
State abundance comments: 1.4 million (USFWS 2003).

Trends:
Global trends: Variable (Baird 1994).
State trends: Variable since the mid 1970s (Dragoo 2003).

C. Problems, issues, or concerns for species

Existing
- Exotic mammals (for example, rats, foxes)
- Habitat change due to changing and warming temperatures
- Prey abundance variability
- Oil pollution, including chronic oiling (may be bilge dumping)

Potential
- Oil spills
- Disturbance at nesting sites (commercial fishing, tourism near to shore)
- Contaminants
- Artificially enhanced concentrations of natural predators (e.g., gulls, eagles)

D. Location and condition of key or important habitat areas

Summer
Breeding: cliff ledges on oceanic islands or the mainland coast, the majority of which lie within designated conservation lands. Condition: These areas are generally pristine, but some have introduced predators.
Foraging: marine waters. Condition: good

Winter
Foraging: in marine waters in Gulf and in Southeast Alaska. Condition: very good

Areas of particular significance: Beringian Seabird Colony Catalog suggests that largest colonies are northern and western Gulf of Alaska and Bering Sea (USFWS 2003).

E. Concerns associated with key habitats

Summer breeding: threat of rat spills, change in land management status and land use regulations
Summer foraging: oil spills, climate change (changes in the food web), changes in land use regulations
Winter foraging: oil spills, climate change (changes in the food web)

Attributes surrounding species success: Most of the nesting habitat lies within protected areas; no commercial harvest currently occurs for forage species; oil discharge regulations; lack of human disturbance; foxes removed from certain islands.

F. Goal: Ensure Black-legged Kittiwake populations remain sustainable and viable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

Objective: Maintain 2004 population levels of Black-legged Kittiwake.

Target: Maintain Alaska population of 2.5 million, along with viable global population.

Measure: Index of abundance; Black-legged Kittiwake currently monitored by USFWS periodically (some annually, others not) at approximately 16 locations in Alaska, mostly federal refuges but also some state lands (e.g., Round Island) and Native lands, and reported regularly in "Breeding Status, Population Trends and Diets of Seabirds in Alaska" (e.g., see Dragoo et al. 2003); continue current level or increase monitoring, since this species has been included as an indicator species.

Issue 1: Additional introduction of exotic predators and artificially concentrating native predators; failure to address the above mentioned threats.

Conservation actions:

a) Continue or expand existing level of research.
b) Continue or expand existing monitoring of abundance.
c) Conduct additional predator removal programs.
d) Prevent rat introductions.
e) Conduct rat response program.
f) Regulate supplement feeding or open trash near kittiwake colonies.

Issue 2: Oil pollution, including chronic oiling (maybe bilge dumping).

Conservation actions:

a) Bilge control (to prevent chronic oiling).
b) Oil spill planning and response (product shippers) – one idea/measure is to develop and distribute a multilingual press kit/education and outreach program designed to reduce chronic oiling.

Issue 3: Prey abundance variability.

Conservation action: Monitor status and trends of forage fish used by Black-legged Kittiwake as prey (state-managed waters, 0–3 mi).

Issue 4: Climate change.

Conservation action: Monitor changes in the marine environment relative to Black-legged Kittiwake population parameters.

H. Plan and time frames for monitoring species and their habitats

Surveys would be conducted at index locations on the current schedule of once every 1–5 years.

USFWS is currently lead on surveys, with assistance from ADF&G. Continue this relationship.

I. Recommended time frame for reviewing species status and trends

Ten years, or at more frequent intervals in response to additional information.

J. Bibliography

Baird, P.H. 1994. Black-legged Kittiwake, *Rissa tridactyla*. In: A. Poole and F. Gill, editors. The Birds of North America, 92.

Dragoo, D.E., G.V. Byrd, and D.B. Irons. 2003. Breeding status, population trends and diets of seabirds in Alaska, 2001. USFWS. Report AMNWR 03/05.

USFWS. 2003. Beringian Seabird Colony Catalog—computer database and Colony Status Record archives. Anchorage: USFWS Migratory Bird Management.

Red-legged Kittiwake

Rationale

This species was selected because:

- Species has noticeably declined in abundance or productivity from historical levels outside the range of natural variability.
- Species is rare (i.e., small/low overall population size/density).
- Species is endemic (i.e., occurs primarily in Alaska or occurs entirely within an ecoregion found in Alaska).
- Species makes seasonal use of a restricted local range (breeding, wintering, migration).
- Species is disjunct (i.e., isolated from other populations or occurrences in adjacent ecoregions).
- Species is important internationally (e.g., targeted for cross-jurisdictional action and/or recognized in bi- or multilateral agreements; or useful for cross-jurisdictional monitoring).

Human Uses

Subsistence egging and subsistence hunting in Pribilofs and possibly Commander Islands

A. Species description

Common name: Red-legged Kittiwake
Scientific name: *Rissa brevirostris*

B. Distribution and abundance (see map page 229, Appendix 4)

Range:

Global range:

Breeding: Southern Bering Sea, Aleutian, Pribilof and Commander Islands (Byrd and Williams 1993).

Winter range: At sea, probably North Pacific (Byrd and Williams 1993).

State range:

Breeding: Pribilof Islands (St. George and St. Paul), Bogoslof Island, and Buldir Island. (Byrd and Williams 1993).

Winter range: North Gulf of Alaska and the Bering Sea. (Byrd and Williams 1993).

Abundance:

Global abundance: approximately 200,000 individuals (Byrd unpublished data).

State abundance: approximately 195,000 individuals (over 80% on St. George Island) (Byrd unpublished data).

Trends: **(based on Pribilof data)**

Global trends: Declined from mid 1970s to mid 1980s, but have increased since, to near 1970s levels (Dragoo et al. 2003).

State trends: Declined from mid 1970s to mid 1980s, but have increased since, to near 1970s levels (Byrd et al. 1997, Dragoo et al. 2003).

C. Problems, issues, or concerns for species

- Winter range and winter threats are poorly understood.
- Reasons for large population fluctuations in Pribilofs not well understood.

Existing

- Prey abundance and quality variability
- Oil pollution, including chronic oiling (may be bilge dumping)

Potential

- Oil spills
- Contaminants
- Rat spills

D. Location and condition of key or important habitat areas

Summer:

Nesting and roosting: cliff ledges on oceanic islands. Condition: good, mostly protected.

Foraging: marine waters, near breeding colonies near the continental shelf edge. Condition: unknown

Winter:

Foraging: poorly known, probably marine waters in North Pacific. Condition: unknown

Main nesting colonies: St. Paul, St. George, Bogoslof, Buldir, and Commander Islands (USFWS 2003).

E. Concerns associated with key habitats

- Rat spills, chronic oiling, climate change (changes in the food web)
- Change in land management status and/or land use regulations

Attributes surrounding species success: The entire nesting/roosting habitat lies within protected areas; no commercial harvest currently occurs for forage species; oil discharge regulations; lack of human disturbance.

F. Goal: Ensure Red-legged Kittiwake populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

Objective: Restore population levels of Red-legged Kittiwake to 1970s levels.

Target: Maintain Alaska-wide population of at least 200,000 individuals (mid 1970s estimate).

Measure: Develop and use an index of abundance at key locations.

Issue 1: Contamination, oil pollution, including chronic oiling (may be bilge dumping)

Conservation actions:

a) Bilge control (to prevent chronic oiling).
b) Oil spill planning and response (product shippers) – one idea/measure is to develop and distribute a multilingual press kit/education and outreach program designed to reduce chronic oiling.
c) Measure contaminants in eggs and determine if negative effects are occurring.

Issue 2: Prey abundance and quality variability

Conservation action: Monitor foraging species status and trends (state-managed waters, 0–3 mi).

Issue 3: Rat spills

Conservation actions:

a) Prevent rat introductions.
b) Educate regarding rat introductions.

Issue 4: Reasons for large population fluctuations in Pribilofs not well understood.

Conservation actions:

a) Determine wintering locations.
b) Measure productivity (to evaluate fluctuations based on prey variability).
c) Evaluate prey variability.
d) Maintain a population monitoring program.
e) Evaluate disturbance at index colonies.

Global conservation and management needs:

Objective: Determine amount of interaction between Russian and Alaska populations

Target: Genetic markers and/or radiotelemetry in place on an adequate sample of birds from each population to determine interaction

Measure: Number of genetic markers and/or radiotelemetry in place relative to the population sizes

Issue: Genetic distinctiveness of populations is not well understood.

Conservation action: If distinct, Alaska populations need even more scrutiny.

H. Propose plan and time frames for monitoring species and their habitats

Surveys would be conducted at index locations once every 3 years for 20 years.

Colony surveys would be conducted at the index locations by USFWS. Audubon is a potential partner especially at Commander Islands.

I. Recommended time frame for reviewing species status and trends

Ten years, or at more frequent intervals in response to additional information.

J. Bibliography

Byrd, G.V. and J.C. Williams. 1993. Red-legged Kittiwakes *Rissa brevirostri*s. In: A. Poole and F. Gill, editors. The Birds of North America, No. 60,

Byrd, G.V., J.C. Williams, Y.B. Artukhin and P.S. Vyatkin. 1997. Trends in populations of Red-legged Kittiwake *Rissa brevirostris*, a Bering Sea endemic. Bird Conservation International 7:167–180.

Dragoo, D.E., G.V. Byrd, and D.B. Irons. 2003. Breeding status, population trends and diets of seabirds in Alaska, 2001. USFWS. Report AMNWR 03/05.

USFWS. 2003. Beringian Seabird Colony Catalog—computer database and Colony Status Record archives. Anchorage: USFWS Migratory Bird Management.

Arctic Tern

Rationale
This species was selected because:

- Species has noticeably declined in abundance or productivity from historical levels outside the range of natural variability.
- Species is sensitive to environmental disturbance.
- Species status is unknown (e.g., population information is unknown, or taxonomy is questionable).
- Species is representative of broad array of other species found in a particular habitat type.
- Species is important internationally (e.g., targeted for cross-jurisdictional action and/or recognized in bi- or multilateral agreements; or useful for cross-jurisdictional monitoring).

Human Uses
Possible subsistence egging at Nunivak and Yakutat

A. Species description

Common name: Arctic Tern
Scientific name: *Sterna paradisaea*

B. Distribution and abundance (see map page 230, Appendix 4)

Range:
Global range:
Breeding: Circumpolar from the shores of the Arctic Ocean to as far south as 41^{o}, nests widely inland in the far north.
Winter: Principally Antarctica, but little data. Birds seen as far south as Ross Sea, numerous sightings around Australia and a few from South Africa.
State range:
Breeding: Nests coastally and inland from the Arctic Ocean to Southeast Alaska
Winter: Thought that birds from around the circumpolar north winter principally in Antarctica, but little data. Birds seen as far south as Ross Sea, numerous sightings around Australia and a few from South Africa.

Abundance:
Global abundance comments: incomplete data, but likely 1–2 million individuals (Hatch 2003)
State abundance comments: ~10,000 individuals nesting coastally, unknown inland (USFWS 2003)

Trends:
Global trends: Population is not monitored, but thought to be declining
State trends: Population is not monitored, but coastal population has declined (Agler 1999, Stephensen et al. 2002, Stephensen et al. 2003).

C. Problems, issues, or concerns for species

- Population is not monitored, especially at inland breeding areas
- Winter range is not known well for Alaskan birds
- Potential for identification confusion with Aleutian Terns

Existing

- Human disturbance at particular times
- Introduced predators (e.g., rats, foxes) and human-caused increases in corvids, gulls, and other native predators
- Prey abundance variability
- Oil pollution, including chronic oiling (possibly bilge dumping)

Potential

- Oil spills
- Highly susceptible to disturbance at nesting sites (commercial fishing, tourism near to shore)
- Contaminants
- Rat spills
- Ship wakes
- Heavy predation (gulls)

D. Location and condition of key or important habitat areas

Summer:
Breeding: Flat, grassy or mossy areas, coastal spits; frequently mixed with Aleutian Terns. Some colonies degraded due to disturbance from humans.
Relatively large colonies occurred in Prince William Sound and on Kodiak Island in the Gulf of Alaska, but those populations have declined by more than 90%. These habitats are dynamic and subject to dramatic change (e.g., earthquakes and marine erosion).
Foraging: Inshore marine waters, coastal lagoons, streams and lakes (Hatch 2003). Condition good (as far as we know).

Winter:
Foraging: little known, but probably nearshore waters. Condition unknown.

Arctic Tern habitat may be affected by climate change (change in distribution of prey species). Arctic Terns are susceptible to disturbance by humans and domestic dogs.

E. Concerns associated with key habitats

- Rat spills, chronic oiling, climate change (changes in the food web)

- Change in land management status and/or land use regulations (research: how many sites are within/outside protected areas)

Attributes surrounding species success: Most of the nesting/roosting habitat lies within protected areas; no commercial harvest currently occurs for forage species; oil discharge regulations; lack of human disturbance in remote areas; foxes removed from certain islands.

F. Goal: Ensure Arctic Tern populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

Objective: Restore Arctic Tern coastal population levels to those of the late 1970s by 2025 (1970s represent first "comprehensive" baseline numbers).

Target: Alaska coastal population of at least 30,000 individuals.

Measure: Populations at index locations would be surveyed (e.g., Prince William Sound, Kodiak Island, Port Moller, Yakutat, Andreanof Islands) once every 5 years for 20 years.

Issue 1: Except for effects of the 1964 earthquake, factors causing the population decline or preventing population recovery are unknown.

Conservation action: Determine factors affecting population decline and recovery.

Issue 2: Population is not monitored; winter range is unknown.

Conservation actions:

a) Establish a monitoring program including species identification training.
b) Determine wintering locations (e.g., access Seabird Observer Database from fisheries observers).
c) Measure productivity.
d) Complete a nesting inventory.

Issue 3: Human disturbance.

Conservation actions:

a) Evaluate disturbance at index colonies.
b) Educate public to avoid disturbance of Arctic Terns.

Issue 4: Introduced predators.

Conservation actions:

a) Prevent rat introductions.
b) Control domestic and feral dogs and cats.
c) Control sources of human-caused increases in predators (e.g., uncovered dumps near colonies).

Issue 5: Prey abundance variability.

Conservation action: Determine foraging habits.

Issue 6: Contaminants; oil pollution, including chronic oiling (e.g., bilge pumping).

Conservation actions:
a) Measure contaminants in Arctic Tern eggs.
b) Monitor compliance with regulations on oil and other contaminants discharges.

Issue 7: Ship wakes can cause waves that flood nests.

Conservation action: Develop an education program for vessel users operating near colonies

Issue 8: Heavy predation by gulls.

Conservation action: Control sources of gull attraction/supplemental feeding.

Global conservation and management needs:

Objective: Determine the extent of interaction and genetic exchange with Russian populations.

Target: Genetic markers and/or radiotelemetry in place on an adequate sample of birds from each population to determine interaction.

Measure: Number of genetic markers and/or radiotelemetry relative to the population sizes.

Issue: Genetic distinctiveness of populations is uncertain.

Conservation action: If distinct, Alaska populations need even more scrutiny.

H. Plan and time frames for monitoring species and their habitats

Surveys would be conducted at index locations once every 5 years for 20 years.

Colony surveys would be conducted at the index locations by ADF&G. USFWS, NPS, USFS, and the Copper River Delta Inst. (USFS), the Prince William Sound Science Center, and TNC are potential partners.

I. Recommended time frame for reviewing species status and trends

Ten years, or at more frequent intervals in response to additional information

J. Bibliography

Agler, B.A., S.J. Kendall, D.B. Irons, and S.P. Klosiewski. 1999. Declines in Marine Bird Populations in Prince William Sound, Alaska Coincident with a Climatic Regime Shift. Waterbirds 22 (1): 98–103.

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Hatch, J.J. 2002. Arctic Tern (*Sterna paradisaea*). In: A. Poole and F. Gill, editors. The Birds of North America, No. 707.

Stephensen, S.W., D.C. Zwiefelhofer, and R.J. Howard. 2002. Seabird Colony Survey of South and East Kodiak Island, Alaska, June 2001. USFWS Report. Migratory Bird Management, Anchorage, AK.

Stephensen, S.W., D.C. Zwiefelhofer, and L. Slater. 2003. Seabird Colony Survey of North and West Kodiak Island, Alaska, June 2002. USFWS Report. Migratory Bird Management, Anchorage, AK.

USFWS. 2003. Beringian Seabird Colony Catalog—computer database and Colony Status Record archives. USFWS. Migratory Bird Management, Anchorage, AK.

Aleutian Tern

Rationale
This species was selected because:
- The population has recently declined
- Small restricted range
- Rare species, endemic to Alaska
- Winter range unknown
- Imperiled
- Species is sensitive to environmental disturbance

Human Uses
Possible subsistence egging at Nunivak and Yakutat

A. Species description

Common name: Aleutian Tern
Scientific name: *Sterna aleutica*

B. Distribution and abundance (see map page 231, Appendix 4)

Range:
Global range comments:
Breeding: Alaska and Eastern Russia (Sakalin Island) (North 1997)
Winter range: Outside Alaska, location unknown, probably Southeast Asia (North 1997)
State range comments:
Breeding: Extend patchily along coast from Yakutat to Attu, and north to southeastern Chukchi Sea (USFWS 2003)

Abundance:
<u>Global abundance comments:</u> 20,400 individuals (North 1997)
<u>State abundance comments:</u> 12,900 individuals (North 1997)

Trends:
<u>Global trends:</u> Population is not monitored, but thought to be declining
<u>State trends:</u> Population is not monitored, but thought to be declining

C. Problems, issues, or concerns for species

- Population is not monitored
- Winter range is not known
- Potential for confusion of identification with Arctic Tern

Existing
- Competition with Arctic Tern
- Human disturbance at particular times
- Introduced predators (e.g., rats, foxes)
- Human-caused increases in natural predators (e.g. gulls, corvids)
- Prey abundance variability
- Oil pollution, including chronic oiling (may be bilge dumping)

Potential
- Oil spills
- Highly susceptible to disturbance at nesting sites (commercial fishing, tourism near to shore)
- Contaminants
- Rat spills
- Ship wakes
- Heavy predation (gulls)

D. Location and condition of key or important habitat areas

Summer:
Breeding: flat grassy or mossy areas, coastal spits; frequently mixed with Arctic Terns. Some colonies degraded due to disturbance from humans
Relatively large colonies occur at Yakutat, Icy Bay, Port Moller Spit, Safety Lagoon and Amchitka Island. The Copper River Delta, which was formerly a large nesting location, is apparently no longer used. These habitats are dynamic and subject to dramatic change (e.g., earthquakes and marine erosion).
Foraging: Inshore marine waters, coastal lagoons (North 1997). Condition good (as far as we know).

Winter:
Foraging: little known, but probably nearshore waters. Condition of habitat unknown.

Aleutian Tern habitat may be affected by climate change (change in distribution of prey species). Aleutian Terns are susceptible to disturbance by humans and domestic dogs.

Areas of Significance: Port Moller Spit, Yakutat, Icy Bay, Safety Lagoon and Amchitka Island

E. Concerns associated with key habitats

- Summer breeding: threat of rat spills, chronic oiling, climate change (changes in the food web)
- Change in land management status and/or land use regulations (research: how many sites are within/outside conservation areas)
- Winter foraging: oil spills

Attributes surrounding species success: Most of the nesting/roosting habitat lies within protected areas; no commercial harvest currently occurs for forage species; oil discharge regulations; lack of human disturbance; foxes removed from certain islands.

F. Goal: Ensure Aleutian Tern populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

<u>Objective</u>: Restore Aleutian Tern population levels to those of the late 1970s by 2025 (1970s represent first "comprehensive" baseline numbers).

Target: Alaska-wide population of at least 10,000 individuals (late 1970s estimate).

Measure: Populations at index locations would be surveyed (e.g. Port Moller Spit, Yakutat, Icy Bay, Safety Lagoon and Amchitka Island) once every 5 years for 20 years.

<u>**Issue 1**: Except for effects of the 1964 earthquake, factors causing the population decline or preventing population recovery are unknown.</u>

Conservation action: Determine factors affecting population decline and recovery.

<u>**Issue 2:** Population is not monitored; winter range is unknown.</u>

Conservation actions:

a) Establish a monitoring program including species identification training.
b) Determine wintering locations.
c) Measure productivity.
d) Complete a nesting inventory.

<u>**Issue 3**: Human disturbance.</u>

Conservation actions:

a) Evaluate disturbance at index colonies.
b) Educate public to avoid disturbance of Aleutian Terns.

<u>Issue 4:</u> <u>Introduced predators.</u>

Conservation actions:

a) Prevent rat introductions.
b) Control domestic and feral dogs and cats.

<u>Issue 5:</u> <u>Prey abundance variability.</u>

Conservation action: Determine foraging habits.

<u>Issue 6:</u> <u>Contaminants; oil pollution, including chronic oiling (e.g., bilge pumping).</u>

Conservation actions:

a) Measure contaminants in Aleutian Tern eggs.
b) Monitor compliance to regulations on oil and contaminant discharges from ships.

<u>Issue 7:</u> <u>Ship wakes can cause waves that flood nests.</u>

Conservation action: Develop an education and outreach program to fishing, tour, and recreational vessels.

<u>Issue 8:</u> <u>Heavy predation by gulls.</u>

Conservation action: Control sources of gull attraction (e.g., uncovered dumps) near tern colonies.

Global conservation and management needs:

<u>Objective</u>: Determine the extent of interaction and genetic exchange with Russian populations.

Target: Genetic markers and/or radiotelemetry in place on an adequate sample of birds from each population to determine interaction.

Measure: Number of genetic markers and/or radiotelemetry relative to the population sizes.

<u>Issue</u>: <u>Are the populations distinct genetically?</u>

Conservation action: If distinct, Alaska populations need even more scrutiny.

H. Plan and time frames for monitoring species and their habitats

Surveys would be conducted at index locations once every 5 years for 20 years.

Colony surveys would be conducted at the index locations by ADF&G. USFWS, NPS, USFS, and the Copper River Delta Inst. (USFS), the Prince William Sound Science Center, and TNC are potential partners.

I. Recommended time frame for reviewing species status and trends

Ten years, or at more frequent intervals in response to additional information.

J. Bibliography

North, M.R. 1997. Aleutian Tern (*Sterna aleutica*) In: A. Poole and F. Gill, editors. The Birds of North America, No. 291.

USFWS. 2003. Beringian Seabird Colony Catalog—computer database and Colony Status Record archives. Anchorage: USFWS Migratory Bird Management.

Common and Thick-billed Murres

Rationale

These species were selected because:

- Species are sensitive to environmental disturbance.
- Species are representative of broad array of other species found in a particular habitat type.
- Species are important internationally (e.g., targeted for cross-jurisdictional action and/or recognized in bi- or multilateral agreements; or useful for cross-jurisdictional monitoring).

Human Uses

Subsistence egging, subsistence hunting, and viewing.

A. Species group description

Common names: Common Murre and Thick-billed Murre
Scientific names: *Uria aalge* and *Uria lomvia*

B. Distribution and abundance (see maps pages 232–235, Appendix 4)

Range:
Common Murre

Global range comments: circumpolar, sub-Arctic and Arctic regions
Breeding: Greenland, Iceland, Norway, Sea of Okhotsk, and Chukchi Sea along Asian coast of Bering Sea to Kamchatka.
Wintering: pelagic south of ice edge, little islands in the Pacific

State range comments:
Breeding: Southeast through Gulf of Alaska and Aleutian Islands, north to Cape Lisburne.
Winter range: Pelagic, south of ice edge, Gulf of Alaska, Aleutians and Southeast Alaska.

Thick-billed Murre
<u>Global range comments:</u> circumpolar, sub-Arctic and Arctic regions
Breeding: Canada, Greenland, Iceland, Norway, Siberian Coast, Kamchatka, and Sea of Okhotsk.
Wintering: open waters off of breeding sites
<u>State range comments:</u>
Breeding: Southeast through Gulf of Alaska and Aleutian Islands, north to Cape Lisburne.
Winter range: Pelagic, south of ice edge, Gulf of Alaska, Aleutians and Southeast Alaska.

Abundance:
Common Murre
<u>Global abundance comments:</u> 13.0–20.7 million individuals (Ainley 2002)
<u>State abundance comments:</u> each species approximately 5 million (USFWS 2003)

Thick-billed Murre
<u>Global abundance comments:</u> 15–20 million individuals (Gaston 2000).
<u>State abundance comments:</u> both species approximately 5 million (USFWS 2003)

Trends:
Common Murre
<u>Global trends:</u> Changes in decadal sea surface temperatures in climatic indices seem to be associated with changes in murre population levels. Overall, no clear trend direction. Likely declining in Atlantic, but unclear trends in Pacific. (D. Irons, USFWS, unpubl. data)
<u>State trends:</u> Unclear (Dragoo 2003).

Thick-billed Murre
<u>Global trends:</u> Eastern Canada stable or increasing, Greenland substantially decrease during 1940s to 1980s probably unchanged since then. (Gaston 2000).
<u>State trends:</u> Unclear (Dragoo 2003).

C. Problems, issues, or concerns for species group

Existing

In the past, gillnet fisheries impacted murre populations, particularly in California, but this problem has been resolved in California. Gillnets are still a source of mortality in Alaska; murres were the most common bycatch in gillnets in studies done in Prince William Sound, South Unimak, and Kodiak (Wynne et al. 1991; Manly et al. 2003).

- Exotic mammals (e.g., rats, foxes)
- Habitat change due to changing and warming temperatures
- Prey abundance variability
- Oil pollution, including chronic oiling (may be bilge dumping); most of birds killed in 1989 Exxon Valdez oil spill were murres (Piatt et al. 1990)
- Interactions with fisheries – gillnets, etc.
- Mortality in derelict fishing gear
- Winter die-offs (most common species in seabird die-offs) (Piatt and Van Pelt 1997) may indicate starvation problems in winter, or presence of marine biotoxins, which can increase as sea temperatures increase

Potential

- Oil spills
- Disturbance at nesting sites (commercial fishing, tourism near to shore)
- Contaminants
- Egging and harvest
- Increased occurrence of toxic algae blooms, etc., due to warming of water temperature

D. Location and condition of key or important habitat areas

Summer:

Breeding: Cliff ledges on oceanic islands or the mainland coast, the majority of which lie within designated conservation lands. These areas are generally pristine, but some have introduced predators.

Foraging: Common murre, marine waters within 60–0 km of colony; thick-billed murres, up to 170 km from colony (Gaston 2000).

Winter:

Foraging: In offshore marine waters (though they occasionally occur in large numbers in some inside waters, such as Prince William Sound, Resurrection Bay [USFWS unpubl. data])

Areas of particular significance:

Common Murre: St. George, Round Island, Hall Island (USFWS 2003). Cape Pierce, Bluff, Chammisso, Puffin Islands, St. Lawrence Island, and Little Diomede Island. Most big Bering Sea islands (St. Matthew, Hall, St. Lawrence, Little Diomede are about 50% Common Murre and 50% Thick-billed Murre, and so are significant to both species.

Thick-billed Murre: St. George (USFWS 2003) and Cape Lisburne. Cape Thompson and Cape Lisburne in the eastern Chukchi Sea are about 70% Thick-billed Murres and 30% Common Murres.

E. Concerns associated with key habitats

- Summer breeding: threat of rat spills, change in land management status and land use regulations
- Summer foraging: oil spills, climate change (changes in the food web), changes in land use regulations, toxic algae blooms
- Winter foraging: oil spills

Attributes surrounding species success: Most of the nesting habitat lies within conservation units; no commercial harvest currently occurs for forage species; oil discharge regulations; lack of human disturbance; foxes removed from certain islands; introduced rat prevention programs; minimal subsistence harvest by Alaskans (relative to Atlantic communities)

F. Goal: Ensure murre populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

Objective: Maintain 2004 population levels of murres.

Target: Maintain Alaska breeding population of 5 million individuals of each species, along with a viable global population.

Measure: Index of abundance for both murres, (They are currently monitored by USFWS periodically [some annually, others not] at locations in Alaska [common: at approximately 15 locations; thick-billed at approximately 10 sites] mostly federal refuges but also some state lands [e.g., Round Islands] and Native land [Gull Island in Kachemak Bay]. These trends reported regularly in “Breeding Status, Population Trends and Diets of Seabirds in Alaska”). Continue current level or increase monitoring, since these species have been included as indicator species.

Issue 1: Additional introduction of exotic predators and rats (often called “rat spills” when animals escape from shipwrecks) can cause reduced productivity and population declines because introduced predators eat adults, chicks, and eggs.

Conservation actions:
a) Conduct additional predator removal programs.
b) Prevent rat introductions.
c) Conduct rat response program.

Issue 2: Prey abundance variability can cause reproductive failures.

Conservation action: Monitor foraging species status and trends (state-managed waters, 0–3 mi).

Issue 3: Contaminants, oil pollution, including chronic oiling (may be bilge dumping).

Conservation actions:
a) Bilge control (chronic oiling); oil spill planning and response (product shippers)—one idea/measure is to develop and distribute a multilingual press kit/education and outreach program designed to reduce chronic oiling.
b) Continue or expand existing level of research/monitoring.

Issue 4: Climate change (changes in food web).

Conservation actions:
a) Monitor winter die-offs more consistently; implement regular beach surveys with set protocol. Combine with lab analysis of body condition, contaminants, toxins.
b) Continue or expand existing level of research/monitoring.
c) Monitor species status and trends (state-managed waters, 0–3 mi).

Issue 5: Disturbance at nesting sites (commercial fishing, tourism near shore).

Conservation actions:
a) Reduce fishing around colonies, especially trawl and gillnet fisheries.
b) Educate pilots about low flight around active colonies.
c) Clean up derelict fishing gear, especially pots and gillnets.

Issue 6: Egging and harvest by Alaska Natives may cause local reductions in productivity and potentially reduce local populations.

Conservation actions:
a) Improve certainty of population counts in Alaska
b) Monitor egging and compare colonies subject to egging vs. not egged.

H. Plan and time frames for monitoring species and their habitats

Surveys would be conducted at index locations on the current schedule of once every 1–5 years.

USFWS is currently lead on surveys, with assistance from ADF&G. Continue with this relationship.

I. Recommended time frame for reviewing species status and trends

Ten years, or at more frequent intervals in response to additional information.

J. Bibliography

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Marbled Murrelet

Rationale
This species was selected because:

Species is imperiled.
Species has noticeably declined in abundance or productivity from historical levels outside the range of natural variability.
Species is designated as at risk (threatened, candidate, or endangered under ESA; state endangered or species of concern; depleted under Marine Mammal Protection Act).
Species is sensitive to environmental disturbance.

Human Uses
Viewing

A. Species description

Common name: Marbled Murrelet
Scientific name: *Brachyramphus marmoratus*

B. Distribution and abundance

Range:
Global range comments: Nests in coastal forests in North American and Asia, in the Pacific.
Breeding: Coastal areas of Russia and Japan (Nelson 1997)
Wintering: Few data, marine habitat similar to breeding
State range comments: From Southeast Alaska through the Aleutian Islands and Bristol Bay
Breeding: Coastal areas of Alaska; primarily bays, inlets and fjords (Nelson 1997).
Wintering: Few data, marine habitat similar to breeding, farther off shore in some areas of Gulf of Alaska (Nelson 1997).

Abundance:
Global abundance comments: Unknown, but over 947,500 (McShane 2004)
State abundance comments: About 850,000 individuals as of 1994 (Agler 1998), but this estimate includes surveys > 10 yrs old, and likely now lower.

Trends:
Global trends: Unknown for Asian populations, declining in United States (Stephenson 2001)
State trends: Declining (Nelson 1997, Stephensen 2001) in most areas; exception is Kenai Fjords, where numbers increased between 1986 and 2002 (after decline between 1976 and 1986; Van Pelt and Piatt 2003).

C. Problems, issues, or concerns for species

Existing

- Declining populations
- Incidental mortality in fishing gear (Manly et al. 2003; Wynne et al. 1991, 1992; Carter et al. 1995)
- Prey abundance variability
- Oil pollution, including chronic oiling (possibly bilge dumping)
- Vessel disturbance
- Avian and mammal predation
- Spruce beetle kill in areas with potential nesting habitat.

Potential

- Contaminants
- Aquaculture
- Logging

D. Location and condition of key or important habitat areas

Summer

Nesting: Generally, individually nest in trees in older coastal forests; a few nest on the ground in tundra, scree slopes, or cliffs. Many forest nesting areas have been degraded by logging.

Foraging: Inshore marine waters. Conditions range from pristine to degraded.

Winter

Foraging: Inshore marine waters to continental shelf. Conditions from pristine to degraded.

Areas of significance: Prince William Sound, Southeast Alaska, Lower Cook Inlet/Kenai Peninsula. (Afognak was a high-density nesting area [USFWS, unpubl data], and Kodiak bays may be important wintering area for some populations [D. Zwiefelhofer, Kodiak Natl. Wildl. Refuge, Unpubl. data]).

E. Concerns associated with key habitats

<u>Summer</u>

Nesting: Habitat degradation due to logging nest trees. Spruce beetle infestation and other conifer diseases (i.e., cedars in Southeast Alaska) degrading nesting habitat (currently associated with global warming, and this may increase).

Foraging habitat: Disturbance, degradation (i.e., by dumping of pollutants, waste, and toxins), and mortality by cruise and fishing vessels, climate change, oil spills. Rich, well-protected bays are prized by aquaculture.

Winter
Foraging: Potential chronic oiling from bilge pumping, climate change, oil spills.

Attributes surrounding species success: No commercial harvest currently occurs for some forage species (capelin, sand lance, Myctophids, smelts), but Marbled Murrelets also feed on juveniles of herring (important prey in many areas), cod, pollock, and older age classes of these species are harvested.

F. Goal: Ensure Marbled Murrelet populations remain sustainable throughout their natural range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

Objective: Restore Alaska's Marbled Murrelet population to 1994 levels by 2025.

Target: Alaskan population of about 750,000 individuals.
Measure: Apply index of abundance for determining population levels at key sites, including Southeast Alaska, Prince William Sound, Kodiak Island, and Cook Inlet.

Issue 1: Habitat degradation due to logging nest trees.

Conservation actions:
a) First step: Identify important nesting areas of murrelets (not well mapped in Alaska).
b) Quantify effect of logging on Marbled Murrelet nesting habitat.
c) Reduce logging in high density Marbled Murrelet nesting habitat.
d) Manage re-planted areas to increase large trees and "old-growth" effects, such as thinning, selected cutting, etc.

Issue 2: Marine and inland effects of climate change.

Conservation actions:
a) Monitor marine changes relative to murrelet population; compare sites with positive trend (Kenai Fjords) to those with negative trends (Prince William Sound, Glacier Bay), and identify reasons.
b) Monitor effect of degradation/loss of nesting habitat from beetle infestation and other diseases. Quantify effect on nesting behavior and success.
c) Manage forests to reduce infestation and/or provide best nesting options (i.e., thinning, managing for "old-growth" forest effect, etc.).

Issue 3: Incidental mortality in fishing gear.

Conservation actions:
a) Quantify mortality related to fishing gear, including spatial/temporal overlap.
b) Develop gillnet gear or practices that reduce bycatch of diving birds; fund studies for this.

Issue 4: Prey abundance variability.

Conservation action: Determine the status and trends of primary forage species (state-managed waters, 0–3 mi).

Issue 5: Contamination, oil pollution, including chronic oiling (possibly bilge pumping).

Conservation actions:
a) Research to measure contaminants in Marbled Murrelet.
b) Monitor compliance with contaminant discharges and oil pollution prevention/preparedness.
c) Work to reduce small-vessel sinkings and related oil spills, especially for inside waters.

Issue 6: Cruise and fishing vessel disturbance.

Conservation actions:
a) Determine extent of potential for disturbance, what specifically are problems, and where.
b) Determine potential for murrelet habituation to disturbance.
c) Determine effects of very fast boats, especially hydrofoils, jet boats, etc.; determine "safe" speeds under different habitat conditions.
d) Outreach for proper vessel operation where tourism, fishing, and murrelets overlap.

Issue 7: Avian and mammal predation.

Conservation actions:
a) Reduce human-caused increases in corvids (jays, magpies, crows, and ravens prey on eggs and chicks), Bald Eagles, and gulls (Glaucous-winged and Herring gulls take adults).
b) Monitor predation on murrelet adults by bald eagles in areas where artificially high concentrations of eagles are created by supplemental feeding. Reduce such activities.

Global conservation and management needs:

Objective: Determine extent of population interactions and distinctiveness.

Target: Assess genetic distinctiveness of major populations.
Measure: Blood, tissue, feather samples used for genetic analyses.

Issue 1: Determination of "distinct population segments"

Conservation action: Develop collection protocols, coordinate collection of samples and lab analysis, synthesis.

H. Plan and time frames for monitoring species and their habitats

Surveys will be conducted every 3 years to determine population change at index locations, including Southeast Alaska, Kodiak Island, Cook Inlet, and Prince William Sound. Kenai Fjords. Less regularly – the outer coast from Cross Sound to Icy Bay.

USFWS is a potential partner with the state for this effort.
Other potential partners include land owners in key Marbled Murrelet areas, such as the USFS (Chugach, Tongass), NPS (Kenai Fjords, Wrangell-St. Elias, Glacier Bay), and Native groups (Afognak Island, parts of Kenai and Southeast Alaska).

I. Recommended time frame for reviewing species status and trends

Five years, or at more frequent intervals in response to additional information.

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Kittlitz's Murrelet

Rationale

This species was selected because:

- Species is imperiled.
- Species has noticeably declined in abundance or productivity from historical levels outside the range of natural variability.
- Species is rare (i.e., small/low overall population size/density).
- Species is designated as at-risk (threatened, candidate, or endangered under ESA; state endangered or species of concern; depleted under Marine Mammal Protection Act.
- Species is endemic (i.e., occurs primarily in Alaska or occurs entirely within an ecoregion found in Alaska).
- Species makes seasonal use of a restricted local range (breeding, wintering, and migration).
- Species is sensitive to environmental disturbance.

- Species is disjunct (i.e., isolated from other populations or occurrences in adjacent ecoregions).

Human Uses
Viewing

A. Species description

Common name: Kittlitz's Murrelet
Scientific name: *Brachyramphus brevirostris*

B. Distribution and abundance (see map page 236, Appendix 4)

Range:
Global range comments: Alaska and Russian Far East (Day 1999).
Breeding: Arctic, sub-Arctic and boreal waters off of Eastern Russia (Day 1999).
Wintering: Range is poorly known, recorded along outer edge of pack ice in southeast Bering Sea (Day 1999). Found in low densities in northern Gulf of Alaska; prefer the Alaska Coastal Current and mid-shelf regions, and avoid the shelf-break front and Alaska Stream (Day and Prichard 2001).

State range comments:
Breeding: Glaciated areas, from Glacier Bay to Alaska Peninsula; small populations south of Glacier Bay in Holkham Bay, and in some nonglaciated areas of northwestern Alaska (Day 1999).
Wintering: Range is poorly known, recorded in open waters of Prince William Sound and in Southeast Alaska over open continental shelf near submerged shoals (Day 1999). Also in low densities throughout the Alaska Coastal Current and mid-shelf regions of northern Gulf of Alaska (Day and Prichard 2001).

Abundance:
Global abundance comments: Unknown; Day et al. (1999) estimated Russian population to be only 5% of total; thus, based on estimate for Alaska (USFWS 2004), global population may be about 10,000–28,000. Russian population not well surveyed and may be higher than previously noted (Vyatkin 1999).

State abundance comments: Based on rigorous surveys and anecdotal accounts for smaller populations, estimated to be about 9500–26,700 individuals (as of 2003) (USFWS 2004).

Trends:
Global trends: Declining (unknown for Russian populations)
State trends: Declining

C. Problems, issues, or concerns for species

- Habitat loss (receding glaciers)
- Gillnet mortality
- Vessel disturbance
- Mining in some areas
- Climate change
- Regime shifts in marine habitat, (e.g., possible impacts on foraging habitat from

D. Location and condition of key or important habitat areas

Summer

Nesting: Individually nest in recently de-glaciated sites. These areas are generally pristine.

Foraging: Inshore marine waters generally associated with tidewater glaciers. Condition ranges from pristine to degraded.

Winter

Foraging: Inshore marine waters to continental shelf.

Areas of significance: Glacier Bay, Prince William Sound, Kenai Fjords, Yakutat Bay, Icy Bay, Lower Cook Inlet, outer coast from Palma Bay to Fairweather Glacier.

E. Concerns associated with key habitats

<u>Summer</u>

Nesting: Disturbance from mineral exploration in some areas.
Glacial recession and subsequent vegetation (nesting habitat retreat farther inland).

Foraging Habitat: Disturbance and possible mortality from cruise and fishing vessels, climate change, oil spills, gillnet mortality.

<u>Winter</u>

Foraging: Oil spills, potential chronic oiling from bilge pumping, climate change

Attributes surrounding species success: No commercial harvest currently occurs for many forage species; oil discharge regulations; lack of human disturbance in nesting habitat.

F. Goal: Ensure Kittlitz's Murrelet populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

<u>Objective</u>: Halt the decline of Kittlitz's Murrelet populations within 5 years.

Target: Zero population decline by 2010.

Measure: Conduct annual index of abundance at key locations, including Prince William Sound, Kenai Fjords, and Glacier Bay, areas of Lower Cook Inlet.

Issue 1: Disturbance by cruise and fishing vessels/associated mortality from fishing gear

Conservation actions:

a) Quantify mortality related to boat traffic and fishing gear.
b) Reduce the amount of boat and fishing activity in Kittlitz's Murrelet habitats
c) Reduce mortality related to boat traffic and fishing gear.
d) Quantify physical parameters of summer foraging habitat and compare where Kittlitz's now occur and where they used to occur.

Issue 2: Prey abundance variability can cause reproductive failure.

Conservation action: Determine species status and trends of primary forage species used by murrelets (state-managed waters, 0–3 mi).

Issue 3: Contaminants, oil pollution, including chronic oiling (may be bilge dumping).

Conservation actions:

a) Research to measure contaminants in Kittlitz's Murrelet.
b) Monitor compliance with contaminate discharges and oil pollution prevention/preparedness.
c) Work to reduce small-vessel sinkings and related oil spills, especially in inside waters.

Issue 4: Avian and mammal predation.

Conservation actions:

a) Reduce human-caused increases in corvids, gulls, and Bald Eagles in areas used by Kittlitz's Murrelet.
b) Monitor avian and mammal movement into higher elevations as glaciers recede.

Issue 5: Climate change; habitat loss from melting glaciers.

Conservation action: Quantify physical parameters of summer foraging habitat and compare where Kittlitz's now occur and where they used to occur.

Issue 6: Disturbance from mineral exploration in some areas.

Conservation action: Prior to exploration, survey or assess potential for Kittlitz's Murrelet nesting in the area.

Global conservation and management needs:

Objective: Determine size and genetic relatedness of Russian population.

Target: Obtain statistically valid population estimates with confidence intervals for key regions.

Measure: At-sea surveys, extrapolations from birds/km^2.

Issue: Gillnet mortality (has been documented in Russian waters), oil spills.

Conservation actions:

a) Document location and extent of gillnet mortality, overlap of Kittlitz's and fisheries.
b) Monitor oil spills, sites and sources of chronic pollution.

H. Plan and time frames for monitoring species and their habitats

To determine rate of population decline, surveys will be conducted every other year at index locations, including Prince William Sound, Kenai Fjords, Glacier Bay, Cook Inlet; at lower intervals for sections of Southeast Alaska outer coast.

USFWS and landowners* in important murrelet areas are potential partners with the state for this effort.

*USFS (Chugach), NPS (Kenai Fjords, Wrangell-St. Elias, Glacier Bay), and communities (Homer, Kachemak Bay in Cook Inlet).

I. Recommended time frame for reviewing species status and trends

Five years, or at more frequent intervals in response to additional information.

J. Bibliography

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Least and Crested Auklets

Rationale
These species were selected because:
- Species are endemic (i.e., occur primarily in Alaska or occur entirely within an ecoregion found in Alaska).
- Species are sensitive to environmental disturbance.
- Species are representative of broad array of other species found in a particular habitat type (diving planktivore).
- Species are important internationally (e.g., targeted for cross-jurisdictional action and/or recognized in bi- or multilateral agreements; or useful for cross-jurisdictional monitoring). Cooperative monitoring with Russia.

Human uses: Subsistence egging, subsistence hunting, and viewing

A. Species group description

Common names: Least Auklet and Crested Auklet
Scientific names: *Aethia pusilla* and *Aethia cristatella*

B. Distribution and abundance (see maps pages 237–240, Appendix 4)

Range:
Least Auklet (*Aethia pusilla*)
Global range:
Breeding: Alaska and Eastern Russia (Jones 1993)
Winter: Poorly known but at sea near breeding areas where ice-free (Jones 1993).
State range:
Breeding: Western Aleutians to western Gulf of Alaska throughout Bering Sea to Diomede Island (Jones 1993).
Winter: Poorly known but at sea near breeding areas where ice-free as far south as Japan (Jones 1993).

Crested Auklet (*Aethia cristatella*)
Global range:
Breeding: Alaska and Eastern Russia (Jones 1993)
Winter: Poorly known but at sea near breeding areas where ice-free (Jones 1993).
State range:
Breeding: Western Aleutians to western Gulf of Alaska throughout Bering Sea to Diomede Island (Jones 1993).
Winter: Poorly known but at sea near breeding areas where ice-free (Jones 1993).

Abundance:
Aethia pusilla
Global abundance: 17 million individuals (Jones 1993; USFWS 2000)
State abundance: 9 million individuals (Jones 1993; USFWS 2000)

Aethia cristatella
Global abundance: 6 million individuals (Jones 1993; USFWS 2000)
State abundance: 3 million individuals (Jones 1993; USFWS 2000)

Trends:
Aethia pusilla
Global trends: Largely unknown (Jones 1993; Dragoo et al. 2003)
State trends: Largely unknown (Jones 1993; Dragoo et al. 2003)
Aethia cristatella
Global trends: Largely unknown (Jones 1993; Dragoo et al. 2003)
State trends: Largely unknown (Jones 1993; Dragoo et al. 2003)

C. Problems, issues, or concerns for species group

- Population is sparsely monitored.
- Specific winter range not well defined.

Existing
- Rat spills
- Human disturbance at particular times
- Introduced predators (e.g., rats, foxes)
- Prey abundance variability
- Oil pollution, including chronic oiling (may be bilge dumping)
- Mortality by attraction to large fishing vessel lights

Potential
- Oil spills
- Contaminants
- Heavy predation (gulls). (Supplemental food from fish processing could artificially increase gull populations.)
- Light pollution (from fishing vessels anchored near colonies)

D. Location and condition of key or important habitat areas

Summer:
Breeding: rock crevices in talus slopes, cliffs, boulder fields and lava flows. Degraded in some locations due to introduced mammals, and degraded in some locations by the growth of vegetation and associated soil closing the entrances to crevices. (Jones 1993)
Foraging: Inshore and offshore waters relatively near breeding sites. (Jones 1993). Condition not known.
Winter:
Foraging: Ice-free areas in the North Pacific as far south as Hokkaido Japan (Jones 1993). Condition unknown.

Areas of significance: Kiska, Buldir, Little Diomede, Gareloi, and Segula Islands; Ivekan Mountains, Cape Myaughee, Sevuokuk Mountains.

E. Concerns associated with key habitats

Threat of rat spills, chronic oiling, climate change (changes in the food web)

Attributes surrounding species success: Most of the nesting habitat lies within protected areas; no commercial harvest currently occurs for forage species.

F. Goal: Ensure auklet populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

Objective: Restore Least and Crested Auklet population and distribution to pre-fox, pre-rat introduction conditions (i.e., reestablish populations on islands after introduced mammals are removed).

Target: Maintain Alaska-wide populations at least at year 2000 levels.

Measure: Populations at index locations would be surveyed (e.g., Buldir, Kiska, Kasatochi, St. Matthew, and St. Lawrence Islands) at least once every 3 years for 20 years. Evaluate also reestablishment on islands where introduced mammals have been removed.

Issue 1: Population is sparsely monitored.

Conservation actions:

a) Determine wintering locations.
b) Maintain a monitoring program.
c) Complete a nesting inventory.

Issue 2: Human disturbance at particular times.

Conservation actions:

a) Minimize human disturbance.
b) Evaluate disturbance at index colonies.

Issue 3: Introduced predators (e.g., rat spills, foxes).

Conservation actions:

a) Remove foxes from certain islands.
b) Evaluate reestablishment on islands where introduced mammals have been removed.
c) Educate ship crews about rat introduction.
d) Prevent additional rat introductions.

Issue 4: Light pollution attracts birds and may result in death or injuries from collisions.

Conservation actions:

a) Educate (ship crews) about light pollution issue and care and release of birds that come aboard.
b) Encourage the use of shielded lights on ships and ocean platforms that eliminate lateral light emissions.

Issue 5: Prey abundance variability.

Conservation action: Monitor foraging species status and trends (state-managed waters, 0–3 mi).

Issue 6: Oil pollution and chronic oiling; contaminants.

Conservation actions:

a) Monitoring compliance with oil discharge regulations.
b) Conduct research to measure contaminants in eggs.
c) Conduct beached bird surveys in selected areas.

H. Plan and time frames for monitoring species and their habitats

Surveys would be conducted at index locations once every 3 years for 20 years.

Add a site in Russia within 5 years.

Colony surveys would be conducted at the index locations (all within the federal refuge system). USFWS is a potential partner with ADF&G or others.

I. Recommended time frame for reviewing species status and trends

Ten years, or at more frequent intervals in response to additional information.

J. Bibliography

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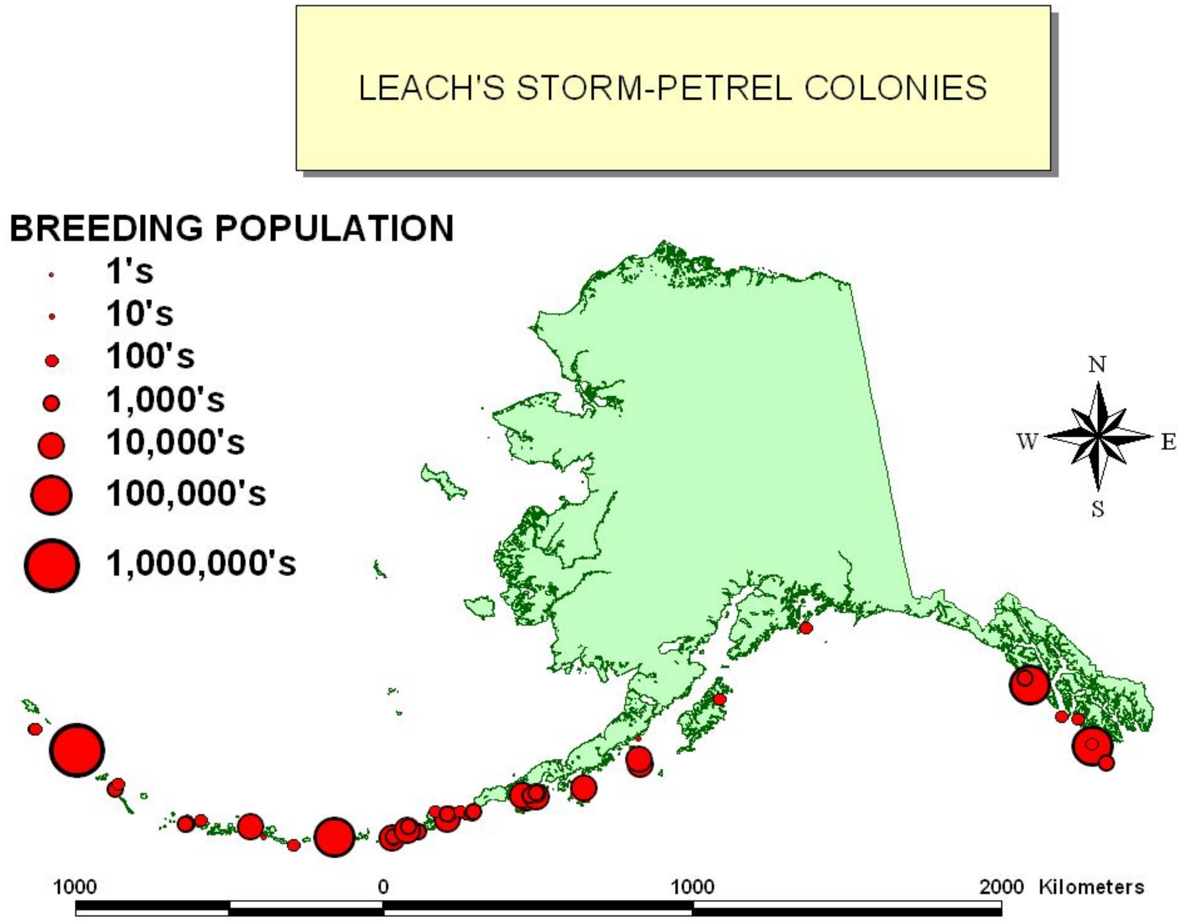

Figure 4.1 Leach's Storm-Petrel colonies in Alaska

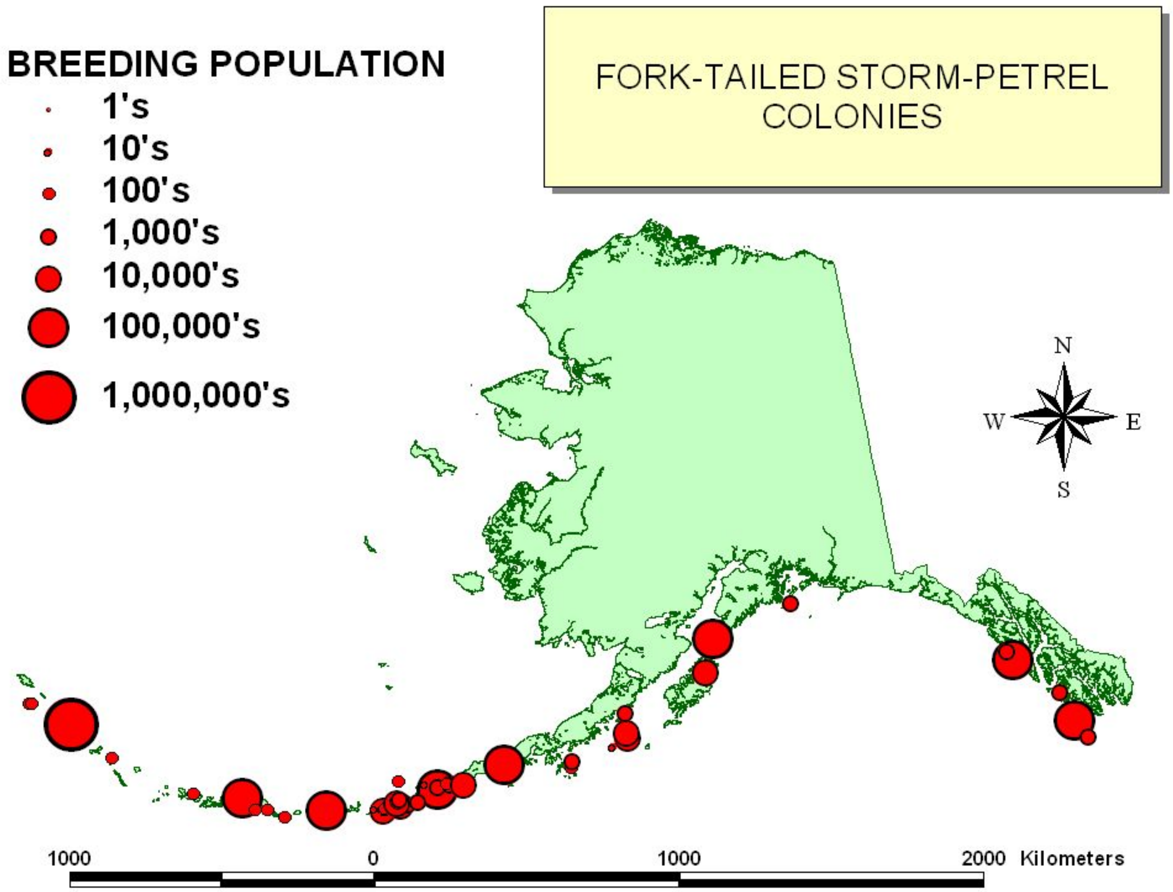

Figure 4.2 Fork-tailed Storm-Petrel colonies in Alaska

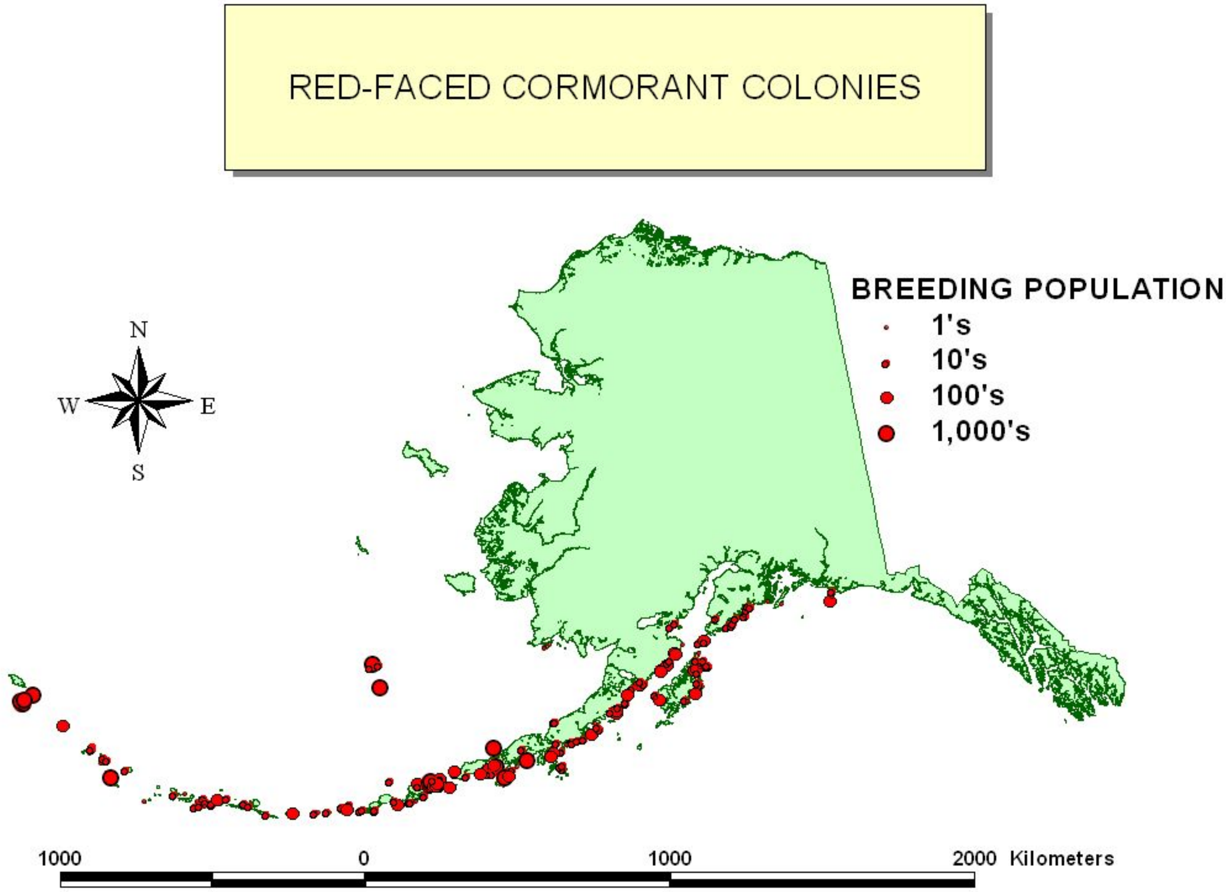

Figure 4.3 Red-faced Cormorant colonies in Alaska

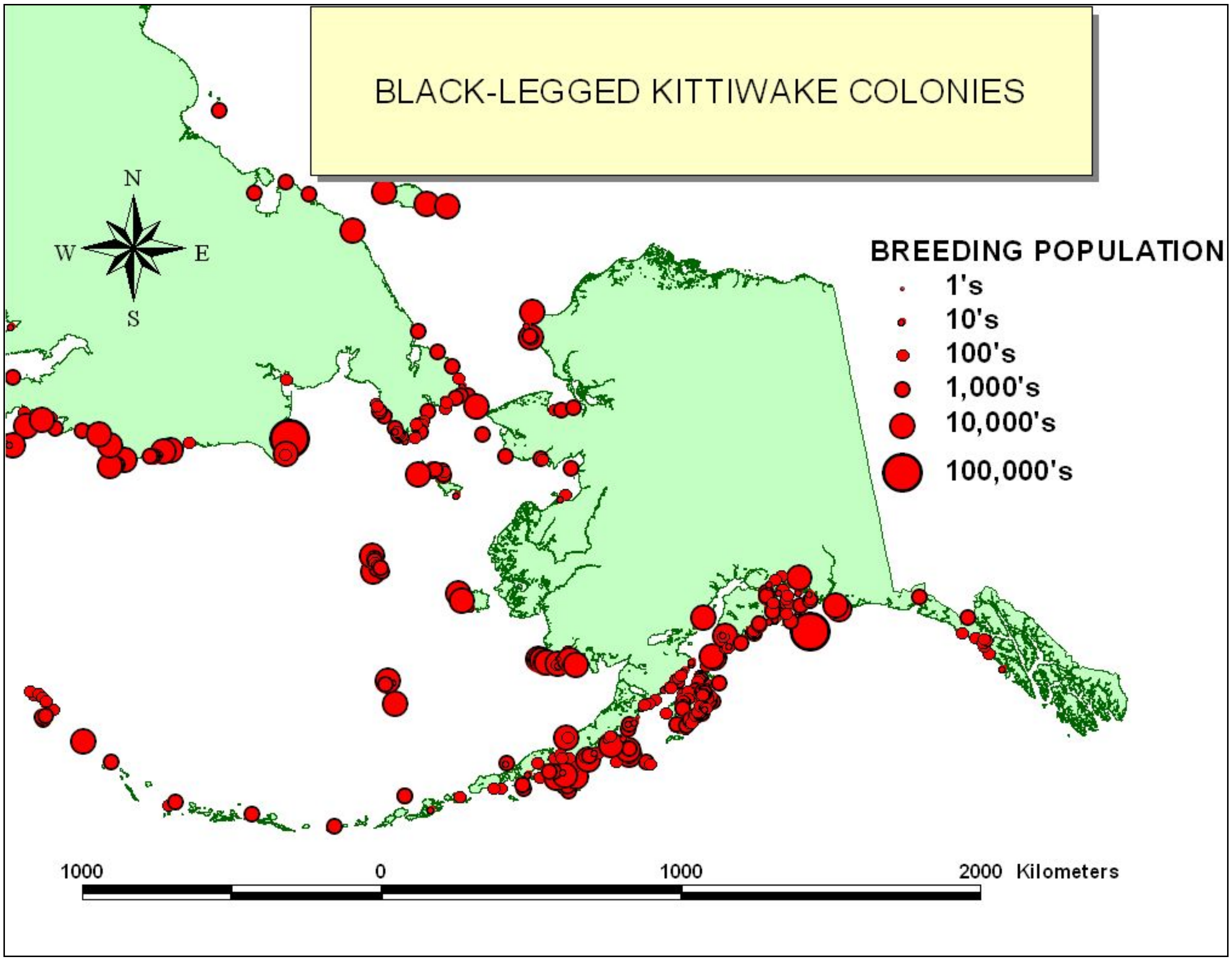

Figure 4.4 Black-legged Kittiwake colonies in Alaska

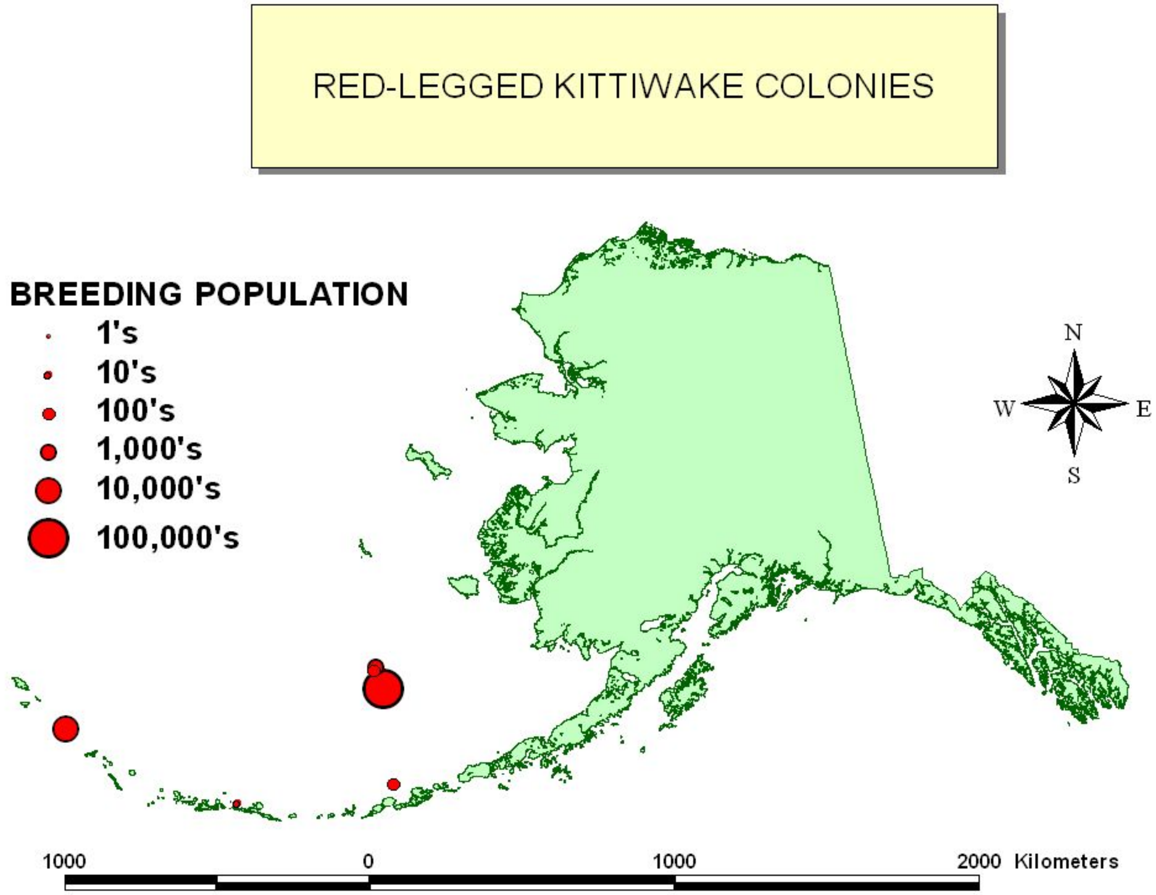

Figure 4.5 Red-legged Kittiwake colonies in Alaska

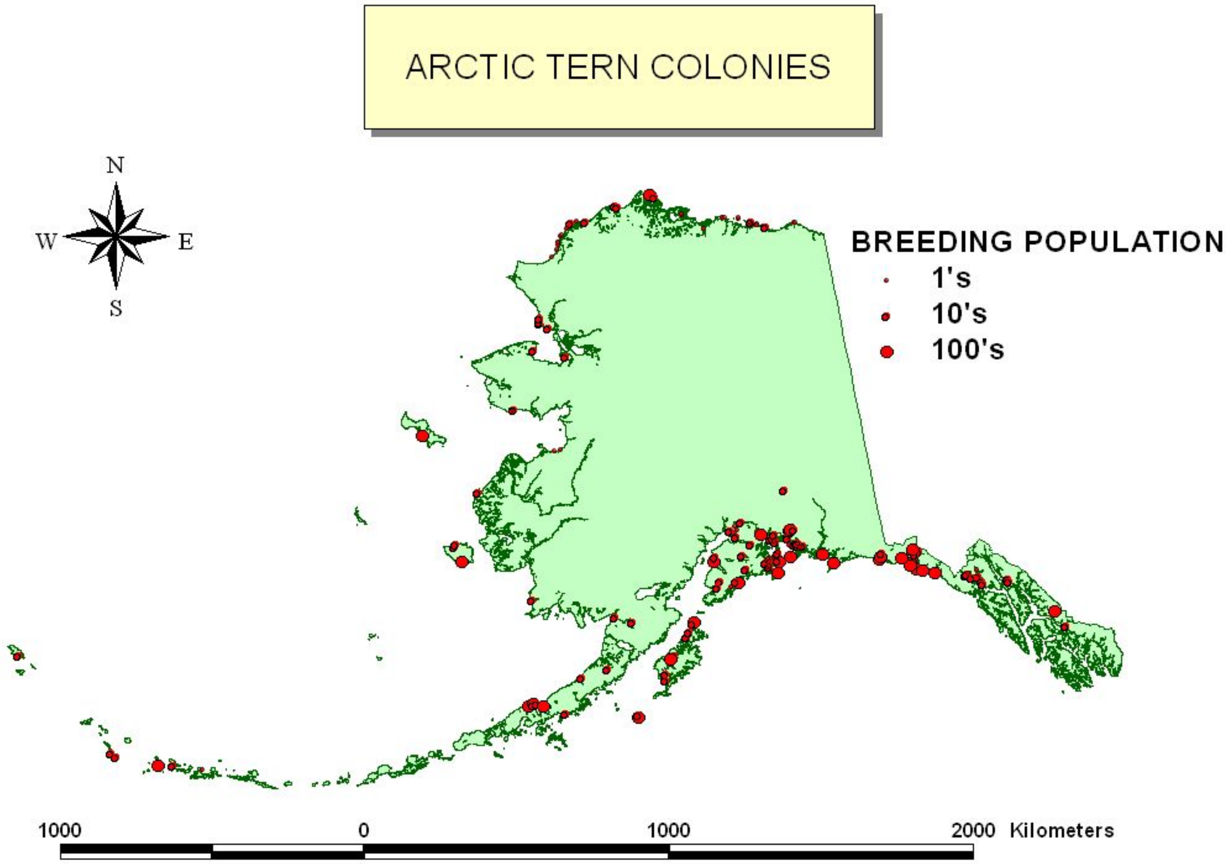

Figure 4.6 Arctic Tern colonies in Alaska

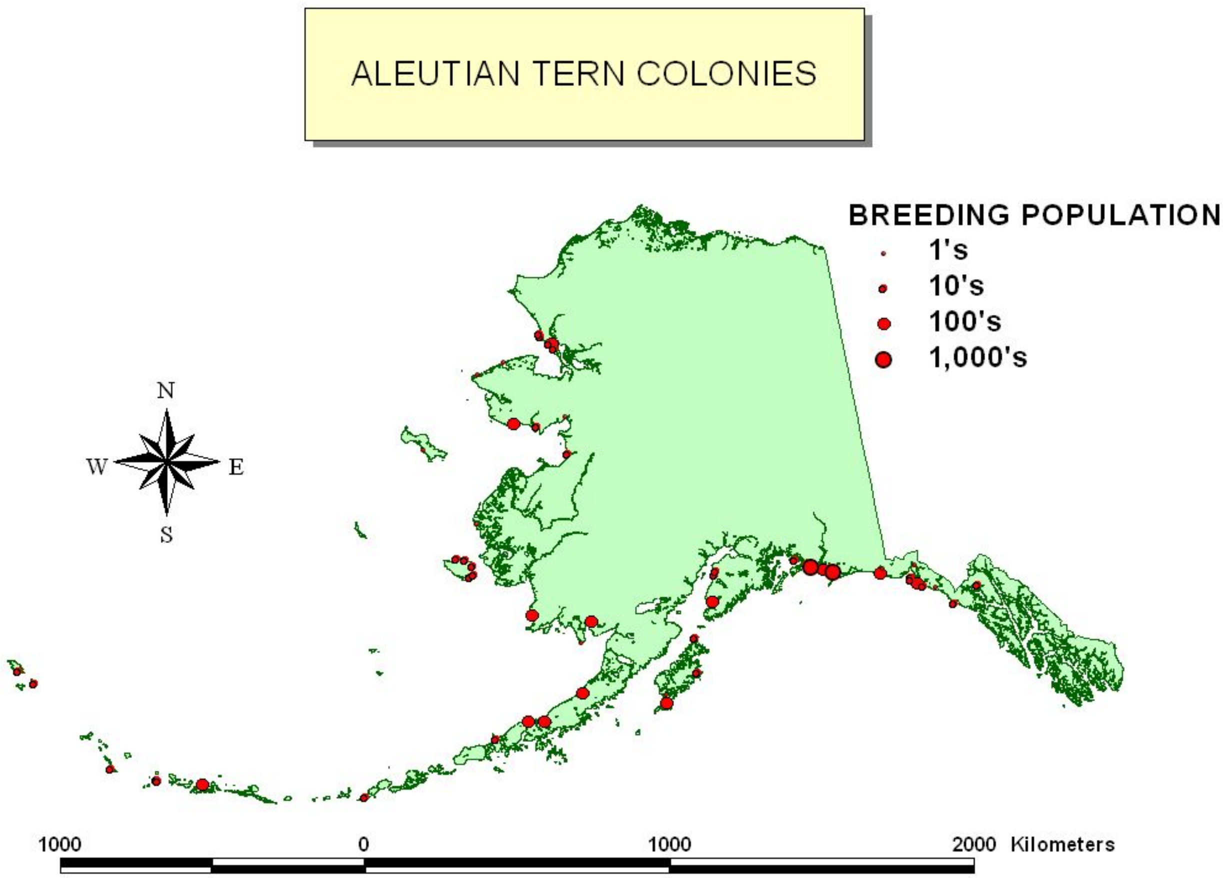

Figure 4.7 Aleutian Tern colonies in Alaska

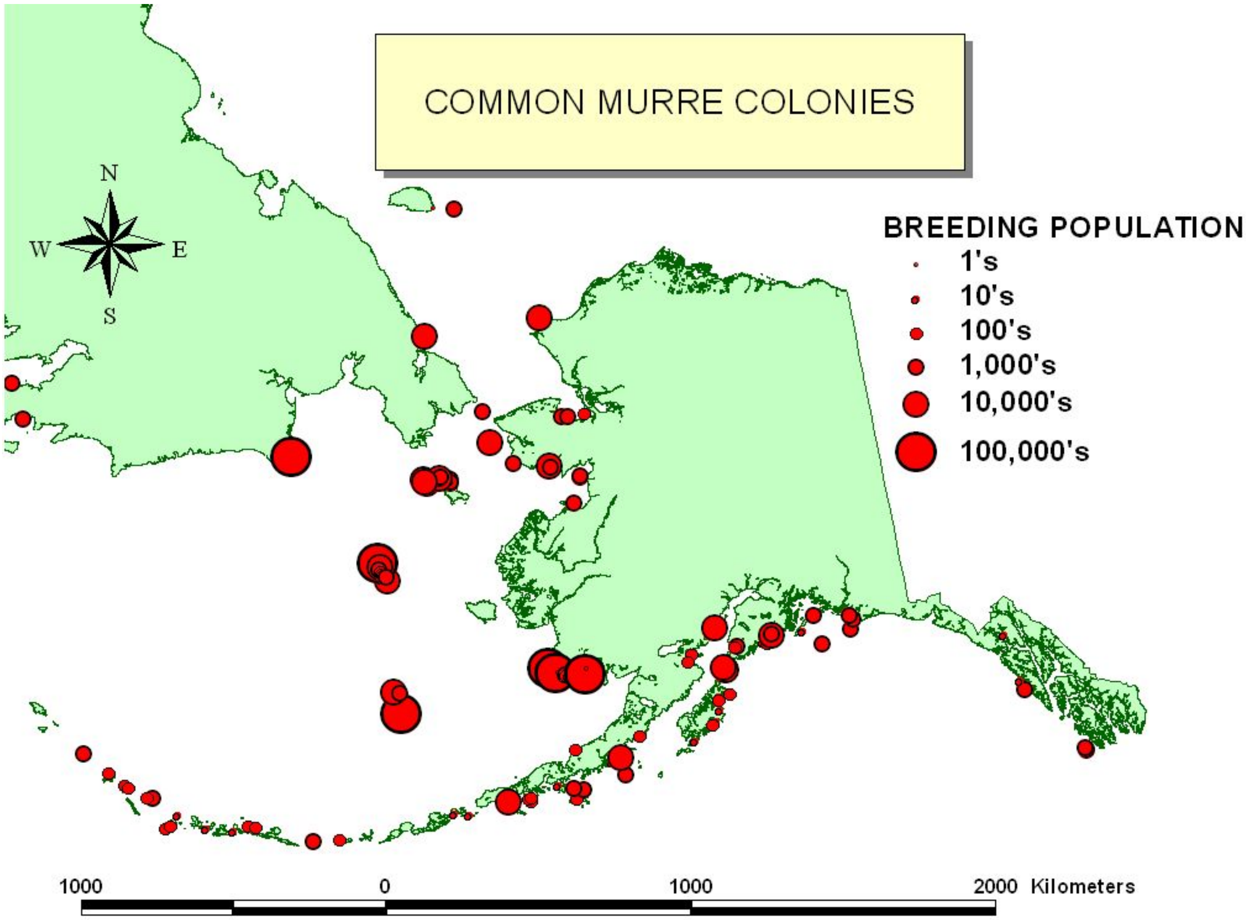

Figure 4.8 Common Murre colonies in Alaska

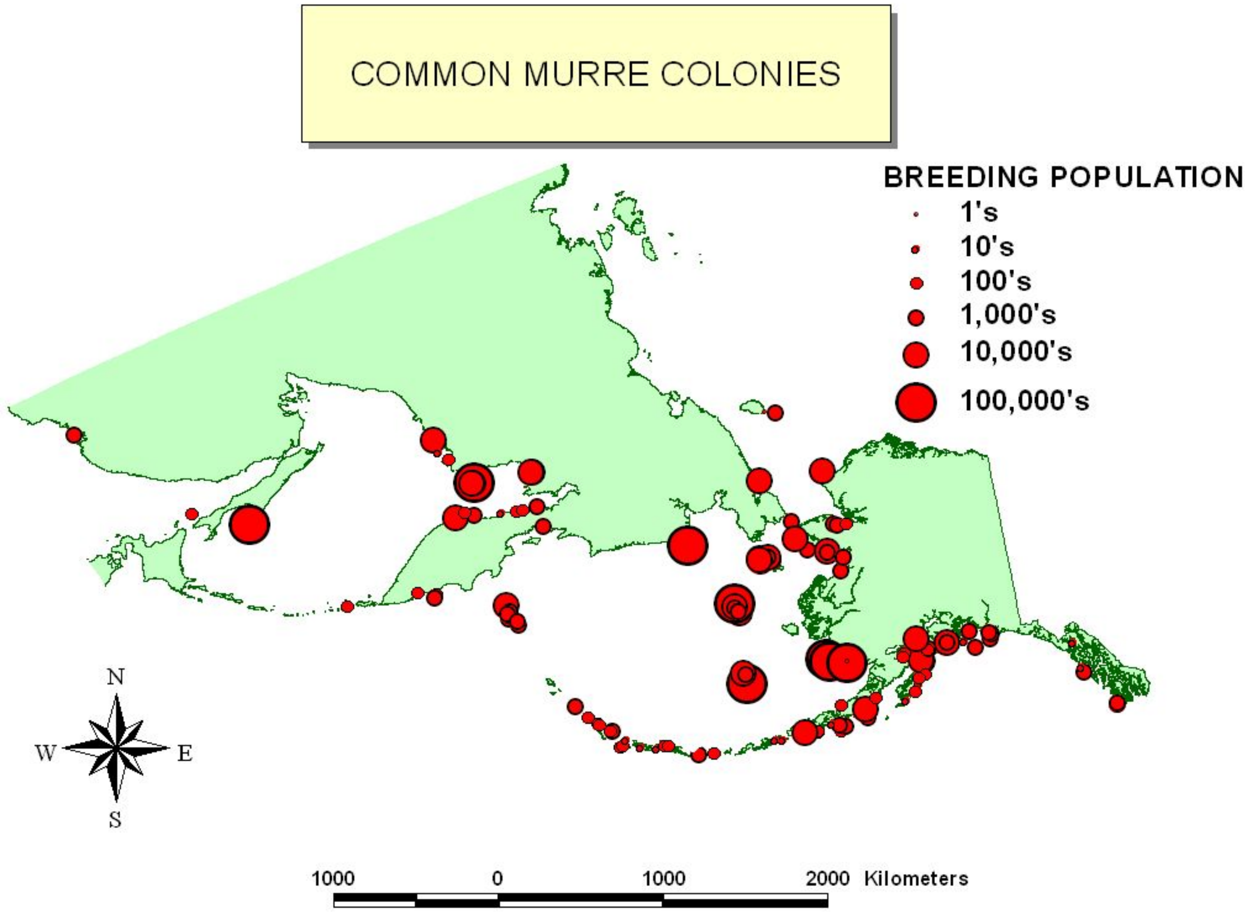

Figure 4.9 Common Murre colonies in Alaska and Russian Far East

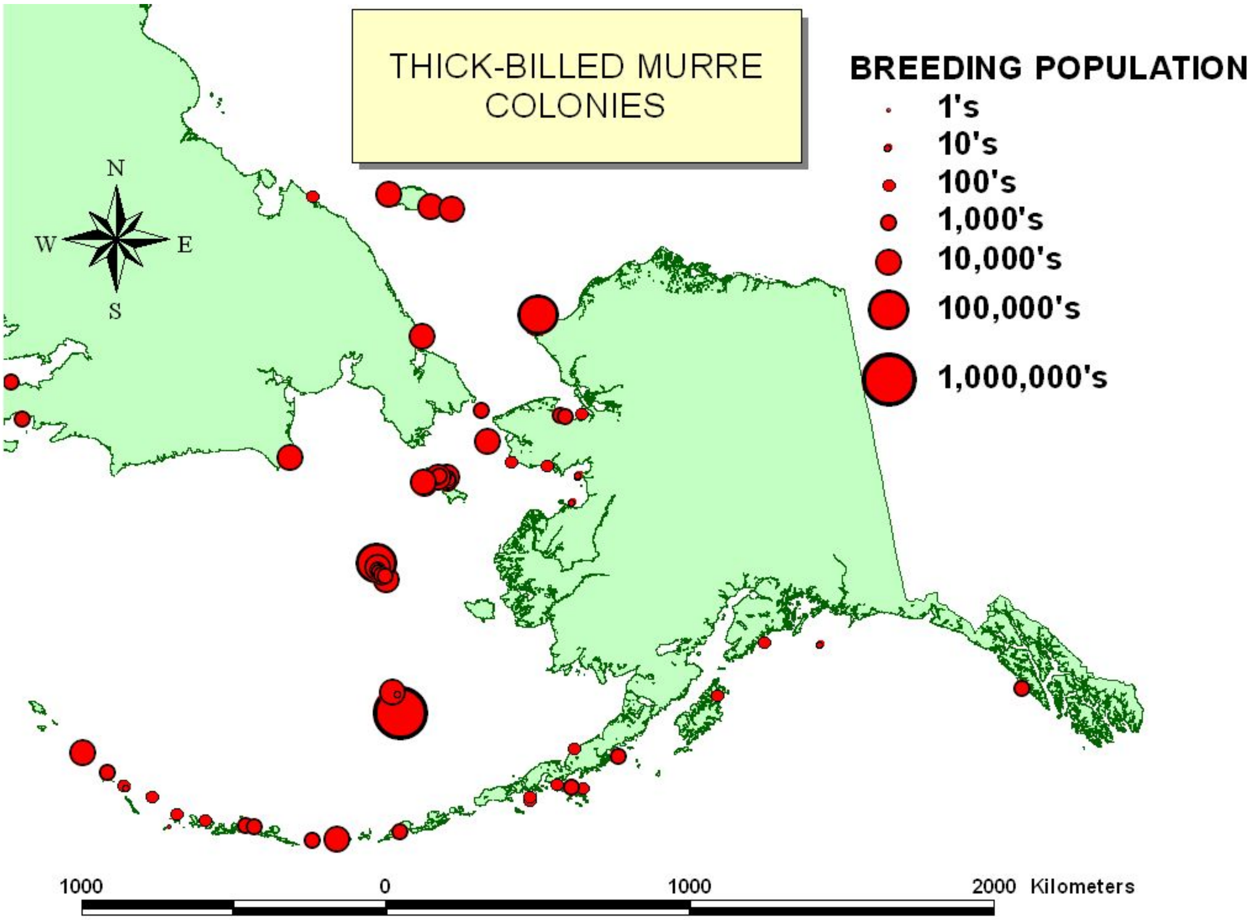

Figure 4.10 Thick-billed Murres in Alaska

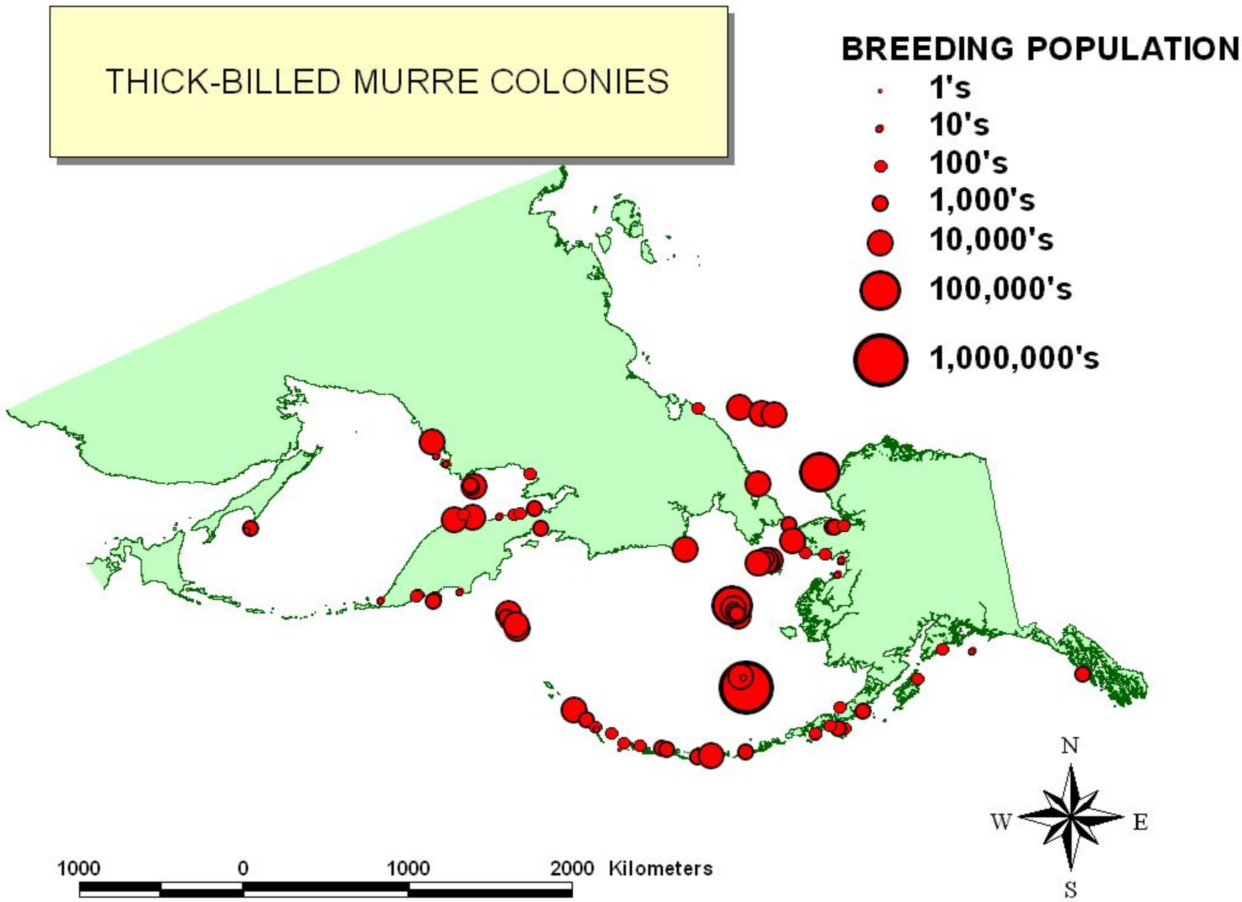

Figure 4.11 Thick-billed Murres in Alaska and Russian Far East

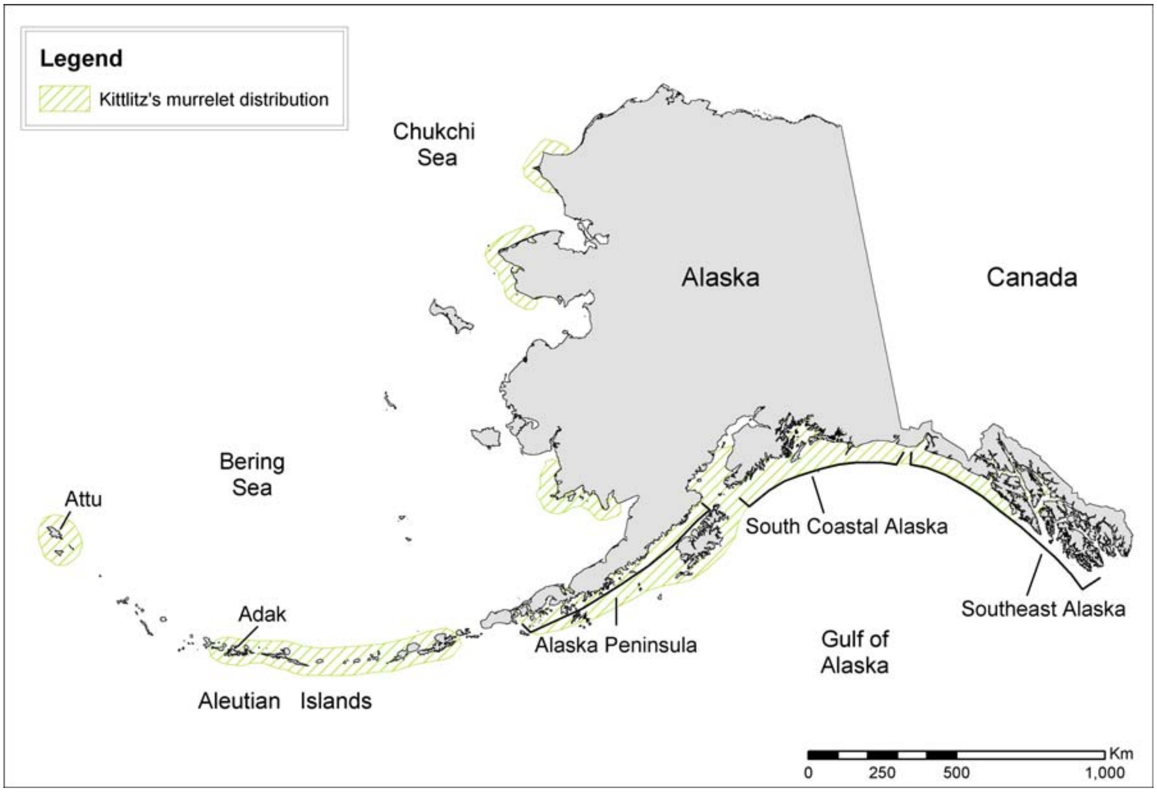

Figure 4.12 Distribution of Kittlitz's Murrelets in Alaska

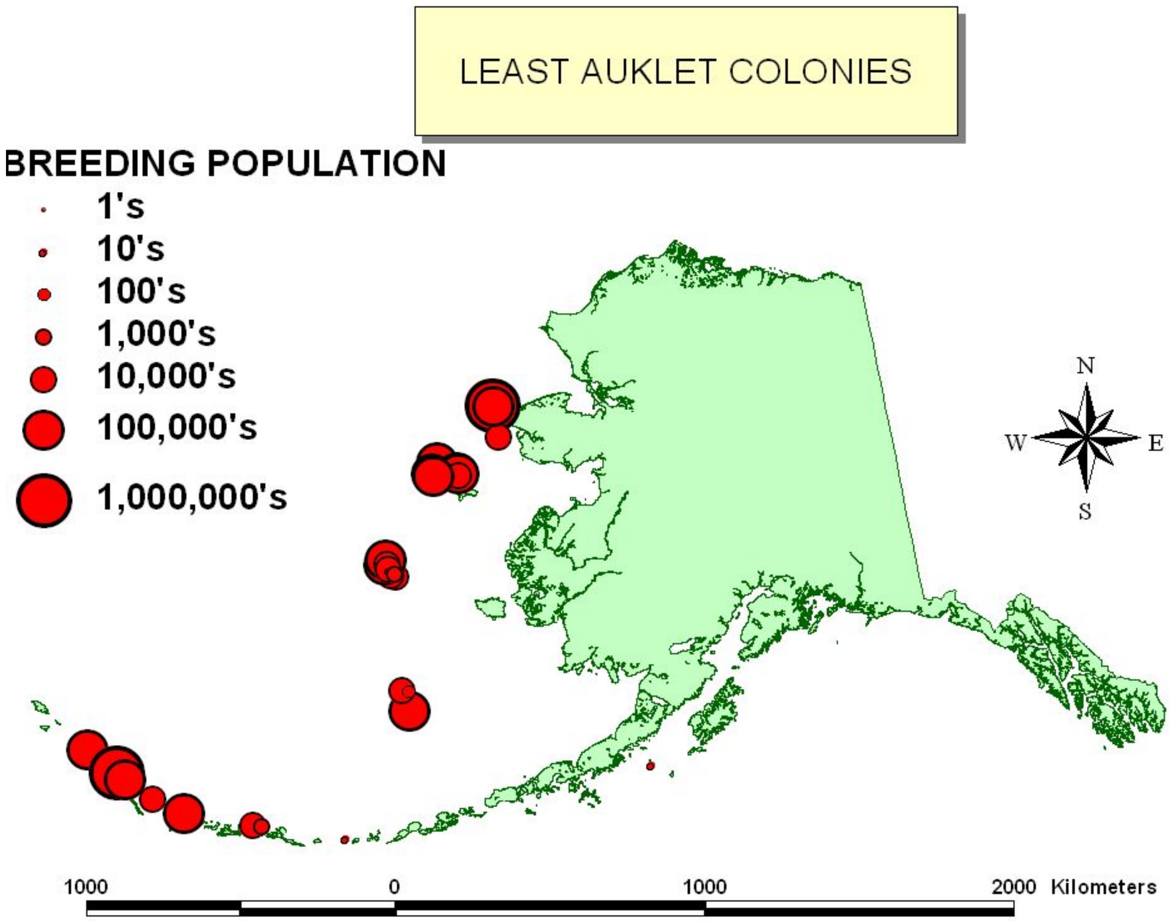

Figure 4.13 Least Auklet colonies in Alaska

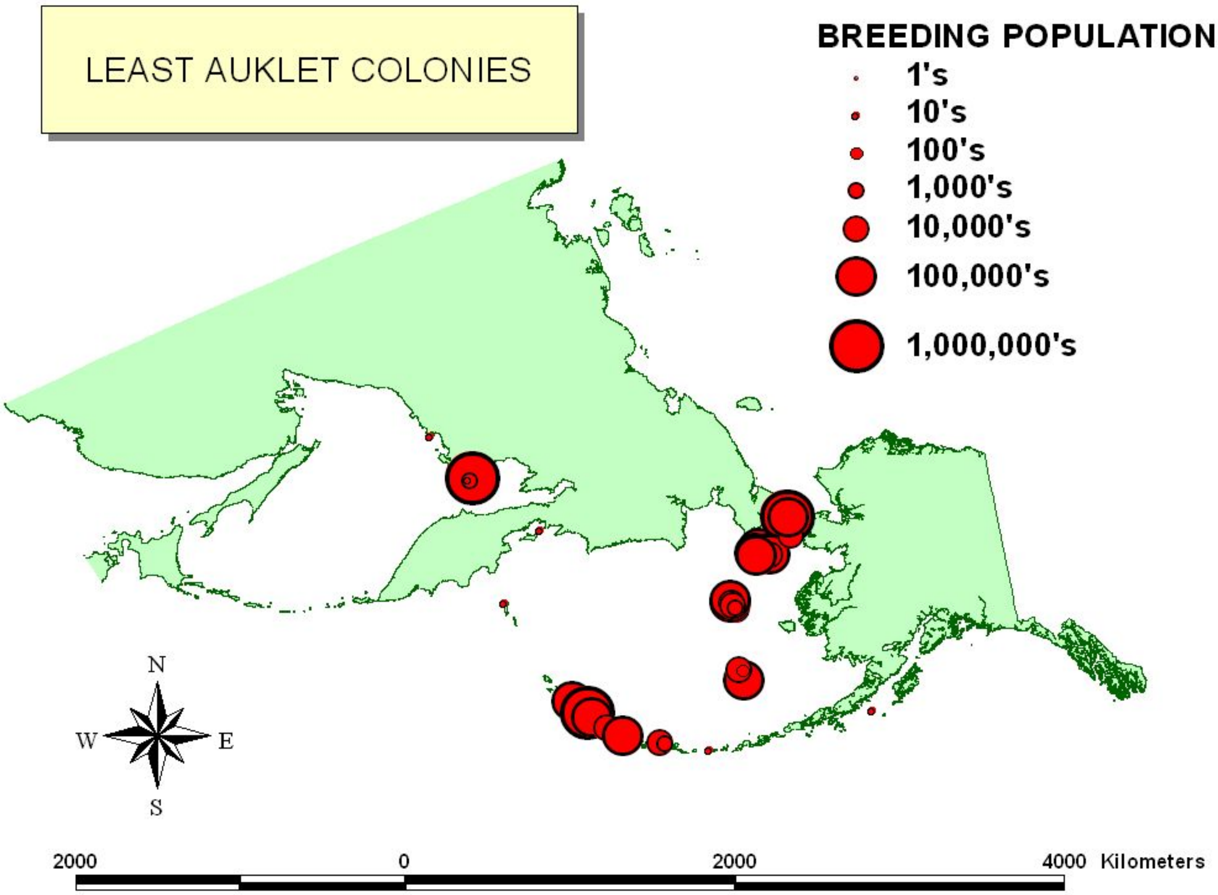

Figure 4.14 Least Auklet colonies in Alaska and Russian Far East

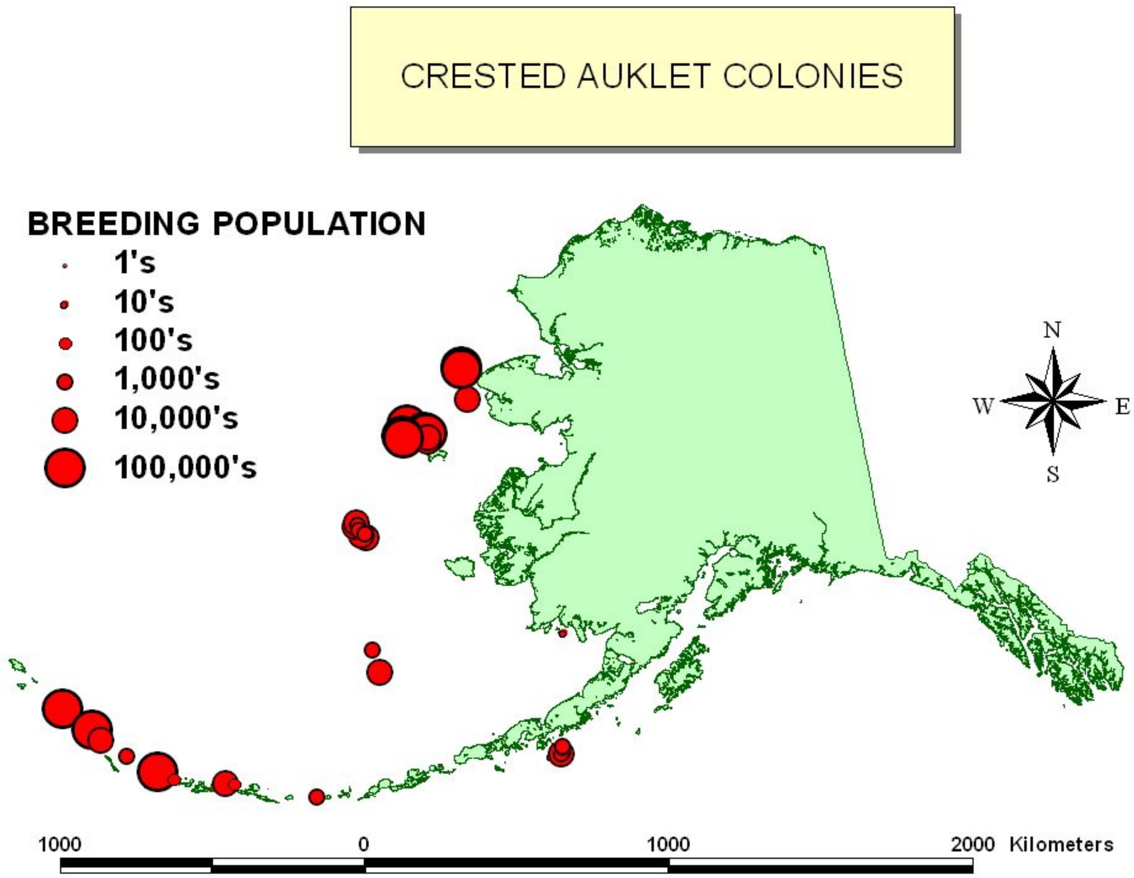

Figure 4.15 Crested Auklet colonies in Alaska

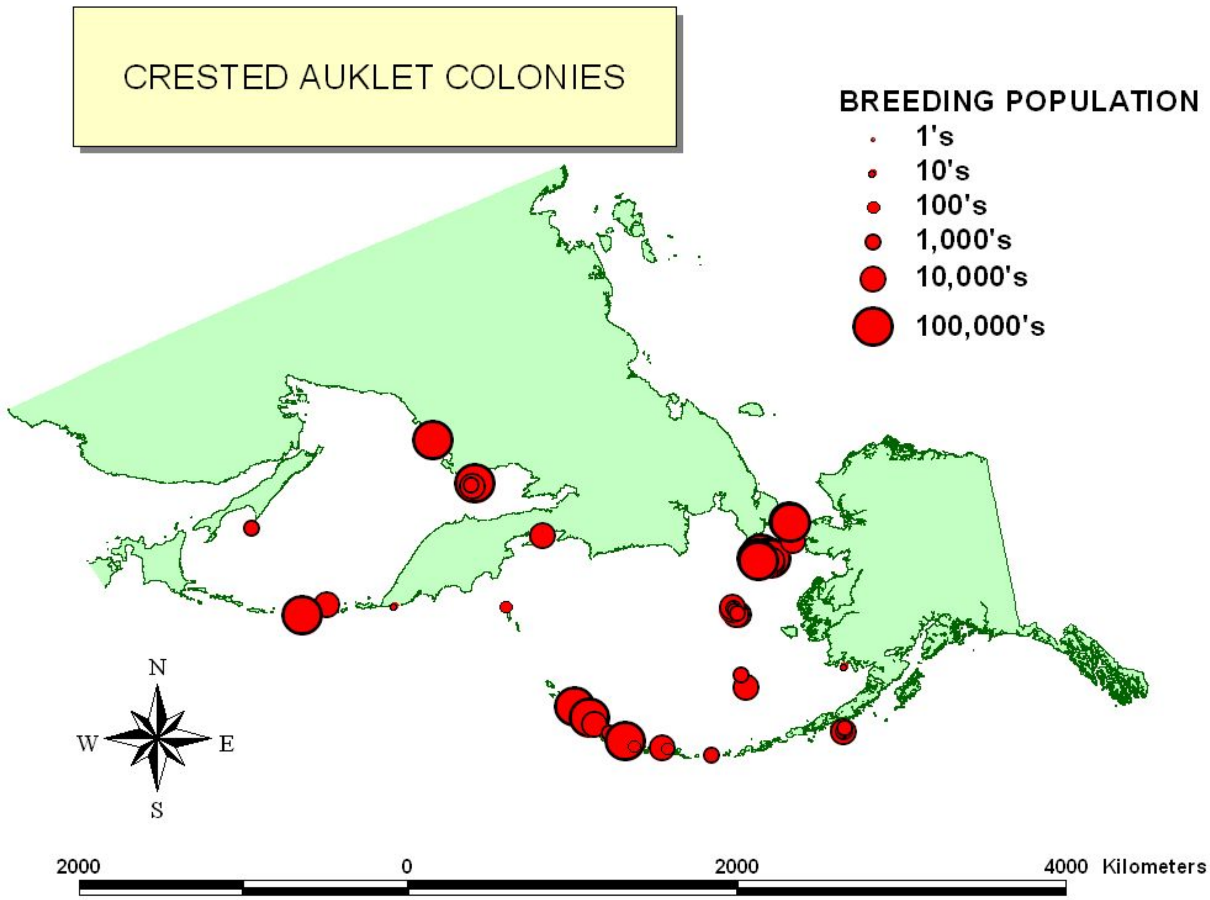

Figure 4.16 Crested Auklet colonies in Alaska and Russian Far East

Raptors – Introduction

This species group includes resident and migratory raptors that breed in Alaska and have experienced (or are likely to experience impacts causing) population declines, loss of habitat, impacts from contaminants, changes in breeding range, or threats while migrating or wintering outside Alaska. Since raptors are high trophic-level predatory birds, they serve as indicator species of ecological changes and other human-induced influences or impacts and may serve as "barometers" of significant impacts in the ecosystem. Some raptors are secretive and not well known or understood, and these species have been included to further understand and conserve little-known species.

This account is an assemblage of templates that addresses the conservation of raptors using species with historical baseline studies that demonstrate sensitivity to environmental or ecological changes. Monitoring of selected raptor populations in Alaska largely began in the mid 1970s, with particular emphasis on cliff-nesting raptors in tundra regions, peregrine falcons in Interior and Arctic Alaska, Bald Eagles in south coastal areas, and forest owls in Southcentral Alaska. Species templates were developed to include species with conservation concerns representing a cross-section of biomes (tundra, boreal forest, and temperate rain forest), contaminant-affected species, migrant species, forest owl species, restricted habitat species, little-known species, and high-profile species of public interest.

Six templates covering single species or groups of species are presented. Additional introductory information is provided at the beginning of each template:

Northern Goshawk (*Accipiter gentilis atricapillus*) and Queen Charlotte Goshawk (*A. g. laingi*), representing boreal forest and temperate rain forest habitats (respectively) where forest management (logging, fire) may affect species through changes in habitat and/or prey.

Contaminant-affected species (Peregrine Falcon, *Falco peregrinus*; Bald Eagle, *Haliaeetus leucocephalus*; Osprey, *Pandion halieatus*; and Merlin, *Falco columbarius*) associated with aquatic habitats and the presence of environmental contaminants.

Migrant raptors (Golden Eagle, *Aquila chrysaetos*; Rough-legged Hawk, *Buteo lagopus*; Red-tailed or Harlan's Hawk, *Buteo jamaicensis*; Sharp-shinned Hawk, *Accipiter striatus*; Northern Harrier, *Circus cyaneus*; and Short-eared Owl, *Asio flammeus*) that may have some conservation concerns away from Alaska while migrating and/or on their wintering grounds.

Forest owl species in coastal temperate rain forest (Western Screech-Owl, *Megascops kennicottii*; Northern Pygmy-Owl, *Glaucidium gnoma*; Barred Owl, *Strix varia*; Northern Saw-whet Owl, *Aegolius acadicus*; Great Horned Owl, *Bubo virginianus*, also found in boreal forest) and boreal forest (Great Gray Owl, *Strix nebulosa*; Boreal Owl, *Aegolius funereus*; Northern Hawk Owl, *Surnia ulula*; Great Horned Owl) that are little understood.

Snowy Owl (*Bubo scandiacus*), a species closely linked with the abundance of brown lemmings (*Lemmus sibiricus*) and highly responsive to varying abundance of prey, nest in localized areas on the North Slope in close proximity to expanding oil/gas infrastructure and may be impacted by broad climate changes or localized resource development.

Gyrfalcons (*Falco rusticolus*) and Black Merlins (*Falco columbarius suckleyi*), species with high public or scientific profile and restricted or specific habitat requirements, are representative of tundra and temperate rain forest habitats (respectively) where broad-scale changes in habitat or impacts from resource development would have significant impact on species abundance or distribution.

Northern Goshawk

A. Species description description

Common name: Northern goshawk
Scientific name: *Accipiter gentilis*

Two subspecies exist in Alaska, the widely distributed Northern Goshawk (*A. g. atricapillus*), which occurs throughout most of the state, and the Queen Charlotte Goshawk (*A. g. laingi*), which occupies the coastal temperate rain forests of Southeast Alaska (Squires and Reynolds 1997). These subspecies probably intergrade in northern Southeast Alaska (ADF&G unpublished data, Iverson et al. 1996). For the purposes of this document, we regard goshawks in Southeast Alaska as *A. g. laingi,* and those in other portions of the state as *A. g. atricapillus*.

B. Distribution and abundance

Range:

Global range comments: Holarctic.

State range comments:

A. g. laingi: Coastal temperate rain forest from Dixon Entrance to northern Southeast Alaska, boundary unknown.

A. g. atricapillus: Boreal forests throughout state, northern extent not clear but sightings up to and beyond the northern extent of trees.

Abundance:

Global abundance comments: Approximately 490,000 (Rich et al. 2004).

State abundance comments:

A. g. laingi: Unknown.

A. g. atricapillus: No reliable population estimates exist (USFWS 2001); Interior breeding density ranged from 1 pair/41 km^2 to 1 pair/372 km^2 (McGowan 1975), and appeared tied to snowshoe hare numbers (Doyle and Smith 1994).

Trends:

Global trends: Unknown but thought to be stable, increasing in some areas, decreasing in others.

State trends: Unknown but potentially declining in some parts due to habitat alteration. Populations fluctuate with prey cycles.

C. Problems, issues, or concerns for species

- Queen Charlotte Goshawks are landscape species, i.e., use space at a landscape level of scale and thus are difficult and costly to study.
- Standard techniques used to locate breeding goshawks and monitor population have limited utility in Southeast Alaska.
- After a 10-year study, still do not have realistic estimate of goshawk population in Southeast Alaska.
- Importance of prey species is not well understood.
- Goshawk ecology and habitat relationships in boreal forests are known only from specific locales and broad-based information is needed.
- Effects of forest management are not well studied.
- Use of second-growth forest by goshawks in forest management areas is not well understood.
- Raptors in general and Northern Goshawks specifically, are susceptible to West Nile Virus (Saito et al. 2003, Marge Gibson, personal communication).

D. Location and condition of key or important habitat areas

A. g. laingi: Coastal, temperate old growth – Goshawks nest and forage in forest stands with high timber volume and dense overstory canopy above a relatively open understory (Reynolds et al. 1982; Beier and Drennan 1997; Squires and Reynolds 1997; Widén 1989; Daw and DeStefano 2001); condition of this habitat is good.

A. g. atricapillus: Boreal forest, general (McGowan 1975); condition of this habitat is very good to pristine.

E. Concerns associated with key habitats

A. g. laingi: Forest management in portions of Southeast Alaska (for nesting and foraging):

- No knowledge of prelogging population status.
- Previous study in relation to forest management practices has produced incomplete assessment of impacts on species.
- Nest-based management systems are not effective because goshawk nests are very difficult to locate.

A. g. atricapillus: Changes in boreal forest habitat

- Possibly due to logging, death of forest from spruce bark beetle infestation, catastrophic fire caused by suppression, or some combination of the above.

F. Goal: Ensure Northern Goshawk populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

<u>Objective 1</u>: Conserve sustainable goshawk populations in Southeast Alaska.

Target: A naturally distributed population in Southeast Alaska.
Measure: Index of abundance based on survey of known nesting areas.

Issue: Considerable effort has gone into surveying for breeding goshawks and monitoring known nests, yet these resulting data are insufficient for a reliable assessment regarding the status of goshawks in Southeast Alaska.

Conservation actions:

a) Maintain habitat capable of sustaining goshawks distributed through the region.
b) Maintain current old-growth reserve system stipulated in Tongass National Forest - Forest Plan (TLMP).
c) Employ resource selection modeling based on existing nesting and foraging habitat data to build predictive model to determine what landscape is most favorable to goshawks.
d) Work collaboratively to review existing goshawk conservation measures in TLMP.

Objective 2: Manage habitats to ensure long-term sustainable goshawk populations in Southeast Alaska.

Target: Integrated forest management that provides for sustainable goshawk populations in Southeast Alaska.
Measure: Conservation strategies associated with forest management.

Issue: Review current standards and guidelines in forest plan.

Conservation actions:

a) Evaluate existing goshawk conservation measures in TLMP.
b) Based on interagency goshawk study, recommend refined standards and guidelines for conserving and sustaining goshawk habitats in a multiple use setting on national forest managed lands.
c) Work with state and private land managers to conserve and sustain goshawk habitat in a multiple use setting.
d) Coordinate with agencies in British Columbia to compile information on Queen Charlotte Goshawk and standardize techniques.
e) Coordinate with Northern Goshawk researchers in other states on management and conservation guidelines and strategies for this species.
f) Publish results of ADF&G/USFS cooperative goshawk study.

Objective 3: Learn more about Northern Goshawk ecology in Southeast Alaska.

Target: More complete understanding of goshawk ecology in Southeast Alaska.
Measure: Data concerning goshawk ecology, habitat relationships, and prey ecology.

Issue 1: We have little knowledge about the ecology of important prey species of goshawks in Southeast Alaska, including Blue Grouse (*Dendragapus obscurus*) and Spruce Grouse (*Falcipennis canadensis*), red squirrel (*Tamiasciurus hudsonicus*), Stellar's Jay (*Cyanocitta sterlleri*), thrushes (Varied Thrush [*Ixoreus naevius*], American Robin [*Turdus migratorius*], *Catharus* spp.), Northwestern Crow (*Corvus caurinus*), and ptarmigan spp. (*Lagopus* spp.) (Lewis 2001).

Conservation actions:

a) Learn best methods to survey prey species to determine density in a variety of landscapes.
b) Learn how key prey species are associated with forest management.

Issue 2: A lack of knowledge concerning how forest management affects goshawks.

Conservation actions:

a) Investigate species response to land management practices, especially logging; determine if there are thresholds in the amount of the landscape logged below which goshawk populations decline.
b) Quantify relationship between amount of mature forest and nesting density and survival.

Issue 3: A lack of knowledge concerning how goshawks use second-growth forest.

Conservation actions:

a) Determine how goshawks use second growth.
b) Determine if second growth can be managed to improve it for goshawks, or make it available to them sooner for foraging.
c) Partner with USFS to study second-growth management to improve habitat for goshawks, their prey, and other wildlife.

Issue 4: Standard inventory methods do not provide consistent method to monitor goshawk population.

Conservation action: Develop a standardized, cost-efficient protocol for inventory, data collection, and monitoring.

Issue 5: Efficacy of nest-based conservation strategy.

Conservation action: Investigate landscape level conservation strategy for goshawks in Southeast Alaska (and possibly in conjunction with British Columbia) similar to that being used in Southwest region of USFS (Reynolds et al. 1992).

Issue 6: Little knowledge of goshawk ecology and habitat relationships on boreal forests of state.

Conservation action: Develop population status and trend information over broad areas of boreal forest (document populations, locations, habitat used, diet, and other aspects of ecology).

Issue 7: Little knowledge concerning potential impact of West Nile Virus on goshawks and their susceptibility to this virus in Alaska.

Conservation action: Collaborate with existing ADF&G and U.S. Centers for Disease Control and Prevention efforts on surveying dead birds for virus to detect if (or when) virus appears in Alaska.

H. Plan and time frames for monitoring species and their habitats

ADF&G recently completed field portion of long-term study of ecology and habitat relationships of goshawk in Southeast Alaska. Data should be thoroughly analyzed in cooperation with other agencies, and future field work should rely on the results from previous work among all key agencies.

I. Recommended time frame for reviewing species status and trends

In 5 years, review state of knowledge (final results from interagency study will have been peer-reviewed and published); annual cooperator meetings should be convened to outline the goals and objectives among all key agencies.

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Contaminant-affected Raptor Species

A. Species group description

Raptor species affected by environmental contamination due to their trophic position, aquatic associations, or documented contaminant levels
Common names: Bald Eagle, Osprey, Peregrine Falcon, and Merlin
Scientific names: *Haliaeetus leucocephalus*, *Pandion halieatus*, *Falco peregrinus*, and *Falco columbarius*

B. Distribution and abundance

Range:
Global breeding range comments:
Bald Eagle: North America; associated with aquatic habitats (coastal, rivers, lakes, reservoirs)
Osprey: Cosmopolitan; associated with aquatic habitats (especially shallow water for foraging)
Peregrine Falcon: Cosmopolitan; diverse habitats
Merlin: Holarctic; circumboreal; occasional occurrence in Central and South America
State range comments: All statewide

Abundance:
Global abundance comments:
Bald Eagle: estimated at 100,000 in 1999, increasing (Buehler 2000)
Osprey: estimated at 24,000 to 31,000 in early 1980s; increased 50–100% in many areas since then (BNA 2002)
Peregrine Falcon: no estimate of abundance (BNA 2002); anatum = 1365 in United States (USFWS 2003)
Merlin: no estimate of abundance in BNA (1993); 1972 population estimate of 8000 in Canada and United States (Johnsgard 1990)
State abundance comments:
Bald Eagle: 45,000 (Alaska Raptor Management Plan, based on Stalmaster 1987); likely more now
Osprey: Low hundreds of breeding pairs (Alaska Raptor Management Plan)
Peregrine Falcon: American subspecies (P.f. anatum) - 750–900 pairs (USFWS unpubl. data, 2001); Arctic subspecies (P.f. tundrius) - 225–250 pairs (USFWS unpubl. data, 1994); Peale's subspecies (P.f. pealei) - 600 pairs (Ambrose et al. 1988)
Merlin: Unknown; possibly in the low thousands

Trends:
Global trends: Since the Pesticide Era (post-1970), all have increasing to stable trend
Bald Eagle: increasing from estimate of 70,000 in 1980 (Buehler 2000)
Osprey: increasing (BNA 2002)

Peregrine Falcon: North America – increasing 5–10% annually in late 1990s (BNA
Merlin: decreasing numbers of migrants in 1980s and early 1990s; recent increases (BNA 1993)

State trends:

Bald Eagle – increasing; stable in Southeast Alaska since the early 1980s; limited evidence for increasing numbers in Prince William Sound (no data for last decade) and the Alaska Peninsula.
Osprey – stable
Peregrine Falcon – increasing
Merlin – stable or increasing

C. Problems, issues, or concerns for species group

All species vulnerable to effects of environmental contaminants due to their top trophic position, aquatic associations, or documented contaminant concentrations with associated effects. Recent studies indicate contaminants are still a problem for raptors in the Aleutians. Being apical predators, owls tend to be susceptible to contaminant loading. Consumption of prey with small amounts of environmental contaminants can result in bioaccumulation, leading to death or diminishing the potential for successful reproduction. An obvious example is DDT and its derivatives that caused eggshell-thinning and reduced reproductive performance in peregrines.

D. Location and condition of key or important habitat areas

Peregrines: Aleutians, Interior rivers, North Slope rivers, Southeast Alaska coast – very good/pristine
Bald Eagles: Aleutians, lake shore habitats, riverine areas, coastal areas – very good/pristine
Osprey: Interior lakes and rivers – very good/pristine
Merlin: Forest and tundra statewide – very good/pristine

These species occur in a variety of habitats, which are in a variety of conditions. However, the primary issue is contaminant exposure, through point sources or atmospheric transport, in breeding, migrating, and wintering areas. This issue is not given to traditional evaluation of habitat quality, nor limited to within the state of Alaska. Within the state of Alaska, however, aquatic habitats are key to minimizing contaminant exposure.

E. Concerns associated with key habitats

Because aquatic habitats concentrate contaminants from large terrestrial areas, they are key habitats to conserve from point source contamination, including leachate from landfills, mercury contamination from old mining sites, and persistent organic pollutants such as PCBs and DDT from military, municipal, and industrial sites.

F. Goal: Conserve Peregrine Falcon, Bald Eagle, Osprey, and Merlin populations so that they remain sustainable throughout their natural range and within natural population-level variation and there is no need for endangered species type of management.

G. Conservation objectives and actions

State conservation and management needs:

Objective: Ensure that reproduction, mortality, and other population parameters are not significantly affected by contaminant concentrations in birds or their habitats.

Target: Contaminant concentrations (mercury and persistent organic pollutants, including chlorinated and brominated compounds) below those associated with reproductive impairment (e.g. mercury < 0.5 ppm wet weight in eggs, Peakall et al. 1990).

Measure: Periodic measurements of contaminants and reproductive or demographic parameters in breeding populations; compare contaminant concentrations to reproductive parameters and toxicity thresholds, and evaluate for trends through time.

Issue 1: Increases in levels of contaminants in these birds could affect their reproductive success and ability to sustain current population levels.

Conservation actions:

Coordinate with other state and federal agencies to:

a) Collect samples to assess presence and degree of contamination (addled egg, feather) using standardized protocols (e.g. USFWS 2003).
b) Determine if contaminants are found in Alaska or are being obtained during migration or during the winter.
c) Leverage funding for collection and analyses.
d) Interpret and analyze chemical and population parameter data as part of an interdisciplinary contaminant monitoring program.
e) Monitor reproduction, mortality, or other population parameters in selected species affected by contaminants.

Issue 2: Point sources of contamination, including leachate from landfills, mercury contamination from old mining sites, and persistent organic pollutants such as PCBs and DDT from military, municipal, and industrial sites may concentrate in aquatic habitats and lead to increases in contaminant levels in these bird species.

Conservation actions:

a) Monitor for presence of contaminants in raptors.
b) Ensure contaminant levels in raptor habitats or food do not exceed safe levels.

Global conservation and management needs:

Objective: Similar to state conservation and management needs, above.

Issue: Atmospheric transport of contaminants from other countries to northern regions. Ultimately, raptor exposure to environmental contaminants is a global threat requiring international cooperation and regulation.

Conservation action: Participate in national and international efforts to reduce impact of environmental contaminants to raptors (e.g., AMAP).

H. Plan and time frames for monitoring species and their habitats

Integrate the American Peregrine Falcon post-delisting monitoring plan (USFWS 2003) with a comprehensive contaminant monitoring program that coordinates sample collections from ongoing studies and recommends contaminant sample collection every 3–5 years. Use the SWG Program to coordinate and supplement existing monitoring program. Although sample-size dependent, this is an appropriate interval (e.g., Ambrose et al. 2000) for raptors affected by contaminants.

I. Recommended time frame for reviewing species status and trends

Review and evaluate collected data at least every 5 years; revise strategy as appropriate based on contaminant concentrations in individual species.

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Diurnal Migrant Raptors – Introduction

Rationale for choosing these species/species group: There is potential for impacts to these species when they are not in Alaska, either on the wintering grounds or during migration. The condition of habitats and threats along migration routes/wintering areas are major concerns for migratory raptors. Differing migration strategies and life histories need to be considered when developing conservation strategies for these species. For example, species migrating into Central and South America may have greater threats than species wintering north of Mexico. Grouping these species provides a broad-based connection based on their migratory behavior, and it reduces the total number of featured species requiring individual treatment.

Diurnal Migrant Raptors

A. Species group description

Common and Scientific names: species group – diurnal migrant raptors
Golden Eagle - *Aquila chrysaetos*
Rough-legged Hawk - *Buteo lagopus*
Red-tailed Hawk - *Buteo jamaicensis* (Harlan's Hawk - *Buteo jamaicensis harlani*)
Sharp-shinned Hawk - *Accipiter striatus*
Northern Harrier - *Circus cyaneus*
Short-eared Owl - *Asio flammeus*

B. Distribution and abundance

Range:
Global range comments:
Golden Eagle - Holarctic – open spaces with cliff-nesting habitat
Rough-legged Hawk - Panboreal – taiga and tundra habitats
Red-tailed Hawk - North and Central America, Caribbean Islands; diverse habitats – woodlands with open areas
Sharp-shinned Hawk - New World: North and South America; deciduous, coniferous and mixed forests (Bildstein and Meyer 2000)
Northern Harrier - Holarctic; New World includes Central America (MacWhirter and Bildstein1996)
Short-eared Owl - Holarctic; New World includes South America – open, nonforested habitats
State range comments: can be found statewide.

Abundance:
Global abundance comments: variable by species
Golden Eagle – up to 100,000 in North America during 1970s; subsequent declines outside of Alaska (Kochert et al. 2002)
Rough-legged Hawk – no estimate of abundance; CBC estimate of 50,000 wintering birds in North America (Bechard and Swem 2002)

Red-tailed Hawk – *B. j. harlani* – no estimate of abundance
Sharp-shinned Hawk – no estimate of abundance (Bildstein and Meyer 2000)
Northern Harrier – no estimate of abundance (MacWhirter and Bildstein1996)
Short-eared Owl – no estimate of abundance

State abundance comments: variable by species. Within specific habitats, certain species are frequent.

Golden Eagle – high densities in Denali National Park (Kochert et al. 2002)
Rough-legged Hawk – high densities along some rivers in some years associated with small mammal populations
Red-tailed Hawk – unknown and variable by region and habitat
Sharp-shinned Hawk – unknown
Northern Harrier – unknown
Short-eared Owl – unknown

Trends:

Global trends: unknown, but not believed to be declining, except perhaps for Short-eared Owl, which may be declining.

Golden Eagle – declining in western United States; stable in Denali National Park, Alaska; unknown in remainder of Alaska (Kochert et al. 2002).
Rough-legged Hawk – Palmer (1988) reported no evidence of change in North America (Bechard and Swem 2002); natural variations in abundance occur.
Red-tailed Hawk – *B. jamaicensis* – recent increases, up to 30% in some areas; *B. j. harlani* – no data (Preston and Beane 1993).
Sharp-shinned Hawk – declining in North America 1940s–1970s and again in 1990s (Bildstein and Meyer 2000).
Northern Harrier – declining in North America during 20th Century due to loss of habitat (MacWhirter and Bildstein1996).
Short-eared Owl – declining in North America since listed by National Audubon Society in 1976 (Holt and Leasure 1993); declining in North America and designated high priority by Partners in Flight (2004).

State trends: currently undetermined. Habitat for Harlan's Hawk may be increasing in Southcentral Alaska with changes in habitat. Prey-dependent species (Short-eared owl, Northern Harrier, Rough-legged Hawk, Golden Eagle) can vary widely in annual abundance.

Golden Eagle – unknown
Rough-legged Hawk – unknown
Red-tailed Hawk – unknown
Sharp-shinned Hawk – unknown
Northern Harrier – unknown
Short-eared Owl – unknown

C. Problems, issues, or concerns for species group

- Lack of knowledge about population size and trend (e.g., Sharp-shinned Hawk, Harlan's Hawk, Northern Harrier, Short-eared Owl, Golden Eagle and Rough-legged Hawk)

- Migration corridors may not be well defined; patterns possibly too diffuse; difficulty of finding, and accessing, suitable migration corridors; finding sufficient, qualified personnel to operate sites; migration count data in Alaska is not reliable to monitor population trends
- Need for long-term data stewardship
- Potential impacts at wintering grounds such as shooting, poisoning, and habitat alteration and habitat loss
- As migrants, these species have increased potential for exposure to West Nile Virus

D. Location and condition of key or important habitat areas

- tundra – very good
- temperate forest – variable by location
- boreal forest – variable by location
- Southcentral forests – spruce bark beetle impacted
- temperate rain forest – variable by location
- migratory routes – variable by location
- wintering grounds – variable by location

E. Concerns associated with key habitats

Concerns for key breeding habitats in Alaska:

- logging – loss or conversion of nesting habitat has an impact on migrant species returning to Alaska to breed (exception: Harlan's Hawks and other species may actually benefit from conversion of dense or mature stands to more open areas).
- spruce bark beetle – created massive habitat change in Southcentral forests, which is likely to have impacts on migratory raptors that use this area.
- tundra – impact of resource development (oil, gas and mining). Roads bring people, disturbance, increased competitors/predators associated with humans (e.g., fox, ravens).

F. Goal: Ensure that diurnal raptor populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

Objective: Maintain diurnal migrants at sustainable population levels.

Target: Maintain population indices within observed variability.

Measure: Index of population size based on standardized counts of migrants at established monitoring sites (to be considered in combination with breeding ground counts, reproductive estimates, etc.).

Issue 1: Migration corridors may not be well defined; patterns possibly too diffuse; difficulty of finding, and accessing, suitable migration corridors.

Conservation actions:

a) Identify and develop migratory monitoring sites by coordinating work and efforts with biologists from Yukon Territory, Canada and Hawk Watch International.
b) Use protocol for identifying locations established by Hawk Migration Association of North America.

Issue 2: Finding sufficient, qualified personnel to operate monitoring sites is difficult.

Conservation actions:

a) Coordinate with organizations already involved (e.g., Alaska Bird Observatory, Hawk Watch International).
b) Publicize the concept of migratory raptor management which utilizes standardized monitoring procedures within professional and/or volunteer birding community, e.g. Hawk Migration Association of North America.

Issue 3: Lack of knowledge about population levels of diurnal migrants.

Conservation action: Develop methods to link abundance and trend of migrants with their actual population size.

Issue 4: Spruce bark beetle infestations have created massive habitat change in Southcentral forests, which is likely to have impacts on migratory raptors that use this area.

Conservation action: Coordinate with researchers involved with consequences of spruce bark beetle infestation to assess potential impacts to migratory raptors.

Issue 5: Potential impacts at wintering grounds (e.g., shooting Rough-legged Hawk and Golden Eagle, road kills, poisoning of Golden Eagle on ranches), habitat alteration and habitat loss.

Conservation action: Use stable isotope methods to locate wintering grounds. Explore potential for feather analysis to determine natal areas through use of stable isotopes.

Issue 6: There is no single entity responsible for the long-term stewardship of data.

Conservation action: Initiate discussions with potential governmental and nongovernmental organizations on who should be the lead coordinating group for data storage and standardized protocol development.

Issue 7: As migrants, these species have increased potential for exposure to West Nile Virus, may be more susceptible to it, and may affect Alaska breeding populations by succumbing to disease outside of Alaska.

Conservation action: Continue existing ADF&G and CDC efforts on surveying dead birds for virus to detect if (or when) virus appears in Alaska.

Global conservation and management needs:

Conservation actions:

a) Determine if Short-eared Owls are nomadic between continents.
b) Consult Birds of North America accounts for global impacts.
c) Access Bird Banding Lab database for information about band recoveries and returns to determine summer/winter relationships using existing data.

H. Plan and time frames for monitoring species and their habitats

Year 1–2: review data and develop monitoring plan

1. Review existing information on migration monitoring in Alaska and western Canada.
2. Determine efficacy of additional monitoring and sample sizes necessary.
3. Use results from 1 and 2 to determine the feasibility of establishing more monitoring sites.
4. If monitoring or migrants is not feasible, evaluate alternatives.
5. If feasible, then establish partnership with HawkWatch International to start developing a migration monitoring strategy.

Year 3 +: Continue monitoring.
Year 5 +: Begin assessing data collected to establish baseline.

I. Recommended time frame for reviewing species status and trends

Review strategy every 5 years.

J. Bibliography

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Black Merlin and Gyrfalcon

A. Species group description

This group contains 2 raptors, Gyrfalcon and Black Merlin, that have restricted ranges in Alaska and conservation issues related to habitat change and population status.

Common name: Gyrfalcon **Scientific name:** *Falco rusticolus*
Common name: Black Merlin **Scientific name:** *Falco columbarius suckleyi*

B. Distribution and abundance

Gyrfalcon:

Range:

Global range comments: Holarctic – Arctic regions of Northern Hemisphere.
State range comments: Most common north of Brooks Range, in parts of Alaska Range, and on the Seward and Lisburne Peninsulas but distributed throughout tundra locations (USFWS 2001).

Abundance:

Global abundance comments: Approximately 110,000 (Rich et al. 2004).
State abundance comments: Estimated 375–675 pairs in Alaska (Swem et al. 1994) but varies with season. Some Alaskan birds migrate from state during winter while others remain in general breeding areas.

Trends:

Global trends: Unknown
State trends: Unknown – likely stable overall

Black Merlin:

Range:

Global range comments: Coastal locations from northern Southeast Alaska south to Oregon (Sodhi et al. 1993).
State range comments: Southeast Alaska (USFWS 2001)

Abundance:

Global abundance comments: Unknown
State abundance comments: Unknown

Trends:

Global trends: Unknown but thought to be stable, increasing in some areas, decreasing in others.

State trends: Unknown but potentially declining in some parts due to habitat loss.

C. Problems, issues, or concerns for species group

Gyrfalcon: Baseline information only available from specific locales, need baseline information from majority of range, i.e., habitat associations, response to fluctuating prey base, migratory and movement patterns.

Black Merlin: Lack of information concerning natural history and taxonomic status of subspecies.

D. Location and condition of key or important habitat areas

Gyrfalcon: nest on protected ledges on cliffs, along rivers, mountains and coasts – pristine; forage over tundra – pristine.

Black Merlin: coastal, temperate rain forest – very good to pristine; localized areas of forest management – degraded.

E. Concerns associated with key habitats

Gyrfalcon: Anticipated localized loss of nesting habitat in areas planned for mining in northwestern Alaska. Changes in habitat and prey due to climate change.

Black Merlin: Loss of forest habitat in Southeast Alaska.

F. Goal: Ensure that Black Merlin and Gyrfalcon populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

Gyrfalcon:

Objective: Maintain Gyrfalcon populations in Alaska at current levels.

Target: Maintain nesting habitat protections for Gyrfalcons.

Measure: Monitor Gyrfalcons at known nesting sites.

Issue: Lack of knowledge of population status and trend.

Conservation actions:

a) Learn more about Gyrfalcon populations so we have baseline information on which to base decisions concerning conservation status and threats to populations;
b) Develop reliable survey methods for remote, inaccessible species.
c) Monitor nesting success at important sites at risk.
d) Collaborate with falconers for monitoring status and sharing data

Black Merlin:
Objective: Maintain Black Merlin populations in Alaska at current levels.

Target: Increase knowledge and information about population abundance of Black Merlins.

Measure: Population and habitat monitoring.

Issue 1: Lack of knowledge about natural history of this species.

Conservation action:

a) Obtain baseline information about Black Merlin ecology in Southeast Alaska.
b) Evaluate relationships between forest management and Black Merlins.
c) Coordinate with other entities to understand merlin ecology throughout range.
d) Develop practical survey method.

Issue 2: Lack of knowledge concerning taxonomic status of Black Merlin as a subspecies or simply a color morph.

Conservation action: In conjunction with natural history studies, collect feathers and or tissue with which to begin to evaluate taxonomic status of this species.

H. Plan and time frames for monitoring species and their habitats

Gyrfalcon:
USFWS, NPS, ADF&G, and private entities (e.g., ABR, Inc.) have expertise in the study of tundra raptors; use cooperative partnership of raptor biologists to identify study objectives and survey areas in monitoring plans. Reports should be in the form of a report due at 5 years after plan implementation, with annual summary reports (should not be required to be extensive).

Black Merlin:
Various state and federal agencies have raptor expertise, and they should use a coordinated approach in the study of this species along with other field studies. Reports should be in the form of a report due 5 years after plan implementation, with annual summary reports.

I. Recommended time frame for reviewing species status and trends

Review at 5 years.

J. Bibliography

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Forest Owls – Introduction

Forest owls occurring in Alaska are identified as featured species in the conservation plan because of several factors. These factors include:

- Forest owls are hard to detect, enumerate, and monitor. Therefore, we have very little knowledge about population size, status, and trend.
- Forest fragmentation is occurring, and we don't have reliable statistics on the rate change occurring in the forest types where these owls occur.
- Some owl species are negatively impacted by forest fragmentation, but we don't know the threshold of fragmentation that causes impacts, nor do we know the magnitude of the impact in relation to the total range of these species in Alaska.
- Some owl species are enhanced by forest fragmentation, and we do not know the threshold of fragmentation that causes species to expand into new areas, nor do we know the magnitude of expansion in relation to the total range of these species in Alaska.
- Conserving common species is an important conservation strategy; however, the lack of knowledge about forest owl species makes it hard to identify the commonness of these owl species.
- Protecting vulnerable species is a core conservation strategy, yet lacking specific knowledge about forest owl species makes it difficult to identify strategies applicable to impacted species because we do not know which forest owl species are vulnerable or impacted.

Forest Owls

A. Species group description

"Forest Owls" is a grouping of 8 little-known species occurring in boreal forest (3 species) or temperate rain forest (4 species) in Alaska. One species (Great Horned Owl) occurs in both forest types.

Common names:

Coastal temperate rain forest owls include:

Western Screech-Owl, Northern Pygmy-Owl, Barred Owl, Northern Saw-whet Owl, and Great Horned Owl (also found in boreal forest)

Boreal forest owls include:

Great Gray Owl, Boreal Owl, Northern Hawk Owl, and Great Horned Owl (also found in coastal temperate rain forest)

Scientific names:
Western Screech-Owl – *Megascops kennicottii*
Northern Pygmy-Owl – *Glaucidium gnoma*
Barred Owl – *Strix varia*
Northern Saw-whet Owl – *Aegolius acadicus*
Great Gray Owl – *Strix nebulosa*
Boreal Owl – *Aegolius funereus*
Northern Hawk Owl – *Surnia ulula*
Great Horned Owl – *Bubo virginianus*

B. Distribution and abundance

Range:

Global range comments: See Birds of North America.

Western Screech-Owl – Western North America – woodland and forest habitats; riparian deciduous; suburban.

Northern Pygmy-Owl – New World – Southeast Alaska through the western cordillera to Guatemala.

Barred Owl – New World – Southeast Alaska, central British Columbia eastward through southern Canada to New Brunswick and Nova Scotia, southward through most of the United States, into Mexico and Central America to Guatemala and Honduras; primarily in heavily forested areas.

Northern Saw-whet Owl – New World – woodlands and coniferous forests at moderate elevations and latitude.

Great Gray Owl – Circumboreal – boreal forest and montane coniferous forest.

Boreal Owl – Circumboreal – boreal forest and subalpine forest.

Northern Hawk Owl – Circumboreal – boreal forest and mixed deciduous/coniferous forest, burned areas.

Great Horned Owl–New World–North and South America; diverse habitats and elevation.

State range comments:

Western Screech-Owl, Northern Pygmy-Owl, Barred Owl, Northern Saw-whet Owl – generally, breeding limited to Southeast and Southcentral Alaska (coastal temperate rain forest).

Great Gray Owl, Boreal Owl, Northern Hawk Owl – generally, breeding in Southcentral and Interior Alaska (boreal forest).

Great Horned Owl – generalist; throughout Alaska where trees or thick shrubbery are available.

Abundance:

Global abundance comments: See Birds of North America.

Western Screech-Owl – no estimate of abundance (Cannings and Angell 2001); 740,000 worldwide; about 540,000 in North America (Rich et al. 2004).

Northern Pygmy-Owl – 2,000 to 10,000 in Canada (Holt and Petersen. 2000); 100,000, about 84,000 in North America (Rich et al. 2004).

Barred Owl –10,000–50,000 pairs in Canada (Mazur and James 2000); 560,000 (Rich et al. 2004).

Northern Saw-whet Owl – 100,000–300,000 individuals (Cannings 1993); 2,000,000, with about 1,920,000 in North America (Rich et al. 2004).

Great Gray Owl – no estimate of abundance. Density: 0.66 to 1.72 pairs/km^2 (Bull et al. 1993); 63,000, with about 31,500 in North America (Rich et al. 2004).
Boreal Owl – no estimate of abundance (Hayward and Hayward 1993); 2,000,000, with about 600,000 in North America (Rich et al. 2004).
Northern Hawk Owl – 10,000–50,000 individuals based on North America densities (Duncan and Duncan 1998); 130,000, with about 65,000 in North America (Rich et al. 2004).
Great Horned Owl – no estimate of abundance (Houston et al. 1998); 5,300,000, with about 2,300,000 in North America (Rich et al. 2004).

<u>State abundance comments:</u> unknown

Trends:

<u>Global trends:</u> see references

Western Screech-Owl – declining due to habitat loss and invasion of Barred Owls (Cannings and Angell 2001).
Northern Pygmy-Owl – unknown
Barred Owl – expanding numbers and range in western North America (Mazur and James 2000).
Northern Saw-whet Owl – unknown
Great Gray Owl – unknown
Boreal Owl – Scandinavia – reduced numbers due to removal of forest (Hayward and Hayward 1993).
Northern Hawk Owl – Anecdotal evidence of decline since 1800s; decline in Northern Europe (Duncan and Duncan 1998).
Great Horned Owl – cycle with prey availability; increasing in disturbed areas (Houston et al. 1998).

<u>State trends:</u> unknown

C. Problems, issues, or concerns for species group

- Lack of knowledge about population status and trends. Current broad-scale bird survey methodologies (e.g., BBS, CBC) are generally lacking for owls and do not effectively monitor these species
- Habitat alteration and fragmentation (e.g., logging, urbanization, mining) are occurring and impacts have not been assessed
- Contaminants may affect health and reproduction
- Disease (e.g., West Nile Virus)
- Since the 1970s, Barred Owls have been expanding into Alaska and they may be impacting other owl species

D. Location and condition of key or important habitat areas

Western Screech-Owl, Northern Pygmy-Owl, Barred Owl, Northern Saw-whet Owl: coastal, temperate rain forest – locally degraded.

Northern Hawk Owl, Boreal Owl, and Great Gray Owl: boreal forest – good.

E. Concerns associated with key habitats

- Lack of knowledge about species abundance and use of habitats
- Habitat alteration from logging, urbanization, and mining is occurring in both habitats (boreal forest, rain forest)

F. Goal: Ensure that forest owl populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

Objective: Maintain current population levels for forest owls in respective biomes.

Target: For selected forest owls, identify and obtain density estimates (e g. singing males/distance sampled).

Measure: Index of abundance based on density estimate methodology used (e.g., number of singing males during the breeding season per distance sampled).

Issue 1: Survey methods. There is a lack of knowledge about population status and trends because current broad-scale bird survey methodologies (e.g., BBS, CBC) do not effectively monitor owls. It is not clear what density of singing males is needed to conserve species, and it is unclear if singing male method is an appropriate method to estimate abundance.

Conservation actions:

a) Develop and employ methodologies to measure populations accurately.
b) Coordinate with existing owl monitoring groups to keep updated on changes or improvements in survey methods.
c) Assess standard owl monitoring techniques (e.g., singing surveys, playback surveys, monitoring of nest boxes).
d) Based on assessment above, identify, employ and, if necessary, develop methods to determine abundance and trend.
e) Develop methodologies for nonsinging, noncavity-nesting species.
f) Investigate relationship between health of non-owl species that build nests that may also be used as nesting sites by owls.

Issue 2: Nest boxes. It is unclear how placement and occupancy of nest boxes relates to population status and dynamics. Artificial nest structures may enhance breeding opportunity for several species and/or create artificially high densities in formerly vacant habitat. Populations using nest boxes may not be reflective of larger metapopulations.

Conservation action: Assess nest box checks as a standard owl monitoring technique.

Issue 3: Lack of knowledge about species use of habitats.

Conservation actions:

a) Investigate habitat associations
b) Conduct research to increase understanding of dependence on certain prey items, and what effect variations in prey abundance may have on owl populations
c) Identify the spatial dispersion and physical features of suitable nesting cavities and surrounding vegetation types to include in conservation guidelines for forest managers.

Issue 4: Habitat modifications. It is unclear what amount of habitat change could negatively affect populations of these species.

Conservation action: Assess potential status related to habitat change.

<u>Issue 5</u><u>: Contaminants may affect health and reproduction of owls.</u>

Conservation action: Assess potential threats from contaminants.

<u>Issue 6</u><u>: Disease, such as West Nile Virus, may affect health and reproduction of owls.</u>

Conservation action: Assess potential threats from disease.

H. Plan and time frames for monitoring species and their habitats

Survey methods need development and 3–5 years will be needed to develop methods for assessing forest owl population status and trend for at least 2 species in each biome.

I. Recommended time frame for reviewing species status and trends

Five years from plan implementation.

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Snowy Owl - Introduction

The rationale for featuring this species includes climate change and increasing human development (village growth and resource extraction) and the associated infrastructure, which may lead to changes in nesting of Snowy Owls. On the North Slope, Snowy Owls nest most reliably and are usually most abundant near the village of Barrow. Near Barrow, numbers and reproductive effort of Snowy Owls are thought to be linked to abundance of brown lemmings, which varies considerably from year to year. Anecdotal observations indicate that the periodicity and amplitude of brown lemming population fluctuations near Barrow may have changed in recent years. If so, this may affect Snowy Owl reproductive performance.

Snowy Owl

A. Species description description

Common name: Snowy Owl
Scientific name: *Bubo scandiacus*

B. Distribution and abundance

Range:
Global range comments: holarctic and nomadic
State breeding range comments: coastal tundra of northern and western Alaska

Abundance:
Global abundance comments: irruptive (increase rapidly and irregularly in number)
State abundance comments: irruptive

Trends:
Global trends: unknown

State trends: unknown

C. Problems, issues, or concerns for species

- Increased human presence in tundra areas (from village growth and expansion of development infrastructure and roads) may increase disturbance of Snowy Owls.
- Given their dependence on brown lemming populations, Snowy Owls may be impacted by changes in brown lemming population ecology, which may in turn be impacted by global climate change. Snowy Owls may be representative of a broad array of Arctic Coastal Plain species that could be impacted by broad-scale environmental change.

- Satellite telemetry data from work at Barrow suggests that Snowy Owls are a single Holarctic population. Effective management will need to address issues throughout the Arctic.

D. Location and condition of key or important habitat areas

Arctic tundra: very good but locally degraded, particularly immediately adjacent to Barrow where Snowy Owls habitually nest.

Yukon-Kuskokwim Delta: very good but locally degraded.

Aleutians and Bering Sea, winter habitat: very good.

Beyond the borders of Alaska: unknown

E. Concerns associated with key habitats

- Human disturbance on tundra, including recreational use around villages (both foot and vehicular)
- Human take by Siberian trappers (causing significant mortality) needs to be evaluated in relation to species characteristics and distribution (e g. single holarctic species)
- Broad-scale environmental changes (e.g., climate change)

F. Goal: Ensure Snowy Owl populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

Objective: Maintain sustainable numbers of Snowy Owls, within observed annual variability.

Target: Ensure that Snowy Owls continue to nest in key habitats and locales.
Measure: On the North Slope and other breeding areas, use aerial waterfowl surveys as index of abundance and distribution.

Issue 1: Tremendous natural annual variation in density and distribution may reduce the power of surveys to discern long-term population trends.

Conservation actions:

a) Use historic data to establish baseline detections and sample sizes to determine population trends.
b) To monitor trends, repeat and expand the USFWS analysis of Snowy Owl abundance and distribution from aerial waterfowl survey data (Arctic Coastal Plain Eider Survey, North Slope Waterfowl Breeding Pair Survey).
c) Cooperate with Canadian Wildlife Service to institute or expand surveys of Snowy Owls in Canada, including waterfowl surveys in which Snowy Owl observations are recorded.
d) Cooperate with Russian and European biologists working with Snowy Owls on Wrangell Island and elsewhere to estimate abundance and trend globally.

Issue 2: Increased human presence in tundra areas (from village growth and expansion of development infrastructure and roads) may increase disturbance of nesting Snowy Owls, resulting in nest failures.

Conservation action: Determine the effect on Snowy Owls of disturbance from human presence.

Issue 3: Snowy Owls are closely linked with prey species (e g., brown lemming) and may respond to climate change by being impacted by changes in availability and abundance of their primary prey. This species may be representative of a broad array of Arctic Coastal Plain species that could be impacted by broad-scale environmental change.

Conservation action: Evaluate population dynamics of brown lemmings and other small mammals near Barrow related to environmental change, including extrapolation to Snowy Owls and other Arctic Coastal Plain species.

Global conservation and management needs:

Objective: Ensure that Snowy Owls continue to nest in important nesting areas.

Target: Use aerial surveys as index of abundance and distribution.
Measure: Maintain numbers of Snowy Owls, within observed annual variability.

Issue: Changes in the global climate may affect brown lemmings, the primary prey species of Snowy Owls, and could therefore reduce Snowy Owl numbers.

Conservation action: Assess climatic change by investigating changes in Arctic habitats and winter sea ice conditions in relation to Snowy Owl distribution at the edge of the Arctic Ocean.

H. Plan and time frames for monitoring species and their habitats

Annual aerial waterfowl surveys on North Slope are currently conducted by USFWS. Additional surveys (western Alaska, Canada) should be conducted annually.

I. Recommended time frame for reviewing species status and trends

Strategy should be reviewed after 5 years; additional information should be compiled in the meantime.

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Shorebirds – Introduction

Alaska provides breeding habitat for more shorebirds than any other state in the United States. Seventy-three species of shorebirds have been recorded in Alaska, representing fully one-third of the world's shorebird species. Of these, 46 species have been documented breeding; 37 are regular breeders and 9 are irregular breeders or breed in small numbers (Gill et al. 1994, Gill and Senner 1996). This incredible diversity is the result of Alaska's proximity to the major flyways of the world and the unique characteristics of the region's landscape, geomorphology, and vegetation (Kessel and Gibson 1978**)**. Most of these species migrate south of the U.S.-Mexico border and a third migrate to South America, Asia, or Oceania. Only a few species remain in Alaska throughout the year.

The list of shorebird taxa restricted wholly or in large part to Alaska is impressive. For example, most of the world's breeding populations of 3 species (Bristle-thighed Curlew, Black Turnstone and Western Sandpiper) and 5 subspecies (Dunlin *C. a. pacifica* and *C. a. arcticola*; Rock Sandpiper *C. p. ptilocnemis* and *C. p. couesi*; and Short-billed Dowitcher *L. g. caurinus*) occur entirely within Alaska. As much as 75% of the world's breeding populations of Surfbird and a subspecies of the Rock Sandpiper (*C. p. tschuktschorum*) occur in the state. A large proportion of North American populations of several other taxa also occur in Alaska, including Black Oystercatcher, Pacific Golden-Plover, Wandering Tattler, Whimbrel (*N. p. rufiventris*), Bar-tailed Godwit (*L. l. baueri*), and Red Knot (*C. c. roselaari*).

Recent evidence suggests many shorebird species throughout the world are declining (International Wader Study Group 2003). Such declines are also occurring in North America. Indeed, of the 72 species and subspecies of shorebirds addressed in the U.S. and Canada National Shorebird Plans, almost half (49%) have experienced apparent population declines since 1970. For many species, the relative status is poorly known and basic monitoring is needed. Outright loss of habitat is the cause of the population decline of many species; for others, it is less clear what factors are responsible for the observed declines.

To better ascertain the reasons for these declines and to gather baseline data on species occurring in Alaska, the shorebird group selected 7 species to highlight in the CWCS. They include the Black Oystercatcher, Bristle-thighed Curlew, Buff-breasted Sandpiper, Marbled Godwit, Rock Sandpiper, Lesser Yellowlegs, and Solitary Sandpiper. Detailed conservation action plans for these species are presented separately. These 7 species exhibit a variety of life history patterns, have population sizes that range from a few thousand to hundreds of thousands, and have population trends that range from stable to possibly increasing to dramatically decreasing. We also relied on a species prioritization process developed as part of the U.S. Shorebird Conservation Plan (Brown et al. 2001). That process is based upon factors such as: 1) population trend and population trend uncertainty, 2) relative abundance, 3) threats during breeding season, 4) threats during nonbreeding season, 5) breeding distribution, and 6) nonbreeding distribution. The result of this process is an Alaskan conservation priority list that includes 2 taxa ranked as highly imperiled and 17 ranked as of high concern. These species are covered in more detail in the Alaska Shorebird Conservation Plan (Alaska Shorebird Group 2000).

Beyond studying individual species, there are many conservation needs that transcend a single species and are common to particular shorebird groups or to all shorebirds. Several of these areas are outlined here.

Alaska Shorebird Information and Data

The first step in conserving wildlife is to understand what information is currently available on a given species or subject. There is a need to develop an information clearinghouse, which would synthesize current information on the geographic distribution, abundance, and dynamics of shorebird populations inhabiting the different regions of Alaska. This relational database would include information on where, when, and how studies were conducted, which species were present, counts or estimates of abundance, and other demographic information (e.g., nest initiation, success). The goal is to provide easily accessible web-based information on Alaska's 73 species of shorebirds to a variety of interested parties. It also could be used to identify information gaps and guide development of monitoring and research programs.

Clearinghouse information could be shared directly with the AKNHP, which is Alaska's statewide clearinghouse for information on plant and animal species of conservation concern, natural communities of conservation concern, and invasive nonnative plant species. AKNHP collects, validates, and distributes this information, and assists natural resource managers and others in applying it effectively. The AKNHP is part of NatureServe, and its data are linked to similar programs in all 50 states, most Canadian provinces, and many Latin American countries.

Monitoring and Assessment of Shorebird Populations

Traditional methods of monitoring have been problematic for shorebirds, especially species that occupy remote breeding areas, occur at very low densities, exhibit cryptic behavior near the nest, or frequently forage well outside their nesting territory. For many of these species, an analysis of vital demographic rates may be a more practical approach to determine (1) which rates have the greatest effect on population size, (2) how populations might change with changes in vital rates, and (3) whether the status of these populations can be easily monitored through the most sensitive vital rates. For a few species, basic information on adult survival, age of reproduction, productivity, and annual recruitment is available or can be estimated from a sister taxon. For other species, this basic information needs to be collected by conducting field studies.

Due to the large ranges and migratory nature of many of these species, the ability to identify and assess changes in shorebird populations requires well-coordinated state, national, and international efforts. Within Alaska, state, federal, and private organizations must work cooperatively to obtain objectives that transcend jurisdictional boundaries. Improved and coordinated monitoring of shorebirds would allow suspected population trends to be confirmed and provide better estimates of the rates of change. This information, in turn, could be used to inform many important management decisions, including 1) detecting species at risk, 2) identifying causes of population changes, 3) evaluating conservation and restoration programs, and 4) setting priorities for conservation of species and habitats. Responding to this need, the U.S. and Canadian Shorebird Council's Monitoring Committee established the Program for Regional and International Shorebird Monitoring (PRISM) in 2001 (Bart et al. 2002). This international program includes monitoring of shorebirds in the Arctic, boreal and montane regions of Alaska, as well as on migration stopover and staging sites throughout the coastal areas of the state. The following projects represent the first steps to fully implementing PRISM.

(1) Arctic and Sub-Arctic Monitoring of Shorebirds
A general approach for the Arctic surveys has been developed during the past 5 years (Bart and Earnst 2002). It uses double sampling and habitat-based models to estimate population size.

(2) Development of Survey Methods for Monitoring Boreal-Nesting Shorebirds
Currently, scientists lack an appropriate survey method(s) for boreal-nesting species. Primary methodologies that warrant evaluation are point count surveys and line transects that use distance estimation, double-sampling, and fixed- and rotary-winged surveys. Several species of shorebirds breed in the boreal region of Alaska, including 3 of known conservation concern and several (> 7) of unknown population status (Gill 1996; Alaska Shorebird Group 2000).

(3) Inventory of Shorebirds Using State Critical Habitat Areas and State Game Refuges on the Alaska Peninsula
Alaska Peninsula estuaries are extremely important staging and stopover sites for autumn-migrant shorebirds that disperse to nonbreeding areas throughout the Americas, Oceania, and Australasia. Much less clear is the spatial and temporal extent to which shorebirds use these estuaries in spring. A study is needed to assess the relative importance of Bristol Bay estuaries and the adjacent terrestrial areas to spring migrant and breeding shorebirds. Such a study would fill critical gaps in life history information for several species of conservation concern, such as the Marbled Godwit, whose nesting appears restricted to the Egegik Bay-Port Heiden portion of the Alaska Peninsula. It also would greatly facilitate efforts to implement species-specific, regional, and/or statewide monitoring programs to establish size and trends of Alaska shorebird populations.

(4) Regional Assessments of Migration Stopover Sites for Shorebirds in Southcentral, Southeastern, and Northern Alaska
The relative importance of intertidal mudflats, estuaries, and wetlands along the Southcentral and Southeastern coast of Alaska as essential wildlife habitat to many animals, particularly migrating shorebirds, is undisputed (Isleib 1979; Senner et al. 1981). Many of these fall under state jurisdiction. Also, research done during the Outer Continental Shelf Environmental Assessment Program in the mid 1970s (Connors et al. 1979, 1984) indicated that shorebirds changed habitat use from upland tundra breeding sites to coastal littoral staging areas as the summer progressed. Virtually nothing is

known on how shorebirds aggregate along the coast and whether congregations in one area represent birds from adjacent tundra or from large areas of the coastal plain. A summary of the existing shorebird information from these regions is needed. This "regional assessment" includes a site description, previous shorebird abundance and diversity information, appropriate survey methods, measurement error and bias concerns associated with counting shorebirds, and need for pilot studies to accurately count birds. This information, along with GIS land coverage of coastlines, could be used to identify other locations where shorebirds may stopover during migration. The completed regional assessment will be an invaluable tool for regional biologists as they prioritize and plan future coastal studies and assess the potential effects of proposed habitat development projects. But most important, this document will provide the needed information, when combined with similar data from Canada and the contiguous United States, to develop a statistically sound sampling plan for estimating shorebird abundance and population trends across the Pacific Flyway.

Conservation Issues Affecting Shorebird Populations

There are a number of natural and anthropogenic factors that represent real and potential threats to Alaskan shorebird populations and require further study. The 2nd edition of the Alaska Shorebird Conservation Plan (Alaska Shorebird Group 2000) describes known and potential effects on shorebird populations from oil and gas development and infrastructure in Prince William Sound, Cook Inlet, Bristol Bay, and the Arctic Coastal Plain; marine transport of diesel fuel to coastal communities; marine-based recreation; mining; subsistence harvest; increased populations of native and introduced predators; and climate change. It also identifies data gaps and information needs.

Natural History of Shorebirds in Alaska

For many species of shorebirds in Alaska, little is known about many aspects of their natural history. Detailed studies are needed to document distribution and abundance, migration and staging patterns, physiology, population discreteness, and general breeding biology. Information on factors limiting the growth of a population is particularly needed given the decline of many species. Natural history projects that also help address conservation issues presented above would be most helpful. In addition, several species of shorebirds reside in Alaska during the winter months, including the Black Oystercatcher, Surfbird, Black Turnstone and Pribilof Rock Sandpiper. These species occupy regions of Cook Inlet, Prince William Sound, Kodiak Island and Southeast Alaska. Virtually nothing is known about the winter ecology of these species, where species winter relative to where they breed, and whether seasonal movements of these birds occur.

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Black Oystercatcher

A. Species description

Common name: Black Oystercatcher
Scientific name: *Haematopus bachmani*

Conservation designation: Classified as species of "high concern" within the United States (Brown et al. 2001), Canadian (Donaldson et al. 2001), and Alaska shorebird conservation plans (Alaska Shorebird Group 2004). Listed as bird of conservation concern within national and regions 1 and 7 lists of the USFWS, and is included in the Alaska Audubon Watchlist.

B. Distribution and abundance (see map page 310, Appendix 4)

Range: (from Andres and Falxa 1995)

Global range comments: Generally resident throughout range that extends from Alaska to Baja California. Common throughout most of Aleutian Islands and coastal Southcentral Alaska, along outer coast of Southeast Alaska, British Columbia, Washington, Oregon, and California, and along Pacific coast of Baja California south to Laguna San Ignacio.

State range comments: In western Alaska common throughout Aleutian Archipelago west to Kiska Island and locally in northern Bristol Bay. Most of population occurs in Southcentral Alaska where common throughout Kodiak Archipelago and east to Kenai Fjords National Park and to eastern Prince William Sound. Also regular along outer coast of Southeast Alaska. Occasionally found on Pribilof Islands in winter.

Abundance:

Global abundance comments: Estimated at 8900 individuals (Brown et al. 2001).

State abundance comments: About 60% of the global population (5300 individuals) thought to reside in Alaska, mostly within Kodiak Archipelago and east throughout Prince William Sound.

Trends:

Global trends: Thought to be stable but data limited.

State trends: Within Prince William Sound, number of pairs have increased or remained constant between 1991 and 1998 (Murphy and Mabee 2000). A large population increase has occurred on Middleton Island since the late 1980s (Gill et al. 2004).

C. Problems, issues, or concerns for species

Oystercatchers are completely dependent upon a narrow coastal area throughout their life cycle, where they are highly susceptible to direct and indirect (through long-term residues remaining in the intertidal areas) exposure to oil spills. Their strong fidelity to breeding territories, easy accessibility, conspicuous behavior, and limited reproductive potential (at most 3 young raised per pair per year and a delayed maturation) also make them particularly vulnerable to local extirpation through persistent disturbance by predation and humans (Andres 1997, 1998). Subsistence harvest of either breeding adults or eggs is a potential threat to some local populations of this species in Alaska. There is also increasingly disturbance by kayakers, fishermen, and tourists within Prince William Sound and Kenai Fjords National Park.

D. Location and condition of key or important habitat areas

Black Oystercatchers are obligate users of the intertidal zone during their entire annual cycle. Here they obtain the necessary food resources for survival and reproduction. In many parts of their range, individual pairs may set up year-long territories or when migratory, exhibit rather high territory site fidelity among years. These factors make the species especially vulnerable to disturbance from marine industrial pollution (e.g., oil spills, waste discharge), human disturbance from tourism and fishing, and harvest or scientific collection. Long-term damage of intertidal areas may occur when oil residues remain in the sediments for years; this is especially relevant in cases where little washing of the area occurs through natural wave action.

Within most of their range, habitat conditions remain relatively pristine, although increasing human disturbance is occurring. In British Columbia, development of nearshore oyster farms and other aquaculture may hinder oystercatchers from breeding. In Prince William Sound and Kenai Fjords, human tourism may make nesting sites less desirable despite little actual habitat alteration.

E. Concerns associated with key habitats

- Marine pollution along coastal shorelines, which may directly kill adults and indirectly affect breeding pairs for years if oil residue remains in sediments within feeding territories.

- Increasing numbers of boaters, kayakers, fisherman, and campers in previously remote coastal areas of Alaska and British Columbia.

- Local extirpation of breeding pairs through subsistence harvest of adults or eggs, scientific collection, and high predator numbers.

- Increasing numbers of wild and feral predators in nearshore areas, such as cats, dogs, foxes, ravens, gulls, rats, and livestock.

F. Goal: Ensure Black Oystercatcher populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

Objective: Maintain sufficient habitat and population viability.

Target: Maintain territory occupancy and productivity levels at or above those documented in Prince William Sound in the 1990s (these are most comprehensive data sets available). Conduct breeding and nonbreeding studies throughout range to determine vital rates necessary for building population viability models and evaluating effects of human disturbance.

Measure: Assess changes in vital rates and determine population trends in areas previously surveyed, and establish baseline levels in new survey sites.

Issue 1: Marine pollution along coastal shorelines.
Issue 2: Increasing numbers of boaters, kayakers, fishermen, and campers in previously remote coastal areas may reduce nesting propensity and reproductive success.
Issue 3: Local extirpation of breeding pairs through subsistence harvest of adults or eggs, scientific collection, and high predator numbers.
Issue 4: Increasing numbers of wild and feral predators in nearshore areas, such as cats, dogs, foxes, ravens, gulls, rats, and livestock.

Conservation actions:

a) Determine vital parameters and sensitivity of each to stochastic and anthropogenic perturbations (e.g., oil spills, human disturbance).
b) Determine importance of Southeast Alaska, Kodiak, Middleton Island, and Prince William Sound to postbreeding populations.
c) Determine extent of postbreeding movements between breeding and wintering areas.
d) Evaluate impacts from subsistence harvest on adults and eggs.
e) Promote development of outreach and educational information to inform the public (recreational boaters and campers, local hunters, and pet owners) on the effects of disturbance, subsistence harvest, and introduced predators.

Global conservation and management needs:

Objective: Conserve sufficient habitat to ensure population sustainability.

Target: Maintain territory occupancy and productivity levels at or above those documented in British Columbia and coastal western states (these are most comprehensive data sets available).

Measure: Assess changes in vital rates and determine population trends in areas previously surveyed, and establish baseline levels in new survey sites.

Issue 1: Marine pollution along coastal shorelines.
Issue 2: Increasing numbers of boaters, kayakers, fishermen, and campers in previously remote coastal areas may reduce nesting propensity and reproductive success.
Issue 3: Increasing numbers of wild and feral predators in nearshore areas, such as cats, dogs, foxes, ravens, gulls, rats, and livestock.
Issue 4: Increasing levels of coastal development may hinder or enhance habitat.

Conservation actions:

a) Determine extent of postbreeding movements between breeding and wintering areas.
b) Determine population size and trends in breeding areas.
c) Evaluate impact of feral and wild predators on oystercatcher adult survival and productivity.
d) Determine vital parameters and sensitivity of each to stochastic and anthropogenic perturbations (e.g., oil spills, human disturbance).
e) Support implementation of the Black Oystercatcher Working Group to promote collaboration on national and international level.
f) Promote development of outreach and educational information to inform the public on the effects of disturbance and introduced predators.
g) Promote identification and protection of key areas through collaborations with NGOs and state and federal entities.

H. Plan and time frames for monitoring species and their habitats

Surveys should be conducted at key breeding and nonbreeding sites once every 5 years to evaluate population abundance and status. Given that much of the intertidal area is under state jurisdiction, funding and some logistical and personnel support to conduct surveys should come from the State of Alaska. The USFSW, the Canadian Wildlife Service, the USGS, as well as other state and provincial governments throughout the species range should contribute funds and personnel to conduct surveys.

I. Recommended time frame for reviewing species status and trends

Every 5 years in conjunction with the Alaska Shorebird Group and revision of its Alaska Shorebird Conservation Plan.

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Lesser Yellowlegs

A. Species description

Common name: Lesser Yellowlegs
Scientific name: *Tringa flavipes*

Conservation designation: Considered a "species of moderate concern" in both the U.S. Shorebird Conservation Plan (Brown et al. 2001) and the Alaska Shorebird Conservation Plan (Alaska Shorebird Group 2004). However, significant population declines (4–9% per year) identified recently in NABBS data (Sauer et al. 2003) has generated a higher level of concern for this species.

B. Distribution and abundance (see map page 311, Appendix 4)

Range: (from Tibbitts and Moskoff 1999)
Global range comments: Breeding range extends from western Québec to western Alaska and from southern portions of the Prairie Provinces to northern MacKenzie. Nonbreeding range extends along the Atlantic Coast from southern New Jersey to southern Texas; and the Pacific Coast from San Francisco Bay to southern California and at the Salton Sea. Widespread on the mainland of Mexico down through southern Panama. Also winters in West Indies and throughout South America to Chile and Argentina. Most birds migrate via the Central Flyway in spring and fall and on the Atlantic Coast in fall. Widespread elsewhere in North America during migration but in low numbers.
State range comments: In Alaska, breeds throughout the area bordered by Anaktuvuk Pass in the north, Kobuk River in northwest, Sheenjek Valley in northeast, Situk River Flats in southeast, and Innoko National Wildlife Refuge in west.

Abundance:

Global abundance comments: Cumulative totals of birds at fall staging areas and aerial surveys on nonbreeding areas suggest the population numbers about 500,000 birds (Morrison et al. 2001). However, this species is difficult to census accurately because of its tendency to disperse over large areas.

State abundance comments: Alaska breeding population thought to be about 150,000 birds (Alaska Shorebird Group 2004). To date, no comprehensive effort has been made to quantitatively estimate the size of the Alaska population.

Trends:

Global trends: Steep decline of 9% per year (P = 0.00, N = 28 routes) between 1980 and 2002 along NABBS routes in Canada (Sauer et al. 2003).

State trends: Similar trend in NABBS data from Alaska, where an estimated annual rate of decline of 4% (P = 0.06, N = 37 routes) has occurred during this same time period.

C. Problems, issues, or concerns for species

Existing

- Lack of practicable methods to census Lesser Yellowlegs throughout their annual cycle
- Lack of information about regions and specific habitats preferred by this species in the Neotropics
- Lack of information about habitat preferences in Alaska
- Alteration and loss of nesting habitat in boreal region
- Alteration and loss of wetland habitats throughout nonbreeding range

Potential

- Pesticides and other contaminants may be ingested by Lesser Yellowlegs in habitats they commonly use on nonbreeding grounds, including estuaries, flooded agricultural fields, and sewage lagoons
- Habitat change, especially drying of boreal wetlands

D. Location and condition of key or important habitat areas

Breeding: Breeds primarily in boreal forest and forest/tundra transition habitats. Typical nesting area in Alaska contains a combination of shallow wetlands, trees or shrubs, and open areas. Habitat at nesting areas has been described as open or semi-open forest interspersed with marshes, bogs, ponds, lakes, and sedge meadows.

Foraging: During breeding, forage mostly in small boreal forest wetlands nearby nest areas (e.g., ponds, flooded woodlands, creek banks). Birds nesting near the coast forage in salt marsh ponds. Nesting birds will make daily foraging flights between boreal nest sites and nearby wetlands (up to 13 km away). Vegetated intertidal areas appear important to migrants in Alaska.

E. Concerns associated with key habitats

Boreal forest habitats are being altered and lost at increasing rates; effects of climate change uncertain. Wooded wetlands in Central and South America continue to be altered at considerable rates.

Attributes surrounding species success: Dispersed distribution during breeding insulates this species from local disturbance events (e.g., road construction, fire).

F. Goal: Ensure Lesser Yellowlegs populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

Objective: Maintain sufficient habitat and population viability.

Target: Reverse downward trend in population size estimated with the NABBS route data by 2010.

Measure: Document number and geographic coverage of off-road surveys relative to species' breeding distribution. Compare the ability of different survey techniques to accurately estimate breeding pair densities.

Issue 1: Lack of statistically valid and logistically feasible methods to census and evaluate productivity of Lesser Yellowlegs during breeding and staging; measurement of this objective may be difficult.
Issue 2: Alteration and loss of nesting habitat in boreal region from human development.
Issue 3: Habitat change, especially drying of boreal wetlands

Conservation actions:

a) Verify accuracy of existing trend data in Alaska and implement more intensive off-road surveys.
b) Identify causes of the apparent decline.
c) Develop, test, and implement a statistically valid statewide monitoring protocol for boreal forest shorebirds, including Lesser Yellowlegs.
d) Quantify nesting, adult feeding, and brood-rearing habitat in greater detail to learn what types of habitat or habitat complexes are required for successful reproduction.
e) Develop feasible options for tracking changes in habitat using remote sensing methods.
f) Quantify differences in breeding density and breeding success among habitats.
g) Monitor changes in the extent and primary productivity of boreal forest wetlands.
h) Advocate for policies and conservation planning that protects Lesser Yellowlegs habitat.

Global conservation and management needs:

<u>Objective</u>: Conserve sufficient habitat and population sustainability.

Target: Assess rate of wetland habitat loss and exposure to contaminants on nonbreeding grounds. Expand off-road BBS routes and implement other techniques for enumerating Lesser Yellowlegs by 2007.

Measure: Determine known rates of habitat loss and levels of contaminant exposure. Estimate population trend using new and improved survey methods.

<u>**Issue 1:** Lack of statistically valid and logistically feasible methods to survey Lesser Yellowlegs throughout their annual cycle.</u>
<u>**Issue 2:** Lack of information about regions and specific habitats preferred by this species in the Neotropics.</u>
<u>**Issue 3:** Alteration and loss of wetland habitats throughout nonbreeding range.</u>
<u>**Issue 4:** Pesticides and other contaminants may be ingested by Lesser Yellowlegs in habitats they commonly use on nonbreeding grounds, including estuaries, flooded agricultural fields, and sewage lagoons.</u>

Conservation actions:

a) Assess the accuracy of BBS population trend data by testing and implementing methods.
b) Identify causes of the apparent decline.
c) Develop, test, and implement a statistically valid monitoring protocol for Lesser Yellowlegs during nonbreeding season.
d) Document regions and habitats used by species in the Neotropics.
e) Evaluate extent and rate of wetland habitat loss in nonbreeding areas.
f) Evaluate exposure to contaminants on nonbreeding grounds.

H. Plan and time frames for monitoring species and their habitats

Develop and implement statistically valid and logistically feasible survey method(s) by 2008. Monitor changes in the extent and primary productivity of boreal forest wetlands and evaluate effects on Lesser Yellowlegs by 2010. Potential partners include municipalities, ADF&G, DNR, BLM, various Native regional and village corporations, USFWS, and the USGS. Additional support from the State of Alaska to conduct surveys on state lands, which cover most of the suspected breeding range, is especially needed. Fieldwork should be planned with the Boreal Partners in Flight groups who are working extensively in boreal regions of North America.

The difficulty in developing a reliable census technique for this species is significant. Periodic review is needed to determine if monitoring and survey recommendations are unrealistic and in need of revision. Monitoring via a population index, as opposed to estimating actual population, may prove to be a more attainable goal.

By 2010, initiate studies on nonbreeding areas to investigate the distribution and habitat use by yellowlegs and assess the potential for the species to be exposed to contaminants. Continue to evaluate and improve survey methods on nonbreeding grounds. Federal, state, provincial, nongovernmental organizations, and Native villages and regional corporations throughout the species range should contribute funds and personnel to assess these objectives.

I. Recommended time frame for reviewing species status and trends

Every 5 years in conjunction with the Alaska Shorebird Group and revision of its Alaska Shorebird Conservation Plan.

J. Bibliography

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Solitary Sandpiper

A. Species description

Common name: Solitary Sandpiper
Scientific name: *Tringa solitaria* (*T. s. cinnamomea* race breeds in Alaska)

Conservation designation: Alaska-breeding population considered "highly imperiled" (Alaska Shorebird Group 2004) and of "high conservation concern" (Boreal Partners-In-Flight); continental population considered "species of high concern" in U.S. Shorebird Conservation Plan (Brown et al. 2001). The species is also a bird of conservation concern on the national and region 6 lists of the USFWS. All designations are based on the extremely small population estimate, rapid rate of population decline (4.1%) in Alaska Breeding Bird Survey data, and the uncertainty about the accuracy of these estimates.

B. Distribution and abundance (see map page 312, Appendix 4)

Range:

Global range comments: Species breeds across the boreal forests of Alaska and Canada. Nonbreeding range extends from southeast Texas and Sinaloa, Mexico, throughout Central America, and south to Peru, Bolivia, and south-central Argentina. Most birds migrate via the Central Flyway and are broadly dispersed in fall and somewhat more concentrated (in time and space) in spring.

State range comments: Nests from within 25 km of the Bering Sea in western Alaska east to the Alaska/Canada border, and from the northern Alaska Peninsula north to the Brooks Range. Probably migrates across a broad front in small flocks (<10 birds) or singly. Areas of concentration not yet identified for migrants or postbreeders. *T. s. cinnamomea* breeds in boreal forests of Alaska (Moskoff 1995).

Abundance:

Global abundance comments: Species population estimated at about 25,000 birds (Morrison et al. 2001), but quality of estimate poor and may be several times larger.

State abundance comments: *T. s. cinnamomea* population estimated at only 4000 individuals (Brown et al. 2001). If accurate, this estimate indicates that the Alaskan-breeding race is among the rarest shorebirds in North America.

Trends:

Global trends: Very little data, but recent analyses indicate downward trends in all data sets that have sufficient information to investigate such trends (i.e., NABBS in Alaska, NABBS in Canada, and migrant monitoring in Ontario and Quebec). Although not statistically significant, NABBS data from Canada show an annual rate of decline of 10% between 1966 and 1999 (P = 0.13, N = 12 routes). Point estimates of trend for migrant birds in both Ontario and Quebec between the late 1970s and the late 1990s are also negative, but neither approaches significance (Aubry and Cotter 2001; Ross et al. 2001).

State trends: Breeding Bird Survey data from Alaska since 1980 show a significant population decline of 4.1% per year (P = 0.02, N = 20 routes; Sauer et al. 2003). This suggests that the Alaskan population (*T. s. cinnamomea)* today is only about a third the size of a quarter century ago.

C. Problems, issues, or concerns for species

Existing

- Paucity of information about population status and trends
- Lack of workable methods to survey Solitary Sandpipers throughout their annual cycle
- Lack of information about regions and specific habitats preferred by this species in the Neotropics
- Lack of information about habitat preferences in Alaska
- Loss of nesting habitats to logging in boreal forests
- Loss of nonbreeding habitats to logging in tropical woodlands
- Loss of wetland habitats throughout the species distribution
- Decline in other species whose nests this species uses

Potential

- Pesticides and other contaminants
- Habitat change, especially drying of boreal forest wetlands

D. Location and condition of key or important habitat areas

Breeding: Wooded wetlands in muskeg bogs, spruce forests, and deciduous riparian woodlands (Moskoff 1995), occasionally riparian tall shrub thickets.

Postbreeding and staging: Same as breeding but also uses nonwooded wetlands such as margins of large lakes and coastal salt marshes.

Nonbreeding: Does not occur in Alaska during this period. Habitats used within suspected nonbreeding range include wooded wetlands, intertidal mudflats, mangrove swamps, flooded ricefields, estuaries, and riverbanks.

E. Concerns associated with key habitats

- Effects of climate change are uncertain.
- Boreal forest habitats are being altered and lost at increasing rates, particularly in Canada.
- Wooded wetlands in Central and South America have undergone considerable alteration and loss.

Attributes surrounding species success: Dispersed distribution during all phases of annual cycle protects this species from local catastrophic events (e.g., oil spills). Only low levels of human disturbance likely experienced by this species during breeding and postbreeding periods.

F. Goal: Ensure Solitary Sandpiper (*T. s. cinnamonea*) populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions (applies only to *T. s. cinnamomea*)

State conservation and management needs:

Objective: Maintain sufficient habitat and population viability.

Target: Reverse downward trend in population size estimated with the BBS route data by 2010.

Measure: Document number and geographic coverage of off-road surveys relative to species' breeding distribution. Compare the ability of different survey techniques to accurately estimate breeding pair densities.

Issue 1: Lack of statistically valid and logistically feasible methods to survey and evaluate productivity of Solitary Sandpipers during breeding and staging; measurement of this objective may be difficult.
Issue 2: Alteration and loss of nesting habitat in boreal region from logging and other human development.
Issue 3: Habitat change, especially drying of boreal wetlands.
Issue 4: Decline in other species (e.g., Rusty Blackbird) whose nests this species uses.

Conservation actions:

a) Verify accuracy of existing trend data in Alaska and implement more intensive off-road surveys.
b) Identify causes of the apparent decline.
c) Develop, test, and implement a statistically valid statewide monitoring protocol for boreal forest shorebirds, including Solitary Sandpipers.
d) Quantify nesting, adult feeding, and brood-rearing habitat in greater detail to learn what types of habitat or habitat complexes are required for successful reproduction.
e) Develop feasible options for tracking changes in habitat using remote sensing methods.
f) Conduct population viability analysis to identify important vital rates regulating population.
g) Quantify differences in breeding density and breeding success among habitats.
h) Monitor changes in the extent (i.e., loss of habitat due to logging) and primary productivity of boreal forest wetlands.
i) Assess relationships with those passerine species that provide the nesting substrates for the Solitary Sandpipers.
j) Advocate for policies and conservation planning that protects Solitary Sandpiper habitat.

Global conservation and management needs:

Objective: Maintain sufficient habitat and population viability.

Target: Assess rate of wetland habitat loss and exposure to contaminants on nonbreeding grounds. Expand off-road BBS routes and implement other techniques for enumerating Solitary Sandpipers by 2007.

Measure: Determine known rates of habitat loss and levels of contaminant exposure. Estimate population trend using new and improved survey methods.

Issue 1: Lack of statistically valid and logistically feasible methods to census Solitary Sandpipers throughout their annual cycle.
Issue 2: Lack of information about regions and specific habitats preferred by this species in the Neotropics.
Issue 3: Alteration and loss of wetland habitats throughout nonbreeding range.
Issue 4: Solitary Sandpipers may ingest pesticides and other contaminants in habitats they commonly use on nonbreeding grounds including estuaries, flooded agricultural fields, and sewage lagoons.

Conservation actions:

a) Assess the accuracy of BBS population trend data by testing and implementing survey methods.
b) Identify causes of the apparent decline.
c) Develop, test, and implement a statistically valid monitoring protocol for Solitary Sandpipers during the nonbreeding season.
d) Document regions and habitats used by subspecies in the Neotropics.
e) Determine extent of postbreeding movements between breeding and nonbreeding areas, using population genetics, stable isotopes, and mark-recapture studies.
f) Evaluate extent and rate of wetland habitat loss in nonbreeding areas.
g) Evaluate exposure to contaminants on nonbreeding grounds.

H. Plan and time frames for monitoring species and their habitats

Develop and implement statistically valid and logistically feasible survey method by 2008. Monitor changes in the extent and primary productivity of boreal forest wetlands and evaluate effects on Solitary Sandpipers by 2010. Potential partners include ADF&G, DNR, BLM, various Native regional and village corporations, USFWS, and the USGS. Additional support from the State of Alaska to conduct surveys on state lands, which cover most of the suspected breeding range, is especially needed. Fieldwork should be planned with the Boreal Partners in Flight groups who are working extensively in boreal regions.

The difficulty in developing a reliable census technique for this species is significant. Periodic review is needed to determine if monitoring and survey recommendations are unrealistic and in need of revision. Monitoring via a population index, as opposed to estimating actual population, may prove to be a more attainable goal.

By 2010, initiate studies on nonbreeding areas to investigate the distribution, habitat use, and potential for contaminant exposure to the species. Continue to evaluate and improve survey methods on nonbreeding grounds. Federal, state, provincial, and nongovernmental organizations, and Native villages and regional corporations throughout the species range should contribute funds and personnel to conduct these objectives.

I. Recommended time frame for reviewing species status and trends

Every 5 years in conjunction with the Alaska Shorebird Group and revision of its Alaska Shorebird Conservation Plan.

J. Bibliography

Alaska Shorebird Group. 2004. A conservation plan for Alaska shorebirds. Unpublished Report, Alaska Shorebird Group. Available through USFWS, Migratory Bird Management, Anchorage, AK.

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Bristle-thighed Curlew

A. Species description

Common name: Bristle-thighed Curlew
Scientific name: *Numenius tahitiensis*

Conservation designation: IUCN "Vulnerable" species (Waterbirds International 2002); on National Audubon Society's Watch List; a species of high conservation concern within U.S. Shorebird Conservation Plan (Brown et al. 2001); a bird of conservation concern on the national and region 7 lists of the USFWS; and one of top 3 species of concern by Alaska Shorebird Group (Alaska Shorebird Group 2004). All designations based on small population size, limited breeding range, and concern over threats on the nonbreeding grounds (Marks et al. 2002).

B. Distribution and abundance (see map page 313, Appendix 4)

Range: (from Marks et al. 2002)
Global range comments: Restricted range species with nesting confined to 2 relatively small, disjunct regions of western Alaska and recent evidence of genetic separation between birds inhabiting the 2 breeding areas (J. Gust, USGS, unpubl.). Nonbreeding range on other hand possibly largest of any avian species, encompassing south-central Pacific Ocean from the Hawaiian Archipelago south to Pitcairn Island and east to west from the Marquesas Islands to the Marshall Islands. Only migratory shorebird found exclusively on atolls and islands during nonbreeding season. Listed as "Vulnerable" by Wetlands International owing to small and supposedly declining population size and predation by exotic mammals on nonbreeding grounds.
State range comments: Nesting restricted to northern Seward Peninsula and Andreafsky Wilderness of southwest Norton Sound. Postbreeding birds stage on coastal portions of central and southern Yukon-Kuskokwim River Delta. Birds occasionally common in spring on Alaska Peninsula estuaries; rare but annual in north Gulf of Alaska in spring.

Abundance:
Global abundance comments: Population is among smallest of all shorebirds with estimated size (including nonbreeding subadults) at 10,000 individuals (Waterbirds International 2002).
State abundance comments: Comprehensive survey of known breeding range from 1988 to 1989 yielded about 3200 breeding pairs with 60% in Nulato Hills portion of Andreafsky Wilderness and 40% on Seward Peninsula.

Trends:
Global trends: Numerous lines of evidence suggest the population is being negatively affected by anthropogenic factors on the nonbreeding grounds in central Oceania. Average number of birds declined steadily between 1988 and 2000 at a site in the northern portion of the range; however, site is on northern edge of nonbreeding range and used by comparatively few birds.

<u>State trends:</u> Replication of 1988–1989 survey in 1999–2000 resulted in too much variation to assess trend over this decade.

C. Problems, issues, or concerns for species

Existing

- Exotic predators on nonbreeding grounds
- Subsistence hunting throughout range. (Uncertainty about the specific identity of "large shorebirds" harvested in western Alaska raises the possibility that subsistence harvest in Alaska may also be a threat to this species.)
- Small genetically effective population size

Potential

- Road construction and increased human access to Seward Peninsula
- Increase in natural predators (Common Ravens *Corvus corax*) associated with human landfill practices in western Alaska
- Contaminants on nonbreeding grounds

D. Location and condition of key or important habitat areas (from Marks et al. 2002; Alaska Shorebird Group 2004)

Breeding: Rolling hills (50–500 m elevation; slopes 3–10%) covered with upland tundra; lower parts of drainages with medium to tall (1.2–2.4 m) shrubs, and upper elevations (ridges and slopes) with extremely short vegetation and/or bare ground. Northern breeding area occurs on north-central Seward Peninsula from Kougarok River west to Ear Mountain. Most of this region is state-owned or Native-selected land with some federal inholdings managed by the BLM. Entire region site of active mineral (mostly gold) extraction efforts with associated roads, trails, and site-based infrastructures. Southern breeding area largely within Andreafsky Wilderness Area within Yukon-Delta National Wildlife Refuge. Species relatively secure on breeding range because of extremely low nesting density and general inaccessibility of the area to humans during this season.

Postbreeding Staging: Entire breeding population thought to stage on outer Yukon-Kuskokwim Delta from Scammon Lagoon south to Kuskokwim River. Most birds restricted to dwarf-shrub tundra, graminoid meadows, and mosaic of tundra/meadow habitat. Unknown proportion of Seward Peninsula breeding population moves to coast of southern Seward Peninsula before moving on to Yukon-Kuskokwim Delta. Annual variation in standing crop of fruits of black crowberry and ericaceous shrubs appears major determinant of habitat use. Birds rarely found on unvegetated, soft-substrate intertidal habitats. All staging habitats are generally pristine.

Nonbreeding: Uses wide variety of habitats on islands and atolls, including tidal mudflats, marshy areas, edges of mangrove swamps and lagoons, reefs, saltpans, channels among islets, beaches, forb mats, and human-created habitats (airport runways, lawns, *Cocos* "forests," other open areas). Most birds found at sea level in these habitats but on high volcanic islands also occasionally found in meadows up to 800 m elevation. Condition of habitats varies from very degraded to pristine, with most little altered by humans.

E. Concerns associated with key habitats

Breeding habitats on Seward Peninsula historically the focus of several mining initiatives with current effort largely a function of world market prices. Associated infrastructure, namely roads, has allowed human access to the southern portions of the breeding range. Off-road vehicles and use of tracked vehicles in support of mining operations have in places caused significant degradation of tundra habitats. Proposed new roads and extraction of road materials from within breeding range could affect breeding distribution. No known threats to habitats on southern breeding area or postbreeding staging areas on the Yukon-Kuskokwim Delta. Habitat modification severe in many parts of nonbreeding range, but degradation per se probably not as important to curlews as predation by introduced mammals.

Attributes surrounding species success: Most breeding and staging habitats are either remote, pristine, and/or within conservation units. Relatively few, but critical, nonbreeding sites also designated as conservation units. Natural history traits, especially extent of dispersal during breeding and nonbreeding seasons, likely buffer adverse affects of small-scale habitat degradation.

F. Goal: Ensure Bristle-thighed Curlew populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

<u>Objective</u>: Maintain sufficient habitat and population sustainability.

Target: Maintain a minimum of 1280 and 1920 breeding pairs on the Seward Peninsula and Nulato Hills, respectively (C. Handel et al. in Marks et al. 2002).

Measure: Improve (i.e. increased number of survey sites) previously established surveys. Conduct surveys on 3 breeding areas every 5 years. Use new satellite imagery and other GIS-based tools to quantify changes in habitat availability.

<u>**Issue 1:** Financial and logistical constraints for conducting surveys.</u>
<u>**Issue 2:** The species' complex life history strategies, including extremely low nesting densities and low detection probabilities during breeding, have hampered efforts to achieve above objective.</u>
<u>**Issue 3:** Road construction and increased human access to Seward Peninsula.</u>
<u>**Issue 4:** Increase in natural predators (Common Ravens) associated with human landfill practices in western Alaska.</u>
<u>**Issue 5:** Poor reporting of subsistence harvest during breeding and staging (e.g., poor identification of "large shorebirds" and inadequate survey coverage).</u>

Conservation actions:

a) Conduct surveys on breeding and staging areas.
b) Develop demographic models to evaluate which vital rates are most important in regulating population size.

c) Evaluate habitat damage associated with human access and development, and work with stakeholders to minimize and mitigate effects.
d) Evaluate effect of artificially enhanced populations of predators on reproductive success and survival of species.
e) Evaluate extent and impact of subsistence harvest throughout annual cycle.
f) Implement education initiatives throughout species' range, particularly in relation to human development and subsistence harvest.

Global conservation and management needs:

Objective: Maintain sufficient habitat and population sustainability.

Target: Partition and visit nonbreeding grounds to evaluate species presence and use, habitat alteration and predator effects, and obtain blood samples for population genetic structure.

Measure: Document the location and number of islands/atolls (i.e., percentage of nonbreeding grounds) visited over the next 10 years.

Issue 1: Exotic predators.
Issue 2: Insufficient surveys.
Issue 3: Contaminant exposure.
Issue 4: Lack of information on stopover sites and nonbreeding distribution.
Issue 5: Poor international collaboration throughout Oceania.

Conservation actions:

a) Determine population structure throughout nonbreeding grounds and link nonbreeding areas to discrete breeding populations.
b) Evaluate impact and control of exotic predators on nonbreeding grounds.
c) Evaluate effective and genetic population sizes.
d) Identify areas throughout nonbreeding range that host large numbers of birds.
e) Identify migratory stopover sites south of Hawaiian Archipelago.
f) Assess levels of heavy metal contamination to birds using certain islands in the Northwestern Hawaiian Archipelago.
g) Implement international efforts to protect and manage key nonbreeding areas, including active removal of exotic animals.
h) Implement education initiatives to make indigenous people aware of impacts of introducing exotic predators and disturbing natural habitats throughout nonbreeding grounds.

H. Plan and time frames for monitoring species and their habitats

Survey methodologies are in place for obtaining population indices on breeding and staging areas. This work was conducted through a collaborative effort between the USGS and the USFWS. Additional support from the ADF&G to conduct surveys on state lands, which cover a large portion of the Seward Peninsula, is needed. All 3 partners should promote outreach with local communities.

I. Recommended time frame for reviewing species status and trends

Every 5 years in conjunction with the Alaska Shorebird Group and revision of its Alaska Shorebird Conservation Plan.

J. Bibliography

Alaska Shorebird Group. 2004. A conservation plan for Alaska shorebirds. Unpublished Report, Alaska Shorebird Group. Available through USFWS, Migratory Bird Management, Anchorage, AK.

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Marbled Godwit

A. Species description

Common name: Marbled Godwit
Scientific name: *Limosa fedoa* (*L. f. beringiae* subspecies breeds only on the Alaska Peninsula, see below)

Conservation designation: Species of High Conservation Concern in the U.S., Canadian, and Alaska shorebird conservation plans because of declining population trend and threats on breeding grounds (Brown et al. 2001; Donaldson et al. 2001; Alaska Shorebird Group 2004). .*L. f. beringiea* represents a geographically and morphologically distinct population. Also a bird of conservation concern on the national and Region 7 lists of the USFWS and is included on the National Audubon Society's Watch List.

B. Distribution and abundance (see map page 314, Appendix 4)

Range: (mostly from Gratto-Trevor 2000)

Global range comments: The species breeds only in North America in 3 disjunct areas: (1) majority in grasslands of northern United States and southern Prairie Provinces of Canada, (2) small population also along coast of southwest James Bay, Ontario, and (3) equally small population on northern Alaska Peninsula, Alaska. During the nonbreeding season, it is found along the Pacific coast from southwest British Columbia (where rare) south to El Salvador with most occurring from Washington to Baja California. Also in this region found inland in interior California (Sacramento-San Joaquin Valley and Salton Sea). Rare, local visitor to Pacific coast of Costa Rica, Panama, Columbia, Ecuador, and Chile. Also rare, local and irregular in nonbreeding season along immediate Atlantic coast from about Massachusetts south to Virginia but regular and more numerous from North Carolina south to Florida, and west along coast of Gulf of Mexico to northern coast of Yucatan Peninsula. Uncommon along Atlantic coast of Venezuela.

State range comments: Nesting confirmed only from the Ugashik Bay area, but suspected of breeding in 100 by 50 km area from just north of Ugashik Bay south to Port Heiden. Common migrant in spring along coast of Southeast Alaska (e.g., Yakutat Forelands), but rare Prince William Sound and Cook Inlet, suggesting spring migrants cross north Gulf of Alaska to Alaska Peninsula. Prior to nesting, fairly common on intertidal habitats of Ugashik Bay and Cinder-Hook Lagoon. Postbreeding birds also common on these estuaries as well as at Egegik Bay and Port Heiden, occasionally south to Nelson and Izembek lagoons. *L. f. beringiae* population thought to spend nonbreeding season along coast of Washington, Oregon, and northern California.

Abundance: (from Gratto-Trevor 2000; Morrison et al. 2001)

Global abundance comments: Species population estimated at between 140,000 and 200,000 birds.

State abundance comments: *L. f. beringiae* population estimated at 3000 individuals and among smallest of all North America shorebird populations. Estimate derived from scattered, non-systematic counts of postbreeding birds on Alaska Peninsula estuaries; extent of breeding range of *L. f. beringiae* population poorly defined, and no population assessment has been made during the breeding season.

Trends:

Global trends: Historically few data, but the species had a larger breeding range and population before 1900 (Page and Gill 1994). Breeding range no longer includes Wisconsin, Iowa, Nebraska, and much of Minnesota. Slight increasing trend in numbers since 1950s in Florida and Carolinas, possibly also Washington coast. Trends from Breeding Bird Survey routes indicate no overall changes in Canada and U.S. prairie populations from 1966 to 1996. Numbers in United States increased slightly but significantly; those in Canada remained the same. Numbers in North Dakota did not change significantly from 1967 to 1992–1993.

State trends: No information.

C. Problems, issues, or concerns for species

Existing

- Subsistence hunting
- Small population size and restricted breeding range makes species vulnerable to local extirpation

Potential

- Pesticides and other contaminants
- Loss of nonbreeding habitat to aquaculture development (Mexico)
- Loss of wetland habitats used during migration
- Sea level rise
- Indirect and direct effects from oil spills in Bristol Bay
- Habitat change, especially intertidal habitats of Alaska Peninsula estuaries altered in conjunction with development of oil and natural gas

D. Location and condition of key or important habitat areas (following for *L. f. beringiae* subspecies only)

Breeding: Lowland areas inland from immediate coast from just north of Pilot Point south to Cinder-Hook Lagoon. “Preferred” areas (additional study needed) composed of marsh/very wet bog and wet bog/wet meadow habitats dominated by moist-bluejoint, moist-sedge meadows, scattered willows 1–2 m tall, and scattered ponds. Apparently not found in shrub-graminoid habitat that predominates in this region. All known and suspected nesting habitats are pristine.

Postbreeding Staging: Entire breeding population thought to move to intertidal habitats of Alaska Peninsula estuaries, primarily Egegik and Ugashik Bays and Cinder-Hook Lagoon with juveniles lingering into late September. Birds also recorded at Seal Islands, Port Heiden, and occasionally Nelson and Izembek Lagoons. Unknown to what extent Kvichak and Nushagak Bays used following nesting. No other Alaska sites known to support this taxon during this period. Migration of both adults and juveniles thought to entail direct flight across Gulf of Alaska to nonbreeding areas. All habitats used during postbreeding period appear in very good to pristine condition.

Nonbreeding: Does not occur in Alaska during this period. Habitats used within suspected nonbreeding range of *L. f. beringiae* include coastal mudflats, adjoining savannas or meadows, estuaries, sandy beaches and sandflats; sometimes roosting at salt ponds. Significant historic degradation or loss of estuarine habitats along Pacific coast. Existing habitats a mixture from pristine to highly degraded, with most having been altered to some extent.

E. Concerns associated with key habitats

Breeding habitats remote and pristine, but extremely small population size and propensity to occur in flocks increases taxon's susceptibility to environmental perturbations. Proposal for road construction along the Alaska Peninsula could directly affect nesting habitat, and may increase illegal harvest. Contamination of benthic foods from oil spills likely, while birds themselves prone to direct oiling of plumage. Sea level rise from global climate change likely to alter food web and structure of nonbreeding foraging habitats.

Attributes surrounding species success: Alaska breeding habitat pristine but only small proportion within conservation units. Known major postbreeding sites are within conservation units, mostly those administered by of the State of Alaska. Little human disturbance during breeding and postbreeding periods.

F. Goal: Ensure Marbled Godwit (*L. f. beringiae*) populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions (for *L. f. beringiae* only)

State conservation and management needs:

Objective: Conserve sufficient habitat to ensure population sustainability across the natural range of the species.

Target: Define the breeding range and determine the size of the breeding population by 2007.

Measure: Range maps and population estimates generated based on GIS-based habitat model and extensive on-ground sampling.

Issue 1: Breeding is confirmed for only a single localized site, yet observations during nonbreeding periods suggest the breeding range is more extensive.
Issue 2: Very small population that may be vulnerable to local extirpation.
Issue 3: Legal subsistence harvest of Bar-tailed Godwits may result in accidental mortality.
Issue 4: Habitat change, especially intertidal habitats of Alaska Peninsula estuaries altered in conjunction with development of oil and natural gas.

Conservation actions:

a) Conduct ground surveys in potential breeding range and nearby areas to estimate population size and habitat use.
b) Assess and refine habitat-bird model developed previously.
c) Acquire conservation designation for breeding habitat.
d) Link use of Alaska Peninsula estuaries by nonbreeding birds to specific nesting areas.
e) Determine extent of area used in Alaska during nonbreeding periods.
f) Determine extent of illegal harvest, and promote outreach to reduce accidental take.

Global conservation and management needs:

Objective: Conserve sufficient habitat to ensure population sustainability across the natural range of the species.

Target: Establish geo- and habitat-referenced bounds on nonbreeding area(s) of the *L. f. berengiae* population.

Measure: Site use and range will be established using radiotelemetry, resightings of individually marked birds, and genetic analysis.

Issue 1: Birds that breed in Alaska are suspected of spending the nonbreeding season along the coast from Washington to northern California, but this has yet to be confirmed.
Issue 2: Effective conservation requires that all areas and habitats be identified throughout a species' annual cycle.
Issue 3: Potential exposure to pesticides and other contaminants on nonbreeding grounds in Mexico and Canada.
Issue 4: Potential loss of nonbreeding habitat to aquaculture development (Mexico).
Issue 5: Loss of wetland habitats used during migration.

Conservation action:

a) Identify nonbreeding areas outside Alaska and encourage appropriate conservation designation.
b) Over portions of nonbreeding range in Mexico and Canada conduct studies to evaluate contaminant exposure and effects of aquaculture development.
c) Determine southward migration strategy.
d) Evaluate effective and genetic population sizes.

H. Plan and time frames for monitoring species and their habitats

By 2007, conduct survey of breeding range to assess habitat use and population size. Assess use of Alaska Peninsula estuaries by pre- and postbreeding populations. Potential partners include ADF&G, DNR, BLM, various Native regional and village corporations, USFWS, USGS, and University of Alaska. Additional support from the State of Alaska to conduct surveys on state lands, which cover most of the suspected breeding range, is especially needed.

By 2008, determine extent of nonbreeding range from data collected through techniques involving analyses of stable isotopes, genetics, and marked birds. Federal, state, provincial and nongovernmental organizations, and Native villages and regional corporations throughout the species' range should contribute funds and personnel to accomplish these objectives.

I. Recommended time frame for reviewing species status and trends

Every 5 years in conjunction with the Alaska Shorebird Group and revision of its Alaska Shorebird Conservation Plan.

J. Bibliography

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Rock Sandpiper

A. Species description

Common name: Rock Sandpiper (Pribilof Sandpiper, Aleutian Sandpiper, Northern Rock Sandpiper)
Scientific name: *Calidris ptilocnemis* (subspecies: *C. p. ptilocnemis*, *C. p. couesi*, *C. p. tschuktschorum*)

Conservation designation: Nominate race considered population of high conservation concern in U.S. Shorebird Conservation Plan (Brown et al. 2001) and Alaska Shorebird Conservation Plan (Alaska Shorebird Group 2004).

B. Distribution and abundance (see map page 315, Appendix 4)

Range: (from Gill et al. 2002)
Global range comments: North Pacific Ocean centered on Bering Sea (from Japan Archipelago north through Commander, Aleutian, and central Bering Sea Islands; mainland from southern Kamchatka Peninsula, coastal Chukotsky Peninsula, coastal Alaska from northern Seward Peninsula south throughout coastal Yukon-Kuskokwim River Delta and Alaska Peninsula; and also among islands of western Gulf of Alaska. In nonbreeding season south of normal limit of sea ice from central Alaska Peninsula, throughout Aleutian Archipelago, Gulf of Alaska (including Cook Inlet), and North Pacific south to northern California and Japan Archipelago.
State range comments: Generally nonmigratory with seasonal movements (some pronounced) regulated by severity of conditions during the nonbreeding season.

Abundance:
Global abundance comments: 150,000 (Morrison et al. 2001), Wetlands International (2002).
State abundance comments: Alaska estimated at <150,000 individuals as of 2003 (*C. p. ptilocnemis* <20,000; *C. p. couesi* 75,000; *C. p. tschuktschorum* 50,000).

Trends:
Global trends: Largely unknown. CBC data from Pacific Northwest suggests decline in nonbreeding season population of *C. p. tschuktschorum* (Buchanan 1999 in Gill et al. 2002).
State trends: Unknown.

C. Problems, issues, or concerns for species

Existing

- Alteration of nesting habitat on Bering Sea Islands from introduced ungulates, mostly reindeer (effects on Rock Sandpiper populations unknown)
- Predation on nesting birds, eggs, and young from exotic animals (foxes, rats) in Aleutian Archipelago

Potential

- Oil spills
- Habitat change, especially intertidal habitats

D. Location and condition of key or important habitat areas

Breeding: Coastal lowland tundra at elevations seldom higher than a few hundred meters above sea level. Most nesting habitat pristine (except on Bering Sea Islands) and within designated conservation lands (National Wildlife Refuges and State of Alaska Critical Habitat areas and Game Refuges).

Roosting: Typical of most intertidal-foraging shorebirds in that species forms roosts at high tide. Roosts invariably formed immediately adjacent to intertidal areas on exposed rocky, cut bank, and sandspit shorelines. Will readily roost on man-made structures such as piers, wharfs, jetties, and riprap.

Foraging: During breeding, forages mostly on tundra, but if nesting in proximity to intertidal habitats will make foraging flights between tundra and intertidal areas; during nonbreeding period forages on various intertidal habitats (rock, gravel, soft-substrate, vegetated). Vegetated intertidal areas appear important in early spring when birds arrive on breeding grounds and nonvegetated intertidal habitats still mostly covered in ice.

E. Concerns associated with key habitats

Contamination of benthic foods from oil spills and to lesser extent from direct oiling of plumage. Areas most likely to be affected include Cook Inlet and Bristol Bay estuaries. Sea level rise from global climate change likely to alter food web and vegetative structure of breeding and foraging habitats (see above).

Attributes surrounding species success: Most of North American breeding habitat pristine and within conservation units. There is general awareness by industry of environmental responsibilities associated with oil and gas development in Cook Inlet and Bering Sea; spill response and efficacy is a key for this and other intertidal species. General lack of human disturbance throughout all phases of annual cycle.

F. Goal: Ensure Rock Sandpiper populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

<u>Objective</u>: Maintain sufficient habitat and population sustainability.

Target: Substantiate and maintain population estimates determined during recent surveys.

Measure: Base-line assessments would be made for each subspecific population and repeated at 5-year intervals. Use remote imagery and ground-truthing to assess habitat change caused by reindeer.

Issue 1: Lack of rigorous assessments of population size for 2 subspecies (Aleutian and Northern).
Issue 2: Impacts of reindeer on habitat use unknown (Pribilof Islands).
Issue 3: Impacts of fox and/or rat predation on distribution and productivity (all subspecies).
Issue 4: Oil and gas development in Cook Inlet.

Conservation actions:

a) Determine size structure and levels of genetic variation among subspecific populations of Rock Sandpiper.
b) Maintain genetic viability among all subspecific populations.
c) Evaluate impacts of fox and/or rat predation on distribution and productivity, and if necessary, promote or conduct removal of predators.
d) Evaluate potential direct and indirect impacts from oil and gas development, including assessing the background levels of hydrocarbon contaminants in birds and their prey in Cook Inlet.
e) Elevate awareness and continue protection of critical habitat areas throughout range. (ADF&G is the key land manager in all 7 major estuaries on the Alaska Peninsula, as well as major portions of the nonbreeding sites used in Cook Inlet.)
f) Continue existing local surveys and conduct periodic rangewide surveys to assess the size, status, and trend of the various populations:
    - Determine vital parameters and sensitivity of each population to natural and anthropogenic perturbations (e.g., oil spills, extreme cold events).
    - Assess impacts to habitat quality from reindeer grazing on Bering Sea Islands.
    - Determine importance of Alaska Peninsula estuaries to postbreeding populations of the nominate subspecies.
    - Determine extent of postbreeding movement among all subspecific populations.

Global conservation and management needs:

Objective: Maintain sufficient habitat and population sustainability of the northern subspecies.

Target: Develop and implement an international management plan.

Measure: Document number of studies being conducted, lands under new protection, and international collaborations.

Issue 1: Lack of information on population size and distribution, including breeding range.
Issue 2: CBC data in British Columbia and Washington have identified a decline in population size, although extent of decline throughout population unknown.
Issue 3: Threats have not been identified in Russia.

Conservation actions:

a) Determine proportion of population that breeds in Russia.
b) Identify key breeding areas and promote conservation designation and management.
c) Encourage population surveys on nonbreeding grounds in coastal Alaska, British Columbia, and Washington.

H. Plan and time frames for monitoring species and their habitats

A breeding population assessment was recently completed for the Pribilof subspecies. This survey should be replicated at 5-year intervals with support from the USGS, USFWS, and Native villages and regional corporations.

New surveys are needed for the Aleutian and Northern subspecies on Alaska Peninsula, Aleutian Archipelago, and western Alaskan. Potential partners for these surveys are USGS, USFWS, ADF&G, NPS, and various Native villages and regional corporations.

Surveys on nonbreeding sites are needed throughout the Aleutians, in Lower Cook Inlet, Prince William Sound, and from the Alaskan Panhandle through British Columbia to Washington state. Potential partners include the USFWS, USFS, NPS, USGS, Canadian Wildlife Service, provincial government of British Columbia, and Native villages and regional corporations. The State of Alaska is the principal land custodian for areas used by these taxa during the nonbreeding season (postbreeding through winter) and thus has a disproportionate responsibility for ensuring these tasks are accomplished.

I. Recommended time frame for reviewing species status and trends

Every 5 years in conjunction with the Alaska Shorebird Group and revision of its Alaska Shorebird Conservation Plan.

J. Bibliography

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Buff-breasted Sandpiper

A. Species description

Common name: Buff-breasted Sandpiper
Scientific name: *Tryngities subruficollis*

Conservation designation: Globally classified as "near threatened" (IUCN 2003). Included in Appendix I (migratory species that are endangered) of the Convention on the Conservation of Migratory Species of Wild Animals (CMS 2005), and classified as "high concern" in both the U.S. (Brown et al. 2001) and Canadian (Donaldson et al. 2001) shorebird conservation plans. Listed as bird of conservation concern on USFWS's national and Region 7 lists. Also listed as "vulnerable" in Brazil's Red Data Book and on the list of Official Endangered Species for Rio Grande do Sul State (Fontana et al. 2003; Decreto Estadual 41.672, 11 de junho de 2002 - the endangered species list for the state.).

B. Distribution and abundance (see maps pages 316–318, Appendix 4)

Range: (from Lanctot and Laredo 1994)

Global range comments: High Arctic (66°–76° N) including Alaska, Yukon (Herschel Island, Blow River to Clarence Lagoon), Mackenzie (Anderson River to Horton River, Franklin Bay, Rasmussen Basin Lowlands), Banks Island (south of Bernard River, Sach's Harbor, De Salis Bay), Melville Island (Polynia Lake, Winter Harbor), Bathurst Island (Cape Cockburn, Polar Bear Pass), Devon Island (Truelove Lowland, Cape Sparbo), Victoria Island (Cambridge Bay, Prince Albert Sound, Richard Collinson Inlet), Jenny Lind Island, King William Island, Prince of Wales Island (Crooked Lake), Boothia Peninsula (Wrottesley Valley), and Somerset Island (Creswell River; see references in Lanctot and Laredo 1994; Figure 3.23). Historic information and more contemporary data indicate that the main wintering range of the species is within the coastal sectors of the Rio de La Plata Grasslands, at the eastern portion of the Flooding Pampa of Argentina, and adjacent to large lagoon complexes in the coastal plain of Rio Grande do Sul of Brazil and Uruguay. Incidental sightings during the nonbreeding season were also reported in the remaining portions of the Rio de La Plata Grassland (subregions of the rolling pampa, inland pampa, southern pampa, mesopotamic pampa). Smaller numbers have also been observed in saline lagoons of the Puna Ecoregion of Argentina and Bolivia, and the Central Trough of Rio Grande do Sul, Brazil (see Lanctot et al. 2002, Figure 3.24).

State range comments: Primarily east of Point Barrow along the coastal portion of the Alaska Coastal Plain, but also observed near Cape Woolley, Seward Peninsula in western Alaska (see Gotthardt and Lanctot 2002, Figure 3.25). Much of the potential breeding area has not been adequately surveyed.

Abundance:

Global abundance comments: Estimated at between 15,000 and 25,000 individuals (Brown et al. 2001; Morrison et al. 2001).

State abundance comments: 20–25% of global population or 3000 to 6250 individuals (Alaska Shorebird Conservation Plan 2004).

Trends:

Global trends: Thought to be declining based on declines observed in local areas on breeding, migration, and nonbreeding sites.

State trends: Number of adults seen during surveys on breeding grounds varies dramatically on an annual basis; breeding density (nr./km^2) in Alaska varied from 0 to 10 during 1971–1974 (Bergman et al. 1977) and 0.5–14.0 from 1981 to 1989 (average = 5.7; Troy and Wickliffe 1990). Once listed as an abundant species at Point Barrow in the late 1880s and is now rarely seen there.

C. Problems, issues, or concerns for species (from Gotthardt and Lanctot 2002 and references therein)

Habitat loss/Degradation of habitat: Conversion of native grasslands or pastures to agriculture and suburbs along the migration corridor has resulted in an enormous loss of habitat for upland shorebirds. Grassland areas that have been preserved in the United States are frequently managed for species preferring tall grass, and as such do not have historic levels of grazing required to maintain shorter vegetation preferred by Buff-breasted Sandpipers. Pampas grasslands on the nonbreeding grounds also have been lost to agricultural row crops. In addition, the development of mines and forest plantations in Brazil, construction of buildings and roads for tourism in Uruguay, and the subdivision of haciendas (i.e., ranches) in Argentina all threaten to degrade upland habitats that this species prefers. Cattle ranching on the nonbreeding grounds has transformed grassland communities from taller tussock grasses to shorter grasses and dicots, possibly resulting in an expansion of the nonbreeding range of Buff-breasted Sandpipers. On the nonbreeding grounds the majority of the grasslands visited by Buff-breasted Sandpipers are located within privately owned ranches. Few of these sites are legally protected. Land management practices in unprotected areas are subject to change with global and regional economic constraints. The introduction and movement of livestock (e.g., cattle, horses, and sheep) at a local and regional level could have profound effects on the distribution and abundance of this species. Increased protection of these “key” nonbreeding areas is needed, and adequate livestock grazing patterns must be maintained to ensure the conservation of this species. The remaining nonbreeding range is unlikely to be converted to agriculture because of flooding and saline conditions near the coast, although these areas have the potential to be developed as beach resorts, mines, and pine plantations.

Sensitivity to disturbance at nest and roosting sites. The development and extraction of oil and gas resources in northern Alaska and Canada may affect the species. These developments are frequently sited in drier upland habitats to avoid impacting wetlands, but as a result alter habitats typically used by Buff-breasted Sandpipers. The availability of garbage around development sites and Arctic communities may increase predator populations, and be indirectly responsible for higher predation of nests and juveniles by species such as Arctic fox (*Alopex lagopus*), red fox (*Vulpes vulpes*), Glaucous Gull (*Larus hyperboreus*), and Common Raven (*Corvus corax*).

Commercial hunting and trapping: Buff-breasted Sandpiper numbers declined dramatically in the late 1800s and early 1900s due to market hunting. This species was hunted most heavily in the central United States and to a lesser degree on the South American nonbreeding grounds. Since 1918, this species has been protected by the Migratory Bird Treaty Act in the United States and in Canada. Currently, hunting of Buff-breasted Sandpipers is thought to be minimal or nonexistent throughout their range.

Pesticides and other contaminants: Exposure to pesticides and herbicides used on lands frequented by Buff-breasted Sandpipers during migration may pose a threat to the species. Such lands include agricultural fields (e.g., rice and alfalfa), sod and stubble fields, golf courses, airport runways, and cemeteries. Buff-breasted Sandpipers may use these nonconventional, man-alterated habitats because the majority of short-grass prairies are destroyed. Native prairies preserved today are frequently managed as tall grass prairies making them unavailable to this species. Buff-breasted Sandpipers may also be exposed to organochlorines in rice fields on the nonbreeding grounds. Furthermore, natural grasslands in the Rio de La Plata Grassland are being increasingly plowed and replaced by sown pastures that are supplemented with imported fertilizers and other agrochemicals. Such chemical exposure may cause individuals to die. Three adult Buff-breasted Sandpipers died from feeding on planted rice seed treated illegally with Furadan 4F in Calhoun County, Texas, in 1983. Death of other sandpipers species (Calidris mauri and C. melanotos) has been attributed to exposure to Furadan 3G, a rice pesticide closely related to Furadan 4F. Pesticide exposure has been implicated in the decline of other upland species in South America. Sublethal doses of pesticides can reduce survival, growth, and reproduction rates in birds.

D. Location and condition of key or important habitat areas (from Lanctot and Laredo 1994; Lanctot et al. 2002; Gotthardt and Lanctot 2002)

Nesting Habitat: Breeding restricted to tundra ecoregion. Habitat use depends on sex and breeding stage; males display in first snow-free areas, typically along barren ridges, creek banks, and raised, well-drained areas with reticulate-patterned ground and scant vegetation. Leks occur in moist, graminoid meadows with *Carex aquatilis* and *Eriophorum angustifolium* as dominant vegetation types. Display areas tend to be on non-patterned ground with closely spaced tussocks about 20 cm high and 25–50 cm in diameter, often with dwarf willow thickets (Salix glauca and S. lanata). Nests are on dry slopes with numerous sedge tussocks, on moss-willow-varied grass tundra, and in moist or wet sedge-graminoid meadows on non-patterned or strangmoor (series of aligned tussocks) ground. Females on incubation breaks found primarily along streambanks in non- and reticulate-patterned ground with scant vegetation. Females with broods are seen primarily in moist and emergent vegetation along or in streambeds. Buff-breasted Sandpipers are considered part of the "upland species" guild because of their dependence on drier, sloping areas or tundra with many polygons. This species is also one of the few shorebird species that do not show a pronounced seasonal shift toward lowland, wet (ponded) sites during brood-rearing.

The majority of Arctic-nesting habitat is in pristine condition, although continuing development of natural resources on the Arctic Coastal Plain is leading to habitat degradation.

Nonbreeding Habitat: Buff-breasted Sandpipers are typically found in pasturelands that are being grazed by livestock and are very short (2- to 5-cm tall). The species is found less frequently in agriculture (e.g. rice) and abandoned fields. In Brazil and Uruguay, Buff-breasted Sandpipers were found almost exclusively in heavily grazed grasslands along the margins of salt and freshwater lagoons. Birds detected in Argentina were in very large pastures that were part of large ranches and were not restricted to lagoon margins.

Most of the sites identified as being key nonbreeding areas in this study are privately owned, and few are legally protected. Fortunately, these areas are unlikely to be converted to agriculture because of flooding and saline conditions near the coast. However, these areas are likely to be flooded should global warming lead to higher water levels. Further, large fluctuations in the proportion of land devoted to cropping and animal husbandry in the Rio de la Plata Grassland has occurred during the past 20–30 years. These changes appear to be directly related to the price of beef and grain.

Other forms of development, such as mines and pine plantations in Brazil, construction of roads and buildings for tourism in Brazil and Uruguay, and the subdivision of ranches in Argentina, may also have a negative effect on the species. Development of coastal beaches for tourism in Uruguay is also a threat. The introduction and movement of livestock at a local and regional level may indirectly have strong within- and among-year effects on the distribution and abundance of Buff-breasted Sandpipers. Pastures may never become suitable if livestock are moved too frequently among pastures (i.e., to minimize overgrazing), introduced too late in the austral summer, or removed altogether. Overall nonbreeding habitats appear to be of suitable quantity now, but degradation is occurring slowly throughout their winter range.

Migration Habitat: Buff-breasted Sandpipers frequent short-grass areas such as pastures, burned grasslands, sodfields, golf courses, cemeteries, airports, and lawns. The species is also found along damp margins of freshwater lakes, ponds, and lagoons. Buff-breasted Sandpipers use a variety of agricultural fields, including recently plowed or cut alfalfa fields or fields of newly planted or emerging rice, cotton, and potatoes. In South America, birds are in recently harvested and burned sugar cane fields of Surinam; in open, dry fields with short grasses in Brazil; and on dry sandbars in rivers.

Natural short-grass prairies occur rarely as management tends to favor species that prefer tall grass prairies, and the use of bison and other herbivores to maintain short grass heights is uncommon. Much of the human-altered habitat is under constant change, as farmers manage agricultural lands according to their resources and the regional agricultural economics. Overall, migration habitat appears to be the most degraded and appropriate habitat is not being provided by current management regime.

E. Concerns associated with key habitats (from Lanctot and Laredo 1994; Lanctot et al. 2002; Gotthardt and Lanctot 2002).

Nesting Habitat: Oil and gas development on the Arctic Coastal Plain may decrease the suitability of drier upland habitats and lead to increased predation on nests and young.

Nonbreeding Habitat: The reliance of Buff-breasted Sandpipers on old and new rice fields on their nonbreeding grounds in South America may expose the species to herbicides and pesticides. Natural grasslands in the Rio de La Plata Grassland are being increasingly plowed and replaced by sown pastures supplemented with fertilizers and other agrochemicals. While most pastureland along the coast is unsuitable for conversion to agriculture, other forms of development, such as mines and pine plantations in Brazil, construction of roads and buildings for tourism in Brazil and Uruguay, and the subdivision of ranches in Argentina, may also decrease the suitability of the habitat for the species.

Migration Habitat: Buff-breasted Sandpipers may be also exposed to agrochemicals along their migration route in the United States. Here the species frequents altered habitats such as golf courses, sod fields, airport runways, cemeteries, and newly planted rice fields that are subject to herbicide and pesticide applications.

F. Goal: Ensure Buff-breasted Sandpiper populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

Objective: Conserve sufficient habitat and population sustainability.

Target: Evaluate state trend in population size and increase accuracy of population estimate by developing habitat-based models to identify suitable breeding sites and extrapolating population density estimates.

Measure: Repeat target (see above) on 5-year intervals.

Issue 1: Lack of data on breeding distribution and population size.
Issue 2: Artificially enhanced numbers of predators and increasing development on Arctic Coastal Plain.
Issue 3: Unpredictable and sporadic occurrence in breeding locations.

Conservation actions:

a) Determine breeding distribution and population size.
b) Document potential impacts from predators and human development.
c) Develop habitat-based model to predict distribution on Arctic Coastal Plain.
d) Educate policy makers on impacts of development on the “upland” birds.
e) Evaluate contaminant exposure to birds breeding in Alaska.

Global conservation and management needs:

Objective: Conserve sufficient habitat and population sustainability.

Target: Maintain population size at levels recorded in 1999 and 2001 on the nonbreeding grounds.

Measure: Conduct population surveys on nonbreeding grounds at 5-year intervals.

Issue 1: Potential contaminant exposure during migration and on nonbreeding grounds. (The species frequents altered habitats such as golf courses, sod fields, airport runways, cemeteries, and newly planted rice and other agricultural fields where pesticides and herbicides are commonly applied.)
Issue 2: Habitat loss through agricultural conversion on wintering grounds.
Issue 3: Effect of livestock management regimes on habitat availability.
Issue 4: Inadequate funding in South America to do conservation studies.

Conservation actions:

a) Capture and test a minimum of Buff-breasted Sandpiper adults for exposure to organophosphorus and carbamate pesticides on migration and nonbreeding sites. These studies are inappropriate in Alaska as birds either die or metabolize chemicals prior to arriving in the state.
b) Evaluate impacts of livestock management practices on habitat use on nonbreeding grounds.
c) Evaluate impacts from human development on habitat availability on nonbreeding sites.
d) Develop international partnerships and manage species on a flyway basis.
e) Repeat population surveys on nonbreeding grounds every 5 years.

H. Plan and time frames for monitoring species and their habitats

Initial survey of population conducted on nonbreeding range over 2-year period in 1999 and 2001. Such surveys should be conducted once every 5 years to determine population stability. Intensive surveys should be conducted at key nonbreeding habitat sites identified in previous surveys.

The difficulty in developing a reliable census technique for this species is significant. Periodic review is needed to determine if monitoring and survey recommendations are unrealistic and in need of revision. Monitoring via a population index, as opposed to estimating actual population, may prove to be a more attainable goal.

I. Recommended time frame for reviewing species status and trends

Given the small size of the species population, we recommend reviewing and revising the strategy every 5 years, or at more frequent intervals in response to additional information. Plan should be prepared in conjunction with the Alaska Shorebird Group and revision of its Alaska Shorebird Conservation Plan.

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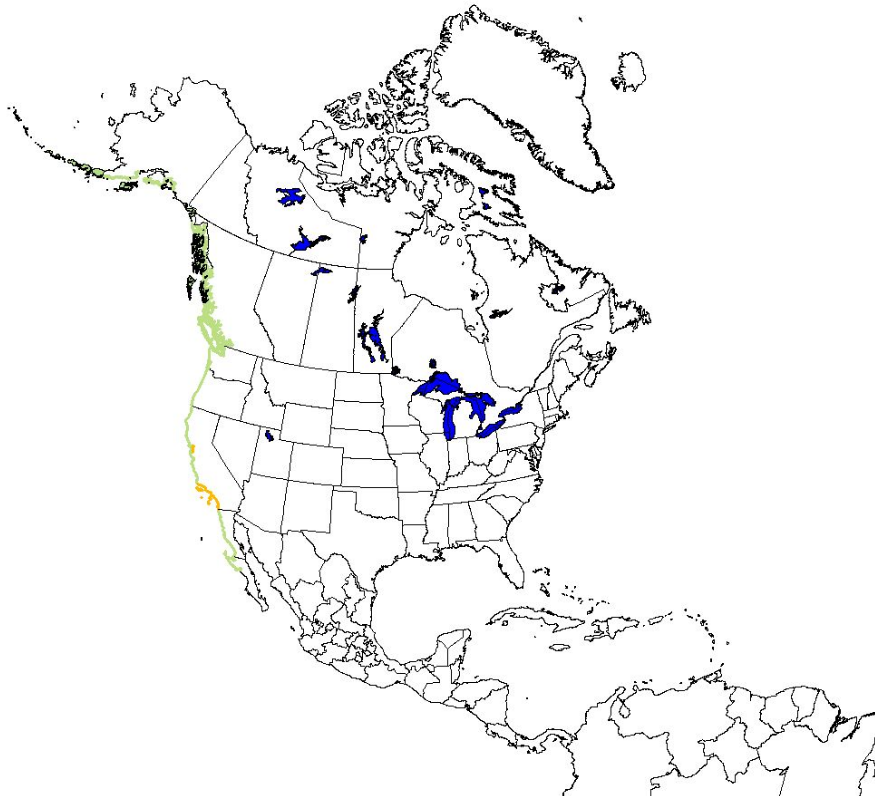

Figure 4.17 Year-round (green) and nonbreeding (yellow) distribution of the Black Oystercatcher

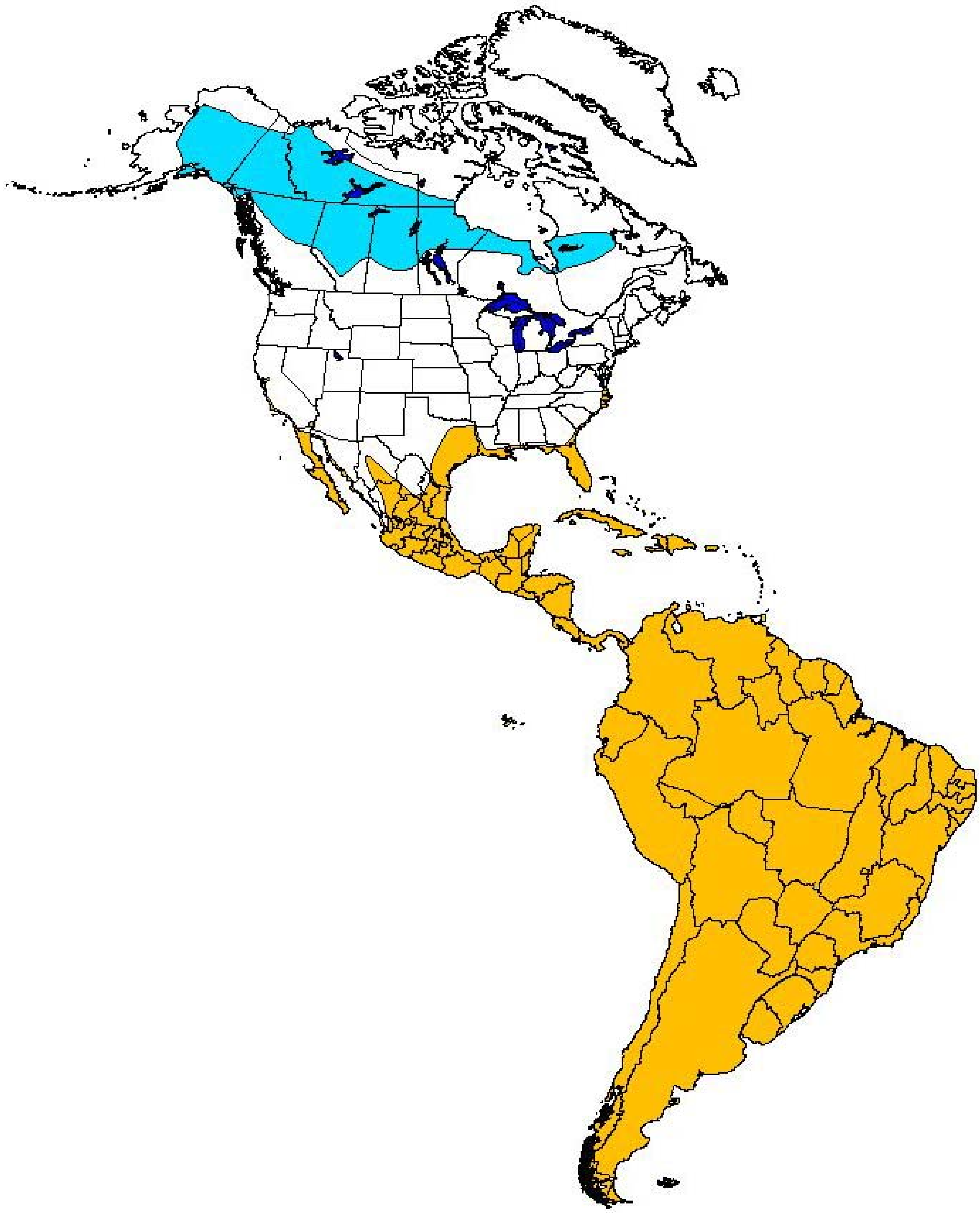

Figure 4.18 Breeding (blue) and nonbreeding (yellow) ranges of the Lesser Yellowlegs (from Tibbitts and Moskoff 1999)

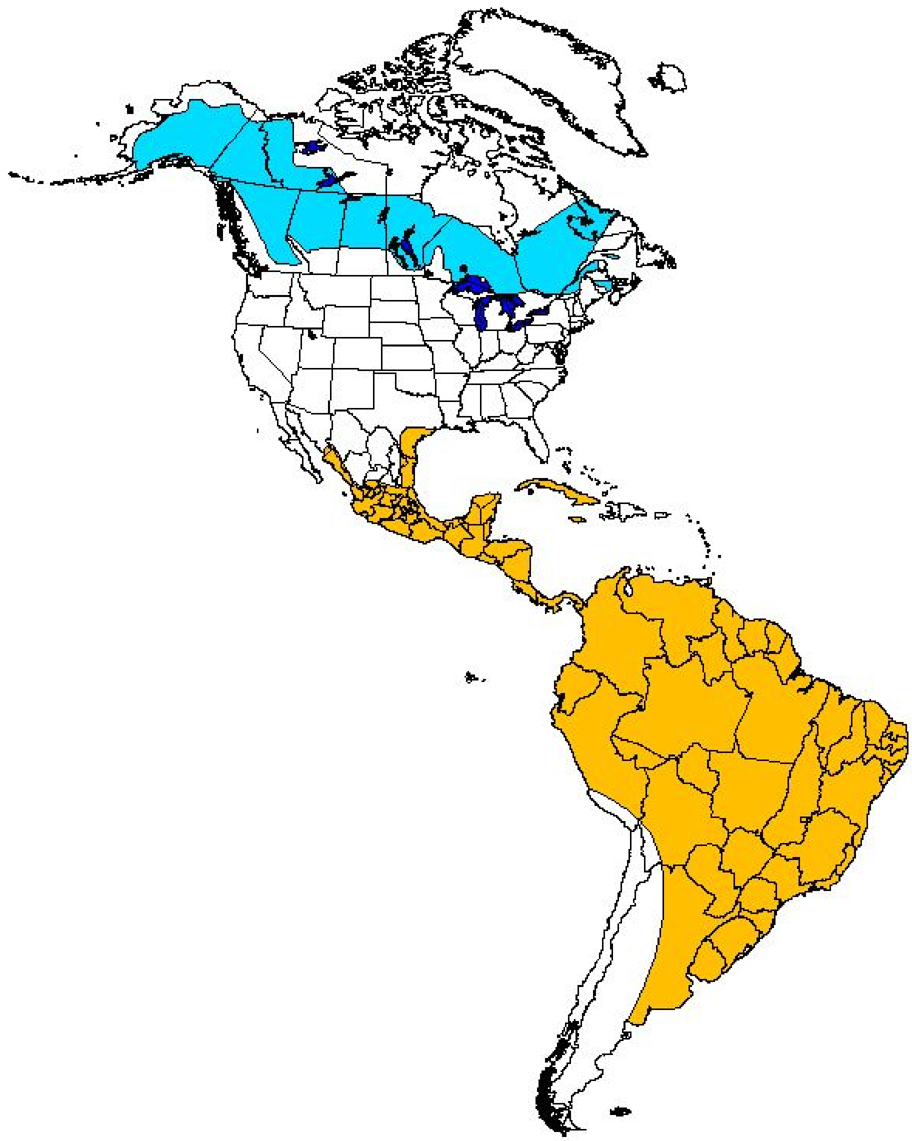

Figure 4.19 Breeding (blue) and nonbreeding (yellow) distribution of the Solitary Sandpiper (includes both subspecies, Moskoff 1995)

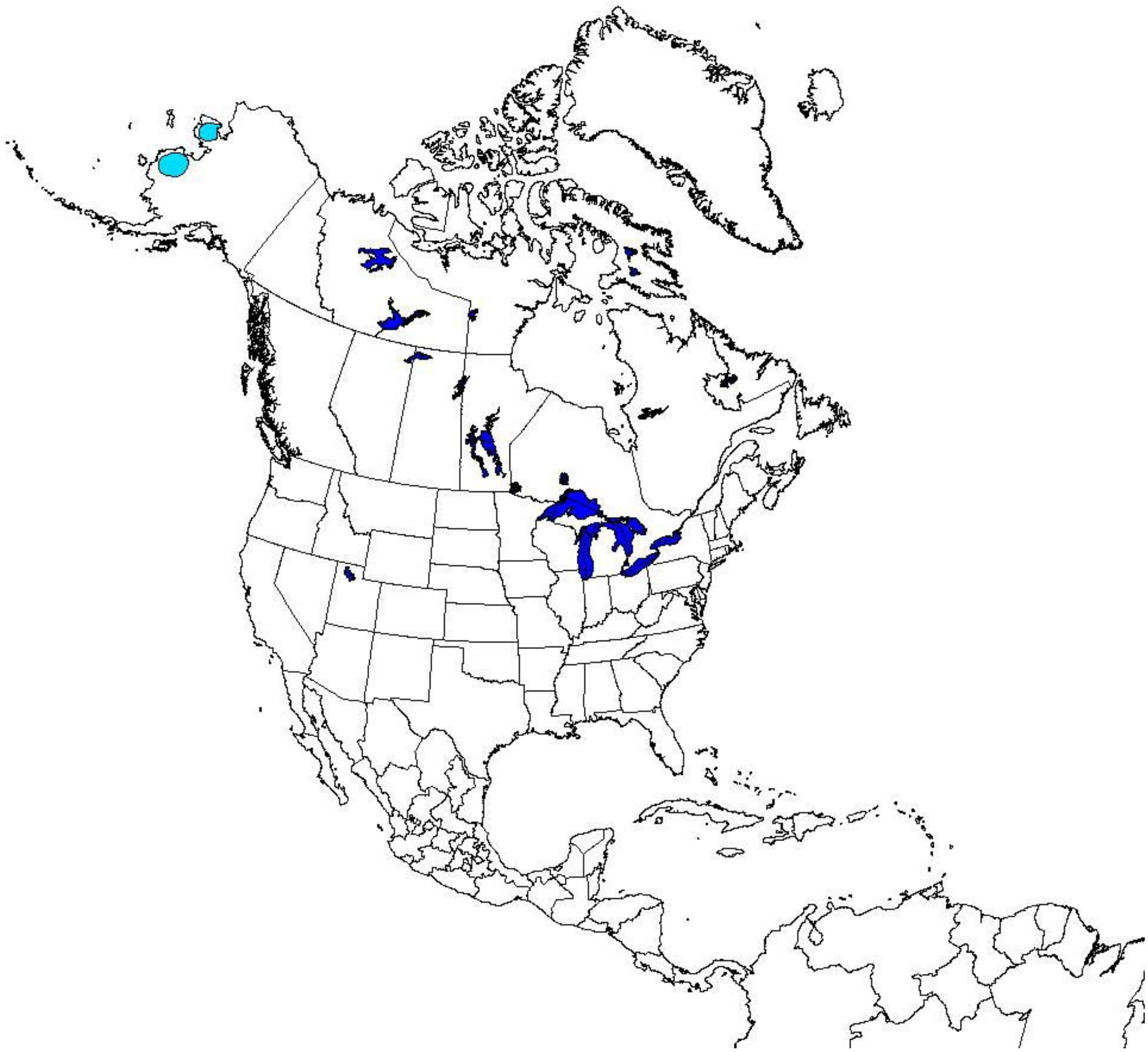

Figure 4.20 The breeding range of the Bristle-thighed Curlew is restricted to two small portions (shown in light blue) of western Alaska (Marks et al. 2002).

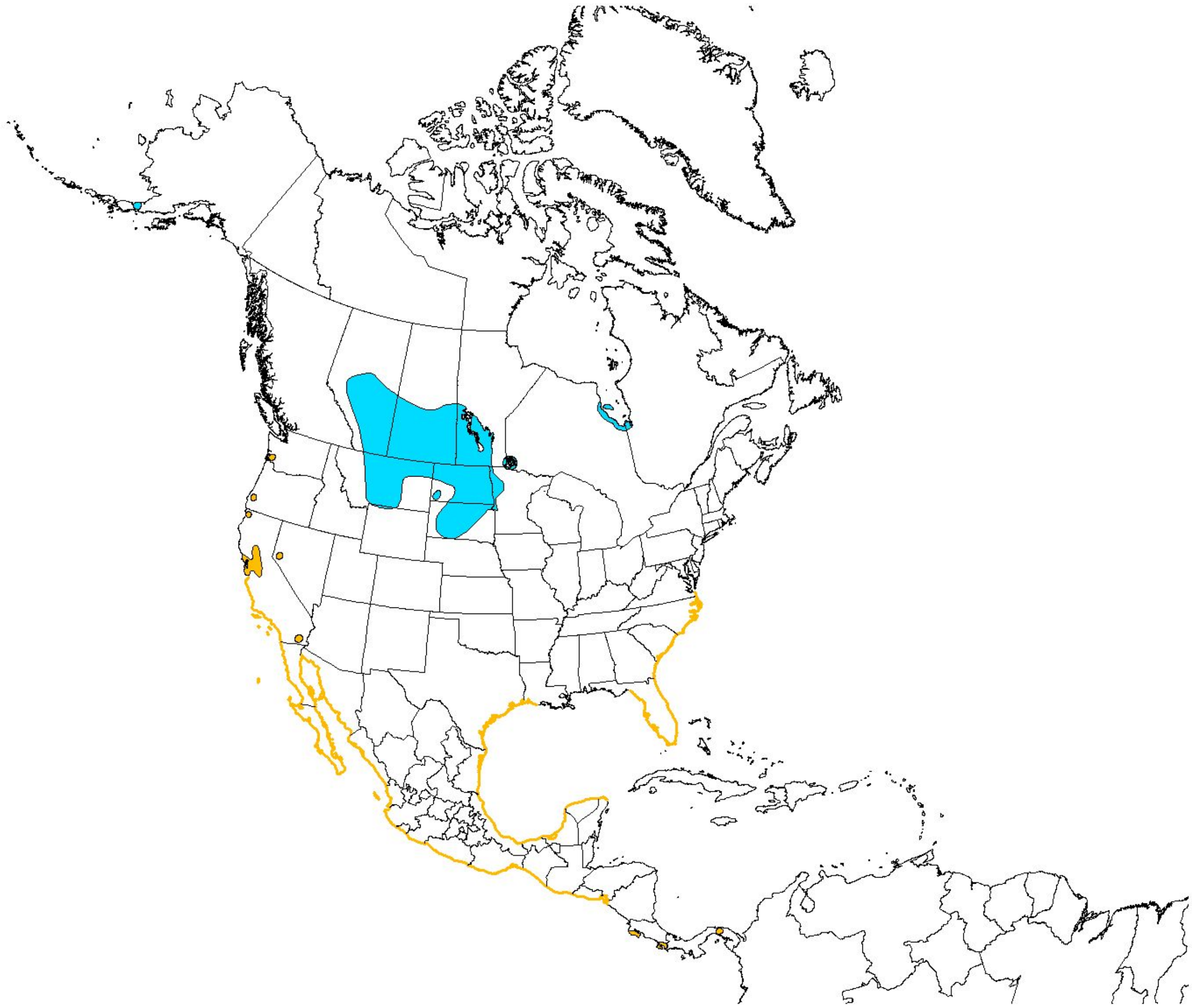

Figure 4.21 Breeding (blue) and nonbreeding (yellow) distributions of the Marbled Godwit. Note the small polygon of blue along the Alaska Peninsula.

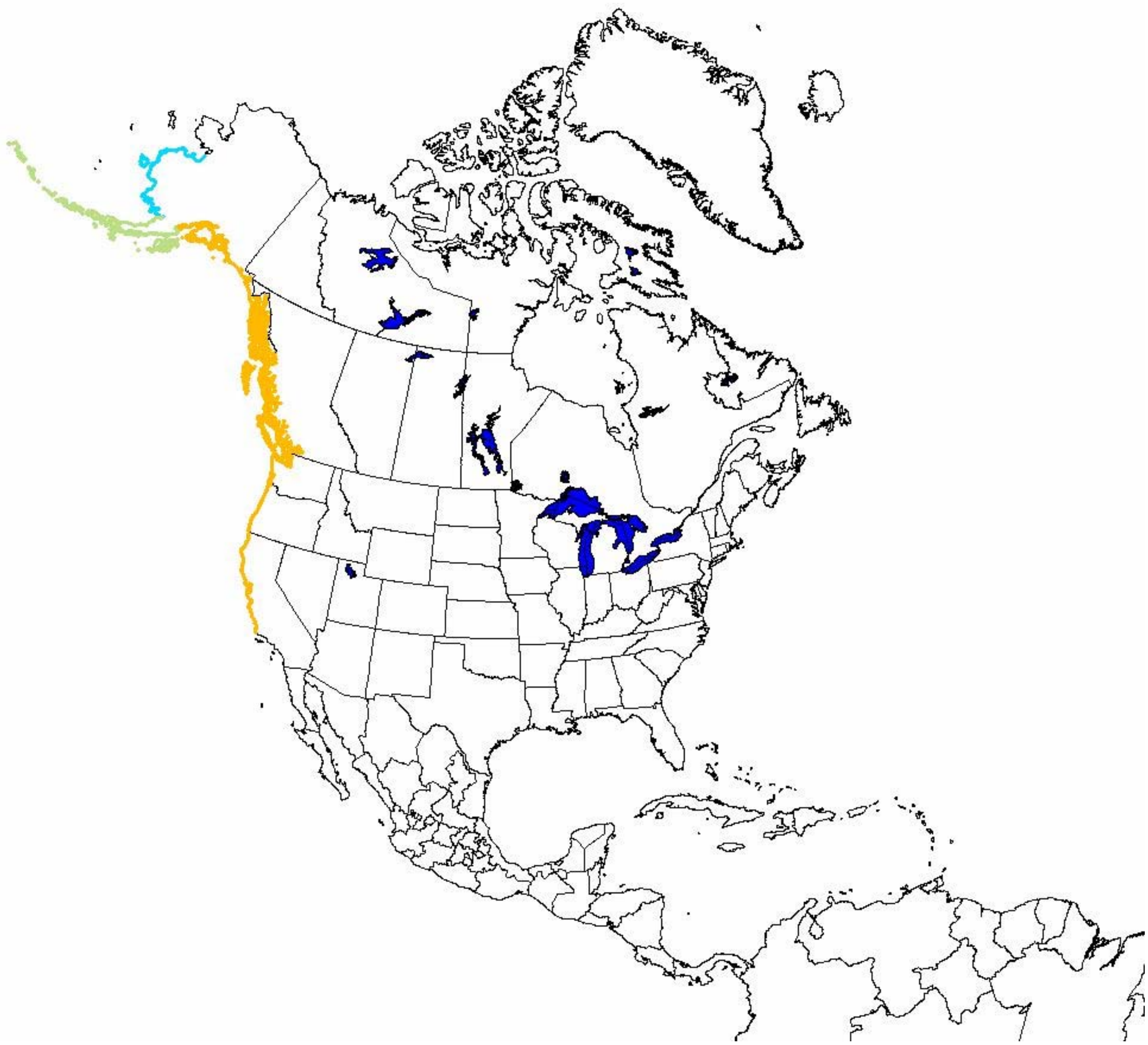

Figure 4.22 Breeding (blue), breeding and nonbreeding (green), and nonbreeding (yellow) distributions of the Rock Sandpiper. See narrative for breeding distribution of subspecific populations within Alaska.

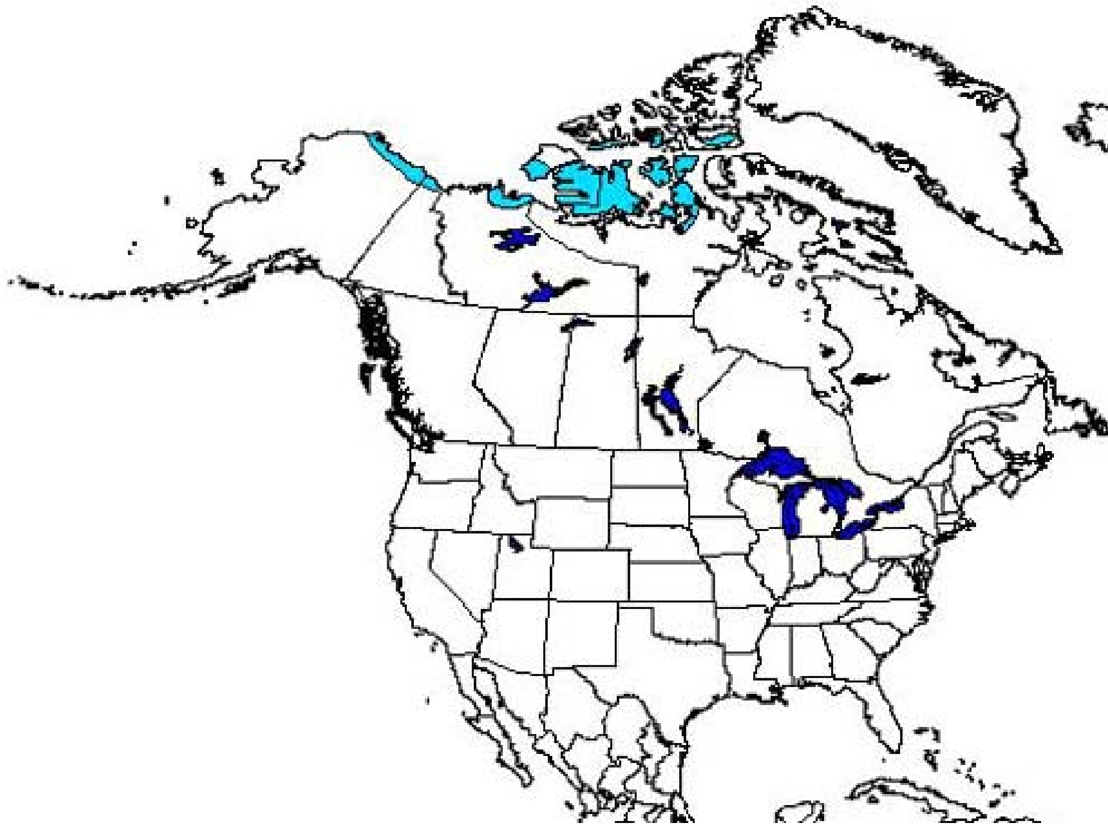

Figure 4.23 Breeding range (light blue) of the Buff-breasted Sandpiper, excluding small areas of Russia where the species occurs sporadically (from Lanctot and Laredo 1994).

Figure 4.24 Primary nonbreeding range (dark gray) of the Buff-breasted Sandpiper excluding small areas of northwestern Argentina and southwestern Bolivia (from Lanctot et al. 2002).

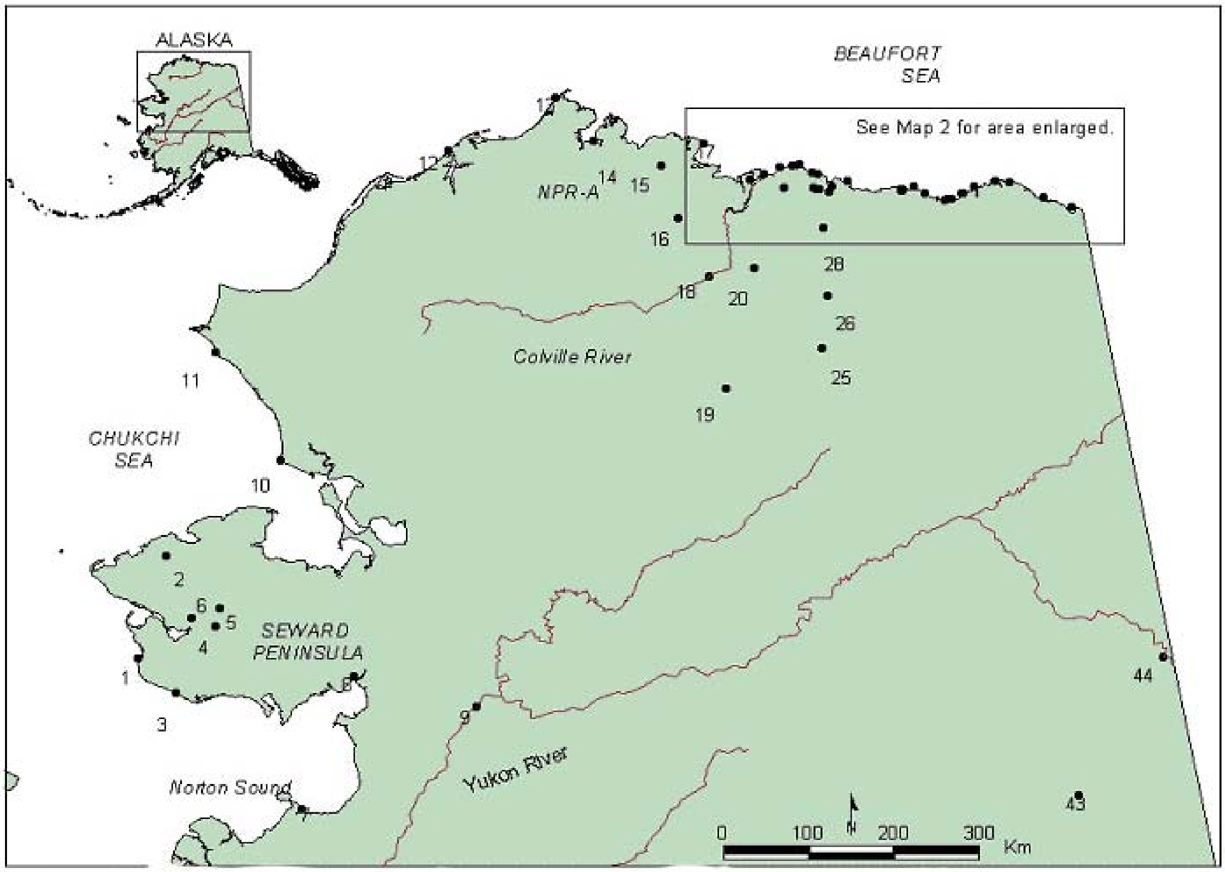

Figure 4.25 Location of Buff-breasted Sandpiper sightings in Alaska from 1883 to 2001. The lack of observations from an area does not indicate the area does not have Buff-breasted Sandpipers as many areas have not been searched, and the species occurs sporadically from year-to-year (from Gotthardt and Lanctot 2002).

Landbirds – Introduction

Alaska is home to 135 species of breeding birds that principally use terrestrial habitats throughout the year. These birds, commonly referred to as "landbirds," compose the largest and most ecologically diverse component of Alaska's avifauna and include raptors, grouse, woodpeckers, flycatchers, jays, chickadees, thrushes, warblers, and sparrows, among others (Boreal Partners in Flight 1999, Alaska Raptor Management Program 2001[1]). Collectively, landbirds occupy all terrestrial habitats in Alaska, where they play vital roles in ecosystems by feeding on insect pests, pollinating plants, dispersing seeds, serving as prey, and acting as top predators. They also provide important functions to the people of Alaska by helping define our culture and contributing to our economy. The Willow Ptarmigan, for example, serves as the state bird, a traditional source of food for Alaska Natives, and an important prey item for many predators. Moreover, the economies of many communities throughout Alaska are bolstered by the thousands of bird watchers who visit the state each summer to view the many species of landbirds found nowhere else in North America. In order to maintain these contributions to the ecosystems and people of Alaska we must sustain viable and well distributed populations of these birds in the state through time (Boreal Partners in Flight 1999). Fundamental to achieving this goal is an understanding of the relative vulnerabilities of species and subspecies to range reductions and extinctions and using this information to focus limited resources on taxa most in need of conservation (Rich et al. 2004).

In April 2004, a group of experts met to identify landbird priority species and conservation issues for the next 10 years. The group reviewed information on the relative vulnerabilities of Alaskan landbirds based on population size, restrictions on distribution, threats to populations, and population trend (Boreal Partners in Flight 1999; Rich et al. 2004) and identified the following landbird taxa and taxa groups as the most important for conservation:

1. Aleutian and Bering Sea island endemic landbird species and subspecies (p. 357);
2. Smith's Longspur (p. 363);
3. Landbirds sensitive to forest management (p. 328); and
4. Landbirds with long-term declines in population size (p. 322), with the Olive-sided Flycatcher (p. 336), Blackpoll Warbler (p. 342), and Rusty Blackbird (p. 350) species of particular concern within the group.

Specific goals and recommendations for conservation were developed for these birds and are included in the CWCS. The expert panel also recognized, however, that many additional conservation issues will need to be addressed in Alaska in order to keep our common landbirds common (Handel 2000). In addition to the birds and issues listed

[1] A separate group of experts addressed raptors (eagles, hawks, falcons, and owls) because of their specialized conservation needs (Alaska Raptor Management Program 2001). However, we included in our discussion 2 game species, grouse and ptarmigan, because the conservation needs of these birds were not addressed by any management plan in the state, and several populations are either undergoing rangewide population reductions or are threatened by current land management practices in Alaska.

above, and the priorities noted in the Landbird Conservation Plan for Alaska Biogeographic Regions (Boreal Partners in Flight 1999), landbird conservation in Alaska will be advanced if the following issues are addressed over the next 10 years:

Assessing the changing status of Alaska's landbirds—Although several landbird species have been highlighted in this plan because of documented declines, there is still extremely limited information on the changing status and trends of most of Alaska's 135 species of breeding landbirds. In particular, few are adequately monitored by any of the current monitoring programs in North America. Thus, we greatly need more effective community and species-specific inventory and monitoring programs for landbirds in Alaska to establish baselines of population size for future comparison, identify key areas and habitats for conservation, and detect population declines before species become imperiled.

Conservation of landbird taxa with small population sizes and restricted ranges—Extremely vulnerable to threats are those birds with small populations and restricted ranges. Although Smith's Longspur and the endemic species and subspecies of Aleutian and Bering Sea Islands fall into this category and are addressed in templates in the plan, several other landbird taxa have ranges in North America that are entirely or largely restricted to Alaska. Additional taxa that should be of conservation focus in this category are: 1) a unique group of Paleotropic-Nearctic migrants in Alaska, including the Alaska endemic breeding Arctic Warbler (*Phylloscopus borealis kennicotti*), and Eastern Wagtail (*Motacilla tschutschensis*); 2) "subspecies" largely restricted to Southeast Alaska, such as the Spruce Grouse on Prince of Wales Island (*Falcipennis canadensis isleibi*, Dickerman and Gustafson 1996); and 3) resident species common in Eurasia but restricted to Alaska in North America, such as the Gray-headed Chickadee (*Poecile cincta*). The Gray-headed Chickadee is of particular concern. Its nonmigratory habits suggest that it might be genetically isolated from conspecifics in the Palearctic. If this is the case, the North American population is nearly an Alaskan endemic with only a small part of its range extending into the Yukon and Northwest Territory. Although little population information is available, the species appears to be rare, and is at least partly reliant on isolated cottonwood stands north of the limits of spruce forest.

Protecting landbirds from large-scale threats—In addition to forest management, several other factors threaten Alaska's landbird populations and should be carefully studied and managed in order to conserve our birds. Global warming may be the number one future threat to birds in the region as current models predict large changes to important avian habitat. Such potential changes include shrinkage of boreal wetlands as well as substantial alterations to wind and weather patterns that may significantly increase the energetic costs of migration for our long-distance migrants. A short list of other threats includes accumulation of persistent organic pollutants, outbreaks of diseases such as West Nile virus and bill deformities, and the cumulative impacts of resource and urban development.

Conserving important nonbreeding habitats outside of Alaska—Approximately 75% of Alaska's breeding landbird species winter outside of the state (Boreal Partners in Flight

1999). Thus, efforts are needed to ensure that the conservation needs of our birds are being met along important migration pathways and wintering areas beyond our borders. Because the ranges of Alaska's migrant birds are not confined by political borders, considerable coordination among states, provinces, and countries is needed to advance rangewide conservation for our birds.

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Landbirds with Long-term Declines in Population Size

A. Species group description

This group includes Alaska landbird taxa experiencing significant ($P < 0.15$) long-term declines ($\geq$ 1.5% population decline per year for 10 years or more) in their breeding range, including or excluding Alaska. This template is meant to generally address the conservation of Alaskan landbirds with documented declines, but also accommodates species which are later found to have declines within the next 10 years. Monitoring of landbird populations in Alaska largely began in the early to mid 1990s; thus, documented declines are largely restricted to species that are still currently abundant and experience moderate declines or more uncommon species experiencing dramatic reductions in population size.

In this account we focus on 3 classes of declining species. First are species that are declining in most of their range, but declines in Alaska are unsubstantiated, usually due to lack of data. This group includes species such as Blue Grouse, Black Swift, and Rufous Hummingbird (Rich et al. 2004; Sauer et al. 2004). Second are species that are still abundant but are showing evidence of declines in Alaska, but not always across their broader breeding ranges in North America. Violet-green Swallow, Hermit Thrush, and White-crowned Sparrow are examples of such species (Sauer et al. 2004). Additionally, species with documented low rates of survival or productivity either statewide or across large regions of the state, such as Wilson's Warblers in upper Cook Inlet (DeSante et al. 2003), are included here.

Finally, we have developed individual species accounts for landbirds with severe long-term declines throughout their range, including Alaska, because these species are of paramount concern. This group includes Blackpoll Warbler, Olive-sided Flycatcher, and Rusty Blackbird (Rich et al. 2004; Sauer et al. 2003). All further details on these birds are included in the individual species accounts on separate templates.

Common/Scientific names: Alaskan landbirds experiencing long-term declines

Widespread declines (but not in Alaska)
Blue Grouse, *Dendragapus obscurus*
Black Swift, *Cypseloides niger*
Rufous Hummingbird, *Selasphorus rufus*
Belted Kingfisher, *Ceryle alcyon*
Black-backed Woodpecker, *Picoides arcticus*
Bank Swallow, *Riparia riparia*
Barn Swallow, *Hirundo rustica*
Wilson's Warbler, *Wilsonia pusilla*
Dark-eyed Junco, *Junco hyemalis*

Widespread declines (but not in Alaska)
Pine Grosbeak, *Pinicola enucleator*
Red Crossbill, *Loxia curvirostra*
Pine Siskin, *Carduelis pinus*

Declines in Alaska (but not rangewide)
Violet-green Swallow, *Tachycineta thalassina*
Cliff Swallow, *Petrochelidon pyrrhonota*
Hermit Thrush, *Catharus guttatus*
White-crowned Sparrow, *Zonotrichia leucophrys*

B. Distribution and abundance

Range:

Global and state range comments: Variable by species.

Abundance:

Global abundance comments: Population estimates (expressed as number of individuals) from Rich et al. (2004).

Widespread declines (but not in Alaska)
Blue Grouse: 2,600,000
Black Swift: 150,000
Rufous Hummingbird: 6,500,000
Belted Kingfisher: 2,200,000
Black-backed Woodpecker: 1,300,000
Bank Swallow: 46,000,000
Barn Swallow: 190,000,000
Wilson's Warbler: 36,000,000
Dark-eyed Junco: 260,000,000

Widespread declines (but not in Alaska)
Pine Grosbeak: 4,400,000
Red Crossbill: 15,000,000
Pine Siskin: 22,000,000

Declines in Alaska (but not range-wide)
Violet-green Swallow: 11,000,000
Cliff Swallow: 89,000,000
Hermit Thrush: 56,000,000
White-crowned Sparrow: 72,000,000

State abundance comments: Estimates of population size (% global population in Alaska) from Rosenberg (2004a and 2004b) are expected to be inaccurate, but provide the only available estimates of statewide population size.

Widespread declines
Blue Grouse: 590,000 (23%)
Black Swift: n/a
Rufous Hummingbird: 1,100,000 (17%)
Belted Kingfisher: 250,000 (11%)
Black-backed Woodpecker: n/a
Bank Swallow: 4,500,000 (10%)
Barn Swallow: 100,000 (<1%)
Wilson's Warbler: 17,500,000 (48%)
Dark-eyed Junco: 47,200,000 (18%)

Widespread declines (but not in Alaska)
Pine Grosbeak: 320,000 (7%)
Red Crossbill: 810,000 (5%)
Pine Siskin: 1,500,000 (7%)

Declines in Alaska
Violet-green Swallow: 1,200,000 (11%)
Cliff Swallow: 1,800,000 (2%)
Hermit Thrush: 5,800,000 (10%)
White-crowned Sparrow: 21,900,000 (31%)

Trends:

Global trends: Population trends (% change per year) calculated from data (1980–2002) from the North American Breeding Bird Survey (NABBS) (Sauer et al. 2003); n = number of routes.

Blue Grouse: –1.8% ($P = 0.01$, $n = 81$)
Black Swift: –7.1% ($P = 0.05$, $n = 43$)
Rufous Hummingbird: –2.3% ($P = 0.01$, $n = 201$)
Belted Kingfisher: –1.6% ($P < 0.01$, $n = 1754$)
Black-backed Woodpecker: –7.2% ($P = 0.01$, $n = 67$)
Bank Swallow: –1.9% ($P = 0.05$, $n = 947$)
Barn Swallow: –2.1 ($P < 0.01$, $n = 3275$)
Wilson's Warbler: –2.5% ($P < 0.01$, $n = 456$)
Dark-eyed Junco: –2.0% ($P < 0.01$, $n = 1051$)

Pine Grosbeak: –6.7% ($P = 0.01$, $n = 79$)
Red Crossbill: –2.3% ($P < 0.01$, $n = 413$)
Pine Siskin: –3.3 ($P < 0.01$, $n = 791$)

Violet-green Swallow: 0.8% ($P = 0.28$, $n = 623$)
Cliff Swallow: 0.5% ($P = 0.36$, $n = 1841$)
Hermit Thrush: 0.9% ($P < 0.01$, $n = 1040$)
White-crowned Sparrow: -–0.1% ($P = 0.95$, $n = 297$)

State trends: Population trends (% change per year) calculated from data (1980–2002) from the North American Breeding Bird Survey in Alaska (Sauer et al. 2003); *n* = number of routes.

Blue Grouse: 0.0% (*P* = 1.00, *n* = 10)
Black Swift: n/a
Rufous Hummingbird: 3.9% (*P* = 0.33, *n* = 17)
Belted Kingfisher: –2.5% (*P* = 0.32, *n* = 32)
Black-backed Woodpecker: n/a
Bank Swallow: 4.1% (*P* = 0.05, *n* = 38)
Barn Swallow: 0.9% (*P* = 0.89, *n* = 10)
Wilson's Warbler: 1.0% (*P* = 0.37, *n* = 77)
Dark-eyed Junco: –1.1% (*P* = 0.06, *n* = 80)
Pine Grosbeak: 3.3% (*P* = 0.25, *n* = 35)
Red Crossbill: 3.8% (*P* = 0.04, *n* = 15)
Pine Siskin: 5.5% (*P* = 0.10, *n* = 41)
Violet-green Swallow: –5.1% (*P* = 0.01, *n* = 37)
Cliff Swallow: –6.0% (*P* = 0.09, *n* = 30)
Hermit Thrush: –1.8% (*P* = 0.06, *n* = 65)
White-crowned Sparrow: –1.9% (*P* = 0.02, *n* = 73)

C. Problems, issues, or concerns for species group

All of these species are showing signs of population decline either in Alaska or significant portions of their breeding range outside of Alaska. Although many of these species are still common, at least regionally, we currently have little insight into whether these declines are part of natural population cycles or larger ecological problems. Research and conservation efforts are needed to identify the causes of declines and stabilize their populations before they become rare, and their functional roles in terrestrial ecosystems in Alaska are lost. These declines warrant further investigation also because they may be indicative of larger ecosystemic problems either in Alaska or in other parts of these species' ranges.

Because monitoring programs for landbirds in Alaska were not widely instituted until the early 1990s, many of these declines have not been documented until very recently. Few biologists and resource managers are aware of these declines in Alaska, and thus, these species have received little to no recognition in the conservation planning process in the state.

D. Location and condition of key or important habitat areas

Habitats used by these birds vary widely among species.

E. Concerns associated with key habitats

Variable by species.

F. Goal: Conserve declining landbird populations so that they remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

Objective: At a minimum, maintain species widely distributed across their current range and within the range of natural cycles. However, it may be more appropriate to increase population size to 1966 levels for species declining over large parts of their range (i.e., PIF Watchlist species listed in Rich et al. 2004).

Target: Increasing breeding distributions and population trends.

Measure: Population trends estimated jointly from the North American Breeding Bird Survey (NABBS) in Alaska and its complementary program in roadless areas of the state, the Alaska Landbird Monitoring Survey (ALMS).

Issue 1: Ability to maintain long-term monitoring of NABBS routes in appropriate places in the state.

Conservation action: Maintain participation in the NABBS in Alaska at no less than present level.

Issue 2: Current knowledge of population trends is based solely on the roadside NABBS, which only samples a small proportion of the species breeding range in Alaska. Therefore, it may be inappropriate to extend the objective for this species to outside of the NABBS corridor without an appropriate evaluation of its status in roadless areas.

Conservation actions:

a) Examine independent data on trends from migration stations, other breeding surveys, and demographic monitoring to determine if declines are evident in areas away from the road system.
b) Encourage and implement full participation in ALMS. Random sampling of roadless areas will improve estimates of population size and percent global population in Alaska, reduce bias in trends associated with geographically limited NABBS, improve knowledge or distribution, and when combined with data from the NABBS, increase statistical power in detecting statewide trends. Surveys should be conducted for no less than 25 years.

Issue 3: There is a general lack of understanding of the breeding habitat associations of these species in Alaska. Thus, it is difficult to conserve important areas to help meet the objective of restoring populations to 1980s levels.

Conservation actions:

a) Conduct field studies and/or analyses of existing data to determine habitats, habitat attributes, and geographic locations that support high densities of this species during breeding and migration in Alaska. Determine if declines in habitat may be linked to declines in population size. Combine such studies with conservation action "j" when possible.
b) Use results from such studies to direct research to important areas and strategically protect or enhance important areas and habitats to help meet the objective of restoring populations to 1980s levels (Rosenberg 2004a and 2004b).
c) Communicate the habitat associations of these species to appropriate agencies in Alaska.

Issue 4: Causes of population declines are rarely known.

Conservation actions:

a) Raise profile of decline of these species to pique interest in the research community for exploring causes.
b) Conduct targeted demographic studies to identify deficits in survival, reproduction, or recruitment and whether such deficits are linked with specific habitats, habitat changes, geographic locations, exposure to contaminants or diseases, or natural cycles. Priority should be placed on studying suites of species that share habitats during critical times of the year.
c) Based on research findings, develop and implement conservation actions in appropriate areas to reverse population decline.

Issue 5: Wilson's Warbler has been found to have low rates of survival and productivity in upper Cook Inlet, suggesting regional problems with the status of this species (DeSante et al. 2003).

Conservation action: Determine if species has different population trajectory in Southcentral Alaska compared to other regions in the state; if so, identify cause of the regional decline and develop strategies to remediate the problem.

Issue 6: For some species, such as Black Swift, even full implementation of the NABBS and ALMS will be insufficient to determine population status and trends due to the species' unique ecology and the sampling parameters of the 2 programs.

Conservation actions:

a) Conduct field studies as appropriate to determine habitats and geographic locations of these species in Alaska.
b) Develop protocols that adequately sample populations of these species.

Global conservation and management needs:

Objective: Reverse population declines.

Target: At a minimum, maintain still common species (e.g., Dark-eyed Junco) appropriately distributed across their current range at population sizes within the range of natural cycles. For Partners in Flight Continental Watch List, increase population size to 1966 levels (Rich et al. 2004).

Measure: NABBS and Christmas Bird Count (CBC).

Issue 1: Cause(s) of decline is/are unknown.

Conservation action: Collaborate with researchers and conservationists in appropriate locations in North and South America to identify the cause(s) of decline, and develop and implement strategies for remediating the problem(s), once identified (Rich et al. 2004).

Issue 2: Poor recognition of population decline among public, academic, and conservation communities.

Conservation action: Develop and distribute information about the decline to the public, academic, and conservation communities.

Issue 3: Much coordination will be needed among states, provinces, and agencies to develop and implement strategies to reverse declines across the ranges of these species.

Conservation action: Develop numerical goals for conservation (i.e., amount of habitats for restoration) appropriately for each state and province included in the species range and implement strategies for reaching these goals for each area (Rich et al. 2004).

H. Plan and time frames for monitoring species and their habitats

Monitoring by NABBS and ALMS should be conducted annually from present for a minimum of 25 years. Studies of demography and habitat associations should begin as soon as possible and continue for a minimum of 5 years. NABBS work is underway in Alaska through cooperative interagency efforts and a network of volunteers. At this point the ALMS, demography, and nesting habitat studies are only partially funded; participants should include USGS, USFWS, NPS, BLM, USFS, DOD, State of Alaska, NGOs, universities, and private landowners, including but not restricted to Native corporations and industry.

I. Recommended time frame for reviewing species status and trends

Five-year intervals for review.

J. Bibliography

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Landbirds Sensitive to Forest Management

A. Species group description

Common name: Landbird species sensitive to forest management

Upland gamebirds:

Blue Grouse, *Dendragapus obscurus*
Prince of Wales Spruce Grouse, *Falcipennis canadensis isleibi*

Canopy-nesting species:

Pacific-slope Flycatcher, *Empidonax difficilis*
Golden-crowned Kinglet, *Regulus satrapa*
Red Crossbill, *Loxia curvirostra*
White-winged Crossbill, *Loxia leucoptera*
Townsend's Warbler, *Dendroica townsendi*
Varied Thrush, *Ixoreus naevius*
Pine Siskin, *Carduelis pinus*

Cavity-nesting species:

Red-breasted Sapsucker, *Sphyrapicus ruber*
Hairy Woodpecker, *Picoides villosus*
American Three-toed Woodpecker, *Picoides dorsalis*
Black-backed Woodpecker, *Picoides arcticus*
Northern Flicker, *Colaptes auratus*
Boreal Chickadee, *Poecile hudsonica*
Chestnut-backed Chickadee, *Poecile rufescens*
Red-breasted Nuthatch, *Sitta canadensis*
Brown Creeper, *Certhia americana*

B. Distribution and abundance

Range:

State range comments: Forested regions of the state including both coastal and boreal forests. Resident species typically undergo some limited seasonal movements within Alaska.

Endemic taxa: Prince of Wales Spruce Grouse

Resident species: Blue Grouse, Red-breasted Sapsucker, *Picoides* woodpeckers, chickadees, Red-breasted Nuthatch, Brown Creeper, Golden-crowned Kinglet, Red Crossbill, White-winged Crossbill, Pine Siskin

Short-distance migrants (within N. America): Northern Flicker, Varied Thrush

Long-distance migrants (winter in Neotropics): Pacific-slope Flycatcher, Townsend's Warbler

Abundance:

Global abundance comments: Population estimates (expressed as number of individuals) from Rich et al. (2004).

Blue Grouse: 2,600,000
Spruce Grouse, Prince of Wales: unknown
Red-breasted Sapsucker: 2,500,000
Hairy Woodpecker: 9,400,000
American Three-toed Woodpecker: 830,000
Black-backed Woodpecker: 1,300,000
Northern Flicker: 16,000,000
Pacific-slope Flycatcher: 8,300,000
Boreal Chickadee: 7,800,000
Chestnut-backed Chickadee: 6,900,000
Red-breasted Nuthatch: 18,000,000
Brown Creeper: 5,400,000
Golden-crowned Kinglet: 34,000,000
Varied Thrush: 26,000,000
Townsend's Warbler: 12,000,000
Red Crossbill: 15,000,000
White-winged Crossbill: 41,000,000
Pine Siskin: 22,000,000

State abundance comments: Population estimates, expressed as number of individuals (% global population) from Rosenberg (2004). Note that the Rosenberg (2004) estimates are suspected to be inaccurate, but provide the best available estimates of statewide populations.

Blue Grouse: 590,000 (23%)
Prince of Wales Spruce Grouse: n/a
Red-breasted Sapsucker: 800,000 (32%)
Hairy Woodpecker: 340,000 (4%)
American Three-toed Woodpecker: 250,000 (30%)
Black-backed Woodpecker: n/a
Northern Flicker: 220,000 (1%)
Pacific-slope Flycatcher: 1,700,000 (20%)
Chestnut-backed Chickadee: 1,700,000 (25%)
Boreal Chickadee: 2,223,000 (29%)
Red-breasted Nuthatch: 180,000 (1%)
Brown Creeper: 350,000 (6%)
Golden-crowned Kinglet: 2,800,000 (8%)
Varied Thrush: 15,000,000 (58%)
Townsend's Warbler: 4,100,000 (34%)
Red Crossbill: 810,000 (5%)
White-winged Crossbill: 2,340,000 (6%)
Pine Siskin: 1,500,000 (7%)

Trends:

Global trends: Population trends (% change per year) calculated from data (1980–2003) from the NABBS (Sauer et al. 2004); n = number or routes trend is based on.

Blue Grouse: –1.8% ($P < 0.01$, $n = 81$)
Prince of Wales Spruce Grouse: n/a[1]
Red-breasted Sapsucker: unknown
Hairy Woodpecker: 1.1% ($P < 0.01$, $n = 1975$)
American Three-toed Woodpecker: –3.1% ($P = 0.64$, $n = 31$)
Black-backed Woodpecker: –7.2% ($P = 0.01$, $n = 67$)
Northern Flicker: n/a
Pacific-slope Flycatcher: n/a
Chestnut-backed Chickadee: –0.7% ($P = 0.31$, $n = 178$)
Boreal Chickadee: –1.9% ($P = 0.18$, $n = 135$)
Red-breasted Nuthatch: 1.2% ($P < 0.01$, $n = 1055$)
Brown Creeper: –0.9% ($P = 0.32$, $n = 539$)
Golden-crowned Kinglet: –1.1% ($P = 0.09$, $n = 635$)
Varied Thrush: –1.0% ($P = 0.07$, $n = 186$)
Townsend's Warbler: 0.9% ($P = 0.18$, $n = 189$)
Red Crossbill: –2.3% ($P < 0.01$, $n = 413$)
White-winged Crossbill: –1.2% ($P = 0.80$, $n = 113$)
Pine Siskin: –3.3% ($P < 0.01$, $n = 791$)

[1]No direct information is available on population trends of Prince of Wales Spruce Grouse; however, this "subspecies" has a limited distribution in Southeast Alaska, and it may be sensitive to forest management activities, although population trends are unknown.

State trends: Population trends (% change per year) calculated from data (1980–2003) from the North American Breeding Bird Survey (Sauer et al. 2004); n = number or routes trend is based on.

Blue Grouse: 0.0% (P = 1.00, n = 10)
Prince of Wales Spruce Grouse: n/a[1]
Red-breasted Sapsucker: 1.9% (P = 0.50, n = 16)
Hairy Woodpecker: 6.8% (P = 0.05, n = 28)
American Three-toed Woodpecker: 6.5% (P = 0.33, n = 16)
Black-backed Woodpecker: n/a
Northern Flicker: 0.2% (P = 0.95, n = 34)
Pacific-slope Flycatcher: 1.3% (P = 0.61, n = 16)
Chestnut-backed Chickadee: 2.0% (P = 0.41, n = 20)
Boreal Chickadee: -0.5% (P = 0.80, n = 43)
Red-breasted Nuthatch: –0.6% (P = 0.82, n = 17)
Brown Creeper: 22.3% (P = 0.20, n = 14)
Golden-crowned Kinglet: –0.5% (P = 0.83, n = 31)
Varied Thrush: -–0.1% (P = 0.89, n = 85)
Townsend's Warbler: 0.2% (P = 0.93, n = 35)
Red Crossbill: 3.8% (P = 0.04, n = 15)
White-winged Crossbill: 4.3% (P = 0.30, n = 47)
Pine Siskin: 5.5% (P = 0.10, n = 41)

C. Problems, issues, or concerns for species group

All of these species are sensitive to losses of mature, coniferous forest throughout their ranges in Alaska. Timber and salvage harvest and associated road construction in Alaska not only decrease forest cover, but also alter or eliminate attributes of forest structure, composition, configuration, and connectivity needed by populations of these birds. Many of the important habitat attributes in mature stands that are needed by these species are not recruited into harvested stands for more than 100 years, such as snags and dead wood material on live trees (e.g., broken treetops) for cavity-nesting birds (Sallabanks et al. 2001). Harvest prescriptions are sometimes applied during timber removal to minimize the negative effects of logging (such as riparian buffers), but their efficacy has not been evaluated. Forest management that protects important resources, such as patches of large diameter trees, riparian corridors, and snags, is likely to be most beneficial to these birds. Postharvest prescriptions such as planting, herbicide application, and thinning are sometimes used to increase commercial tree growth but have unknown consequences on forest-associated birds.

In Southeast Alaska these species are typically found more commonly in large-tree old-growth forests of hemlock-spruce at lower elevations than second-growth stands of varying ages following clearcutting (Kessler and Kogut 1985, Zwickel 1992, DellaSala et al. 1996, Russel 1999, Kissling 2003, Andres et al. in press). Large-scale natural disturbance is largely absent from these coastal forests; thus, widespread disturbance from logging may have landscape effects on these birds. A bird of particular concern among this group of birds is the Prince of Wales Spruce Grouse, which appears to be endemic on Prince of Wales and nearby islands in southern Southeast Alaska (Dickerman and Gustafson 1996).

Many of these species whose breeding ranges extend into the boreal forest, such as the Brown Creeper, Golden-crowned Kinglet, Varied Thrush, and Townsend's Warbler, are also associated with mature white spruce or mixed white spruce/paper birch forests for breeding (Spindler and Kessel 1980, Matsuoka et al. 1997a and 1997b), and therefore, decrease in density following removal of the large trees through fires, outbreaks of bark beetles, and associated salvage logging (Quinlan 1978, Lance and Howell 2000, Collins et al. 2001). Other species, such as Hairy, American Three-toed, and Black-backed woodpeckers, however, increase in abundance during beetle outbreaks (Lance and Howell 2000) or immediately following fires (Hutto 1995, Murphy and Lehnhausen 1998), but salvage logging eliminates resources needed by these birds (Hutto 1995). Because the boreal forest is the home to frequent and large-scale natural disturbances from fires and insect outbreaks, silvicultural systems that mimic natural disturbances may be promising, but require development.

Recent research suggests that changes in climate may be having large-scale effects on forests in Alaska. Warming trends have favored reproduction of spruce beetles, (*Dendroctonus rufipennis*) and larch sawflies (*Pristiphora erichsonil*), leading to unprecedented outbreaks in the last decade, and low snowfall may be causing widespread mortality among yellow cedar in Southeast Alaska. Similarly, the frequency of large-scale fires and wind storms may increase with continued changes in climate. The effects of these forest disturbances and associated salvage logging activities on bird communities are largely unknown and need further study.

Biologists and land managers generally lack information regarding habitat associations for these species, and are thus unable to provide effective strategies for conserving or restoring important avian habitats or habitat attributes. Knowledge of the specific components of forest structure (vertical and horizontal), composition, and configuration used by these species would allow land managers to make better decisions regarding harvest prescriptions, rotations periods, second-growth management, fire management, and habitat restoration and ultimately lead to more effective avian conservation. Results from research in this area must be put into the hands of managers as soon as possible so that findings can be incorporated into the planning process.

D. Location and condition of key or important habitat areas

Key coastal forest habitats include low elevation, medium and large sized conifer forests of uneven age structure. Condition of these habitats varies from much degraded to pristine. Many private and state-owned lands in Southeast Alaska, Prince William Sound, and the Kodiak Archipelago are degraded as a result of logging, mining, and associated road construction. In Southeast Alaska forests on Prince of Wales, Heceta, northeast Chichagof, Kupreanof, and Kuiu Islands are particularly degraded from extensive clearcut logging. Despite large-scale industrial logging in the region, Alaska supports more than ¼ of the Earth’s coastal temperate rain forest and maintains the largest and most pristine tracts left in the world (DellaSala et al. 2001). However, pristine coastal forests in Southeast Alaska are generally restricted to designated parks and monuments, including Admiralty Island National Monument, Misty Fjords National Monument, Glacier Bay National Park and Preserve, and several federally designated wilderness areas within the Tongass National Forest.

Critical interior forest habitat includes mature forests of upland and riparian white spruce and mixed white spruce and variable deciduous species. Similar to coastal forests, interior forest condition is largely related to land ownership. Large tracts of state and private land on the Kenai Peninsula are highly degraded due to salvage logging. Small amounts of logging have also occurred in the Tanana State Forest and the Native lands in the Copper River Basin, leaving these areas somewhat degraded as well. Additionally, Interior forests have been fragmented locally from urban and industrial development (e.g., oil and gas). However, the majority of the boreal forest in Alaska is still largely pristine.

E. Concerns associated with key habitats

See C and D above.

F. Goal: Ensure that populations of bird species sensitive to forest management remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

Objective: Maintain species widely distributed across their current range and at a level of abundance that is $\pm$20% of current population size.

Target 1: Stable geographic breeding distribution and population trend.

Measure 1: Distribution and trends in abundance relative to habitat estimated from the statewide NABBS and ALMS.

Issue 1a: General poor information on distribution, population size, and trends.

Conservation action: Maintain participation in the NABBS in Alaska at no less than present level, and complement information from this program by fully implementing the ALMS program in Alaska. The latter will require broad participation among federal, state, and private land managers in Alaska.

Issue 1b: Early breeding species (e.g., Blue Grouse, woodpeckers), species occurring naturally at low densities (e.g., woodpeckers), species with low detectability (e.g., Brown Creeper), and taxa with restricted ranges (e.g., Spruce Grouse on Prince of Wales and other nearby islands) may not be adequately monitored by existing survey programs (i.e., NABBS and ALMS).

Conservation action: Develop survey and monitoring protocols for early breeding species and those with low detectability and/or low densities.

Issue 1c: Broad-scale monitoring using the NABBS and ALMS program may not meet the information needs for geographic areas that are undergoing rapid and widespread reductions in forest cover. In particular, more specific information is needed on the long-term effects of timber harvest, fire, insect outbreaks, salvage harvest, and associated pre- and postharvest prescriptions on bird populations.

Conservation actions:

a) Develop inventories and/or simulation models to assess the short-term effects of landscape change on bird communities in areas undergoing rapid and widespread changes in forest cover.

b) Monitor successional trajectories of bird communities to evaluate the long-term effects of forest change. Priority should be placed on evaluating pre- and postharvest activities applied to promote wildlife populations (i.e., variable retention, buffers, reforestation, second-growth thinning). Whenever possible, use such data to develop empirical and/or simulation models to assess both current and future benefits of such prescriptions.

Issue 1d: The distribution and population status of the Prince of Wales Spruce Grouse warrants additional assessment as this "subspecies" is endemic to a small number of islands in southern Southeast Alaska.

Conservation actions:

a) Conduct surveys to assess population size, densities, and distribution of this subspecies related to forest management and identify important areas and habitats for conservation.
b) Conduct phylogenetic studies to assess the degree of isolation of this subspecies from other nearby populations of Spruce Grouse.

Target 2: Maintain amount of appropriate habitat needed to support species across current range and at a level of abundance that is ±20% of current population size.

Measure 2: Quantify the amount and distribution of appropriate forest habitat. Changes in forest cover should be monitored grossly by compiling information on forest area harvested and restored in Alaska through existing sources of information. More specific changes in forest structure, cover, and composition should be monitored preferably statewide, but at a minimum in areas with high rates of change, using remote sensing at 10-year intervals.

Issue 2a: Limited information on the appropriate types, amounts, and configurations of forest habitat needed by these species hinders the development of habitat targets. Such information is needed to better evaluate planned harvest activities and to develop habitat targets (Target 2) that will help achieve numerical goals for bird populations (Target 1; Rosenberg 2004 a and 2004b). Information on habitats important in supporting high survival or reproductive success is lacking.

Conservation actions:

a) Compile and review existing information on habitat use and natural history patterns for these birds to identify important habitats and develop general habitat targets.
b) Develop more specific habitat selection models for birds in geographic areas that are undergoing rapid change. When possible, use existing regional GIS data on forest cover (i.e., Southeast Alaska and Kenai Peninsula) in combination with existing data from bird surveys (NABBS, ALMS, and other surveys) to develop more specific habitat targets.
c) For species that are highly restricted to mature forests, specific research should be conducted to identify habitats, habitat attributes, and geographic areas associated with high reproduction success and survival. Such information would give insight into the mechanisms governing avian responses to habitat manipulations and would provide an improved basis for developing habitat targets and recommendations for forest management.
d) Provide information from these efforts to managers as soon as possible so that findings can be incorporated into the planning process.

Issue 2b: Existing information on timber harvest and forest restoration in Alaska is not compiled in order to assess how changes in forest cover may be affecting bird populations.

> **Conservation action:** Monitor gross changes in forest cover by compiling information on timber and salvage harvest and forest restoration activities in Alaska from the USFS, Alaska Division of Forestry, and other appropriate sources on an annual or biennial basis.

Issue 2c: Lack of detailed information on forest cover, structure, and composition for Alaska, particularly on state and private lands, limits our ability to evaluate the cumulative effects of forest management on regional or statewide populations of birds. Detailed data are currently only available for specific areas, such as the Tongass National Forest, Kenai Peninsula, and a growing number of national parks.

> **Conservation action:** Develop a statewide landcover map for Alaska that includes data layers for forest structure and species composition at a minimum resolution of 30 meters.

Issue 2d: Harvest prescriptions and best management practices need to be better designed and implemented on some federal, state, and private lands. The development and application of such prescriptions will be useful in minimizing the negative effects of forest management on birds.

> **Conservation action:** Encourage federal, state, and private landowners to consider and implement best management practices for the conservation of declining forest birds.

H. Plan and time frames for monitoring species and their habitats

NABBS work is ongoing in Alaska through cooperative interagency efforts and a network of volunteers. Presently, the ALMS program has not been fully implemented statewide and is only partially funded. Development of a statewide landcover map is unfunded, and responsibility for this task does not belong to a particular agency or private organization. Studies of demography, habitat selection, and effectiveness monitoring are also unfunded at this time. Participants should include USGS, USFWS, NPS, DOD, USFS, BLM, State of Alaska, nongovernmental organizations, universities, and private landowners.

I. Recommended time frame for reviewing species status and trends

Ten years unless monitoring suggests that population(s) have fallen below target levels.

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Olive-sided Flycatcher

A. Species description

Common name: Olive-sided Flycatcher
Scientific name: *Contopus cooperi*

B. Distribution and abundance

Range:

Global range comments: Breeding range extends from Alaska east through coniferous forests to southern Labrador, in the Northeast south to Massachusetts and locally to North Carolina, in the Midwest south to northern Wisconsin and northeastern Ohio, and in the West south along coastal ranges to Baja California and in the Rockies to southeastern Arizona and western Texas (Altman 1997). Principal wintering range is Panama and Andes Mountains of northern and western South America, from northern and western Venezuela south through Ecuador to southeastern Peru and western Bolivia (Altman and Sallabanks 2000).

State range comments: Regularly breeds in central, south-central, southeast, and sparingly western Alaska. Generally at low densities throughout the coniferous boreal and coastal forests of Alaska (often characterized as uncommon or rare [Armstrong 1995]). Ranges to northern and western extent of coniferous forest to Noatak River in the northwest, Bethel and Katmai areas in the west/southwest, and to Colleen and Porcupine Rivers in the northeast (Kessel and Gibson 1978).

Abundance: Population estimates are suspected to be inaccurate (Rich et al. 2004; Rosenberg 2004a and 2004b), but are the only available estimates at this time.

Global abundance comments: 1,200,000 (Rich et al. 2004)

State abundance comments: 270,000 (Rosenberg 2004a and 2004b)

Trends:

Global trends: From 1966 to 2003 a population decline of 3.5% per year ($P < 0.01$, n = 776 routes) detected on the NABBS (Sauer et al. 2004).

State trends: From 1980 to 2002 a population decline of 3.3% per year ($P = 0.09$, n = 49 routes) detected on the NABBS in Alaska (Sauer et al. 2003). The period of documented population decline is shorter in Alaska due to the lack of monitoring surveys prior to 1980.

C. Problems, issues, or concerns for species

Steep, rangewide decline in numbers of breeding birds. Current estimates suggest that the global population has been reduced by over 70% since 1966. Trend similar in Alaska as in rest of the species range.

Reasons for decline unknown, but rapid losses of forested habitats on wintering grounds in the Andes foothills and mountains are a suspected but untested cause of the decline. Because the genus *Contopus* has the lowest reproductive rate of all North American passerines, lowered survival resulting from losses of favored wintering habitat could be particularly problematic for this species (Altman and Sallabanks 2000). Rates of survivorship not currently known.

Because this species is closely tied to recently burned forests and, to a lesser extent, bark beetle infested forests for breeding, fire suppression and salvage harvest may be detrimental to populations (Hutto 1995; Stone 1995). Harvested stands may act as “ecological traps” that attract breeding birds because of the forest opening they create but support low rates of nest success compared to favored postfire stands because of high densities of predators supported by adjacent live stands (Altman and Sallabanks 2000).

Climate change may also affect this species by changing the energetic requirements of long-distance migration, availability of flying insects for food, frequency of fires and bark beetle epidemics, or drying of favored muskegs and forested bogs and swamps in the boreal forest (Altman and Sallabanks 2000).

D. Location and condition of key or important habitat areas

Breeding:

Considered an indicator species of the coniferous forest biome throughout North America, although it is occasionally found in mixed deciduous/coniferous forests. In central Alaska, most often found in stands of open canopy spruce (*Picea glauca* and *P. mariana*). Usually associated with openings (muskegs, meadows, burns, and logged areas) and water (streams, beaver ponds, bogs, and lakes). Apparently requires an uneven canopy or openings for aerial hawking and wet areas productive of insect prey. Regularly uses prominent dead or partially dead trees for perching, singing, and hawking. In central Alaska, perches averaged 1.4 times the height of surrounding tree canopy; 25% of perches were dead trees, 51% were partially dead (most with dead tops), and 24% were live. Nests were placed in live trees, primarily black spruce, that were slightly shorter than surrounding canopy (Wright 1997). Breeding habitats in Alaska are generally in good condition.

Winter:

Primary wintering habitat (based on limited anecdotal information) is mature evergreen forests, particularly montane forest. Reaches highest densities in Andes in Columbia, where it occurs in lightly forested areas and forested edges from 400 to 2600 m. This is one of the most heavily altered habitats in South America. Andean valleys are almost completely deforested, and 85% or more of montane forests have been cut (Altman and Sallabanks 2000).

E. Concerns associated with key habitats

On breeding grounds in Alaska, forest management, particularly salvage harvest, may be detrimental to this species. Climate change and associated landscape drying could decrease the suitability of muskegs, bogs, and streamside habitat for breeding, as well as alter the availability of flying insects for foraging.

On wintering grounds, forests favored by this species have been one of the most heavily altered habitats in South America. Andean valleys are almost completely deforested, and 85% or more of montane forests have been cut. From an examination of 123 migrant landbirds, the Olive-sided Flycatcher was considered one of the 12 species most vulnerable to extinction from tropical deforestation primarily because of restriction to undisturbed broadleaf forest during winter (Petit et al. 1993, 1995).

F. Goal: Ensure Olive-sided Flycatcher populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

<u>Objective</u>: Restore population to 1980 levels in Alaska.

Target: An average 3.3% increase in population size per year over the next 25 years.

Measure: Population trend estimated jointly from the NABBS in Alaska and its complementary program in roadless areas of the state, ALMS.

Issue 1: Ability to maintain long-term monitoring of NABBS routes in appropriate places in the state.

Conservation action: Maintain participation in the NABBS in Alaska at no less than present level; identify individuals to adopt routes that have been discontinued; observers must commit to no fewer than 3 consecutive years of service.

Issue 2: Current knowledge of population trends is based solely on the roadside NABBS, which only samples a small proportion of the species breeding range in Alaska. Therefore, it may be inappropriate to extend the objective for this species to outside of the NABBS corridor without an appropriate evaluation of its status in roadless areas.

Conservation actions:

a) Examine independent data on trends from migration stations or other breeding surveys to determine if declines are evident in areas away from the road system.
b) Encourage and implement full participation in ALMS, whose random sampling of roadless areas will improve estimates of population size and percent global population in Alaska, reduce bias in trends associated with geographically limited NABBS, improve knowledge of distribution and habitat use and, when combined with data from the NABBS, increase statistical power in detecting statewide trends. Surveys should be run for no less than 25 years.

Issue 3: There is a general lack of understanding of the breeding habitat requirements of this species in Alaska. Thus, it is difficult to develop and implement strategies to conserve or enhance important areas for breeding to help meet the objective of restoring populations to 1980s levels.

Conservation actions:

a) Conduct field studies or analyses of existing data to determine important habitats, habitat attributes, and geographic locations for this species in Alaska. Combine such studies with the second conservation action listed in Issue 4, when possible.
b) Effects of disturbance from fires, insect outbreaks, and particularly associated salvage logging activities should be evaluated.
c) Use results from such studies to strategically protect or enhance important areas and habitats to help meet the objective of restoring populations to 1980s levels (Rosenberg 2004a and 2004b).
d) Communicate the habitat needs of this species to appropriate land managers and regulatory agencies in Alaska.

Issue 4: Current cause of population decline unknown but could be operating outside of Alaska on nonbreeding sites. However, the decline must be linked to deficits in survival, reproduction, or recruitment.

Conservation actions:

a) Raise profile of demise of species to pique interest in the research community for exploring causes of decline.
b) Conduct targeted demographic studies to identify deficits in reproduction and, particularly, survival and recruitment and whether such deficits are linked with specific habitats, habitat changes, geographic locations, or exposure to contaminants or diseases. Information on survival and recruitment are needed in particular.
c) Conduct studies using stable isotopes and/or genetics to determine important nonbreeding sites (migration stopover, wintering) for Alaskan breeding populations and whether losses of habitats in these areas may be contributing to the decline.
d) Based on research findings, develop and implement conservation actions in appropriate areas to reverse population decline.

Global conservation and management needs:

Objective: Restore population to 1966 levels across the breeding range (Rich et al. 2004).

Target: Population level in 1966 (Rich et al. 2004). This equates to an average 3.5% annual increase in population size over the next 38 years.

Measure: NABBS.

Issue 1: Current knowledge of population decline is based solely on the roadside NABBS, which only samples a small proportion of the species breeding range. Therefore, it may be inappropriate to extend the objective for this species to outside of the NABBS corridor without an evaluation of its status in roadless areas.

Conservation action: Analyze data from appropriate migration stations and other breeding and nonbreeding surveys to determine if declines are evident from independent data sets and in roadless areas; the latter may be important in supporting “source” populations.

Issue 2: Cause(s) of decline is/are unknown.

Conservation actions:

a) Collaborate with North and South American researchers and conservationists to determine causes of decline and develop and implement strategies to remediate the problem(s) once identified.
b) Effects of forest management on breeding birds should be further evaluated. In particular, prescribed fire and silvicultural systems that mimic the natural effects of fire and beetle outbreaks should be tested as a means of enhancing habitats for this species.

Issue 3: Poor understanding of linkages between breeding, staging, and wintering sites.

Conservation action: Conduct genetic and stable isotope studies to determine linkages between breeding, staging, and wintering populations to identify important areas and habitats for distinct populations of this species.

Issue 4: Poor recognition of population decline among public, academia, and conservation communities.

Conservation action: Develop and distribute information about the decline to the public, academia, and conservation communities.

H. Plan and time frames for monitoring species and their habitats

Monitoring by NABBS and ALMS should be conducted annually from present for a minimum of 25 years. Studies of demography and habitat requirements should begin as soon as possible and continue for a minimum of 5 years.

NABBS work is underway in Alaska through cooperative interagency efforts and a network of volunteers. At this point the ALMS, demography, and nesting habitat studies are only partially funded; participants should include USGS, USFWS, NPS, BLM, USFS, DOD, State of Alaska, NGOs, universities, and private landowners, including, but not restricted to Native corporations and industry.

I. Recommended time frame for reviewing species status and trends

Five-year intervals for review.

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Blackpoll Warbler

A. Species description

Common name: Blackpoll Warbler
Scientific name: *Dendroica striata*

B. Distribution and abundance

Range:

Global range comments: Breeds from northern and western Alaska, throughout Yukon and southern Northwest Territories, east and south to central plains provinces to northern Ontario, central Quebec, throughout Labrador and Newfoundland; south to New York, Maine and Massachusetts. Winters in Ecuador, Columbia, Venezuela, Peru, Chile and Peru (Terres 1980).

State range comments: In Alaska, breeds in western Alaska as far north as Selawik and the Kobuk and lower Noatak drainages, south to Katmai, common east to central Alaska and south to the Matanuska-Susitna Valleys, less common in east-central Alaska, the Kenai Peninsula. Rare migrant in Southeast Alaska (Kessel and Gibson 1978; Boreal Partners in Flight 1999; Cotter and Andres 2000). Highest breeding densities were recorded in riparian areas along the tributaries of the lower Yukon and Kuskokwim Rivers in western Alaska (Harwood 2002).

Abundance: Population estimates from Rosenberg (2004) are suspected to be inaccurate, but are the only available estimates at this time.

Global abundance comments: 21,000,000 birds.

State abundance comments: 6,400,000 birds.

Trends:

Global trends: Survey data from NABBS, 1980 to 2003 (not including Alaska), showed a population decline of 9.2% per year ($P < 0.01$, $n = 54$ survey routes; Sauer et al. 2004). Increasing from 1966 to 1980 (Sauer et al. 2004).

State trends: Data from NABBS from 1980 to 2003 in Alaska showed a population decline of 3.8% per year ($P = 0.01$, $n = 50$ survey routes; Sauer et al. 2004).

C. Problems, issues, or concerns for species

Precipitous population decline: Data from the NABBS indicate this species has suffered the steepest long-term decline of any Neotropical-Nearctic migrant landbird since 1980, with populations diminished by over 50% and 90% across breeding ranges in Alaska and Canada, respectively (Sauer et al. 2004). Large proportion (30%) of the global population estimated to breed in Alaska (Rosenberg 2004a and 2004b). NABBS trend information may be biased.

Climate change: The causes for this decline are poorly understood; however, climate changes may be in part responsible for this trend. Recent research showed that the abundance of breeding Blackpoll Warblers from 1967 to 1996 was negatively correlated with the frequency and severity of tropical storms over the Atlantic Ocean and Gulf of Mexico during autumn passage the previous year (Butler 2000). As this species undertakes the longest migration of any North American warbler, including a continuous transoceanic autumn flight from northeastern United States and southeastern Canada to northern South America (Nisbet et al. 1995), the Blackpoll Warbler may be particularly susceptible to mortality during migration, which has been found to account for 90% of annual mortality for its congener, the Black-throated Blue Warbler (*Dendroica caerulescens*; Sillett and

Holmes 2002). Climate change may be further threatening the population of this species in Alaska by modifying favored riparian and bog habitats through permafrost degradation and drying.

Habitat loss: Habitat loss at breeding and nonbreeding areas is another concern. Some examples include:

- Logging of Canadian boreal forest. Breeding densities declined in 20 m riparian strips after surrounding habitat was removed by clearcutting (Darveau et al. 1995).
- Degradation of red spruce and subalpine spruce-fir forests resulting from acid precipitation in northeastern United States and southeastern Canada may adversely affect reproduction by eliminating favored red spruce for nesting (Smith et al. 1986; Moegenburg and Greenberg 2004).
- Deforestation of lowland Amazonia may negatively influence Blackpoll Warblers; however, little is known about habitat use during nonbreeding season. One of the migrant landbirds considered most likely to be negatively affected by destruction of tropical forests.
- Degradation of important migration stopover sites, particularly in southeastern Canada, northeastern United States and northern South America.

Poor information on breeding and wintering ecology: In general, the breeding and wintering ecology of this species is poorly studied. In Alaska we have a poor quantitative understanding of what habitats and habitat attributes are important in supporting viable breeding populations of this species. Also, information on survival and reproductive output/success would be useful for developing population models to identify demographic bottlenecks for this species.

Other concerns: This species commonly collides with towers during migration (i.e communication towers, wind turbines, buildings), presumably due to attraction to lights (Hunt and Eliason 1999). Wind energy development and the cell phone industry are resulting in growing numbers of towers in both the United States and Canada. Widespread use of pesticides and dioxins on wintering grounds and accumulations of such materials in Alaska may adversely influence Blackpoll Warblers.

D. Location and condition of key or important habitat areas

Use of habitats for breeding changes from predominantly coniferous forests in the eastern and central portion of range to primarily deciduous habitats in Alaska. In Alaska, typically breeds in moist habitats along rivers, streams, or bogs, particularly in deciduous forest and tall shrub thickets (particularly *Salix alaxensis* and *Alnus incana*), the latter sometimes under a sparse overstory of spruce (*Picea glauca* or *P. mariana*; particularly in central Alaska) or mixed spruce-paper birch (*Betula papyrifera*; Gabrielson and Lincoln 1959; Spindler and Kessel 1980; McCaffery 1996; Kessel 1998; Cotter and Andres 2000). Also found in similar habitats at the transition zone between tree-line taiga and either alpine or coastal tundra (Kessel 1998), with the Yukon Delta being a possible exception (McCaffery 1996). Species reaches its highest breeding density in Alaska in riparian habitats in western Alaska (McCaffery 1996; Harwood 2002). Most of these habitats are not threatened by development.

E. Concerns associated with key habitats

Reductions in the suitability of breeding habitats used by this species across Canada and the northeastern United States as a result of widespread resource development (forestry, oil and gas) and acid rain. Such changes may increase the value of undisturbed habitats in Alaska. Breeding habitats in Alaska generally in good condition. However, since this species is associated with riparian areas and muskegs in Alaska, patterns in landscape drying resulting from climate change may reduce the suitability of habitats favored by this species for breeding.

Threats on nonbreeding areas may be of particular concern for this species. A recent examination of 123 migrant landbirds suggested that Blackpoll Warbler is one of the 12 species most vulnerable to extinction from tropical deforestation primarily because of restriction to undisturbed broadleaf forest during winter (Petit et al. 1993, 1995). Also the quality and quantity of stopover habitats during migration may be paramount for populations of this species as it undergoes the longest migration of any North American warbler, including a continuous transoceanic migration in autumn from the Atlantic coast of southeastern Canada/northeastern United States to northern South America.

(See also the “Habitat Loss” description in section C.)

F. Goal: Ensure Blackpoll Warbler populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

<u>Objective</u>: Restore population to 1980 levels in Alaska.

Target: An average 3.8% increase in population size per year over the next 25 years.
Measure: Population trend estimated jointly from the NABBS in Alaska and its complementary program in roadless areas of the state, ALMS.

<u>**Issue 1:** Ability to maintain long-term monitoring of NABBS routes in appropriate places in the state.</u>

Conservation actions:

a) Maintain participation in the NABBS in Alaska at no less than present level. In particular, encourage running river routes annually.
b) Identify individuals to adopt routes that have been discontinued (particularly river routes); observers must commit to no fewer than 3 consecutive years of service.
c) Resume NABBS routes conducted in lower Yukon and Kuskokwim river watersheds (done 1998–2002) biennially for 25 years.

<u>**Issue 2**: Current knowledge of population trends is based solely on the roadside NABBS, which only samples a small proportion of the species breeding range in Alaska. Therefore, it may be inappropriate to extend the objective for this species to outside of the NABBS corridor without an appropriate evaluation of its status in roadless areas.</u>

Conservation actions:

a) Examine independent data on trends from migration stations, the Alaska Off-road Breeding Bird Survey, or other surveys to determine if declines are evident in areas away from the road system.
b) Encourage and implement full participation in ALMS), whose random sampling of roadless areas will improve estimates of population size and percent global population in Alaska, reduce bias in trends associated with geographically limited NABBS, improve knowledge of distribution and, when combined with data from the NABBS, increase statistical power in detecting statewide trends. Surveys should be run for no less than 25 years.

Issue 3: There is a general lack of understanding of the breeding habitat requirements of this species in Alaska. Thus, it is difficult to conserve or enhance important areas for breeding to help meet the objective or restoring populations to 1980s levels.

Conservation actions:

a) Conduct field studies or analyses of existing data to determine important habitats and habitat attributes that support high densities, abundant food resources, or high rates of survival, reproduction, and recruitment. Combine such studies along with the second conservation action under Issue 4, when possible.
b) Use results from such studies to strategically protect or enhance important areas and habitats to help meet the objective of restoring populations to 1980s levels (Rosenberg 2004a and 2004b).
c) Communicate the habitat needs of this species to appropriate land managers and regulatory agencies in Alaska.

Issue 4: Current cause of population decline unknown but could be operating outside of Alaska on nonbreeding sites. However, the decline must be linked to deficits in survival, reproduction, or recruitment.

Conservation actions:

a) Raise profile of demise of species to pique interest in the research community for exploring causes of decline.
b) Conduct targeted demographic studies to identify deficits in survival, reproduction, or recruitment and whether such deficits are linked with specific habitats, habitat changes, geographic locations, or exposure to contaminants or diseases. Standardized protocols by the Monitoring Avian Productivity and Survivorship (MAPS) program and Breeding Bird Database may be appropriately applied to this species to help answer some of these questions.
c) Conduct studies using stable isotopes and/or genetics to determine important nonbreeding sites (migration stopover, wintering) for Alaskan breeding populations and whether losses of habitats in these areas may be contributing to the decline.
d) Based on research findings, develop and implement conservation actions in appropriate areas to reverse population decline.

Issue 5: Potential exposure to contaminants is a concern across their range.

Conservation action: Conduct assessment of presence of contaminants in breeding and wintering Blackpoll Warblers.

Global conservation and management needs:

Objective: Restore population to 1980 levels across the breeding range.

Target: 1980 population level.
Measure: NABBS.

Issue 1: Current knowledge of population decline is based solely on the roadside NABBS, which only samples a small proportion of the species breeding range. Therefore, it may be inappropriate to extend the objective for this species to outside of the NABBS corridor without an evaluation of its status in roadless areas.

Conservation action: Analyze data from appropriate migration stations and other breeding and nonbreeding surveys to determine if declines are evident from independent data sets.

Issue 2: Cause(s) of decline is/are unknown

Conservation actions:

a) Collaborate with North American, South American, and Caribbean researchers and conservationists to determine causes of decline.
b) Examine further the potential role of storm frequency during fall migration over the Atlantic Ocean in causing declines in this species (Bulter 2000).
c) Future studies on reproduction should focus on replicating previous work (Eliason 1986a and 1986b), complementing ongoing work on the effects of acid rain on the species (Moegenburg and Greenberg 2004), testing the effects of land management actions, or obtaining data from areas still supporting high densities of this species (e.g., Western Alaska).
d) Determine if an assessment of wintering ground habitats and demographics could be incorporated into ongoing research on other migrant birds in South America (e.g., Cerulean Warbler).

Issue 3: Poor understanding of linkages between breeding, staging, and wintering sites.

Conservation action: Conduct genetic and stable isotope studies to determine linkages between breeding, staging, and wintering populations to identify important areas and habitats for distinct populations of this species.

Issue 4: Poor recognition of population decline among public, academia, and conservation communities.

Conservation action: Develop and distribute information about the decline to the public, academic, and conservation communities.

Issue 5: Much coordination will be needed among states, provinces, and agencies to develop and implement strategies to reverse declines across the ranges of this species.

Conservation actions:

a) Develop numerical goals for conservation (i.e., amount of habitats for restoration) appropriately for each state and province included in the species range and implement strategies for reaching these goals for each area (Rich et al. 2004).
b) Increase the amount of land in national or provincial parks and wildlife preserves in Canada and across wintering areas in South America.
c) Encourage the adoption of broad-scale land management policies that protect important breeding habitats or enhance habitats previously degraded from harvest or other management activities.
d) Protect and enhance habitats along key migration stopover sites, particularly along the Eastern seaboard, where autumn migrants depart land to undertake a continuous transoceanic crossing to South America.

H. Plan and time frames for monitoring species and their habitats

Monitoring by NABBS, Yukon-Kuskokwim River BBS, and ALMS should be conducted annually from present for a minimum of 25 years. Studies of demography and habitat requirements should begin as soon as possible and continue for a minimum of 5 years. NABBS work is underway in Alaska through cooperative interagency efforts and a network of volunteers. At this point ALMS and studies of demography, habitat, and identification of nonbreeding areas are only partially funded. Participants should include USGS, USFWS, NPS, DOD, and BLM; State of Alaska; NGOs; private landowners; and universities.

I. Recommended time frame for reviewing species status and trends

Five-year intervals for review.

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Rusty Blackbird

A. Species description

Common name: Rusty Blackbird
Scientific name: *Euphagus carolinus*

B. Distribution and abundance

Range:

Global range comments:

Breeding range: extends from the west coast of Alaska to the east coast of Canada (Avery 1995). The northern extent is delineated by Kotzebue Sound and the Brooks Range in Alaska, Mackenzie Delta, Great Bear Lake, Great Slave Lake, and Nueltin Lake in Northwest Territories, the coast of Hudson Bay from Churchill, Manitoba to northern Quebec, and across Quebec to the coast of central Labrador. The southern edge of the breeding range extends from southern Alaska, through central Canada from the interior of British Columbia to the northern shores of Lake Superior and Lake Huron, through southeastern Ontario to Vermont, New Hampshire, and Maine. Also breeds on the upper peninsula of Michigan, in the Adirondack Mountains of New York, and in western Massachusetts.

Winter range: primarily in the eastern half of the United States from eastern Nebraska, Kansas, Oklahoma, and Texas to the Atlantic coast between southern Massachusetts and central Florida, and from southern Wisconsin and Michigan to the Gulf of Mexico (Avery 1995). Also winters very locally across the northernmost part of the United States and the southern edge of Canada from Maine to the coast of British Columbia and into Southeast Alaska. A few winter in eastern Colorado; otherwise, very rare visitor to western and southwestern United States and south Florida.

State range comments: Found throughout most of mainland Alaska south of the Brooks Range (Kessel and Gibson 1978). Fairly common spring migrant and breeder, locally common fall migrant, and very rare winter visitor in central Alaska. Fairly common to rare migrant and breeder in western and southwestern Alaska (Brann and Andres 1997). Rare spring migrant and possible breeder in the Brooks Range. Very rare to casual spring migrant and summer and fall visitor to the coasts of the Beaufort and Chukchi Seas, the Bering Sea islands, and the coast of Bristol Bay. Uncommon spring migrant and fairly common fall migrant, rare breeder, and rare winter visitor in southcoastal Alaska. Uncommon migrant and rare to uncommon local breeder (mainland), and rare winter visitor in Southeast Alaska.

Abundance: Estimates of abundance from Rich et al. (2004) and Rosenberg (2004a and 2004b) likely inaccurate but are the only available estimates of abundance available for the species.

Global abundance comments: 2,000,000 individuals (Rich et al. 2004).

State abundance comments: 570,000 individuals (Rosenberg 2004a and 2004b).

Trends:

Global trends: Population decline of 9.2% per year ($P = 0.02$, $n = 96$ routes) documented from the NABBS, 1966–2002 (Sauer et al. 2004).

State trends: Population decline of 5.8% per year ($P = 0.03$, $n = 25$ routes) documented from the NABBS, 1980–2002 (Sauer et al. 2004). The period of documented population decline is shorter in Alaska due to the lack of monitoring surveys prior to 1980.

C. Problems, issues, or concerns for species

All evidence suggests that this once abundant bird has been experiencing a chronic decline since the mid 1800s. The decline appears to be accelerating and totaled 90% by 3 independent population surveys (Greenberg and Droege 1999). Causes of the population decline currently unknown; however, on wintering grounds destruction of wooded wetlands and blackbird control programs have been suggested, while on breeding grounds acid precipitation and conversion of boreal forest wetlands have been implied (Greenberg and Droege 1999). Drying of wetlands resulting from global climate change may be a growing issue for this and other boreal wetland species in Alaska.

Increased attention needs to be given to this species now, while populations are large enough to make conservation actions effective (Greenberg and Droege 1999). Currently no research is being conducted to determine the cause of the population decline, although the decline is now well documented (Greenberg 2003). Alaska may be an important stronghold for this species and a prime area for research on breeding population since the species is still found in reasonable numbers (30% of global population, Rosenberg 2004a and 2004b) unlike other parts of its breeding range in Alberta and the Northwest Territories and (Greenberg 2003; S. Droege personal communication).

D. Location and condition of key or important habitat areas

Breeds in wet coniferous and mixed forest from the edge of tundra south to the beginning of deciduous forest and grasslands. Frequently found in fens, alder-willow thickets and bogs, muskeg, beaver ponds, tall riparian shrub, swampy shores of lakes and streams, and other forest openings, such as those created by logging, fire, windthrow, and beaver activity. Likes large numbers of conifer saplings and dense foliage 2–4 m above ground. Breeding habitats in south-southeastern part of range in Canada are being lost due to conversion to agricultural lands, logging, and oil and gas development.

During spring and fall migration will forage in stubble, pasture, plowed fields, and edges of swamps. Usually roost in wooded areas, but will occasionally roost on the ground in open fields. Wintering habitats include swamps, wet woodlands, pond edges, stream borders, cypress lagoons, marsh edges, and fields adjacent to wet areas (Avery 1995). More closely tied to wooded wetlands during the winter than any other passerine (Greenberg and Droege 1999). More then 80% of this habitat has been lost, principally to use for agriculture, since colonization of the United States. However, recent rates of conversion of wooded wetlands on wintering grounds do not explain the recent acceleration in population decline (Greenberg and Droege 1999).

In Alaska, use of habitats not well described except in east-central Alaska, where the Rusty Blackbird is found in open habitats with water where it shows a preference for areas with tall shrubs. Commonly observed perched in white spruce (36% of observation), willow (30%), 10–12% each in alder, poplar, and dead snags (Spindler and Kessel 1980). In western Alaska found in higher breeding densities along rivers of the Seward Peninsula and tributaries of the lower Yukon and Kuskokwim Rivers (Kessel 1989; Harwood 2002). Habitats in Alaska are generally largely intact and not directly disturbed by development (Greenberg 2003). In Southeast Alaska, found to co-occur with Red-winged Blackbirds in freshwater marshes and in sedges surrounding beaver ponds (Johnson 2003).

E. Concerns associated with key habitats

Breeding habitats in south-southeastern part of range in Canada are being lost due to conversion to agricultural lands, logging, and oil and gas development. Habitats in Alaska are generally largely intact and not directly disturbed by development (Greenberg 2003). However, climate change and associated degradation of permafrost and drying of ponds and lakes in Alaska could be resulting in losses of key habitats used by this species. More then 80% of forested wetlands used by this species on wintering ground have been lost, principally to agriculture, since colonization of the United States. However, more modern rates of conversion of these habitats alone do not explain the recent acceleration in population decline (Greenberg and Droege 1999).

F. Goal: Ensure Rusty Blackbird populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

<u>Objective</u>: Restore population to 1980 levels in Alaska.

Target: An average 5.8% increase in population size per year over the next 25 years.
Measure: NABBS in Alaska and its complementary program in roadless areas of the state, ALMS.

<u>**Issue 1:** Ability to maintain long-term monitoring of NABBS routes in appropriate places in the state.</u>

Conservation actions:
a) Maintain participation in the NABBS in Alaska at no less than present level. In particular, encourage running river routes annually.
b) Resume NABBS routes conducted in lower Yukon and Kuskokwim river watersheds (done 1998–2002) biennially for 25 years.

<u>**Issue 2**: Current knowledge of population trends is based solely on the roadside NABBS, which only samples a small proportion of the species breeding range in Alaska. Therefore. it may be inappropriate to extend the objective for this species to outside of the NABBS corridor without an appropriate evaluation of its status in roadless areas.</u>

Conservation actions:
a) Examine independent data on trends from migration stations and other breeding surveys to determine if declines are evident in areas away from the road system.
b) Encourage and implement full participation in ALMS, whose random

sampling of roadless areas will improve estimates of population size and percent global population in Alaska, reduce bias in trends associated with geographically limited NABBS, improve knowledge of distribution and, when combined with data from the NABBS, increase statistical power in detecting statewide trends. Surveys should be run for no less than 25 years.

Issue 3: There is a general lack of understanding of the breeding habitat requirements of this species in Alaska. Thus, it is difficult to conserve or enhance important areas to help meet the objective of restoring populations to 1980s levels.

Conservation actions:

a) Conduct field studies or analyses of existing data to determine habitats, habitat attributes, and geographic locations that support high densities of this species during breeding and migration in Alaska. Aerial surveys of breeding birds could be explored as a means for assessing habitat needs over broad geographic areas. Combine such studies with the second conservation action under Issue 4, when possible.
b) Use results from such studies to direct research to important areas and strategically protect or enhance important areas and habitats to help meet the objective of restoring populations to 1980s levels (Rosenberg 2004a and 2004b).
c) Communicate the habitat needs of this species to appropriate land managers and regulatory agencies in Alaska.

Issue 4: Current cause of population decline unknown but could be operating outside of Alaska on nonbreeding sites. However, the decline must be linked to deficits in survival, reproduction, or recruitment.

Conservation actions:

a) Raise profile of demise of species to pique interest in the research community for exploring causes of decline.
b) Conduct targeted demographic studies to identify deficits in survival, reproduction, or recruitment and whether such deficits are linked with specific habitats, habitat changes, geographic locations, or exposure to contaminants or diseases.
c) Based on research findings, develop and implement conservation strategies in appropriate areas to reverse population decline.

Global conservation and management needs:

Objective: Restore population to 1966 levels across the breeding range.

Target: Population level in 1966, which equates to an average increase of 9.9% in population size over the next 38 years.

Measure: NABBS and CBC.

<u>**Issue 1**: Cause(s) of decline is/are unknown</u>

Conservation actions:

a) Analyze data from NABBS and CBC for spatial variation in abundance and trend to identify both important areas for protection and geographic centers of decline on both breeding and wintering areas.
b) Collaborate with North American researchers and conservationists to determine causes of decline and develop and implement strategies for remediating the problem(s) once identified (Rich et al. 2004).
c) The affects of acidification of wetlands, blackbird control programs, and loss of forested wetlands on wintering areas on populations should be evaluated (Greenberg and Droege 1999; Greenberg 2003).

<u>**Issue 2**: Poor recognition of population decline among public, academic, and conservation communities.</u>

Conservation action: Develop and distribute information about the decline to the public, academic, and conservation communities.

<u>**Issue 3**: Much coordination will be needed among states, provinces, and agencies to develop and implement strategies to reverse declines across the ranges of this species.</u>

Conservation actions:

a) Develop numerical goals for conservation (i.e., amount of habitats for restoration) appropriately for each state and province included in the species range and implement strategies for reaching these goals for each area (Rich et al. 2004).
b) Increase the amount of land in national or provincial parks and preserves in Canada.
c) Encourage the adoption of broad-scale land management policies in the United States and Canada that protect important breeding and wintering habitats and enhance habitats previously degraded from land management activities.
d) Work through the joint ventures to protect and enhance wetlands used by this species.

H. Plan and time frames for monitoring species and their habitats

Monitoring by NABBS, Yukon-Kuskokwim River BBS, and ALMS should be conducted annually from present for a minimum of 25 years. Studies of demography and habitat requirements should begin as soon as possible and continue for a minimum of 5 years. NABBS work is underway in Alaska through cooperative interagency efforts and a network of volunteers. At this point the ALMS, demography, and nesting habitat studies are only partially funded; participants should include USGS, USFWS, NPS, BLM, DOD, State of Alaska, NGOs, private landowners, and universities.

I. Recommended time frame for reviewing species status and trends

Five-year intervals for review.

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Aleutian and Bering Sea Islands Endemic Landbirds

A. Species group description

All of these subspecies and species have extremely restricted ranges to a small number of islands within the Aleutian Islands, adjacent islands off the Alaska Peninsula, or Bering Sea Islands. We do not include subspecies that are widely distributed within this region such as Snow Bunting (*Plectrophenax nivalis townsendi*; Pribilof, Aleutian, and Shumagin islands) and Song Sparrow (*Melospiza melodia sanaka*; central Aleutians, Alaska Peninsula and adjacent islands) since their populations are not as threatened as the taxa included herein.

Common names/Scientific names: Systematics follow Gibson and Kessel (1997).
Rock Ptarmigan, *Lagopus mutus evermanni, L. m. townsendi, L. m. atkhensis*
Winter Wren, *Troglodytes troglodytes meligerus*, *T. t. kiskensis*, *T. t. alascensis*, *T. t. semidiensis*
Song Sparrow, *Melospiza melodia maxima*
Gray-crowned Rosy-Finch, *Leucosticte tephrocotis tumbrina*
McKay's Bunting, *Plectrophenax hyperboreus*

B. Distribution and abundance

Range: Distributions described from (Gibson and Kessel 1997, and Gibson and Byrd [in prep.]).
State range comments:
Rock Ptarmigan
Lagopus mutus evermanni: Resident to Attu Island (reintroduced to Agattu in 2003).
L. m. townsendi: Resident to Rat Islands (Kiska to Amchitka)
L. m. atkhensis: Resident to Andreanof Islands (Tanaga to Atka, possibly Amlia).
Winter Wren
Troglodytes troglodytes meligerus: Resident to Near Islands (Attu and Agattu)
T. t. kiskensis: Resident from Rat Islands (Kiska) east to islands off Alaska Peninsula (Amak and Amagat).
T. t. alascensis: Resident to Pribilof Islands
T. t. semidiensis: Resident to Semidi Islands
Song Sparrow
Melospiza melodia maxima: Resident from the Andreanof Islands to the Near Islands (Attu to Atka, possibly Amlia) in the Aleutians.
Gray-crowned Rosy Finch
Leucosticte tephrocotis tumbrina: Breeds on Pribilofs and St. Matthew and Hall Islands. Resident on the Pribilof Islands.
McKay's Bunting
Breeds principally on St. Matthew and Hall Islands, potentially on St.

Lawrence and Pribilof Islands. Winters on the mainland along the Bering Sea coast, where it is considered a rare to uncommon migrant and visitant (Kessel and Gibson 1978) principally south of Norton Sound and north of Bristol Bay, including Nunivak Island. Casual winter visitant in the Aleutian Islands (Kessel and Gibson 1978).

Abundance:

Global abundance comments: Estimates from Rich et al. (2004) are likely inaccurate but are the only current estimates for these species.

Rock Ptarmigan: 8,200,000 individuals
Winter Wren: 36,000,000 individuals
Song Sparrow: 54,000,000 individuals
Gray-crowned Rosy Finch: 200,000 individuals
McKay's Bunting: 34,000 breeding individuals (S. M. Matsuoka unpublished data from 2003 survey).

State abundance comments: Numerical estimates of population size are not available for any of the subspecies below.

Rock Ptarmigan:
Aleutian subspecies are considered uncommon or fairly common residents and breeders throughout the Aleutians with density ranging from 0.14–0.30 prs./ha; however, does not occur on all islands (Gibson and Byrd, in prep.).

Winter Wren:
Aleutian subspecies (*T. t. meligerus* and *T. t. kiskensis*) considered uncommon residents and breeders throughout the Aleutians; however density varies considerably among islands (high at Buldir and Amchitka; low at Adak and Agattu; extirpated from Amchitka, presumably from rats; Gibson and Byrd, in prep). *T. t. alascensis* considered an uncommon to rare breeder on the Pribilof Islands (D.R. Ruthrauff, USGS, personal communication). No estimates the Semidi island subspecies (*T. t. semidiensis*).

Song Sparrow:
M. m. maxima considered uncommon to common residents and breeder (Gibson and Byrd, in prep.).

Gray-crowned Rosy Finch:
Unknown but likely less than 10,000 individuals (D.R. Ruthrauff, personal communication).

McKay's Bunting:
34,000 breeding individuals (S.M. Matsuoka unpublished data).

Trends:

Global trends:

Rock Ptarmigan, Gray-crowned Rosy Finch and McKay's Bunting:
no estimates of trends available.

Winter Wren:
Abundance in North America increased from 1980 to 2003 (trend = 2.3%/year; $P < 0.01$, $n = 742$ routes; Sauer et al. 2004).

Song Sparrow:

Abundance in North America remained stable from 1980 to 2003 (Sauer et al. 2004).

State trends:

Statewide trends from NABBS that include many other subspecies estimate that both Winter Wrens (trend = –1.4%/year; $P = 0.14$, $n = 21$ routes) and Song Sparrows (trend = –1.4%/year, $P = 0.44$, $n = 31$ routes) have declined in abundance from 1980 to 2003 (Sauer et al. 2004). Statewide trends for Rock Ptarmigan, Gray-crowned Rosy Finch, and McKay's Bunting are unknown.

Introduced foxes have reduced population of Rock Ptarmigan on most of the Aleutian Islands and extirpated them from at least 6. Ptarmigan do increase in numbers following fox removal from islands; however, foxes have not been removed from all islands (Gibson and Byrd in prep). Subspecies of Winter Wrens and Song Sparrows endemic to the Aleutian Islands have been reduced in numbers from introduced foxes and rats. These subspecies have not responded dramatically to removals of foxes, presumably because of continued predation from rats (Gibson and Byrd in prep; V. Byrd, personal communication).

C. Problems, issues, or concerns for species group

These taxa have extremely small population sizes and ranges that are restricted to a small number of islands. Therefore they are particularly susceptible to extirpation from disease, disturbance, and introduced predators. Introduction of mammals, particularly rats and foxes, to islands in the region is the largest concern. On many of the Aleutian Islands, Rock Ptarmigan, Winter Wrens, and Song Sparrows have already been extirpated or reduced in numbers from such introductions (Gibson and Byrd in prep.). Unintended introductions of rats from shipping and fishing vessels are a continual high threat to populations even in areas with aggressive rat prevention programs (e.g., St. Paul Island).

D. Location and condition of key or important habitat areas

Habitats used by these subspecies are generally intact. On the Pribilof Islands, introduced reindeer are degrading habitats used by Winter Wrens and Gray-crowned Rosy Finches. Habitats used by McKay's Buntings on St. Matthew Island have also been degraded by introduced reindeer; however, these ungulates have been absent from the island since the early 1980s.

Contamination from military sites is a chronic issue throughout the Aleutian and Pribilof Islands, but its effects on populations of these birds is currently unknown. The primary factor that threatens this group of birds is introductions of mammalian predators, which have already greatly reduced and even eliminated populations from islands. The entire breeding ranges of these taxa are encompassed by the Alaska Maritime Wildlife Refuge.

Wintering and migration habitats for McKay's Buntings along coastal areas of western Alaska between Norton Sound and Bristol Bay are poorly known. Winter range for this species includes large conservation units (Yukon Delta and Togiak National Wildlife Refuges); however, many Native-owned land holdings that lie within the administrative boundaries of these areas may pose development threats such as wind energy development.

E. Concerns associated with key habitats

See Section D.

F. Goal: Ensure that Aleutian and Bering Sea endemic landbirds remain sustainable throughout their limited range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

Objective 1: On islands currently without introduced mammalian predators (i.e., foxes and rats) maintain species widely distributed across the current range and within the range of natural population cycles.

Target: Stable geographic breeding distribution and population trend. For McKay's Bunting the target population size is the 2003 estimate of 34,000 breeding individuals (S.M. Matsuoka, unpublished data).

Measure: Population trend estimated from periodic surveys.

Issue 1a: Introduction of foxes, rats, reindeer, and other introduced mammals are the primary threat for these birds.

Conservation action: Protect islands from introductions of foxes, rats, and reindeer.

Issue 1b: Standardized surveys, such as the NABBS and ALMS, currently do not sample these islands with sufficient intensity to monitor these bird taxa. Many of these islands are remote and therefore logistically challenging and expensive to sample. Introductions of foxes and rats are a continual threat. Little is known about demographics of any of these taxa.

Conservation action: Design and implement surveys to measure breeding population size or an index of abundance periodically to estimate population trends. If surveys have already been conducted in key locations, they should be evaluated to determine if they provided a sound baseline of abundance or population size. If so, such surveys should be resampled periodically and potentially expanded so as to detect a 25% decline in population size over 10 years. If species are found to decline below 20% of current population size, investigate the causes of declines and develop remedial actions for both stabilizing populations and returning them to target levels.

Issue 1c: Unlike the other avian taxa in this group, McKay's Buntings are migratory, leaving breeding islands to winter on the mainland coast of the Bering Sea in Alaska. Once outside of the islands on which they breed, they are subjected to several additional potential threats. This further complicates the conservation of this species.

Conservation actions:

a) For McKay's Buntings, identify key migration and wintering habitats and threats to populations during the nonbreeding season. In particular, assess the threat of wind turbines in coastal communities to wintering and migrating birds.
b) Conduct mark-recapture study during winter to estimate survival and recruitment. Use demographic information coupled with information from breeding studies on McKay's Buntings or similar species to develop population models to determine if deficits in adult survival, nesting success, or recruitment are most likely to cause populations to decline.

Objective 2: Increase population size on islands with introduced foxes and rats.

Target: Suspected population size prior to introduction of foxes and rats, or double current population size if such information is unavailable.

Measure: Population trend estimated from periodic surveys.

Issue 2a: Many of the islands with introduced foxes and rats are large and remote, making the removal of these exotic mammals extremely difficult and expensive.

Conservation actions:

a) Remove or reduce in number introduced rats and foxes from selected Aleutian Islands.
b) Maintain and potentially expand current program to control, eradicate, and prevent introductions of exotic mammalian predators.
c) Use results from recently initiated tests to eradicate rats from selected Aleutian Islands to develop and implement a strategy for the widespread removal of rats from the island system.
d) Measure the efficacy of exotic species management by monitoring numerical and possibly demographic responses of birds to control and eradication efforts.
e) Reintroduce Rock Ptarmigan to islands from which they have been extirpated following control or removal of foxes.

H. Plan and time frames for monitoring species and their habitats

The USFWS'Alaska Maritime National Wildlife Refuge will be a key partner in managing this group of birds, particularly through prevention, control, and eradications programs for introduced mammalian predators, many of which are ongoing. The Yukon Delta and Togiak National Wildlife Refuges and Native villages on western Alaska coast and the State of Alaska for lands on the northern Alaska Peninsula will be important partners for studying and conserving McKay's Buntings on migration and wintering grounds.

I. Recommended time frame for reviewing species status and trends

Ten years unless monitoring suggests that population have fallen below target levels.

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Smith's Longspur

A. Species description

Common name: Smith's Longspur
Scientific name: *Calcarius pictus*

B. Distribution and abundance

Range:

Global range comments:

Breeds from northern Alaska, northern Yukon Territory, and northern Mackenzie to southern Keewatin, northern Manitoba, and northern Ontario. Small disjunct population in extreme northwestern British Columbia and the uplands of southeastern-central Alaska. Breeding range incompletely known but assumed to encompass suitable habitat across the tree-line west of James Bay to Alaska. Winter distribution limited to the southern great plains from Kansas and central Iowa south to Oklahoma, central Texas, and northwestern Louisiana east to Arkansas, Mississippi, Tennessee, and Alabama. High relative numbers of wintering birds in north-central and northeastern Oklahoma (Grzybowski 1982; Dunn and Dunn 1999).

State range comments: Found in 2 areas in Alaska: Brooks Range and northern foothills and uplands of southeastern-central Alaska. In the Brooks Range they are found as far west as the Noatak headwaters (Kessel and Gibson 1978), and north to the confluence of the Colville and Kogosukruk Rivers (Johnson and Herter 1989). Considered a fairly common breeder in the eastern Brooks Range, at least as far west as Anaktuvuk Pass. Confirmed or probable breeder in the Kongakut, Sheenjek, Hulahula, Canning, Atigun, Sagavanirktok, and Ribdon river valleys. Uncommon to rare breeder west of Anaktuvuk Pass. Rare breeder or probable breeder in Wrangell Mountains, along Denali highway, Mt. Fairplay area, Tanana-Yukon highlands and White Mountains (Kessel and Gibson 1978).

Abundance:

Global abundance comments: The total population size of Smith's Longspur is unknown, but breeding densities in suitable breeding habitat suggest it does not exceed 75,000 birds (Briskie 1993). Population size likely far less than this.
State abundance comments: Unknown.

Trends:

Global trends: Unknown.
State trends: Unknown.

C. Problems, issues, or concerns for species

Small population size coupled with restricted breeding and winter distribution makes this species particularly susceptible to population decline. Smith's Longspur is not currently monitored by any of the North America's avian monitoring programs (Rich et al. 2004). This species uses grasslands during winter in a limited portion of the southern Great Plains (Dunn and Dunn 1999), where land is primarily privately owned and heavily managed through grazing, burning, and frequent use of herbicides and pesticides. Breeding range in Alaska is incompletely known. Considered one of the more poorly studied birds in North America (Ehrlich et al. 1998). Factors controlling population size are unknown, although breeding success is strongly affected by predation levels and climatic conditions (Briskie 1993).

D. Location and condition of key or important habitat areas

Isolated breeding areas largely protect this species from direct human disturbance during part of the year. In northern Alaska in the Brooks Range, prefers moist tussock meadows in wide alpine valleys, often surrounding lakes. In central Alaska prefers dry ridgetop tundra (Kessel and Gibson 1978). Elsewhere found at treeline. May be found in low areas of tundra interspersed with spruce.

During winter this species is gregarious and can be one of the most common grassland birds in north-central and northeastern Oklahoma (Grzybowski 1982; Dunn and Dunn 1999), where it specializes in using specific heavily grazed fields of short grasses, mostly silver beardgrass (Andropongon saccharoides) interspersed with three awn grass (Aristida sp., Grzybowski 1980; Dunn and Dunn 1999). Favored fields appear to have some patches of tall grasses mixed among the patches of shorter grass typically used by birds foraging on the ground (Dunn and Dunn 1999). The species is commonly found near airports, pastures, and regularly cut hayfields, sometimes near lakes, streams, or damp areas (Briskie 1993; Dunn and Dunn 1999).

E. Concerns associated with key habitats

No immediate threats to breeding habitats used in Alaska. Some concerns in Alaska include:

- Changes in the distribution and condition of favored breeding habitat, such as drying of alpine meadows and advance of treeline, resulting from climate change.
- Accumulation of persistent organic pollutants a concern across breeding range.

Threat primarily on wintering grounds, where the species is concentrated within a small portion of the southern Great Plains where favored grasslands are heavily managed for agricultural uses.

F. Goal: Ensure Smith's Longspur populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

State conservation and management needs:

Objective: Maintain species widely distributed across the current range and at a level of abundance that is ±20% of current population size in Alaska.

Target: Stable geographic breeding distribution and population trend in Alaska.

Measure: Distribution and population trend estimated from periodic surveys of breeding birds.

Issue 1: Low breeding densities, patchy distribution, and difficulty in surveying populations using existing broad-scale monitoring programs limits the ability to manage and conserve Alaska populations of this species (BPIF 1999). Monitoring surveys will likely need to be designed specifically for this species to overcome these obstacles. General lack of specific information on the breeding distribution and habitat associations in Alaska severely hampers the ability to design effective surveys for this species.

Conservation actions:

a) A high priority is to extend the systematic-random inventory of montane-nesting birds conducted in the Brooks Range (R.E. Gill, Jr., unpublished data) eastward into the Arctic National Wildlife Refuge. This would be an important inventory to enumerate population size in northern Alaska and identify important geographic locations and habitats for this species in Alaska. This survey should be completed by 2006 so as to be directly comparable to similar data already collected in the western Brooks Range (R.E. Gill, Jr., unpublished data).

b) Once these surveys are completed, conduct a thorough evaluation of the breeding distribution and habitat use of this species in Alaska based on the Brooks Range inventory, information from Kessel and Gibson (1978), and other standardized surveys conducted as part of the NABBS, Alaska Off-road Breeding Bird Survey (Handel 2000), ALMS, and other intensive inventories of birds (Swanson and Nigro 2003) within the species breeding range. Observations of Smith's Longspurs from these surveys should be examined to assess the relative importance of different geographic areas and habitats in supporting breeding population of this species, with the results used to develop objectives for conserving breeding areas for this species.

c) Develop methods for monitoring changes in population size either through intensive local studies in areas with predictable concentrations, or through extensive surveys of key habitats across representative parts of the breeding range in Alaska (i.e., eastern Brooks Range). Information on distribution and habitat use will undoubtedly help the design of such surveys. Consider resampling existing surveys (i.e., eastern Brooks Range) when appropriate.

d) Conduct demographic studies in areas with high concentrations of this species to collect baseline information on annual survival and reproductive success and identify factors affecting reproduction. Compare such information to similar data collected from breeding populations in Churchill and possibly use data from both Churchill and Alaska to model how deficits in survival, reproduction, or recruitment are likely to effect rates of population growth.

Issue 2: Potential accumulation of persistent organic pollutants a concern across breeding range.

Conservation action: Conduct assessment of exposure to persistent organic pollutants in breeding range.

Global conservation and management needs:

<u>Objective</u>: Maintain the species widely distributed across the global breeding and wintering range at population sizes within the range of natural cycles.

Target: Stable geographic breeding distribution and population trend.
Measure: Distribution and population trend estimated from periodic surveys of breeding and/or wintering birds.

<u>**Issue 1**: Current surveys of birds on wintering areas may already be monitoring population trends for this species. However, these data have not been sufficiently evaluated.</u>

Conservation actions:

a) Evaluate data from the CBC to determine if this survey is already adequate for monitoring changes in distribution and population size of Smith's Longspurs on wintering grounds. Data from this survey already go back continuously to the early 1950s, so this survey may already be tracking gross changes in population size.
b) Develop and test winter surveys for monitoring changes in population size if the CBC is proven inadequate in monitoring trends.

<u>**Issue 2**: Species has small population size and occurs both in the United States and Canada.</u>

Conservation actions:

a) Improve communication among Alaskan and Canadian biologists, conservationists, land managers, and policymakers and develop long-term plans for the conservation of this species across its limited range.
b) A priority within this should be to conduct literature reviews or studies to assess threats to birds across entire breeding and nonbreeding range. An assessment of threats on the wintering range should be undertaken first as distribution is limited to areas that are intensively managed.

<u>**Issue 3**: Species has extremely limited wintering range in the southern Great Plain centered in Oklahoma. This area is heavily managed for livestock and agriculture, with much land under private ownership.</u>

Conservation actions:

a) Increase the amount of grassland area in preserves in key wintering areas.
b) Encourage the development of land management policies and practices in wintering areas that protect and enhance habitats for Smith's Longspurs, particularly on private lands.

H. Plan and time frames for monitoring species and their habitats

Surveys in Alaska should be coordinated between key conservation units (i.e., USFWS' Arctic National Wildlife Refuge, NPS' Central and Northern Park complexes), appropriate research (i.e., USGS' Alaska Science Center) and conservation (i.e., USFWS' Migratory Bird Management) agencies.

Rangewide conservation of this species will need to be coordinated among several federal, provincial, state, and nongovernmental agencies; notably the USFWS (Regions 2, 3, 4, 6, 7), the Canadian Wildlife Service, USGS, Fish and Game (Alaska, Arkansas, Kansas, Oklahoma, Texas), and appropriate universities and nongovernmental agencies (Bird Studies Canada, Boreal Songbird Initiative, Sutton Avian Research Center). Evaluations of trend data from the CBC may include National Audubon Society and the USGS' Patuxent Wildlife Research Center among others.

I. Recommended time frame for reviewing species status and trends

Ten years unless evaluation of distribution in Alaska or estimates of population trend from the CBC or other surveys suggest populations may be in decline.

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Terrestrial Mammals – Introduction

Alaska is famous for its large mammals, such as moose and wolves, and these species have been well studied. However, the state is also home to numerous other mammals, including the tiniest species, the bats and shrews. At meetings held in April 2004, wildlife experts were asked to identify those mammal species having important conservation concerns and to recommend a selection of them to feature in the CWCS. This task was formidable due to the paucity of information for so many of Alaska's lesser-known mammal species.

Experts pointed out that, regardless of their conservation status and available funding, many of Alaska's nonmarine mammals are technically considered game species and covered in the annual Alaska Hunting Regulations booklet. These include a number of species that many, if not most, Alaskans typically do *not* consider to be game, such as shrews, mice, crows, and snowy owls. Also, Alaska's legal definition of game covers all birds, reptiles, and mammals, except those that are domesticated; thus, it appears that there are no *non*game birds, reptiles, or mammals. Animals classified as game by state regulations can be used in both game-related (e.g., hunting) and nongame-related (e.g., viewing) ways.

Ultimately, the experts focused on conservation concerns for terrestrial mammals without regard to their technical status. For example, under the state's trapping regulations, there is no bag limit for hoary marmots (*Marmota caligata*). But then consider the Montague Island marmot (*M. c. sheldoni*), which was last seen at the turn of the 20th century and was described as an endemic of Montague Island. Even though they are technically a "game" species, marmots on Montague Island are considered a species of conservation concern due to their limited range (endemism), risk of extinction (because they are a small population on an island), and lack of recent sightings (possibly extinct or cryptic).

The Montague Island marmot also provides a good example of other major issues regarding the inventory of terrestrial mammals of conservation concern in Alaska: endemism and uncertain taxonomy. Many of the state's land mammal species have been described as island endemics, which by definition are at higher risk of extinction than other species. However, the taxonomic validity of these species has not been investigated or confirmed/refuted. Until the phylogeographical history of these species or populations is understood, we cannot understand their distribution. This information, together with abundance and productivity data, is essential for comprehensively identifying species at risk.

The experts began by considering and melding 2 previously compiled lists: 1) a comprehensive list of species and subspecies of conservation concern including their known distribution and agency classification (MacDonald et al. in prep), and 2) a proposed species of concern list developed by experts for the USFWS in May 2003. This combined list (Table 4.1, below) represents species, subspecies and species groups that merit consideration of their taxonomy, distribution, abundance, productivity, and risk factors. Achieving better understanding of the status of these taxa will bring us closer to the overall goal of maintaining biodiversity among Alaska's terrestrial mammals.

Table 4.1 Land mammal taxa of conservation concern. Compiled from MacDonald et al. in prep, experts consulted by the USFWS in 2003 and expert opinion during the April 2004 CWCS meeting. (See Appendix 7 for a key to abbreviations.)

Land mammal taxa of conservation concern	Alaska distribution	Heritage Ranks SRANK	GRANK	USFWS	IUCN	CITES	COSEWIC	BC
INSECTIVORA - shrews								
Sorex alaskanus	SE	SH	G5THQ					
Sorex pribilofensis (hydrodromous)	W	S3	G3		EN			
Sorex jacksoni	W	S3	G3		EN			
Sorex monticolus alascensis	SE, SC	SNR	G5					
S. m. ellassodon	SE	SNR	GNR					
S. m. malitiosus	SE	S3Q	G5T3Q					
Sorex palustrus		SNR	G5					
CHIROPTERA – bats								
Myotis californicus caurinus	SE	S1S2	G5					Yellow
Myotis keenii	SE	S1S3	G2G3				DD	Red
Myotis volans longicrus	SE	S2?	G5					Yellow
Myotis alascensis								
CARNIVORA - carnivores								
Canis lupus ligoni	SE	S2S3Q	G4T2T3Q			A2		
Gulo gulo katschemakensis	SC	S3?	G4T3?					
Lontra canadensis mira	SE	S3S4	G5T3T4			A2		
Martes americana kenaiensis	SC							
Martes caurina caurina	SE							
Mustela erminea alascensis	SE		G5					
M. e. celenda	SE	S4?	G5T4?					
M. e. haidarum	SE?	SNA	G5T2				T	Red
M. e. initis	SE		G5T?					

Land mammal taxa of conservation concern	Alaska distribution	Heritage Ranks: SRANK	Heritage Ranks: GRANK	USFWS	IUCN	CITES	COSEWIC	BC
M. e. kadiacensis	SW	S4?	G5T4?					
M. e. salva	SE	SNR	GNR					
M. e. seclusa	SE	S2?Q	G5T2?Q					
Ursus arctos kenai	SC							
ARTIODACTYLA – even-toed ungulates								
Rangifer tarandus caribou	C, SC	SNR	G5T4	(PS:LE)			(PS)	Blue
RODENTIA - rodents								
Clethrionomys gapperi phaeus	SE							
C. g. solus	SE	S3Q	G5T3Q		DD			
C. g. stikinensis	SE	S2S3	G5T2T3					
C. g. wrangeli	SE	S2S3	G5T2T3					
Clethrionomys rutilus albiventer	W	S3	G5T3					
C. r. insularis	SC	S3	G5T3					
Dicrostonyx groenlandicus exsul	W	S4	G5T4		DD			
D. g. peninsulae	SW							
D. g. stevensoni	SW							
D. g. unalascensis	SW	S3	G5T3		DD			
Glaucomys sabrinus griseifrons	SE	S2?Q	G5T2?Q		EN			
Lemmus trimucronatus harroldi	W	S4	G5T4					
L. t. nigripes	W	S3	G5T3					
Marmota broweri	N, C, W?	S4	G4					
Marmota caligata sheldoni	SC	S2S3	G5T2T3		DD			
M. c. vigilis	SE	S3?	G5T3?		DD			

Land mammal taxa of conservation concern	Alaska distribution	Heritage Ranks SRANK	Heritage Ranks GRANK	USFWS	IUCN	CITES	COSEWIC	BC
Microtus abbreviatus abbreviatus	W	S3Q	G3QT3		DD			
M. a. fisheri	W	S3Q	G3QT3		DD			
Microtus longicaudus littoralis	SE	SNR	G5					
M. l. coronarius	SE	S3Q	G5T3Q		DD			
Microtus oeconomus amakensis	SW	S2Q	G5T2Q		DD			
M. o. elymocetes	SC	S2	G5T2		DD			
M. o. innuitus	W	S3	G5T3		DD			
M. o. popofensis	SW	S3	G5T3		DD			
M. o. punukensis	W	S1	G5T1		DD			
M. o. sitkensis	SE	S3	G5T3		DD			
M. o. unalascensis	SW	S3	G5T3					
M. o. yakutatensis	SE	S4	G5T4					
Microtus pennsylvanicus admiraltiae	SE	S3	G5T3					
Peromyscus keeni	SE	S3	G5					Yellow
P. k. algidus	SE							
P. k. hylaeus	SE							
P. k. macrorhinus	SE							
P. k. oceanicus	SE							
P. k. sitkensis	SE							
Spermophilus parryii ablusus	W, SW, SC							
S. p. kodiacensis	SW	S3	G5T3		DD			
S. p. lyratus	W	S3	G5T3		DD			
S. p. nebulicola	SW	S3	G5T3		DD			
S. p. osgoodi	C	S3?	G5T3?					
Tamiasciurus hudsonicus kenaiensis	SC							
Zapus hudsonius alascensis	SE, SC, SW, C	SNR/ SNA?	G5T4T5					Yellow

Land mammal taxa of conservation concern	Alaska distribution	Heritage Ranks SRANK	Heritage Ranks GRANK	USFWS	IUCN	CITES	COSEWIC	BC
LAGOMORPHA – pikas and hares								
Lepus othus *L. o. othus* *L. o. poadromus* *Ochotona collaris*	SW, W W SW SC, C, N?	S3S4q S5	GG34 G5					 Yellow

Ultimately, the experts identified featured mammal species or species groups by first considering rarity, followed by natural risk or stochastic factors, and then anthropogenic risk. Rare taxa included island endemic species and subspecies, disjunct populations, and/or populations believed to be in decline. Natural and stochastic risk included genetic drift, natural disasters, disease, and climate change. Anthropogenic risk included habitat modification, human encroachment, defense of life or property, and introduction of exotic species.

Experts generated conservation objectives, targets, measures, and actions for each featured mammal species or species group. The experts applied the criteria shown in Section II(C), and also selected the Chisana caribou herd and the Kenai Peninsula population of brown bears as being of concern. The experts felt that existing management plans for these populations did not adequately address the populations' long-term conservation needs.

Chisana caribou herd
The Chisana caribou herd is a small population of caribou inhabiting east-central Alaska, USA, and southwest Yukon, Canada. The herd summers almost entirely in Alaska and winters in Yukon. The herd began an abrupt decline in 1989 from about 1800 animals to an estimated 360 in 2001. While recent, more extensive surveys indicate that the population size may be higher than indicated by earlier surveys, observations of extremely low calf survival (5–10%) substantiate significant continued decline and possible extirpation.

The taxonomy of the herd is somewhat uncertain. In Canada the herd falls under the classification of woodland caribou (*Rangifer tarandus caribou*), but in Alaska all caribou populations have been classified as barren-ground caribou (*R. t. granti*). They are designated as Northern Mountain ecotype based on ecological behavior and body characteristics, as are all other woodland caribou of Yukon and northwestern British Columbia by the Committee on the Status of Endangered Wildlife in Canada.

Information on the genetic status of the herd, using microsatellite DNA (msDNA) analysis, indicates that they are a genetically distinct population exhibiting msDNA far distant from that of adjacent caribou herds in Yukon and Alaska (Zittlau et al.). This information suggests that there are 2 subspecies in Alaska, rather than one, and it ascribes special significance for this herd. These events prompted designation of the herd as a specially protected wildlife population under the Yukon Wildlife Act in 2002. This action includes a prohibition on all hunting, including subsistence harvest. All hunting of this herd is also prohibited in Alaska. A conservation plan was developed that included an ongoing effort to reduce predation on newborns through predator exclusion during periods of high vulnerability. This effort includes capturing, penning, and feeding of parturient females in Canada for 10 weeks beginning just before calving. Cows and calves are released after calves obtain sufficient size to avoid predation.

Several other small caribou herds in the state of Alaska are thought to be at historically low population sizes. For example, the Mentasta, Sunshine Mountains, Beaver

Mountains, Rainy Pass, Tonzona and Big River-Farewell herds each likely consist of only a few hundred animals. Biologists suspected that the remnants of one such herd (Kilbuck Mountains) was recently assimilated into a larger herd, or was extirpated by other factors, and in 2002 recommended that management efforts cease (ADF&G 2003). Although management plans exist for all current populations, there is insufficient information for the long-term conservation of these populations. This is because: 1) genetic, taxonomic, and population identity information is weak or nonexistent for many small herds; 2) basic population data is weak or absent; 3) the ultimate causes and magnitudes of continued population declines are unknown; and 4) the potential for caribou to naturally recolonize these areas is unknown as are the conditions and mechanisms under which such recolonization might occur. If an appropriate funding source can be identified, additional work to address these conservation concerns is recommended.

Brown bear, Kenai Peninsula population
Brown bears on the Kenai Peninsula were designated as a state species of concern in 1998. This administrative designation proactively focused attention and research efforts on an area where steady human population growth and increased human activities had potential to negatively impact the bears. A Kenai Brown Bear Conservation Strategy was created (ADF&G 2000), and great strides have been made in accomplishing some of the strategies' goals. The Kenai Brown Bear Committee has recently outlined an action plan for addressing the most critical issues affecting Kenai brown bears.

The many uncertainties regarding the health and size of the brown bear population, the influence of growing human development, the potential insular qualities of the peninsula, and an apparent increase in human-bear interactions warrant an aggressive approach toward managing for the conservation of the brown bear population on the Kenai Peninsula. Four steps are critical to improving Kenai brown bear conservation:

- First, managers must assess population size, distribution, and structure of brown bears across the peninsula so that a Population Viability Analysis can be conducted.
- Second, Kenai residents and visitors must continue to be informed about special requirements of brown bears and how to minimize human-bear conflict.
- Third, a strategic garbage-management policy must be developed on the peninsula to minimize bear-human conflicts.
- Finally, land use management strategies that consider brown bear foraging and habitat requirements and minimize potential for human-bear interactions are needed to ensure the conservation of this bear population. Agencies or organizations that could play a role in developing and implementing such strategies include the DOT&PF, Kenai Peninsula Borough planning division, and Cook Inlet Region Inc., which owns a large piece of property along the Kenai River.

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Southcoastal Alaska Bats

A. Species group description

Common name: southcoastal Alaska bats
Scientific names: little brown bat (*Myotis lucifugus*; Alaska population probably represents 2 separate species—Joseph A. Cook, pers. comm. 2004), Keen's bat (*M. keenii),* California myotis (*M. californicus),* Long-legged myotis (*M. volans), s*ilver-haired bat (*Lasionycteris noctivagans)*

B. Distribution and abundance

Range:
Global range comments: North America (Hall 1981; van Zyll de Jong and Nagorsen 1994; Nagorsen and Brigham 1993). *M. keenii* may have the most restricted range of any North American bat (van Zyll de Jong 1985).
State range comments: All are limited to Southeast Alaska, except for *M. lucifugus*, which has also been documented in Southcentral, northern Southwestern, and Central Alaska (MacDonald and Cook 1996; Parker and Cook 1996; Parker et al. 1997).

Abundance:
Global abundance comments: Keen's bat is represented in museum collections by only 59 specimens (van Zyll de Jong and Nagorsen 1994) and is Red-listed in British Columbia (precursor to listing as endangered or threatened), as SC (particularly sensitive to human activities or natural events) by COSEWIC, and as G2G3 (imperiled or rare or uncommon) by the AKNHP. All other species are ranked G5 (widespread, abundant, and secure) by AKHNP.
State abundance comments: Unknown. *M. keenii* is known only from 2 records in the Alexander Archipelago of Southeast Alaska, *M. californicus* by 5 records, *M. volans* by 5 records, and *L. noctivagans* by only 4 records. *M. lucifugus* may be relatively common in the narrow belt of temperate forest along the state's southern coasts as far west as Kodiak Island and adjacent Alaska Peninsula.

Trends:
Global trends: Unknown.
State trends: Unknown.

C. Problems, issues, or concerns for species group

- Lack of information on these species' life history, population structure, migration patterns, distribution, and habitat use
- Destruction of karst and old-growth habitat due to timber harvests
- Changes in foraging, roosting, breeding, and hibernaculum habitat associated with timber harvest
- Pesticide use

D. Location and condition of key or important habitat areas

- Karst features, such as caves, on Prince of Wales and other islands (unknown and variable conditions; substantial degradation in heavily harvested areas). Some of the caves may harbor maternity colonies
- Commuting and feeding activity is greatest in old-growth forest and riparian habitats; bat activity in clearcuts and second growth is low to very low (Parker et al. 1996)
- Decaying standing trees may provide roosting habitat (winter, summer, maternity; Fischbach et al. in prep)

E. Concerns associated with key habitats

- See Section C
- Habitat is narrowly and patchily distributed
- Timber harvest focused on rare stands of largest trees
- Salvage logging is focused on possible roost trees
- Conversion to second growth; bat use of second growth is low (Parker et al. 1996)
- Karst destruction

F. Goal: Ensure that southcoastal bat populations remain sustainable throughout their range within natural population-level variation relative to presumed historical distribution in Alaska.

G. Conservation objectives and actions

<u>Objective</u>: Maintain the current distribution, diversity, and abundance of bat species and populations in southcoastal Alaska.

Target: Fully documented occurrence, distribution, and abundance of these species.
Measures: Diversity, population trends, and distribution maps of species.

<u>**Issue 1:** Lack of information on these species' occurrence, abundance, home ranges, migration habits (e.g., whether they migrate), and destinations.</u>

Conservation actions:

a) Increase our knowledge of bat distribution and ecology in southcoastal Alaska.
b) Document distribution and occurrence in Southeast Alaska.
c) Inventory using techniques specific for bats; it is often economical to study multiple bat species at once.
d) Inventory key habitats, identify critical habitat areas.
e) Document distribution and abundance in second-growth habitat; further investigate occurrence and abundance in old-growth and second-growth habitats.
f) Provide scientific samples to natural history museums for phylogeographic and taxonomic studies.
g) Measure home range of each species.

Issue 2: Old-growth forests and karst features are presumed to be prime bat habitat.

Conservation actions:

a) Measure bat use in forest types to identify important habitats (e.g., roosting, breeding, foraging habitat).
b) Measure bat use of karst features (caves) to identify important habitats (e.g. roosting, breeding, foraging, hibernacula habitat).

Issue 3: Effects of some timber actions on habitat quality for bats are unknown.

Conservation actions:

a) Evaluate habitat quality of forest seral stages.
b) Evaluate the potential to manage for old-growth forest structure and function.

Issue 4: Effects of pesticides on bats and their prey are unknown.

Conservation action: Determine the effects of pesticides use.

H. Plan and time frames for monitoring species and their habitats

Collect all the data necessary to do a population viability study for all southcoastal Alaska bat species. Design a long-term monitoring strategy every 2 years between USFWS, USFS and ADF&G to include a trend analysis.

I. Recommended time frame for reviewing species status and trends

No specific suggestion made.

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Southeast Alaska Endemic Small Mammals

A. Species group description

Common name: Southeast Alaska endemic small mammals
Scientific names: Ermine: *Mustela erminea* complex
Marten*: Martes americana/caurina* complex
Flying squirrel*: Glaucomys sabrinus griseifrons*/*alpinus*
Southern red-backed vole: *Clethrionomys gapperi* complex
Long-tailed vole: *Microtus longicaudus/coronarius* complex
Sitka tundra vole: *M. oeconomus sitkensis*
Admiralty Island meadow vole: *M. pennsylvanicus admiraltiae*
Keen's mouse: *Peromyscus keeni* complex
Revillagigedo Island meadow jumping mouse: *Zapus hudsonius*
(Species is wide ranging, but geographically disjunct and may be genetically isolated on this island.)
Montane shrew: *Sorex monticolus* complex
Glacier Bay water shrew: *Sorex alaskanus*
Admiralty Island beaver: *Castor canadensis phaeus*
Glacier Bay marmot: *Marmota caligata vigilis*

B. Distribution and abundance

Range:
Global range comments: N/A
State range comments: Variously distributed throughout and isolated within Southeast Alaska.

Abundance:
Global abundance comments: Unknown
State abundance comments: Unknown

Trends:
Global trends: N/A
State trends: Unknown

C. Problems, issues, or concerns for species group

- Invalid taxonomies fail to adequately reflect the region's diversity; preliminary studies suggest existing taxonomic frameworks underestimate or incorrectly characterize diversity in some cases
- Incomplete distributional and status information
- Need to better evaluate assumptions of the Tongass National Forest - Forest Plan (TLMP) conservation strategy to maintain viable and well-distributed populations
- Timber harvest and road construction leading to habitat loss and fragmentation
- Increased access and potential overexploitation by trappers (marten, ermine, beaver)
- Isolated endemics of presumed small population size (higher probability of

extinction than mainland)

- Genetic swamping of island endemics by the introduction of nonnative species (e.g., *Martes americana americana* occurring on islands where the *Martes americana caurina* is endemic)
- Pesticide contamination related to forest management practices
- Introduction of potential competitors/predators (e.g., red squirrel, raccoon, brown rat)

D. Location and condition of key or important habitat areas

Marten are closely affiliated with high quality, old-growth forests (particularly the rare big-tree stands). Flying squirrels are associated with mature forests and likely limited by large trees and snags in less productive peatland mixed-conifer forest associations. Condition of these habitats in Southeast Alaska ranges from very degraded across broad areas of the archipelago that have experienced industrial timber harvest to very good or pristine in forest stands unaffected by timber harvest or community and road development.

E. Concerns associated with key habitats

- Stands of big trees are rare and disproportionately harvested over time; species associated with stands of big trees may be disproportionately impacted by past and future harvest.
- Connectivity may be disrupted by habitat fragmentation.

F. Goal: Ensure Southeast Alaska endemic small mammal populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

Objective: Maintain distribution and diversity of endemic taxa and distinct population segments.

Target: Maintenance of endemic populations in current distribution and/or restoration of populations impacted by anthropogenic causes.
Measure (1): Survey of island occurrence.
Measure (2): Determination of taxonomic status.

Issue 1: Invalid taxonomies and insufficient distribution data.

Conservation actions:
a) Conduct surveys.
b) Collect and archive samples for taxonomic and genetic analyses.
c) Support phylogeographic studies of endemic taxa.

Issue 2: Habitat loss and fragmentation.

Conservation actions:

a) Evaluate habitat relationships.
b) Evaluate dispersal (linkage and corridors).
c) Recommend management strategies (based on above information).
d) Make the southern outer islands subregion (Prince of Wales Island complex) with its elevated levels of endemism a priority area of conservation concern and action.

Issue 3: Pesticide contamination.

Conservation action: Evaluate impacts of pesticide contamination on small endemic mammal populations.

H. Plan and time frames for monitoring species and their habitats

Studies should be initiated within the next 2 years. Potential partners include ADF&G, USFS, USFWS, and universities.

I. Recommended time frame for reviewing species status and trends

Every 5–6 years.

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Southwest Alaska/Bering Sea Insular Endemic Small Mammals

A. Species group description

Common name: Southwest Alaska/Bering Sea insular endemic voles, lemmings and shrews.
Scientific names: *Sorex pribilofensis*, *S. jacksoni*, *Dicrostonyx groenlandicus stevensoni*, *D. g. unalascensis*, *D. g. exul*, *Lemmus trimucronatus harroldi*, *L. t. nigripes*, *Microtus abbreviatus abbreviatus*, *M. a. fisheri*, *Microtus oeconomus amakensis*, *M. o. innuitus*, *M. o. punukensis*, *M. o. unalascensis*, *Clethrionomys rutilus albiventer*

B. Distribution and abundance

Range:
Global range comments: Not found outside Alaska.
State range comments: Taxa restricted to islands within western Alaska and Bering Sea.

Abundance:
Global abundance comments: NA
State abundance comments: Unknown; anecdotal information suggests substantial fluctuations.

Trends:
Global trends: NA
State trends: Presumably at undisturbed levels, population levels likely cyclical and/or irruptive.

C. Problems, issues, or concerns for species group

- Species or subspecies with naturally restricted distributions and therefore small populations.
- Relictual, cold-adapted (tundra) populations that will likely be compromised by warmer climate.
- Limited data on population distinctness, habitat requirements, and population size.
- Possible threat from proposed efforts to control Norway rats with poisoned baits.
- Introduction of exotic species to islands.

D. Location and condition of key or important habitat areas

Specific islands in the Bering Sea, including the eastern Aleutian Islands and the western Gulf of Alaska. Habitat areas largely pristine but threatened by warming climate and possible human activities.

E. Concerns associated with key habitats

- Possible threat from feral or introduced predators or competitors.
- Possible habitat degradation from livestock grazing and/or other introductions on some islands.
- Warming climate may threaten habitat.

F. Goal: Ensure Southwest Alaska/Bering Sea insular endemic small mammals remain sustainable throughout their range within natural population-level variation and historical distribution in Alaska.

G. Conservation objectives and actions

Objective: Acquire a full understanding of population and/or taxonomic distinctness and habitat use to conserve these taxa.

Target: Measures of the genetic distinctness of the known taxa and screening for potentially undetected subpopulations; delineation of the habitat requirements.

Measure: Estimates of genetic divergence with small confidence intervals. Populations maintain present and historical distributions. (Absolute population size and/or density will likely be difficult to understand even with several years' data.)

Issue: Population densities are cyclical and/or irruptive, and extent of habitat use is greater at higher population densities; therefore, short-term estimations of density and extent of habitat are not predictive.

Conservation actions:

a) Collect and archive material for genetic analyses.
b) Conduct genetic and taxonomic analyses.
c) Develop fine-scale delineation of the geographic occurrence.

H. Plan and time frames for monitoring species and their habitats

An immediate intensive effort of 4 years duration to (a) acquire material for genetic analysis and (b) establish the extent of variability in population density and habitat use. USFWS is a potential partner because most species occur on the Alaska Maritime National Wildlife Refuge. Determination of extinction risk to the southernmost populations of collared lemmings is a priority, because of global climate change.

I. Recommended time frame for reviewing species status and trends

Every 5 years.

J. Bibliography

Cook, J.A. 1998a. *Dicrostonyx exsul* G.M. Allen 1919, St. Lawrence Island collared lemming and *Dicrostonyx unalascensis* Merriam 1900, Unalaska collared lemming. In: D.J. Hafner, E. Yensen, and G.L. Kirkland, Jr., editors. North American rodents: status survey and conservation action plan. IUCN/SSC Rodent Specialist Group. Gland, Switzerland and Cambridge, UK. p. 87–89.

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MacDonald, S.O. and J.A. Cook. In Prep. Catalog of the recent mammals of Alaska. 323 p.

Montague Island Marmot

A. Species description

Common name: Montague Island Marmot
Scientific name: *Marmota caligata sheldoni*

B. Distribution and abundance

Range:
Global range comments: Montague Island
State range comments: Montague Island

Abundance:
Global abundance comments: N/A
State abundance comments: Extremely rare or extinct

Trends:
Global trends: N/A
State trends: Unknown (last seen in mid 1970s)

C. Problems, issues, or concerns for species

Potential

- Extirpation or extinction
- Predation by brown bears
- Forest habitat modification
- Isolation: island endemic
- Vulnerability to population effects due to disease or other stochastic factors

D. Location and condition of key or important habitat areas

- Believed to be restricted to timberline regions of Montague Island (NatureServe 2000), Montague Island marmots also may use talus slopes at lower elevations (Holbrook 1999). However, hoary marmots on neighboring Hinchinbrook Island, Prince William Sound, are typically found on the beach during the summer months.
- Vancouver Island marmots prefer subalpine meadows but also have been found occupying steep cliffs, talus, open meadows with southern exposure, and logging-slash areas (Bryant and Janz 1996; Dearden 1986; Heard 1977).
- Condition of key or important habitat areas for this species is unknown.

E. Concerns associated with key habitats

Since the late 1980s, Vancouver Island marmot populations have undergone a documented population decline of 60–70 percent (Bryant 1998). Bryant (1996) found reduced persistence of Vancouver Island marmots occupying clearcuts, and survival rates were significantly lower in second-growth stands more than 11 years old (Bryant 1998). Moreover, the population “sink” phenomenon exhibited in clearcuts limited sources for recolonization of natural habitats. Vancouver Island marmot populations became concentrated, further reducing the probability of survival by making colonies more susceptible to predators and disease (Bryant 1998).

F. Goal: Determine if Montague Island marmot populations exist, and if so, ensure that they remain sustainable throughout their limited range within natural population variation.

G. Conservation objectives and actions

Objective: Determine if any Montague Island marmots still exist, and if so, obtain sufficient population, distribution, trend, habitat, and taxonomic information to assist in conservation of the species.

Target: Complete understanding of occurrence, distribution, population size, trends, habitat use, and taxonomy.

Measure(1): Validation of occurrence and documentation of distribution
Measure(2): Index of population size and monitoring of trends
Measure(3): Determination/delineation of habitat use
Measure(4): Validation of taxonomy.

Issue 1: The current status is unknown; Montague Island marmots are possibly extinct or extirpated.

Conservation actions:

a) Conduct helicopter surveys in spring and foot surveys in early summer to validate occurrence and document distribution.
b) Collect genetic material to validate taxonomy.

Issue 2: Habitat use by marmots is unknown. Montague Island habitat modification has been underway for some time and may continue; timber is on a rotation schedule.

Conservation action: Determine habitat associations and islandwide distribution.

Issue 3: Predation, hunting, and disease may or may not be an issue, and scale of this may be dependent on hunting regulations; inflated brown bear populations and deer introductions may cause adverse effects. Hoary marmots are managed by ADF&G as a furbearer (Alaska Board of Game 1998-99); there is no closed season or bag limit.

Conservation action: Consider regulatory actions related to hunting and trapping seasons for marmots on Montague Island.

Issue 4: Introduction of exotics (past and future) can adversely affect genetics and survival of indigenous marmots.

Conservation action: Restrict any further mammalian introductions on Montague Island until marmot issues are resolved.

Issue 5: Marmots may act as reservoirs for diseases, such as tularemia and sylvatic plague, and may harbor the tick vectors of other diseases, such as Lyme disease and babesiosis (Eadie 1954).

Conservation action: Conduct parasitology study on Montague Island marmots.

H. Plan and time frames for monitoring species and their habitats

- Helicopter survey to verify existence should be conducted as soon as possible, e.g., as early as spring of 2005.
- Population trend should be monitored annually for 10 years.
- Habitat study and taxonomic evaluation should be conducted upon verifying that these marmots still exist.
- The USFS, USFWS, University of Alaska Museum, and Chugach Alaska Corporation are possible partners.

I. Recommended time frame for reviewing species status and trends

Ten years, or at more frequent intervals in response to additional information.

J. Bibliography

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Kenai Peninsula Endemic Smaller Mammals

A. Species group description

Common names: Kenai red squirrel and Kenai marten
Scientific names: *Tamiasciurus hudsonicus kenaiensis*, *Martes americana kenaiensis*

B. Distribution and abundance

Range:
Forested habitat of Kenai Peninsula (red squirrel, marten).

Abundance:
Unknown for red squirrels; presumably abundant where they occur. Marten are considered rare west of the Kenai Mountains in Game Management Unit (GMU) 15 on the Kenai Peninsula (ADF&G 1978). In GMU 7, east of the Kenai Mountains, approximately 70 marten are harvested on an annual basis (T. McDonough, ADF&G, personal communication).

Trends:
No data for red squirrels or marten. Based on trapping data, marten populations fluctuate every 3 to 5 years (T. McDonough, ADF&G, personal communication).

C. Problems, issues, or concerns for species group

Existing
- Forest loss due to bark beetle infestation on unprecedented scale

Potential
- Replacement of standing forest with grasslands.
- Different forest management practices may have different effects on red squirrels and marten and their forage and prey species (e.g., salvage logging vs. burning).
- Declines in squirrel population could adversely affect predators (e.g., goshawk).
- Small, isolated populations of marten may be at risk from habitat loss and overtrapping.

D. Location and condition of key or important habitat areas

Spruce forests (existing and historical); habitat condition is degraded to very degraded as a result of extensive bark beetle infestation on the Kenai Peninsula.

E. Concerns associated with key habitats

See section C above.

F. Goal: Ensure Kenai Peninsula endemic small mammals remain sustainable throughout their range within natural population-level variation and limited historical distribution in Alaska.

G. Conservation objectives and actions

Objective: Acquire a full understanding of population and/or taxonomic distinctness and a delineation of habitat usage to inform management decision-making.

Target: Complete understanding of red squirrel and marten distribution and demographics on the Kenai Peninsula.

Measure(1): Index of genetic and/or taxonomic uniqueness relative to mainland populations of red squirrels and marten.

Measure(2): Determination of density of red squirrels and marten by habitat type.

Issue 1: The current distribution and abundance of red squirrels or marten on the Kenai Peninsula is unknown, particularly in relation to forest landscape change.

Conservation actions:

a) Conduct inventories for red squirrels throughout the Kenai Peninsula, saving voucher specimens for archival in an accredited natural history collection.
b) Gather harvest information on Kenai marten and obtain carcasses and tissue samples from trappers for archival at a natural history museum.
c) Conduct studies that estimate density of red squirrel and marten in various habitat types; a landscape level analysis can then be conducted to determine effects of change in forested habitats.

Issue 2: The level of genetic isolation and taxonomic distinctness are unknown for Kenai populations.

Conservation action: Conduct standard phylogeographic and/or population genetic assessment.

H. Plan and time frames for monitoring species and their habitats

Conduct inventory for red squirrels across the Kenai Peninsula. Gather harvest information on Kenai marten. Collect voucher specimens of both species to be archived (including frozen tissues), and perform phylogeographic and population genetics studies. ADF&G, USFWS, and USFS should share responsibility.

I. Recommended time frame for reviewing species status and trends

Every 5 years.

J. Bibliography

ADF&G. 1978. Alaska's wildlife and habitat. Vol. 2. Anchorage, AK. 74 p. + maps.

MacDonald, S.O. and J.A. Cook. In Prep. Catalog of the recent mammals of Alaska. 323 manuscript pages.

Alaska Marmot and Barrow Ground Squirrel

A. Species description

Common names: Alaska marmot and Barrow ground squirrel (the North Slope population of arctic ground squirrel) (Howell 1938, Dusfresne 1946)
Scientific names: *Marmota broweri* and *Spermophilus parryii kennicottii*

B. Distribution and abundance

Range:
Alaska marmot: Northern Alaska, possibly northern Yukon Territory. Known from only a dozen or so localities, including relatively recent records [University of Alaska Museum (UAM)] south of the Brooks Range in the Ray Mountains northwest of Rampart and in the Kokrines Hills on the north side of the Yukon River northeast of Ruby (MacDonald and Cook, in prep.)
Barrow ground squirrel: Northern Alaska, Yukon Territory, and northwestern Northwest Territory (MacDonald and Cook, in prep.).

Abundance:
Marmot: Patchily distributed and widely scattered as individuals or in loose colonies (Hoffman 1999).
Ground Squirrel: Uncertain.

Trends:
No data.

C. Problems, issues, or concerns for species

Existing

- Marmot: Uncertain
- Barrow ground squirrel: Uncertain

Potential

- Marmot:
  a) Low population densities
  b) Patchy distribution
  c) Skyward retreat of alpine habitat and northerly expansion of tree line
  d) Major industrial coal and hard rock mining development with the potential for habitat fragmentation
- Barrow ground squirrel**:**
  a) Taxonomy of arctic ground squirrels at intraspecific level is uncertain; North Slope population may represent cryptic endemic and/or genetically isolated lineage (Eddingsaas 2001; Eddingsaas et al., in press).

D. Location and condition of key or important habitat areas

- Boulder fields, talus slopes, rocky outcrops in alpine and subalpine tundra habitat (marmot).
- Mountains, foothills, and coastal plains of Northern Alaska (ground squirrel).
- Habitat condition overall thought to be very good to pristine except in areas of disturbance associated with major resource development.

E. Concerns associated with key habitats

See Section C above.

F. Goal: Ensure Alaska marmot and Barrow ground squirrel populations remain sustainable throughout their range within natural population-level variation and historical distribution across Alaska.

G. Conservation objectives and actions

Objective A: Conserve and maintain marmot distribution and abundance of Alaska marmot.

Target: Fully documented distribution and abundance of Alaska marmots.
Measure: Abundance and mapped distribution of Alaska marmots as determined by surveys of index areas in potential habitat.

Issue 1: Current distribution of marmots is poorly known.

Conservation actions:
a) Conduct aerial and ground surveys to identify populations throughout known and suspected range.
b) Collect voucher specimens for archival in an accredited natural history museum.

Issue 2: Effects of patchy habitat distribution on marmot population subdivision and genetic isolation are unknown.

Conservation action: Conduct phylogeographic and population genetic studies.

Issue 3: Alpine tundra habitat used by marmots may be retreating both northward and skyward as a result of global climate change.

Conservation action: Establish long-term monitoring program to identify marmot population shifts in these habitats.

Objective B: Maintain the current distribution of Barrow ground squirrels after first determining the species' taxonomic status.

Target: Fully documented distribution of Barrow ground squirrels.
Measure: Distribution of Barrow ground squirrels as determined by surveys of index areas in potential habitat.

Issue: Taxonomic status and distribution of ground squirrels occurring in northern Alaska is uncertain (e.g., may be a distinct species or genetically isolated population).

Conservation action: Conduct molecular and morphological taxonomic assessment and survey to determine their range.

H. Plan and time frames for monitoring species and their habitats

Potential partners include the mining industry, NPS, BLM, DOI - MMS and USFWS, whose holdings in northern Alaska support populations of both species, and an accredited natural history museum as a research partner and repository for archived voucher material. Complete taxonomic assessment and survey within 10 years.

I. Recommended time frame for reviewing species status and trends

No specific suggestion made.

J. Bibliography

Dufresne, F. 1946. Alaska's animals and fishes. A.S. Barnes and Co., New York. 297 p.

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Marine Mammals – Introduction

The Marine Mammal group met in late April 2004 to draft the marine mammal "templates" for the CWCS. The first task was to determine which species or species group would be included in the CWCS. The group acknowledged that although all marine mammals in the waters off Alaska fit some or many of the established criteria, they could not all be included in the first iteration of the CWCS. The group decided to include those marine mammals that have (1) very little information available on their population status and basic biology and life history and (2) been listed under the Endangered Species Act as either "Endangered" or "Threatened," or designated as "Depleted" under the Marine Mammal Protection Act. The group decided not to include Steller sea lions, northern fur seals, or the AT1 group of transient killer whales because they believed these species would be added to subsequent revisions of the CWCS, and that ongoing efforts to revise their recovery or conservation plans would focus attention on their status and promote needed conservation actions. The omission of these 3 species in the current CWCS is not intended to indicate that the actions needed to promote their conservation are in any way less important than those for species featured in the CWCS.

The group believed that attention needed to be directed to those marine mammals that are dependent on ice for a substantial portion of their annual life cycle, especially because of the impact of global climate change in the Arctic, and thus created the "ice dependent" species group that includes polar bear, walrus, bearded seal, ringed seal, ribbon seal, and spotted seal. Two other species groups were created, beaked whales and large whales, with additional templates written for each of 3 of the endangered large whales (i.e., right, bowhead, humpback). The remaining 2 templates were written for the Cook Inlet stock of beluga whales and the southwest stock of northern sea otters, both of which have experienced dramatic population declines over the last decade with no current indication of recovery.

The primary source of information on the range, abundance, and trend used in the templates were the Alaska marine mammal stock assessment reports (SARs) compiled by NOAA Fisheries and USFWS. Although this information is based on numerous scientific publications, the template bibliographies list only the SARs. The other main sources of information used in the templates were conservation and recovery plans, yet for some species (e.g., beaked whales, ice seals) very little information is available.

Cook Inlet Beluga Whale

A. Species description

Common name: Cook Inlet beluga; white whale
Scientific name: *Delphinapterus leucas*

B. Distribution and abundance

Range:
Global range comments: circumpolar for species (IUCN 1991)
State range comments: Five stocks in Alaska: Beaufort Sea, Eastern Chukchi Sea, Eastern Bering Sea, Bristol Bay, and Cook Inlet

Abundance:
Global abundance comments: 50,000 – 70,000 animals (IUCN 1991)
State abundance comments: Greater than 40,000 among 5 stocks (Angliss and Lodge 2003)
Cook Inlet abundance: 357 animals (Hobbs, et al. 2000)

Trends:
Global trends: Some populations are clearly much depleted and require adequate management for recovery. (IUCN 1991) Stock that occupies western Hudson Bay in summer is thought to be large and stable, despite a substantial harvest; the effect of hydroelectric development on the estuarine habitat of this stock is unknown; status of the southern Hudson Bay stock should be reviewed when more information on its size, relationship to other stocks, and harvest levels becomes available. The Southeast Baffin Island population is thought to be declining.
State trends: 5 stocks: Bristol Bay stable or increasing, Eastern Bering Sea trend unknown, Eastern Chukchi Sea no evidence of declines, Eastern Beaufort Sea stable or increasing, Cook Inlet Beluga declining (Angliss and Lodge 2003)
Cook Inlet trends: During 1994 – 1998 the stock declined by over 50%, and there has been no indication of a recovery since regulation of the subsistence harvest began (Angliss and Lodge 2003) in 1999.

C. Problems, issues, or concerns for species

Cook Inlet Beluga (CIB) stock (IUCN/SSC Cetacean Specialist Group 2003)

- CIB population is small and has declined by 50% over past 10 years.
- Resource prey competition with people
- Incidental mortality of belugas in fisheries (entanglement in nets, shooting)
- Potential impacts from pollution and contaminants that need monitoring:
    - Oil and gas development (high volume discharge, mud cuttings, produced water)
    - Municipal waste and bilge discharge
    - Marine oil spills

- Subsistence harvest
    - Sustainable harvest levels
    - Co-management
    - Recovery
- Vessel interactions (recreational, commercial, high speed vessels)
    - Ship strikes
    - Harassments
    - Whale watching
- Anthropogenic noise (seismic testing, vessel traffic, drilling, dredging, industrial activities like pile driving, aircraft overflights) potentially resulting in injury or harassment
- Predation by transient killer whales
- Strandings
    - Stranding response plan needs upgrading
    - Acquisition of scientific samples (genetics, contaminants, etc.)
    - Coordination with Natives; allow opportunity to harvest
    - Causation
    - Reporting or identification (need rapid response, increase reporting frequency by public)
- Potential impacts from environmental change
    - Regime shifts
    - Increase in hatchery fish production
    - Coastal development
    - Climate change
- Loss of genetic diversity
- Potential for ESA listing; changes your ability to manage, gather information, take action, etc.
    - Establish prohibited actions
    - Designate critical habitat
    - Potential impact on development
- Unknowns
    - Age-specific survival and reproduction
    - Parasites
    - Diet
    - Many other life history parameters
- Highly concentrated, clustered distribution increases vulnerability (e.g., oil spills, vessel traffic, harassment, etc.).

D. Location and condition of key or important habitat areas

- All of Cook Inlet, particularly north of the Forelands currently
- Apparent feeding concentrations at the mouths of several rivers entering the upper Inlet during the summer: Big Susitna, Little Susitna, Chickaloon, Eagle River, Upper Knik, and Turnagain Arms
- Middle portion of Cook Inlet in winter (Hanson and Hubbard 1999; Rugh et al. 2000)

E. Concerns associated with key habitats

- See Section C
- CIB habitat coincides with highest human population and most developed portion of Alaska
- Generally a high level of human activity in CIB habitats
- Coastal development, especially in the Upper Knik Arm, e.g., bridge crossing, ferry
- Impact of human development on habitat quality is poorly known
- Potential for impact from climate change

F. Goal: Maintain population within the range of OSP (optimum sustainable population) and as significant functioning elements of the marine ecosystem.

G. Conservation objectives and actions

State conservation and management needs (NOAA Fisheries, in prep):

<u>Objective</u>: Recover CIB.

Target: Reach population at Maximum Net Productivity Levels (780 animals) by 2015.

Measure: Abundance estimates based on aerial surveys, TEK.

<u>**Issue 1**: The effect of subsistence harvest on population recovery is unknown.</u>

Conservation actions:

a) Establish depletion (already accomplished).
b) Consult with Alaska Native hunting organizations on hunting locations and practices.
c) Update co-management plans; include TEK.
d) Develop regulations and monitor harvest.
e) Develop harvest models that drive the species management.
   - develop life history parameters for model
   - collect data on abundance
   - collect life history data from harvested whales
f) Provide for enforcement activity as needed.

<u>**Issue 2**: Managers need better information on habitat selection and use.</u>

Conservation actions:

a) Determine essential ecological needs of CIB.
b) Determine habitat needs and functions.
c) Identify essential seasonal habitat use of males and females of various ages (i.e. adults, juveniles, and young).
   - conduct aerial surveys, use telemetry, and collect observation data including TEK.
   - describe use of river mouths by boat, ground, and aerial methods.
   - collect data on temperature, water quality, turbidity, and other oceanographic data for high density use areas.
d) Once food habits and diet are established, determine overlap between

important CIB food resources, and commercial and subsistence fisheries.

Issue 3: Need to investigate ways to work with users of key CIB habitats to develop voluntary and legal protection measures; also assess the potential need for federal, state, and local review permits and regulations to enhance recovery efforts.

Conservation actions:

a) Work with users to minimize harassment and vessel interactions.
   - identify in-water activities with potential to disturb or harass whales
   - identify times and areas in which beluga may be especially sensitive to harassment
   - develop guidelines for water-based commercial whale-watching tours
   - consider development of approach distance regulation for belugas; currently, only guidelines exist
   - decrease speed of recreational boaters at river mouths during critical use times
   - increase awareness of local mariners and commercial boaters about areas with high CIB use
   - sign major access points to encourage voluntary reporting of illegal activity

b) Reduce underwater noises capable of disturbing belugas.

c) Provide guidelines for timing of seismic activity.
   - avoid times when belugas are present
   - limit by frequency and source levels as appropriate

d) Develop stipulations or conditions on appropriate permits to protect CIB and habitat.
   - educate users on when permits are required and subsequent enforcement
   - educate public on legal prohibitions on take
   - educate local, state, and federal officials who issue permits
   - ensure adequate regulation by agencies (issue of timeliness)

e) Develop collaborative enforcement effort for upper Cook Inlet between appropriate Native, federal, state, and local officials.
   - investigate need for funding to increase enforcement activity

f) Investigate establishment of protected water habitats.

g) Investigate establishment of marine protected areas within scope of larger regional system for protection of marine plant and animal diversity.

Issue 4: Current monitoring efforts are not comprehensive.

Conservation actions:

a) Continue annual aerial population surveys.

b) Collect data on age (size) structure of the CIB population to monitor recovery.

c) Collect water quality data in key habitats, especially areas impacted by bilge discharges, oil spills, and sewage.

d) Consistently analyze tissues from stranded or harvest animals to monitor contaminant levels.

e) Expand monitoring to include fish populations in Cook Inlet that are important beluga food resources.

f) Periodically monitor the mortality of belugas in commercial and subsistence fisheries.
g) Track occurrence, abundance, and distribution of killer whale populations in Cook Inlet.
h) Monitor annual frequency of stranding.
   - determine mortality rate associated with strandings
   - collect biological samples from stranded whales to better understand life history parameter (age, growth, reproduction, diet)
   - update the NOAA Fisheries stranding response plan, including determining cause of death and any possible measures to increase survival.
   - distribute muktaak from stranded whales to Alaska Native community

Issue 5: Additional research is needed.

Conservation actions:

a) Follow and update Cook Inlet Research Plan.
b) Determine need for research on predation, especially related to killer whales.
c) Determine need for research on important prey species.
d) Encourage the adoption of least intrusive methods for scientific research.

H. Plan and time frames for monitoring species and their habitats

NOAA Fisheries has the responsibility for management and recovery of Cook Inlet belugas. The conservation plan should be completed as soon as possible, and acquisition of sufficient funding and implementation of conservation actions should begin as soon as possible.

I. Recommended time frame for reviewing species status and trends

Five years or sooner if substantial new information becomes available or the number of whales continues to decrease.

J. Bibliography

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Ice-associated Marine Mammals

A. Species group description

Common name(s): ice-associated marine mammals: polar bear, walrus, bearded seal, ringed seal, ribbon seal, spotted seal
Scientific names: *Ursus maritimus*, *Odobenus rosmarus*, *Erignathus barbatus*, *Phoca hispida*, *Phoca fasciata*, *Phoca largha*

B. Distribution and abundance (Angliss and Lodge 2004)

Range:
Global range comments:

- Polar Bear – Circumpolar, 20 relatively distinct populations. Use ice and terrestrial habitats.
- Walrus – 2 subspecies: Pacific walrus (*O. r. divergens*), and Atlantic walrus (*O. r. rosmarus*). For Atlantic walrus, there are 4 eastern Canadian Arctic stocks, 2 Greenland stocks, and one stock in the Svalbard and Franz Josef Land archipelagos. For Pacific walrus, one stock is currently recognized, ranging throughout the continental shelf waters of the Bering and Chukchi seas, occasionally moving into the East Siberian and Beaufort seas. Use ice and terrestrial haulouts.
- Bearded seal – Circumpolar, from the Arctic Ocean (85 degrees north) south to Hokkaido (45 degrees north) in the western Pacific Ocean. Generally inhabit areas that are less than 200 m deep and seasonally ice covered. During winter they are most common in broken pack ice, yet in some areas they also inhabit shorefast ice. They do not haul out on land.
- Ringed seal – Circumpolar, from ~35 degrees north to the North Pole, occurring in all seas of the Arctic Ocean. Inhabit ice-covered waters and are well adapted to occupying shorefast and pack ice; they do not haul out on land.
- Ribbon seal – North Pacific Ocean and adjacent fringes of the Arctic Ocean. Occur primarily in open seas and on pack ice, rarely on shorefast ice. Prefer broken pack ice and do not haul out on land.

- Spotted seal – Distributed along the continental shelf of the Beaufort, Chukchi, Bering, and Okhotsk seas south to the northern Yellow Sea and western Sea of Japan. Prefer broken ice and ice edge habitats, but will haul out on land in summer.

State range comments:

- Polar bear – 2 stocks recognized: Southern Beaufort Sea stock, and Chukchi/Bering seas stock, which overlap between Point Barrow and Point Hope, centered near Point Lay.
- Pacific walrus – Bering and Chukchi seas.
- Bearded seal – Over the continental shelf of the Bering, Chukchi, and Beaufort seas
- Ringed seal – Bering, Chukchi, and Beaufort seas.
- Ribbon seal – Aleutian Islands, Bristol Bay, Bering and Chukchi seas, western Beaufort Sea.
- Spotted seal – Bering, Chukchi, and Beaufort seas.

Abundance:

Global abundance comments:

- Polar Bear – 21,500–25,000
- Walrus – unknown
- Bearded seal – unknown
- Ringed seal – unknown
- Ribbon seal – unknown
- Spotted seal – unknown

State abundance comments:

- Polar Bear – Southern Beaufort Sea stock: 2272 based on data for the 1986-1998 period; Chukchi/Bering Seas stock: unknown
- Pacific Walrus – reliable estimates not available; USFWS will conduct Bering Sea population assessment in 2006–07
- Bearded seal – unknown
- Ringed seal – unknown
- Ribbon seal – unknown
- Spotted seal – unknown

Trends:

Global trends:

- Polar bear – unknown for some populations, stable or decreasing for others
- Walrus – unknown
- Bearded seal – unknown
- Ringed seal – unknown
- Ribbon seal – unknown
- Spotted seal – unknown

State trends:

- Polar bear – Southern Beaufort Sea stock: likely stable; Chukchi/Bering Seas stock: unknown
- Pacific walrus – unknown
- Bearded seal – unknown
- Ringed seal – unknown
- Ribbon seal – unknown
- Spotted seal – unknown

C. Problems, issues, or concerns for species group (USFWS 1994a, 1994b and 1995)

- Little is known about population size and trends for most species, although more is known for the polar bear
- Global climate change will reduce sea ice extent and thickness, thus reducing available habitat
- Potential increases in shipping and fishing activities in habitats important for ice-associated species
- Coastal development, such as oil and gas exploration
- Contaminants, especially airborne contaminants transported to the Arctic
- Potential for unsustainable harvest of polar bears in Alaska

D. Location and condition of key or important habitat areas

All species associated with ice at some time of the year in the Bering, Chukchi, and Beaufort seas. Spotted seals are not associated with ice during the summer but haul out on land at specific locations along the western and northern coasts of Alaska.

E. Concerns associated with key habitats (USFWS 1994a, 1994b and 1995)

- Changes in sea ice extent/thickness related to climate change
- Coastal development
- Potential increased shipping and fishing activities

F. Goal: Maintain sustainable populations within the range of OSP and as significant functioning element of the marine ecosystem.

G. Conservation objectives and actions

State conservation and management needs:

Objective: Conserve and sustain Alaska's ice-associated marine mammals through a comprehensive program of scientific research, co-management with Alaska Native organizations, and international management and conservation efforts.

Target: Gain adequate scientific information and establish appropriate management mechanisms to predict and respond to changes in marine mammal populations resulting from ecosystem changes.

Measure: Current data on distribution, population size, and habitat use for ice associated marine mammals, continued co-management, and development of predictive mechanisms for assessing expected changes in sea ice extent and thickness.

Issue 1: Information on this species group is limited, which restricts our ability to develop a conservation strategy. Specifically, information is needed for all species on abundance, trends, and habitat requirements, and for some species, data is needed on distribution and life history. In addition, species are widely distributed, and in some cases migratory, requiring international cooperative efforts.

Conservation actions:

a) Establish (for ice seals) and expand (for walrus and polar bear) international collaborative research efforts to document habitat use/needs; abundance and distribution of all species; life history traits, including diet, fecundity, survival, etc.; disease occurrence and exposure; and contaminant levels. It is important that efforts be made to minimize the potential adverse effects of research.
b) Determine population size/trends when possible (no techniques or funds currently available for monitoring ringed, bearded seals).
c) Compare life history traits, such as age at sexual maturity, fecundity, age structure, etc., with historical data.
d) Assess abundance and distribution of prey species.

Issue 2: Impacts of climate change and effects of diminishing sea ice are unknown.

Conservation actions:

a) Develop approach for evaluating effects of climate change on important habitats for this species group.
b) Establish multidisciplinary studies to document habitat change, especially those related to sea ice.

Issue 3: Need better documentation of subsistence harvest, and refinement of management goals.

Conservation actions:

a) Document harvest levels.
b) Document TEK and incorporate with scientific studies and related management actions.
c) Support co-management organizations.
d) Investigate need for establishing international agreements for the management of ice-associated species.
e) Develop harvest management protocols, through co-management organizations, to avoid potential overharvest.

Issue 4: Need to better understand the effects of human activities, and initiate appropriate management efforts to sustain ice-associated species.

Conservation actions:

a) Identify activities with potential for adverse effects.
    - Determine effects of noise on ice-associated species.

- Assess impact of coastal development, and oil and gas activity in Beaufort and Chukchi seas.
- Determine effects of pollution, including persistent contaminants and oil spills.

b) Develop guidelines to reduce/mitigate adverse effects from human activities, including cumulative effects.
c) Implement guidelines through various avenues, such as federal, state, or local permits.
d) Identify and conserve nearshore ringed seal lairs in areas of industrial activity and development (e.g. Beaufort Sea developments) through research, regulation and education. Specifically, continue to require incidental take permits under the Marine Mammal Protection Act, follow DNR guidelines and mitigation measures, and obtain permits through NMFS.
e) Identify and conserve polar bear dens through research, regulation and education. Specifically, continue to require incidental take permits (MMPA), follow DNR guidelines and mitigation measures, and obtain permits through USFWS.
f) Determine and establish methods to monitor volume of shipping traffic and expansion of fisheries in areas used by ice-associated species. There is potential for increased shipping (related to transport, tourism, military, and research) and fishing, as sea ice extent decreases.
g) Also, monitor contaminants in tissues of subsistence harvested animals.

H. Plan and time frames for monitoring species and their habitats

NOAA Fisheries USFWS, in cooperation with Alaska Native marine mammal organizations, have the responsibility for management of this group of ice-associated marine mammals. Acquisition of sufficient funding and implementation of conservation actions should begin immediately.

I. Recommended time frame for reviewing species status and trends

Five years or sooner if significant new information is obtained.

J. Bibliography

Angliss, R.P. and K.L. Lodge. 2004. Alaska marine mammal stock assessments, 2003. NOAA Tech. Memo. NMFS-AFSC-144, 230 p.

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USFWS. 1994b. Conservation Plan for the Pacific Walrus in Alaska. Marine Mammals Management, Anchorage, AK. 79 p.

USFWS. 1995. Habitat conservation strategy for polar bears in Alaska. Marine Mammals Management, Anchorage, AK. 232 p.

Large Whale Group

A. Species group description

Common name: bowhead, fin, sperm, North Pacific right, sei, humpback, blue, and gray whales. (For additional species-specific information, see templates for bowhead, North Pacific right and humpback.)

Scientific name: *Balaena mysticetus, Balaenoptera physalus, Physeter macrocephalus, Eubalaena japonica, Megaptera novaeangliae, Balaenoptera musculus, Eschrichtius robustus*.

B. Distribution and abundance (see separate templates for bowhead, right, and humpback whales for available information on range, abundance, and trend) (Angliss and Lodge 2004; Perrin et al. 2002)

Range:

Global range comments:

- Fin whale – distributed throughout most of the world's large water masses from both polar regions to the equator; typically absent near ice limit.
- Sperm whale – distributed widely throughout the world's large water masses from both polar regions to the equator; large males observed close to the edge of the pack ice. As males grow older, they shift to higher latitudes, whereas females are typically distributed at latitudes less than 40 degrees (except 50 degrees north in the North Pacific).
- Sei whale – Distributed in all ocean basins, but typically farther from shore and not near polar regions.
- Blue whale – Distributed in all ocean basins, and Antarctic waters and north to Svalbard and Spitsbergen in the Atlantic.
- Gray whale – Distribution is much more coastal than other large whales, primarily inshore or shallow waters of the continental shelf. Eastern population ranges from ~20 degrees north in Mexico north along the coast of North America to the Chukchi and Beaufort seas, and east along the Kamchatka Peninsula. Western population may range from both the east and west side of the Kamchatka Peninsula southwest along Asia to the Gulf of Tonkin. North Atlantic population extinct by the late 17th or early 18th century.

State range comments:

- Fin whale – North Pacific Ocean and Bering Sea
- Sperm whale – North Pacific Ocean and southwest Bering Sea
- Sei whale – North Pacific Ocean
- Blue whale – Gulf of Alaska and Aleutian Islands.
- Gray whale – Southeast Alaska, Gulf of Alaska west to Unimak Pass, Bristol Bay, northern Bering Sea, Chukchi and Beaufort seas.

Abundance:

Global abundance comments:

- Fin whale – Largest concentrations in temperate and cold waters, 2 populations (sometimes recognized as subspecies *B. p. physalus B. p. quoyi*) exist within the northern and southern hemispheres. An estimated 27,700–82,000 whales are in the North Atlantic; abundance is unknown in all other areas.
- Sperm whale – unknown
- Sei whale – unknown
- Blue whale – Southern Hemisphere 400–1400 (CV = 0.4) (IWC 2004), abundance is unknown in all other areas.
- Gray whale – eastern population 26,300 (21,900–32,400); western population less than 100.

State abundance comments:

- Fin whale – Based on surveys in the central (1999) and southern (2000) eastern Bering Sea, provisional (not-corrected for whales not observed) estimates for those areas are 3368 (CV=0.29) and 683 (CV = 0.32), respectively.
- Sperm whale – unknown
- Sei whale – unknown
- Blue whale – unknown; in 2005, a single individual was reported 100 nautical miles southeast of Prince William Sound where the ocean is approximately 2 miles deep; 2 more blue whales were sighted a little farther offshore, about 150 nautical miles southeast of the Sound.
- Gray whale – some whales of the eastern population may not migrate north to Alaska, so the abundance is an unknown amount lower than the total (26,300).

Trends:

Global trends:

- Fin whale – unknown
- Sperm whale – unknown
- Sei whale – unknown
- Blue whale – unknown
- Gray whale – increasing or stable for the eastern population; western population unknown

State trends:

- Fin whale – unknown
- Sperm whale – unknown
- Sei whale – unknown
- Blue whale – unknown
- Gray whale – increasing or stable

C. Problems, issues, or concerns for species group (IUCN/SSC Cetacean Specialist Group 2003; NMFS 1998a, NMFS 1998b)

- Coastal development, including oil and gas activity, harbor development, etc.
- Global climate change (may be positive, negative, or both)
- Fisheries interactions: entanglements, competition, etc.
- Ship strikes
- Increasing ambient and peak noise levels from anthropogenic sources
- International distribution and management
- Extensive range/migration and pelagic distribution (except gray whale) complicates obtaining knowledge and implementing management actions
- Limited information on biology for some species
- Limited knowledge about prey species
- Some species are hunted for subsistence
- All but the gray whale are listed as Endangered under the ESA

D. Location and condition of key or important habitat areas

In Alaska:

- All coastal and pelagic waters of Alaska
- Humpback and gray whales use nearshore areas
- Summer feeding areas throughout Alaska are especially important to all species

Worldwide:

- Many habitats throughout the Pacific, including migration pathways along the west coast of North America, and calving/breeding locations in Mexico and Hawaii

E. Concerns associated with key habitats (IUCN/SSC Cetacean Specialist Group 2003; NMFS 1998a, NMFS 1998b)

- Increased noise, especially associated with military and geophysical activities
- Ship strikes
- Fisheries interactions, entanglement, potential competition for prey (sperm whales)
- Climate change (impacts may be positive, negative, or both)
- Extractive resource development in nearshore and offshore areas

F. Goal: Maintain populations within the ranges of OSP and as significant functioning elements of the marine ecosystem.

G. Conservation objectives and actions (IUCN/SSC Cetacean Specialist Group 2003; NMFS 1998a, NMFS 1998b)

State conservation and management needs:

<u>Objective</u>: Recover, maintain, or increase abundance of large whale populations.

Target: Maintain or increase the current population sizes, habitat quality, and range of large whale species.

Measure: Estimates of abundance, extent, and quality of habitat, and distribution of large whales in or adjacent to Alaska

Issue 1: Lack of population and habitat information for most species.

Conservation actions:

a) Determine population size and trend of all large whales in Alaska.
b) Increase knowledge of population structure of all large whales that occur in Alaska.
c) Establish international collaborative research efforts to document distribution and habitat use.
d) Increase the stranding reporting and response program for beach cast and entangled whales.
e) Maximize collection of samples from stranded large whales.
f) Determine effects from killer whale predation

Issue 2: Need better management of factors causing mortality.

Conservation actions:

a) Evaluate rangewide effects of noise, fishing, shipping, and industrial activities.
b) Minimize anthropogenic noise that affects large whales. Develop time and area restrictions on high-level noise sources in important habitat areas. High-level noise sources include seismic (from industrial and research) and military activities.
c) Manage offshore development to conserve large whales.
    - identify and measure the extent of effects from oil and gas activities
    - develop guidelines to eliminate/reduce/mitigate adverse effects
    - implement guidelines through various avenues, such as federal, state, or local permits
d) Improve knowledge of interactions with fisheries for all species.
    - determine magnitude and consequences of interactions between sperm whales and longline fisheries for sablefish in Gulf of Alaska
    - develop fishing gear (or modifications to gear) and methods that minimize impacts/interactions with large whales
    - review response protocol for entanglements in Alaska
    - ensure that all gear is retrieved
e) Develop "Notice to Mariners" or "Marine Advisories" regarding ship operations in areas used by large whales. Notices and advisories are intended to minimize ship strikes, disturbance, and harassment.
f) Evaluate climate change effects on habitats and determine if the changes are positive or negative, emphasizing multidisciplinary studies.
g) Evaluate needs and tools for addressing international distribution and management issues.

H. Plan and time frames for monitoring species and their habitats

NOAA Fisheries has the responsibility for the recovery and management of all large whale species. Recovery plans need to be updated for all species except gray whales, followed by the acquisition of sufficient funding and implementation of conservation actions.

I. Recommended time frame for reviewing species status and trends

Five years or sooner if substantial new information becomes available.

J. Bibliography

Angliss, R.P. and K.L. Lodge. 2004. Alaska marine mammal stock assessments, 2003. NOAA Tech. Memo. NMFS-AFSC-144, 230 p.

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(IWC) International Whaling Commission, whale population estimates for 1980-2000, last updated May 5, 2004: http://www.iwcoffice.org/conservation/estimate.htm

NMFS. 1998a. Recovery plan for the blue whale (*Balaenoptera musculus*). Prepared by Reeves, R.R., P.J. Clapham, R.L. Brownell, Jr., and G.K. Silber for the National Marine Fisheries Service, Silver Spring, MD. 42 p.

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Perrin, W.F., B. Würsig, and J.G.M. Thewissen. 2002. Encyclopedia of Marine Mammals. Academic Press, San Francisco, CA.

Bowhead Whale

A. Species description

Common name: bowhead whale
Scientific name: *Balaena mysticetus*

B. Distribution and abundance (Angliss and Lodge 2004)

Range:
Global range comments: Distributed in seasonally ice-covered waters of the Arctic and near-Arctic, with 5 stocks currently recognized by the International Whaling

Commission for management purposes: Okhotsk, Davis Strait, Hudson Bay, Spitsbergen, and Western Arctic.
State range comments: Western Arctic stock (also known as the Bering stock and Bering-Chukchi-Beaufort stock) is the largest population, and the only stock found in U.S. waters. The majority of the Western Arctic stock migrates annually from wintering areas in the northern Bering Sea, through the Chukchi Sea in the spring to the Beaufort Sea, where they spend much of the summer before returning again to the Bering Sea in the fall to overwinter.

Abundance:
Global abundance comments: The 4 stocks not in U.S. waters are relatively small, only consisting of 10s to 100s of whales.
State abundance comments: The 2001 abundance estimate for the Western Arctic stock abundance is 10,470 (CI: 8100–13,500).

Trends:
Global trends: Most stocks stable
State trends: Western Arctic stock is increasing about ~3.4% (CI: 1.7%–5%) annually

C. Problems, issues, or concerns for species (George et al. 2004; IUCN/SSC Cetacean Specialist Group 2003)

- Coastal development, particularly off the Beaufort Sea coast
- Nearshore/offshore oil and gas exploration in Beaufort and Chukchi seas
- Oil spills
- Potential effects of climate change
- Fisheries interactions, particularly with king crab fishery in the Bering Sea
- Potential increased shipping and fishing in Chukchi and Beaufort seas
- Increased anthropogenic noise
- International distribution
- Important for Alaska Native subsistence harvest
- Extreme longevity, relatively low fecundity
- Listed as Endangered under the ESA
- Bowheads are the longest lived mammal known to exist, and thus long-term data sets will be required

D. Location and condition of key or important habitat areas

- Bering-Chukchi-Beaufort seas
- Polynyas (Anadyr, St. Lawrence, etc.) and ice edge in Bering Sea for wintering habitat
- Leads in sea ice off western Alaska for spring migration
- Northern Chukotka coast for fall feeding/staging
- Eastern Beaufort Sea for summer feeding, Beaufort Sea for feeding during fall migration

All habitats are considered to be in very good to pristine condition.

E. Concerns associated with key habitats (George et al. 2004)

See Section C.

F. Goal: Maintain Western Arctic bowhead stock within the range of OSP and as significant functioning element of the marine ecosystem.

G. Conservation objectives and actions (George et al. 2004)

State conservation and management needs:

Objective: Maintain or increase the abundance and current distribution of the Western Arctic bowhead stock; maintain habitat quality.

Target: Level trend in annual abundance as measured over a 10-year cycle; 100% of habitat currently occupied.

Measure: Index of abundance and documentation of seasonal distribution of Western Arctic bowheads; baseline map of available habitats to compare with monitoring results.

Issue 1: Lack of research addressing current concerns.

Conservation actions:

a) Determine importance of summer vs. winter feeding areas
b) Determine specific areas of concentration (e.g., feeding and wintering)
c) Determine if all bowheads migrate from the Bering to Beaufort in summer
d) Establish international collaborative research efforts to document distribution and habitat use.
e) Evaluate climate change effects on bowhead whale habitats and determine if the changes are positive or negative through multidisciplinary studies.
f) Evaluate stock structure of Western Arctic bowheads, including adequate sample sizes (bowhead tissues) from the Bering Sea, including the Chukotka Peninsula, during summer.
g) Evaluate rangewide effects (e.g., noise, fishing, shipping, industrial activities) on population status of bowheads.
h) Develop and enhance techniques for studying bowhead whales that are not detrimental to whales or intrusive to those who harvest bowheads.

Issue 2: Maintain population monitoring programs.

Conservation actions:

a) Estimate population size of bowheads by 2011. (International Whaling Commission requires an estimate of population size every 10 years; the last estimate was from 2001.)
b) Continue collecting data on life history traits of bowheads, including a better understanding of foraging needs and aging.

Issue 3: International distribution and management.

Conservation actions:

a) Harvest is currently managed through cooperative agreement between the NMFS/NOAA and Alaska Eskimo Whaling Commission, as well as through the International Whaling Commission. Harvest co-management should continue through the most appropriate means possible.
b) Continue to manage the harvest of Western Arctic bowheads through international collaboration with the indigenous peoples and governments of Russia and Canada.

Issue 4: Potential mortality and serious injury of bowhead whales incidental to the Bering Sea crab fishery.

Conservation actions:

a) Evaluate impacts from Bering Sea crab fishery on bowheads.
b) Reduce impacts from Bering Sea crab fishery by designing gear that will least likely entangle bowheads.
c) Monitor frequency of scarring on bowheads from fishing gear through aerial surveys and examination of harvested whales.
d) Ensure that all gear is retrieved.

Issue 5: Potential impacts from oil and gas exploration and development in the Beaufort (United States and Canadian) and Chukchi seas on bowhead whale feeding, movement patterns, and migration.

Conservation actions:

a) Manage offshore explorations and development to conserve bowhead whales.
b) Further identify and measure the extent of effects from oil and gas activities that adversely effect bowheads.
c) Further develop guidelines to eliminate/reduce/mitigate adverse effects from development.
d) Continue to provide guidelines through various avenues, such as federal, state, or local permits or Conflict Avoidance Agreements.
e) In addition to current drilling restrictions during migration, consider establishing acoustic thresholds for the Beaufort Sea to reduce potential for harassment or injury to bowhead whales.
f) Identify important foraging areas for bowheads and implement measures to protect these areas from industrial activities.
g) Continue monitoring effects from existing oil and gas activities in the Beaufort Sea.

H. Plan and time frames for monitoring species and their habitats

NOAA Fisheries, in cooperation with the Alaska Eskimo Whaling Commission, the International Whaling Commission, and the North Slope Borough have the responsibility for the recovery of the western arctic bowhead whale stock. Issues important to bowhead conservation and harvest are discussed annually at International Whaling Commission meetings.

I. Recommended time frame for reviewing species status and trends

Five years or sooner if substantial new information becomes available.

J. Bibliography

Angliss, R.P. and K.L. Lodge. 2004. Alaska marine mammal stock assessments, 2003. NOAA Tech. Memo. NMFS-AFSC-144, 230 p.

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Humpback Whale

A. Species description

Common name: humpback whale
Scientific name: *Megapetera novaeanglia*

B. Distribution and abundance (Angliss and Lodge 2004)

Range:
Global range comments: circumpolar, less common in Arctic waters
State range comments: Alaska is a migratory feeding destination for 2 and possibly 3 stocks of humpback whales in the North Pacific. The western stock winters in the waters of Japan and the Philippines and is known to migrate to Alaskan waters for feeding. This stock is known historically to migrate to the western Aleutian Islands, southern Bering Sea, and possibly the southern Chukchi Sea. Current data for the western stock has shown connections to northern British Columbia, the Kodiak Archipelago and the Shumagin Islands. The central stock is known to migrate to Southeast Alaska, British Columbia, Prince William Sound, Kodiak Island and the

Shumagin Islands. Humpback whales that winter in Mexico's offshore waters (Revillagigedo Archipelago) are not yet connected to any one feeding area, but some of them have been documented in Alaskan waters.

Abundance:
Global abundance comments: Unknown
State abundance comments: North Pacific population is estimated at about 10,000 (Calambokidis et al. in prep). The portion of the population that exists in Alaskan waters is unknown but is less than 10,000 because some of the population feeds in waters off the continental U.S. and Canadian coasts.

Trends:
Global trends: Mst populations are likely recovering from commercial exploitation
State trends: Central stock increasing at 7%/year (Mobley et al. 2001), unknown trends for western stock.

C. Problems, issues, or concerns for species (IUCN/SSC Cetacean Specialist Group 2003; Mobley et al. 2001)

- **Vessel disturbance/whale watching:** Whale watching and vessel traffic have been increasing in most of the areas used by humpback whales. This has reached high levels in some feeding areas, such as Southeast Alaska. Additionally, this is an emerging industry in Canada and along the U.S. West Coast. These activities have the potential to disrupt feeding and displace mothers and calves.
- **Entanglement:** Humpback whales are subject to entanglement in fishing gear, in particular, gillnets and pot gear. The severity of the problem varies regionally, with the highest number of reported cases in Southeast Alaska. The number of entanglements is underreported for all regions, and there are indications the entanglement rate is increasing in some areas.
- **Ship strikes**: Ship strikes are a threat to large whales worldwide. As levels of commerce and tourism increase in North America, the likelihood of vessel strikes to whales also increases. A 2003 NMFS report compiled nearly 300 records of ship strikes worldwide since 1975, and humpbacks were one of the most commonly hit species. The only specific measures at present to reduce the threat of ship strikes for humpbacks are vessel restrictions in Glacier Bay National Park, Alaska. In Southeast Alaska, strikes of humpbacks by cruise ships appear to be increasing, and potential concerns for high-speed ferries that have recently begun operating need to be evaluated.
- **Noise/acoustic injury and disturbance**: Impacts from ocean noise are a serious threat to humpback whales because they produce and use low-frequency sounds, as do other whales. Noise can result in direct physiological trauma through temporary or permanent threshold shifts in hearing, or in avoidance behavior that in turn may force animals away from critical feeding, breeding, or migratory areas. Noise also may cause humpbacks to suspend important social activities, including feeding, mating, and nursing, or mask communication necessary for survival. The variety of low-frequency anthropogenic sound sources in the ocean includes Navy activities (Low-frequency Active mid-range sonar), oceanographic

experiments (like Acoustic Thermometry of Ocean Climate), vessel traffic, and seismic air-gun surveys. Oil exploration and associated seismic surveys are ongoing and proposed in Alaska. It is not clear where sound sources are concentrated; however, a substantial amount of noise exists in the North Pacific Ocean that may threaten humpback whale populations.

- **Impacts on habitat and prey:** Although changes in habitat and prey could result in substantial impacts to humpback whales, the data to fully evaluate this issue are not available. Direct competition for food resources may exist, particularly for herring, both a humpback whale prey item and a targeted commercial fishery. Little is known about krill and other forage fish in humpback feeding areas, especially Alaska. Logging near humpback whale marine habitats may affect their prey base. Climate change and regime shifts triggered by human-induced activities have the potential to impact the survival of whale populations.
- **Contaminants/pollution**: Contaminant impacts are a significant concern for many species of marine mammals that concentrate toxins in their blubber, particularly as more and more chemical compounds end up in the world's oceans. Levels of chemical compounds found in North Pacific populations of killer whales are among the highest documented in any animal worldwide. Stable contaminants, such as PCBs and pesticides, are generally far lower in baleen whales, such as humpbacks, because they feed lower on the food chain, and therefore are less of a problem.

D. Location and condition of key or important habitat areas

Nearshore coastal area is primary habitat for feeding humpback whales in Alaskan waters.

E. Identify threats or concerns associated with key habitats (IUCN/SSC Cetacean Specialist Group 2003; Mobley et al. 2001)

See Section C.

F. Goal: Maintain the population within the range of OSP and as significant functioning element of the marine ecosystem

G. Conservation objectives and actions (IUCN/SSC Cetacean Specialist Group 2003; Mobley et al. 2001)

State conservation and management needs:

<u>Objective</u>: Increase the abundance of western and central stocks of humpback whales.

Target: Increase the current level of abundance, and maintain or increase habitat quality.

Measure: Estimate of abundance and documentation of seasonal distribution.

<u>**Issue 1**: Lack of information on population status, trends, and structure.</u>

Conservation actions:

a) Initiate new efforts, as well as increase existing efforts, to gather current information on abundance, distribution, and population structure.

b) Work to reestablish U.S. funding for a program similar to the Large Whale Initiative.
c) Identify funding to complete portions of SPLASH Project (Structure of Population, Levels of Abundance and Status of Humpback Whales), which provide information on abundance and distribution.
d) Work with the governments of Canada and Mexico to identify funding for all or a portion of the costs of the sampling within their countries.

Issue 2: Develop management options for addressing impacts of human activities on mortality rates and populations.

Conservation actions:

a) Conduct additional coordinated research efforts on the impact of whale-watching vessels; collaboration among countries would be ideal. There are anecdotal reports of shifts in displacement of mothers and calves from some areas with heavy vessel activities, yet this concern needs to be documented.
b) Identify additional funding for enforcement of existing whale-watching regulations. Often, even a few enforcement actions are enough to change the behavior of vessel operators.
c) Identify the principal regions and time periods posing the greatest risk of collision between ships and humpback whales.
d) Encourage voluntary cooperation from the cruise ship and other industries operating large high-speed vessels to reduce speed in these areas during critical time periods.
e) Encourage legislation to impose these restrictions if it is not occurring voluntarily.
f) Encourage sharing of information and collaboration among countries about sources and impacts of anthropogenic sounds.
g) Encourage minimization of projects involving production of loud, low-frequency, anthropogenic sounds in areas and times of critical humpback whale use.
h) Facilitate information sharing between agencies and nations about the extent, nature, and source of entanglement events in order to better understand the problem. In addition, promote information sharing on the development and efficacy of gear modifications in order to optimize mitigation efforts.
i) Increase understanding of this issue to the Ministerial level in Mexico, where the problem has been increasing.
j) Increase the effectiveness of disentanglement efforts. Whereas training and equipment has been put into place in a number of areas in the United States and Canada, problems with reporting and implementation have prevented effective action and successful outcomes.

H. Plan and time frames for monitoring species and their habitats

NOAA Fisheries has the responsibility for management and recovery of humpback whales. Acquisition of sufficient funding and implementation of conservation actions should begin immediately.

I. Recommended time frame for reviewing species status and trends

Five years or sooner if substantially new information is obtained.

J. Bibliography

Angliss, R.P. and K.L. Lodge. 2004. Alaska marine mammal stock assessments, 2003. NOAA Tech. Memo. NMFS-AFSC-144, 230 p.

IUCN/SSC Cetacean Specialist Group. 2003. Dolphins, Whales and Porpoises: 2002–2010 Conservation Action Plan for the World's Cetaceans. Compiled by R.R. Reeves, B.D. Smith, E.A. Crespo, and G. Notarbartolo di Sciara. IUCN, Gland, Switzerland.

Mobley, Jr., J.R., S.S. Spitz, R. Grotefendt, P.H. Forestell, A.S. Frankel and G.A. Bauer. 2001. Abundance of humpback whales in Hawaiian waters: results of 1993–2000 aerial surveys. Report prepared for the Hawaiian Islands Humpback Whale National Marine Sanctuary, Nov. 26, 2001.

Beaked Whale Group

A. Species group description

Common names: beaked whales: Baird's beaked whale, Cuvier's beaked whale, and Stejneger's beaked whale
Scientific names: (*Berardius bairdii*), (*Ziphius cavirostris*), (*Mesoplodon stejnegeri*)

B. Distribution and abundance (Angliss and Lodge 2004; IUCN/SSC Cetacean Specialist Group 2003)

Range:
Global range comments: Currently 20 recognized species in 5 genera; all species are pelagic and live and feed in the open oceans. Very little is known about most species; Cuvier's is thought to perhaps be the most widely distributed beaked whale
State range comments: Baird's and Stejneger's beaked whales occur in the North Pacific Ocean and Western Bering Sea, whereas Cuvier's beaked whale occurs in the North Pacific Ocean

Abundance:
Global abundance comments: Unknown
State abundance comments: Unknown

Trends:
Global trends: Unknown
State trends: Unknown

C. Problems, issues, or concerns for species group (IUCN/SSC Cetacean Specialist Group 2003)

- Lack of information on geographic range, distribution, abundance, life history parameters, population structure and trends, foraging behavior, essential habitat needs.
- Potential impacts of climate change on prey availability, distribution, and biomass.
- Possible fishery interactions – at least 6 different commercial fisheries operate within the range of this species group, and incidental mortality has been documented outside of Alaska. Although no incidental mortality or serious injury has been reported in Alaska, observer coverage is limited, and thus some risk of interaction remains.
- Noise – including naval military operations, shipping and fishing traffic, seismic surveys, and coastal development. Mass strandings have occurred in the north Atlantic associated with naval activities, including the live stranding of 14 individual beaked whales (Cuvier's, Blanville's, and unidentified species) in the Bahamas in March 2000. Necropsies of 6 of these whales found tissue damage from acoustic or impulse injury that likely caused the whales to strand, with mortality resulting from physiologic stress associated with the physical stranding. Similar mortalities have been documented in Mexico. There are no known strandings in Alaskan waters.

D. Location and condition of key or important habitat areas

The available data do not allow assessment of current habitat needs, though beaked whales are thought to feed in deep pelagic waters for fish and squid**.**

E. Concerns associated with key habitats

Unknown.

F. Goal: Maintain beaked whale populations within the range of OSP, and as significant functioning element of the marine ecosystem.

G. Conservation objectives and actions (IUCN/SSC Cetacean Specialist Group 2003)

Objective: Maintain sustainable and well-distributed Beaked whale populations. (Reassess objective as new survey information on abundance becomes available.)

Target: Level trend in annual abundance of each sampled species as measured over a 10-year cycle.

Measure: Trend analysis based on information from baseline surveys. Species and habitat distribution maps acquired through acoustics and shipboard surveys (include genetic sampling and satellite tagging).

Issue 1: Information on this species group is severely limited and fundamentally precludes development of a conservation strategy.

Conservation actions:

a) Develop reliable population estimates, and collect data on population structure, abundance, and trends.
b) Collect data on geographic distribution and movements and life history parameters.
c) Acquire information necessary to identify and protect essential habitat.
d) Develop monitoring protocols.
e) Conduct necropsies on dead beaked whales.
f) Include opportunistic sighting efforts for beaked whales during marine research conducted by federal and state agencies whenever possible.
g) Educate mariners to report sightings and provide verifiable documentation of beaked whales across the North Pacific.
h) Coordinate research efforts internationally with Canada, Russia, and Japan.

Issue 2: The potential effects of noise on beaked whales need evaluation.

Conservation actions:

a) Coordinate management efforts with Canada, particularly with sonar and seismic activities.
b) Educate mariners to report strandings.
c) If strandings occur, monitor military and commercial operations that include sonar for potential lethal impacts on beaked whales.

H. Plan and time frames for monitoring species and their habitats

NOAA Fisheries should review beaked whale monitoring studies conducted off the western United States and Mexico and initiate similar studies in Alaska, if applicable, within 5 years.

I. Recommended time frame for reviewing species status and trends

Review when significant new data become available.

J. Bibliography

Angliss, R.P. and K.L. Lodge. 2004. Alaska marine mammal stock assessments, 2003. NOAA Tech. Memo. NMFS-AFSC-144, 230 p.

IUCN/SSC Cetacean Specialist Group. 2003. Dolphins, whales and porpoises: 2002–2010 conservation action plan for the world's cetaceans. Compiled by R.R. Reeves, B.D. Smith, E.A. Crespo, and G. Notarbartolo di Sciara. IUCN, Gland, Switzerland.

North Pacific Right Whale

A. Species description

Common name: North Pacific right whale
Scientific name: *Eubalaena japonica*

B. Distribution and abundance

Range:
Global range comments: *E. japonica* exists in the North Pacific, *E. glacialis* exists in the North Atlantic, and *E. australis* exists in the Southern Hemisphere.
State range comments: Historically, right whales were distributed throughout the western Pacific, Gulf of Alaska, and southeastern Bering Sea. Current known distribution is limited to a few animals on the Bering Sea shelf and an occasional sighting elsewhere in the North Pacific (NMFS 1991).

Abundance:
Global abundance comments: Potentially, before commercial exploitation, in excess of 11,000 whales existed historically in the North Pacific (Angliss and Lodge 2004). There are possibly 2 populations of right whales in the North Pacific; western and eastern. Survey data indicate the abundance of right whales in the western North Pacific is 900 (CI 404–2108) (NMFS 1991), and the abundance of the eastern population is very low, in the tens of animals.
State abundance comments: Until recently, the eastern North Pacific population existed in Alaska waters with abundance in the tens of animals. In September 2004, biologists following the satellite signal from a whale tagged in August, photographed 25 whales in the Bering Sea about 50 miles due north of Dutch Harbor, including 3 cows accompanied by calves. This doubled the number of the critically endangered whales known to forage near Alaska.

Trends:
Global trends: Unknown
State trends: Unknown

C. Problems, issues, or concerns for species (IUCN/SSC Cetacean Specialist Group 2003)

- Lack of information: specifically geographic range, distribution, abundance, trends, life history parameters, population structure, foraging behavior, and essential habitat needs
- Very small population size
- Climate change with potential for changes in prey availability, distribution, and biomass
- Potential vessel interactions, especially ship strikes
- Potential fishery interactions: serious injury and mortality in winter commercial crab fishery through entanglement (dependent on seasonal distribution of right whales)

- Noise-related injuries from anthropogenic sources: military operations, shipping and fishing traffic, seismic surveys, coastal development
- Effects of contaminants and pollution; i.e., non-halogenated aromatic hydrocarbons, polynuclear aromatic hydrocarbons (NMFS 1991)

D. Location and condition of key or important habitat areas

The available data do not allow assessment of current habitat needs. The only consistent sightings have been in the southeastern Bering Sea during July and August.

E. Concerns associated with key habitats (IUCN/SSC Cetacean Specialist Group 2003)

- Habitat changes associated with climate change, contaminants, or pollution.
- Future oil and gas leasing has the potential to degrade habitat in the historical range of right whales (NMFS 1991).

F. Goal: Maintain the population within the range of OSP and as significant functioning element of the marine ecosystem.

G. Conservation objectives and actions (IUCN/SSC Cetacean Specialist Group 2003)

State conservation and management needs:

<u>Objective</u>: Promote the recovery of North Pacific right whales to a population level that would prevent extinction within the next century.

Target: Allow for maximum growth of population; theoretical maximum for cetaceans is 4%/year.

Measure: Monitor changes in abundance and distribution though acoustic, aerial, and shipboard surveys (include photographic and genetic sampling and satellite tagging).

<u>**Issue 1**: Current abundance is extremely low, and near level of functional extinction.</u>

Conservation actions:

a) Acquire information necessary to identify and protect critical habitat (conduct studies in areas of historical presence).
b) Collect data on population structure, life history parameters, abundance, and trends.
c) Collect data on geographic distribution and movements.
d) Collect photographs for individual identification and frequency of entanglements and ship strikes.
e) Conduct oceanographic surveys to collect data on likely prey species and associated variability with climate change.
f) Compile information from all historical whaling records.
g) Coordinate research efforts with Canada and Russia.
h) Conduct research on feeding ecology.
i) Conduct necropsies on any dead right whale.
j) Educate mariners to report sightings and verifiable documentation of right whales across the North Pacific.

Issue 2: If population is determined to be recoverable, management efforts need to be initiated.

Conservation actions:

a) Coordinate management efforts with Canada.
b) Maintain ban on hunting and directed takes.
c) Increase awareness at federal, state and private level to secure funding for all conservation actions.
d) Consider relevant mitigation measures for noise, contaminants/pollution, and vessel and fishery interactions.
e) Educate mariners of the vulnerability of right whales to ship strikes.

H. Plan and time frames for monitoring species and their habitats

NOAA Fisheries has the responsibility for management and recovery of North Pacific right whales. Acquisition of sufficient funding and implementation of conservation actions should begin immediately. Draft recovery plan needs to be finalized as soon as possible.

I. Recommended time frame for reviewing species status and trends

Five years or sooner if substantially more whales are discovered in the North Pacific.

J. Bibliography

Angliss, R.P. and K.L. Lodge. 2004. Alaska marine mammal stock assessments, 2003. NOAA Tech. Memo. NMFS-AFSC-144, 230 p.

IUCN/SSC Cetacean Specialist Group. 2003. Dolphins, Whales and Porpoises: 2002–2010 Conservation Action Plan for the World's Cetaceans. Compiled by R.R. Reeves, B.D. Smith, E.A. Crespo, and G. Notarbartolo di Sciara. IUCN, Gland, Switzerland.

NMFS. 1991. Recovery plan for the Northern Right Whale (*Eubalaena japonica*). Prepared by the right whale recovery team for the National Marine Fisheries Service, Silver Spring, MD. 86 p.

Northern Sea Otter

A. Species description

Common name: sea otter
Scientific name: *Enhydra lutris*

B. Distribution and abundance (Angliss and Lodge 2004)

Range:
Global range comments: Distributed along Pacific Rim, including the Kamchatka Peninsula in Russia, Alaska, British Columbia, Washington, and central to southern California.
State range comments: 3 management stocks recognized: southeast Alaska, southcentral Alaska, and southwest Alaska.

Abundance:
Global abundance comments:
- Russia: ~30,000
- British Columbia: ~2000
- Washington: ~500
- California: ~2500

State abundance comments:
- Southeast Alaska stock: 12,632
- Southcentral Alaska stock: 16,552
- Southwest Alaska stock: 41,474

Trends:
Global trends:
- Russian population stable in Commander Islands and central Kuril Islands, current range expansion of Kamchatka Peninsula and north and south Kuril Islands.
- British Columbia population listed as threatened under the British Columbia Wildlife Act.
- Washington population listed as endangered by Washington Department of Fish and Wildlife.
- California population listed as threatened under ESA.

State trends:
- Southeast stock uncertain.
- Southcentral stock stable/increasing.
- Southwest stock decreasing, and listed as threatened under ESA.

C. Problems, issues, or concerns for species (USFWS 1994)

- Substantial decline of southwest stock (Burn 2005)
- Coastal development
- Nearshore oil and gas activity exploration, development, and production
- Oil and gas transport
- Fisheries interactions, including incidental mortality from entanglement, competition for prey
- Poaching (Alaska and Russia)
- Important for subsistence harvest (Alaska)
- Climate changes
- Killer whale predation (Southwest Alaska stock)
- Lack of recovery (California)

D. Location and condition of key or important habitat areas (USFWS 1994)

Habitats can be generally characterized as “good” for breeding, feeding, and wintering.

Shallow waters (depth <100 m) are an important habitat:

1. Southeast Alaska: range Cape Yakataga south to the Dixon Entrance.
2. Southcentral Alaska: Kachemak Bay, Kenai Peninsula, Prince William Sound to Cape Yakataga.
3. Southwest Alaska: Aleutian Islands, southern Bristol Bay, Alaska Peninsula, Kodiak Archipelago, Barren Islands, and lower western Cook Inlet.

E. Concerns associated with key habitats (USFWS 1994)

- Oil and gas development and transport.
- Fisheries interactions, including entanglement in gillnets and pot fisheries.
- Increased coastal development.
- Pollutants, persistent ocean contaminants, PCBs.

F. Goal: Maintain Alaska populations within the range of OSP and as significant functioning elements of the marine ecosystem.

G. Conservation objectives and actions (USFWS 1994)

<u>Objective 1</u>: Reverse the population decline of the southwest Alaska stock of sea otters.

Target: Increase the current population size to OSP, and maintain habitat quality and range of the stock.

Measure: Estimate of abundance and documentation of distribution changes of northern sea otters in southwest Alaska.

Issue 1: Cause of the decline is unknown.

Conservation actions:

a) Investigate role of following factors in decline of this population: predation, disease, starvation, contaminants, competition with commercial fisheries, entanglement in commercial fisheries, and unregulated subsistence harvest.

- determine causes of mortality
- determine habitat requirements for sea otters
- develop an understanding of effects of human/sea otter interactions and methods to alleviate resource/habitat conflicts if needed

b) Develop Statewide Stranding Network.

- use volunteers in communities around the state to report stranded sea otters and to transport them to USFWS or Alaska Sea Life Center
- collect tissues from dead animals and analyze for environmental contaminants and signs of disease

Issue 2: Lack of appropriate management and monitoring tools and efforts for conserving this stock.

Conservation actions:

a) Determine appropriate listing action.
- Form recovery team
- Develop recovery plan

b) Investigate minimum population size for population recovery.
c) Conduct surveys to monitor trends in sea otter abundance in southwest Alaska.
d) Monitor habitat status and trends.
e) Monitor indices of health and body condition.
f) Monitor incidence of disease within southwest Alaska.
g) Monitor sea otter prey populations.

Objective 2: Support the ongoing natural recolonization of sea otters in Southeast Alaska.

Target: Increase the current population size to OSP throughout historical range of the stock; maintain habitat quality.

Measure: Estimate abundance and document distribution changes of northern sea otters in Southeast Alaska.

Issue: Recolonization of sea otters in Southeast Alaska has not proceeded in accordance with earlier expectations. Population size and range expansion appear to have slowed, or even stopped. The reasons for this are unknown.

Conservation actions:

a) Investigate role of following factors in limiting recovery of this population to expected levels: predation, disease, starvation, contaminants, competition with commercial fisheries, entanglement in commercial fisheries, and unregulated subsistence harvest.
- determine habitat requirements and patterns of habitat selection for sea otters

- develop an understanding of effects of human/sea otter interactions and methods to alleviate resource/habitat conflicts if needed

b) Develop Statewide Stranding Network.
- use volunteers in communities around the state to report stranded sea otters and to transport them to USFWS or Alaska Sea Life Center
- collect tissues from dead animals and analyze for environmental contaminants and signs of disease

c) Conduct surveys to monitor trends in sea otter abundance in Southeast Alaska.
d) Monitor habitat status and trends.
e) Monitor indices of health and body condition.
f) Monitor incidence of disease within Southeast Alaska.
g) Monitor sea otter prey populations.

H. Plan and time frames for monitoring species and their habitats

USFWS has the lead responsibility for management of sea otters and is required to annually review and revise stock assessment reports as necessary. The USFWS continuously monitors subsistence harvest of sea otters through the marine mammal marking, tagging, and reporting program. In recent years, population monitoring has been a shared activity between USFWS, USGS, and the Alaska Sea Otter and Steller Sea Lion Commission, with USFWS and USGS conducting large-scale aerial surveys, and all 3 entities conducting skiff-based surveys at index sites throughout the state.

I. Recommended time frame for reviewing species status and trends

At least every 3 years with revisions as necessary.

J. Bibliography

Angliss, R.P. and K.L. Lodge. 2004. Alaska marine mammal stock assessments, 2003. NOAA Tech. Memo. NMFS-AFSC-144, 230 p.

Burn, D.M. 2005. Final rule to list the southwest Alaska Distinct Population Segment of the northern sea otter (*Enhydra lutris kenyoni*) as threatened under the ESA. Federal Register. Vol. 70 (152): 46386 – 46366.

USFWS. 1994. Conservation plan for the sea otter in Alaska. Marine Mammals Management, Anchorage, AK. 44 pp.

Appendix 5. Key Habitats of Featured Species

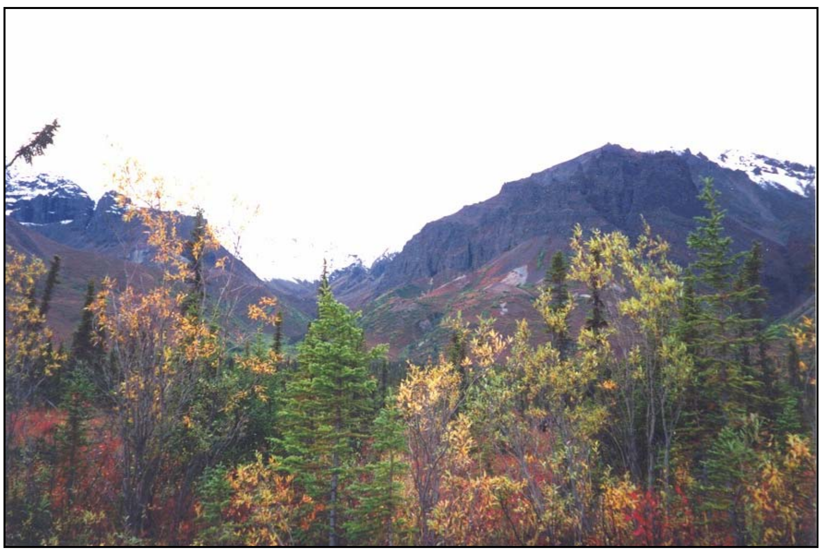
Appendix 5.1 Forest Habitats

Featured Species-Associated Forest Habitats: Boreal Forest and Coastal Temperate Forest

There are approximately 120 million acres of forestland (land with > 10% tree cover) in Alaska (Hutchison 1968). That area can be further classified depending on where it occurs in the state. The vast majority of forestland, about 107 million acres, occurs in Interior Alaska and is classified as "boreal forest." About 13 million acres of forest occurs along Alaska's southern coast, including the Kodiak Archipelago, Prince William Sound, and the islands and mainland of Southeast Alaska. This is classified as coastal temperate rain forest. The Cook Inlet region is considered to be a transition zone between the Interior boreal forest and the coastal temperate forest. For a map showing Alaska's land status and forest types, see Figure 5.1 on page 2.

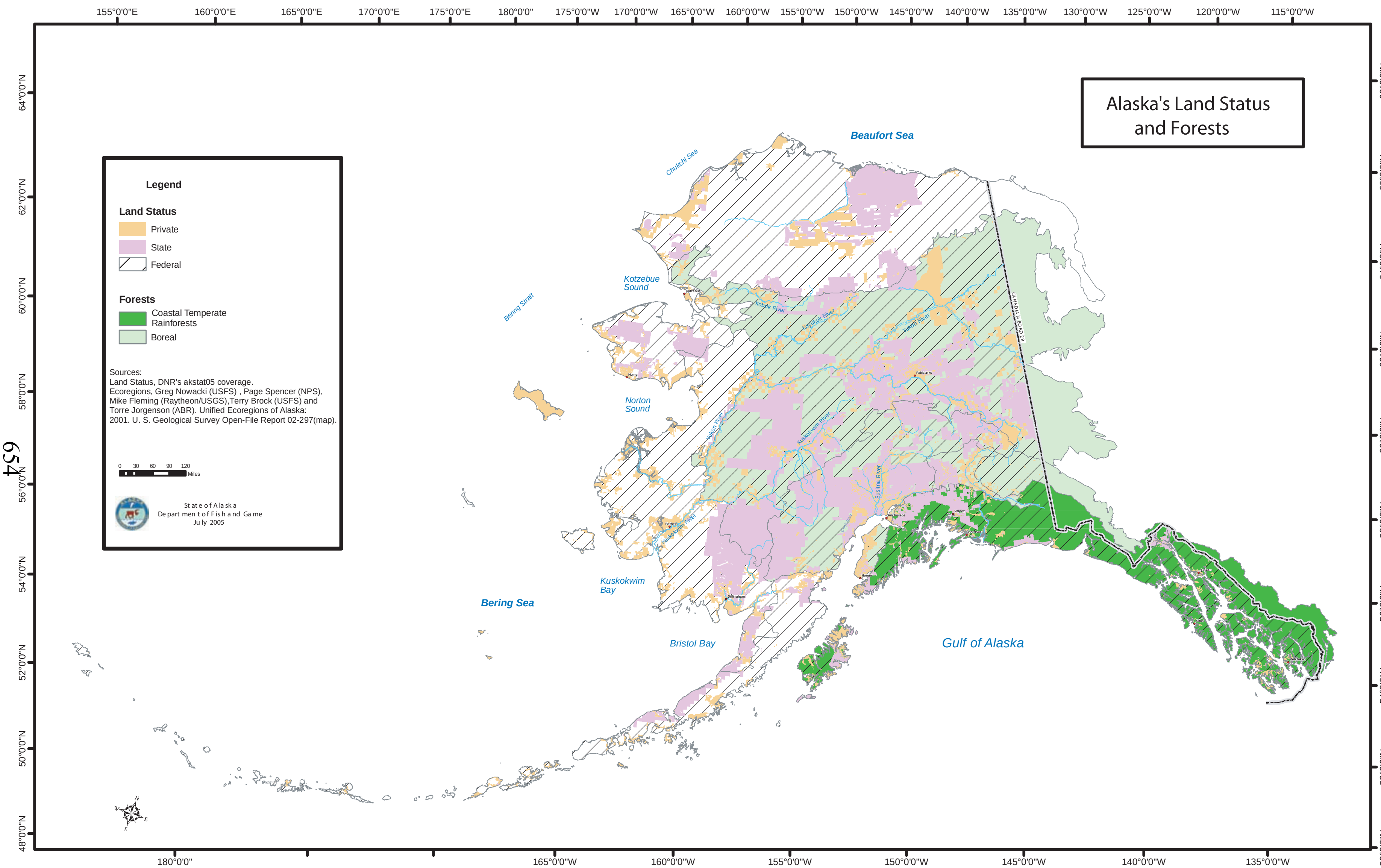
Boreal Forest

The boreal zone is a broad northern circumpolar belt that spans up to 10° of latitude in North America. The boreal forest of North America stretches from Alaska to the Rocky Mountains and eastward to the Atlantic Ocean and occupies approximately 28 % of the continental land area north of Mexico and more than 60 % of the total area of the forests of Canada and Alaska (Johnson et al. 1995). Across its range, coniferous trees make up the primary component of the boreal forest. Dominant tree species vary regionally depending on local soil conditions and variations in microclimate. Broadleaved trees, such as aspen and poplar, occur in pure stands or mixed with conifers. "Boreal forest" and "taiga" are often used interchangeably to refer to the plant communities in this region. Taiga is a Russian word originally applied to the broad ecotone between sub-Arctic forest and tundra in Eurasia. Its use has been expanded to include sub-Arctic forests in Eurasia and North America.



Boreal forest, Nabesna D. Ryland, ADF&G

In Alaska, the boreal biome stretches from the Kenai Peninsula to the south slope of the Brooks Range (Viereck and Little 1972). A transition zone exists south of the Alaska Range in the region surrounding Cook Inlet and stretching northward into the Susitna River Valley.



Appendix 5.1. Alaska's land status and forest types.

Boreal Forest-Associated Species

Varied Thrush, *Ixoreus naevius*
American Three-toed Woodpecker, *Picoides tridactylus*
Black-backed Woodpecker, *Picoides arcticus*
Northern Flicker, *Colaptes auratus*
Violet-green Swallow, *Tachycineta thalassina*
Hermit Thrush, *Catharus guttatus*
White-crowned Sparrow *Zonotrichia leucophrys*
Belted Kingfisher, *Ceryle alcyon*
Dark-eyed Junco, *Junco hyemalis*
Northern Hawk Owl, *Surnia ulula*
Boreal Owl, *Aegolius funereus*
Great Gray Owl, *Strix nebulosa*
Great Horned Owl, *Bubo virginianus*
Merlin, *Falco columbarius*
Harlan's Hawk, *B. j. harlani* or Red-tailed hawk, *Buteo jamaicensis*
Sharp-shinned Hawk, *Accipiter striatus*
Northern Goshawk, *Accipiter gentilis atricapillus*
Olive-sided Flycatcher, *Contopus cooperi*
Blackpoll Warbler, *Dendroica striata*
Rusty Blackbird, *Euphagus carolinus*
Wilson's Warbler, *Wilsonia pusilia*
Keen's mouse, *Peromyscus keeni* complex
Kenai marten, *Martes Americana kenaiensis*
Kenai red squirrel, *Tamiasciurus hudsonicus kenaiensis*
Kenai brown bear, *Ursus arctos*
Columbia spotted frog, *Rana luteiventris*

Interior Forested Lowlands and Uplands[1]

Needleleaf, broadleaf, and mixed forest communities occur across a variety of sites in the boreal zone. Communities composed of tall scrub typically exist in areas of exposed alluvial soil, such as floodplains, streambanks, and lake margins, on burned or otherwise disturbed areas, and near timberline. Low scrub communities develop in moist areas and on slopes with northern aspects. The wettest sites support a mixture of tall scrub swamps, low scrub bogs, or scrub/graminoid communities.

Coniferous forests in the boreal ecoregion are dominated by spruce and occur over a variety of site conditions. White spruce (*Picea glauca* [Moench] Voss) occurs on warm, dry, south-facing slopes on well-drained sites along rivers where permafrost is absent, and at timberline where drainage is good. Dominant understory components in white spruce stands include shrubs such as resin birch (*Betula glandulosa* Michx.), prickly rose (*Rosa acicularis* Lindl.), alder (*Alnus* spp.), willow (*Salix* spp.), buffaloberry (*Shepherdia canadensis* [L.] Nutt.), highbush cranberry (*Viburnum edule* [Michx.] Raf.), and bearberry (*Arctostaphylos* spp.). Herbs such as twinflower (*Linnaea borealis* L.); feathermosses (*e.g. Hylocomium splendens,* and *Pleurozium schreberi*), club lichens (*Cladonia* spp.), and leaf lichens (*Peltigera* spp.) are widespread throughout the boreal forest.

Black spruce (*Picea Mariana* [Mill.] B.S.P.) forests are found on floodplain terraces and flat to rolling uplands on well-drained to poorly drained soils. Tamarack (*Larix laricinia* [Du Roi] K.

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[1] Plant community descriptions primarily taken from:

Gallant, A.L., E.F. Binnian, J.M. Omernik, and M.B. Shasby. 1995. Ecoregions of Alaska. USGS Professional Paper 1567. U.S. Government Printing Office, Washington, DC. 73 p.

Viereck, L.A., C.T. Dyrness, A.R. Batten, and K.J. Wenzlick. 1992. The Alaska Vegetation Classification. USFS General Technical Report PNW-GTR-286. Portland , OR. 278 p.

Koch) may be associated with black spruce in wet bottomland areas. Low shrubs typically associated with black spruce include Labrador-tea (*Ledum* spp.), prickly rose, *Vaccinium* spp., and resin birch. The ground is usually covered with a continuous layer of mosses (*e.g. Hylocomium splendens, Pleurozium schreberi, Polytrichum* spp., and *Sphagnum* spp.) and lichens (*e.g. Peltigera* spp. and *Cladonia* spp.).

Deciduous forests of balsam poplar, quaking aspen, or a mix of the 2 develop on floodplains of meandering rivers. These forest types often follow the establishment of alder and willow thickets and may be subsequently replaced by stands of white spruce. Understory shrubs associated with broadleaf forests include alder, willow, and prickly rose. Herbaceous species typically found in the understory include horsetail (*Equisetum spp*), bluejoint grass (*Calamagrostis canadensis* [Michx.] Beauv.), and cow parsnip (*Heracleum lanatum* Michx.). Mixed forests are dominated by different combinations of spruce, birch, and aspen. Understory species include alder, bluejoint grass, bearberry, and Labrador-tea.

Interior highlands consisting of rounded low mountains primarily sustain dwarf scrub vegetation and open spruce stands, with graminoid-herbaceous communities occurring in poorly drained areas. Open coniferous forests and woodlands typically dominated by white spruce with black spruce, birch, and aspen codominants are often found above 500 m up to timberline. These forest types contain an open shrub layer consisting of resin birch, alder, willow, prickly rose, buffaloberry, and other ericaceous shrubs. Ground cover generally consists of a layer of mosses and lichen similar to those found in conjunction with black spruce.


Boreal forest, Susitna Basin D. Ryland, ADF&G

Interior bottomlands associated with the larger rivers in the Interior are typified by poorly drained, shallow soils, often over permafrost. Bottomland coniferous forests are dominated by white spruce, black spruce, or a combination of the two. Closed stands of white spruce occupy terrace locations with well-drained soils. Understory vegetation consists primarily of low and dwarf scrub such as *Vaccinium* spp. and dwarf birch often accompanied by twinflower and horsetail. A well-developed layer of feathermoss is also common. Closed stands of black spruce occur on floodplains often associated with white spruce and paper birch on well-drained sites. Understory vegetation is composed of alder, prickly rose, willow, Labrador-tea, *Vaccinium* spp., and a moss layer including *Hylocomium* spp. and *Pleurozium* spp. Colder, wetter sites are occupied by black spruce woodlands with a tall shrub understory consisting of alder, willow, and resin birch. On these sites, the tall shrub understory is a more important component of the habitat than in closed stands. Ericaceous shrubs (*e.g. Vaccinium* spp., *Ledum* spp., and *Empetrum nigrum*) commonly occur with sedges (*Carex* spp.), bluejoint grass, mosses, and lichen.

Bottomland deciduous forests consist primarily of closed stands dominated by balsam poplar (*Populus balsamifera* L.) or quaking aspen with an understory of alder, willow, prickly rose, highbush cranberry, buffaloberry, and red-osier dogwood (*Cornus stolonifera* Michx.). An herbaceous layer consisting of northern bedstraw (*Galium boreale* L.), dwarf dogwood (*Cornus canadensis* L.), horsetail, and bluebell (*Mertensia paniculata* [Ait.] G. Don) is typical. Mixed forests are predominantly made up of paper birch with spruce cohorts or white spruce with balsam poplar. Understory species are generally the same as those found with broadleaf or white spruce-dominated stands.

Cook Inlet: A Transition Zone

The area around Cook Inlet is a transition zone between the coastal rain forest and the Interior boreal region. This ecoregion has the mildest climate in the boreal region of Alaska and is generally free from permafrost. Tall scrub communities dominated by alder and willow, either alone or in combination, form thickets on streambanks, floodplains, and drainage ways. Mesic graminoid herbaceous and low scrub graminoid communities occur across a range of moist to dry sites. Dry to mesic sites may be dominated by a combination of grasses (*Festuca* spp., *Deschampsia beringensis*, *Poa eminens*), forbs such as monkshood (*Acontium delphinifolium* DC.) and bluebell, and ericaceous shrubs. Coniferous, deciduous, and mixed forest stands are common. Needleleaf forests include white, black, and Sitka spruce depending on soil conditions and microclimate. Deciduous forests are dominated by quaking aspen, paper birch, balsam poplar, and black cottonwood. Mixed forest types may contain codominant cohorts that include spruce in combination with any of these broadleaf species.

White spruce forests are typically found on well-drained sites. Black spruce, paper birch, balsam poplar, and aspen are common codominant components with white spruce. Low shrubs associated with white spruce stands include dwarf birch (*Betula nana* L.), *Vaccinium* spp., Labrador-tea, crowberry (*Empetrum nigrum* L.), buffaloberry, and prickly rose. Herbaceous cover varies depending on canopy density and local moisture regime. Horsetail, twinflower, and bluejoint grass are all commonly found in conjunction with white spruce. Mosses, such as *Hylocomium* spp. and *Pleurozium* spp., often form a continuous layer under dense canopies.

Quaking aspen can form almost pure stands on relatively warm, well-drained, upland soils. Stands often contain balsam poplar, spruce, and paper birch cohorts. Associated shrubs include alder, willow, prickly rose, buffaloberry, and highbush cranberry. Herbaceous cover is generally sparse under closed stands but may include scattered bluejoint grass, fireweed (*Epilobium angustifolium* L.), horsetail, northern commandra (*Geocaulon lividum* [Richards.] Fern.), and northern bedstraw. Lichens and mosses are scarce. Open stands of quaking aspen tend to have a denser herbaceous understory.

Paper birch generally occupy dry to moist sites in the Cook Inlet region. Open stands of paper birch on drier, warmer sites may include white spruce, while wetter sites may include a black spruce component; however, spruce are not usually abundant in closed paper birch stands. Understory components include alder, prickly rose, and highbush cranberry. Stands that are more open may include resin birch. The herb layer is usually dominated by bluejoint grass; however, horsetail and bluebell are common understory components.

Black spruce tends to be dominant on poorly drained sites and may include a paper birch cohort. Alder is the most common tall shrub associated with black spruce. Low shrubs include prickly rose, willow, Labrador-tea, twinflower, and *Vaccinium* spp. Feathermosses are common, along with *Sphagnum* spp., on wetter sites. Open black spruce forests or stands may include bush cinquefoil (*Potentilla fruticosa* L.), crowberry, and resin birch along with willow, alder, and herbs, such as horsetail and bluejoint grass.

Ecological Role of Boreal Forest Habitats

Forest ecosystems support relatively high levels of biodiversity because they have many vertically differentiated niches, and because they have large accumulations of biomass that can support a diverse food web. Forests with high structural and/or vegetative diversity will also include horizontally differentiated niches, such as edges between forest communities and meadows, or where different vegetative conditions meet within a plant community. The boreal forest region is a large and diverse patchwork of distinctive ecosystems and flora in which complex interrelationships between climate, solar radiation, surface water, slope, aspect, soil characteristics, permafrost, and disturbance regimes create patterns of vegetation across the landscape. As a result, the boreal forest includes a range of habitat types that vary from closed forest to open shrub and herbaceous communities that inhabit both uplands and wetlands.

Birds represent the largest class of vertebrates in the boreal forest. Over 80 % of all terrestrial vertebrates associated with the western boreal region of Canada are birds (Niemi et al. 1998). Of the various species that rely on the boreal forest, approximately 20 % are permanent residents; the remainder are migrants that spend the summer breeding season in the boreal forest (Smith 1993. Birds play a fundamental ecological role in the forest, and data supporting the importance of birds in maintaining healthy forested ecosystems is increasing. During summer, most forest birds eat insects, particularly moth larvae. Research indicates that birds can reduce insect densities (Holmes et al. 1979; Atlegrim 1989), especially when the insect populations are at either low or endemic levels (Crawford and Jennings 1989; Holmes 1990; Torgerson et al. 1990).

For birds in the boreal region, there appears to be a close relationship between habitat diversity and species diversity (Kessel 1998). Some deciduous forest types in the boreal region have a great potential for providing multiple habitat niches. Cottonwood forests in the upper Susitna River basin were found to support high numbers of breeding species of boreal forest birds and the greatest density of breeding territories compared to other boreal forest types in the area. Kessel (1998) hypothesized the high occupancy and species richness found in the cottonwood forests was due to the high productivity of the floodplain ecosystems where these forests were found and the structural diversity within the forest that created many vertical habitat niches. While boreal spruce forests tend to have lower bird densities and species richness than deciduous forests, they provide more stable habitat for resident species, such as Boreal Chickadees, White-winged Crossbills, and Great Horned Owls. The greatest densities of permanent residents occur in forests dominated by white spruce (Kessel 1998).

In the boreal forest, harvest of floodplain white spruce has the potential to reduce age-class diversity at the landscape level. Forest on floodplains and islands have a lower probability of experiencing stand-replacement fire, and therefore, grow considerably older and more complex than forest stands that experience frequent fires. These stands support a large proportion of the boreal forest’s species diversity, particularly invertebrates and nonvascular plants.

Kessel (1998) concluded that most bird species are relatively specific with regard to aspects of their structural habitat requirements across their geographic ranges and that much of the habitat variation previously reported in North America is the result of considering only macrohabitats or measuring factors only indirectly related to a species’ ecology. Many boreal forest birds use macrohabitat across forest types while occupying specific habitat niches. For example, across most of Alaska, Gray-Cheeked Thrush, Fox Sparrow, and White-Crowned Sparrow occupy shrub habitats. However, where specific shrub habitat features occur within a forest, these species will nest under the canopy and superficially appear to be birds of forest habitat (Kessel 1998). Even small patches of different habitat within uniform stands can be enough to account for the occurrence of a particular species. For example, in their analysis of habitat associations of breeding birds of boreal forest in Alaska, Willson and Comet (1996) noted that 1–2 spruce trees in a deciduous stand was enough for Ruby-Crowned Kinglet or Hermit Thrush to hold a territory, and that these species would forage in the surrounding deciduous vegetation.

Many forest bird species, such as flycatchers, thrushes, and wood warblers, use boreal forests for breeding and rearing young, but winter as far away as Central or South America. Such birds require boreal forest habitats for survival. Many of the long-distance migrants are particularly sensitive to fragmentation of breeding habitat (Smith 1993), and Alaska's boreal forest is an important part of the breeding range of several species of boreal forest landbirds known to be declining in other portions of their North American range.

Boreal Forest Conservation Status

Overall, Alaska’s forest habitats are generally healthy. However, localized development will likely continue to result in substantial habitat alteration. Opportunities should be sought that alleviate negative impacts, and maintain connectivity and suitable areas of quality habitat important to the sustainability of species.

Approximately 37% of the total area in Alaska's boreal forest region lies within state or federal conservation units, including federal and state wildlife refuges, parks, national monuments, and other designations. These areas were designated by the state and federal governments to preserve unique or fragile ecosystems and historic sites and to protect essential fish and wildlife habitat. The remaining lands consist of other state lands, municipal or borough lands, Native allotment and corporation lands, and other private holdings.

Management goals and objectives for the conservation units reflect the importance of each area with regard to conserving essential fish and wildlife habitats, and as such, there are usually some restrictions on development within these areas. Generally, the laws and regulations, management plans, goals, and objectives written to guide the management of these areas recognize their importance as essential fish and wildlife habitat, along with the protection of important cultural and historic sites. As a result, development activities on some lands are often restricted or closely controlled to prevent changing the natural character of the lands and waters.

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Coastal Temperate Rain Forest

Coastal temperate rain forests are rare globally, occurring in only 6 or 7 places in the world, where mountains abut the ocean at higher latitudes. These areas experience a maritime climate, with cool summers, warm winters, and abundant precipitation distributed throughout the year.

As trees in this forest age and become decadent, they either die in place or are toppled by wind, creating a small gap in the overhead canopy. This break in the canopy allows light to reach the forest floor, promoting the growth of new trees and understory vegetation. Over time, this high-frequency, low-intensity disturbance results in a forest with many ages of trees and many small gaps intermingled on a fine spatial scale. Such forests are called "old growth." Essential features of old growth include a multilayered canopy, the presence of large (for the site), old trees, a well-developed understory, and dead and down trees on the forest floor.

The vast majority of Alaska's coastal temperate rain forests are in an old-growth condition. Young, primary forests develop on lands newly exposed by landslides, receding glaciers, or beach uplift. When old-growth forests are felled, either by clearcutting or by catastrophic winds, secondary succession also creates a new, young forest. Whether the young, developing forest is the result of primary or secondary succession, the 2 are similar structurally and functionally. These young forests are characterized by uniform tree ages less than 150 years old, a single-layered canopy, and a relatively depauperate understory. It takes 200–300 years for young-growth stands to develop the compositional and structural characteristics of old growth.

Coastal Temperate Rain Forest Types

Alaska's old-growth rain forest can be further subdivided into different forest "types," or habitats, based on the dominant tree species and on forest productivity. The dominant tree species and major types are described below.

Coastal temperate rain forest J. Schoen

Species— The cooler temperatures, low sun angles, and short summer growing season in higher-latitude forests favor dominance by conifers. In coastal Alaska, the most abundant tree species is western hemlock (*Tsuga heterophylla*), followed by Sitka spruce (*Picea sitchensis*), mountain hemlock (*Tsuga mertensiana*), Alaska yellow cedar (*Chamaecyparis nootkatensis*), western red cedar (*Thuja plicata*), and lodgepole pine (*Pinus contorta*). Deciduous hardwoods, including alder (*Alnus* spp.) and cottonwood (*Populus balsamifera*), are least common, being found mostly on avalanche slopes, active riparian zones, and mainland river drainages in Southeast Alaska.

Western hemlock is ubiquitous throughout the Alexander Archipelago and predominates on well-drained, organic soils. There, individual trees may be > 6 ft in diameter and > 500 years old. At higher elevations, higher latitudes, and colder temperatures, western hemlock is replaced by the closely related mountain hemlock (*Tsuga mertensiana*). Both species gradually fade out as one moves north and west through the coastal temperate rain forest ecosystem, where Sitka spruce becomes more dominant.

Sitka spruce occurs throughout the coastal temperate rain forest. On Kodiak and Afognak islands, the forests are nearly pure Sitka spruce stands. In Southeast Alaska, Sitka spruce occur most often in mixed stands with hemlock and cedar, but do occur in pure stands on some active alluvial and colluvial soils, including riparian areas, avalanche slopes, and uplifted beach zones. Sitka spruce are less shade tolerant than other species, and they disproportionately colonize new openings following wind-throw, or clearcutting. In Alaska, the largest Sitka spruce trees can exceed 225 ft in height and 12 ft in diameter.

Western red cedar and Alaska yellow cedar represent a small but important component of the coastal temperate rain forest in Southeast Alaska. Yellow cedar occurs throughout the Alexander Archipelago and Prince William Sound. Western red cedar is restricted to the southern half of the Alexander Archipelago. Both species are most abundant on poorly drained, acidic soils, where they are able to outcompete hemlock and spruce. Natural resistance to decay by both cedar species results in an abundance of dead-standing snags in the forest, but rot-resistant heartwood means relatively few cavities for nesting, roosting, and foraging. Both species are economically valuable and have been disproportionately targeted for logging in recent years. In addition, stands of Alaska yellow cedar have been experiencing a significant natural decline since the late 1800s. Whether this is a function of climate change or some biotic factor is currently unknown.

Major habitat types in the coastal temperate rain forest are defined in terms of their relative mix of species. The species mix, in turn, is a function of soil type and drainage, elevation, and latitude. For the coastal temperate rain forests of Alaska, the major forest types include: western hemlock (46% of area), mixed hemlock/spruce (26%), Sitka spruce (17%), cedar (5%), and hardwood/deciduous (4%) (Hutchison 1968).

Coastal temperate forest, sixty-year growth J. Schoen

Productivity— There is a second dimension, or criteria, against which forests in Alaska can be classified. Forest "productivity" refers to the rate of tree growth and is reflected in the overall size and biomass of trees on a given site. Highly productive forests are different structurally than unproductive forests, and they tend to occur in different landscape positions than unproductive forests. For example, we might find a stand of large hemlock trees growing on the toe-slope of a hillside at low elevation and a sparse stand of small hemlocks growing on a wind-battered ridge at high elevation. Both stands would have the same species composition, but they would look, and function, very differently in terms of wildlife habitat value. The productivity of the forest also has obvious importance from the timber industry's standpoint, with more productive stands being much more profitable to log. As a result, forest inventories often include a breakdown by forest productivity, or size class.

At the coarsest level, the forest can be classified as "commercial" or "noncommercial," depending on whether the forest meets certain requirements for timber extraction. It reflects an economic, not ecological, judgment, but it suffices as a coarse-scale separation of forest types based on size and structure, and so has value as a descriptor of habitat conditions. All of Alaska's forestland has been classified in those terms, and we adopt them in this plan.

Beyond this coarse scale breakdown, the commercial (or productive) forestland can be further defined in terms of tree size (e.g., mean tree diameter or height) and stand biomass (e.g., wood volume per acre). These descriptors are more difficult to discern from remote sensing (i.e., from aerial photographs), involve more subjectivity, and thus, have more error. Although these distinctions are important from a wildlife standpoint, they are probably more detailed than we need consider for the purpose of this plan. It is important, nonetheless, to recognize a general pattern within productive forestland across Alaska, and particularly within the coastal forest type: The forest acreage at the lower end of the productivity scale vastly outweighs the forest acreage at the highly productive end. In other words, the bigger the trees in a stand are, the rarer the stand is. Not surprisingly, the more productive stands in the forest have been disproportionately logged in the past and wildlife biologists have identified this "high-grading" as a long-term conservation concern (Schoen et al 1988; Kiester and Eckhardt 1994).

Within the coastal temperate rain forest, most of the forested land is noncommercial, or "unproductive." Approximately 5.9 million acres, or 45%, is classified as commercial forestland. Of that commercial forestland, the vast majority (85%) exists in Southeast Alaska (i.e., south of Yakutat). The balance exists in Prince William Sound and Afognak Island. The vast majority of forestland in coastal Alaska falls within one of two national forests: The Tongass National Forest in Southeast Alaska, and the Chugach National Forest in Southcentral Alaska. These are, by far, the two largest forests in the National Forest system.

Coastal Forest-Associated Species

Marbled Murrelet, *Brachyramphus mamoratus*
Prince of Wales Spruce Grouse, *Falcipennis canadensis isleibi*
Blue Grouse, *Dendragapus obscurus*
Canopy nesting Pacific-slope Flycatcher, *Empidonax difficilis*
Golden-crowned Kinglet, *Regulus satrapa*
Townsend's Warbler, *Dendroica townsendi*
Varied Thrush, *Ixoreus naevius*

White-winged Crossbill, *Loxia leucoptera*
Rufous Hummingbird, *Selasphorus rufus*
Belted Kingfisher, *Ceryle alcyon*
Black-backed Woodpecker, *Picoides arcticus*
Dark-eyed Junco, *Junco hyemalis*
Wilson's Warbler, *Wilsonia pusilla*
Hermit Thrush, *Catharus guttatus*
White-crowned Sparrow, *Zonotrichia leucophrys*
Pine Grosbeak, *Pinicola enucleator*
Red Crossbill, *Loxia curvirostra*
Pine Siskin, *Carduelis pinus*
Red-breasted Sapsucker, *Sphyrapicus rubber*
Hairy Woodpecker, *Picoides villosus*
Northern Flicker, *Colaptes auratis*
Boreal Chickadee, *Poecile hudsonica*
Chestnut-backed Chickadee, *Poecile rufescens*
Red-breasted Nuthatch, *Sitta Canadensis*
Brown Creeper, *Certhia americana*
Smith's Longspur, *Calcarius pictus*
Northern Pygmy-Owl, *Glaucidium gnoma*
Barred Owl, *Strix varia*
Northern Saw-whet Owl, *Aegolius acadicus*
Western Screech Owl, *Otus kennicottii*
Great Gray Owl, *Strix nebulosa*
Great Horned Owl, *Bubo virginianus*
Bald Eagle, *Haliaeetus leucocephalus*
Merlin, *Falco columbarius*
Sharp-shinned Hawk, *Accipiter striatus*
Northern Goshawk, *A. g. atricapillus*
Queen Charlotte Goshawk, *A. g. laingi*
Northern Goshawk, *A. g. atricapillus*
Black Merlin, *F.c. suckelyi*
Wood frog, *Rana sylvatica*
Long-toed salamander, *Ambystoma macrodactylum*
Rough-skinned newt, *Taricha granulosa*
Ermine, *Mustela erminea* complex
Marten, *Martes Americana/caurina* complex
Flying squirrel, *Glaucomys sabrinus griseifrons/alpinus*
Long-tailed vole, *Microtus longicaudus/coronarius* complex
Keen's mouse, *Peromyscus keeni* complex
Sitka tundra vole, *Microtus oeconomus sitkensis*

Ecological Role of Coastal Temperate Rain Forest Habitats

Coastal temperate rain forests are characterized by cool summers, mild winters, and abundant precipitation distributed throughout the year (Alaback 1991). The absence of a dry season makes wildfire extremely rare, so individual trees can live to very old age. Many trees are > 300 years old, while the oldest trees may be > 1000 years old. Trees can live to extremely old age (800 years or more) before succumbing to disease or rot. The primary agent of disturbance in this forest is wind, which typically topples 1–3 trees at a time, creating a constantly shifting fine-grained mosaic of small openings within the forest (Lertzman et al. 1996; Ott 1997). This gap-phase dynamic produces, over time, a forest with trees of many ages, a multilayered canopy, a diverse, lush understory, and an abundance of dead trees either standing (snags) or lying on the ground in various stages of decay (Capp et al. 1992). These structural and compositional features make old growth valuable as habitat for many wildlife species.

The wind-dominated disturbance regime produces a structurally diverse and highly productive forest. Where it occurs in the Pacific Northwest, this forest type produces more living plant biomass than any other terrestrial ecosystem, including tropical rain forests (Waring and Franklin 1979). Its structural complexity provides niches for diverse animals, including at least 53 species of mammals, 231 birds, and 5 species of amphibians and reptiles (Taylor 1979; MacDonald and Cook 1996a, 1996b). For the coastal rain forest habitat type, the Strategy primarily highlights nongame species, subspecies, and endemics that are associated with it; these species were selected because of conservation concerns, economic importance, or as indicator species for the health of this biome.

Marbled Murrelet

Following is an illustration of the ecological role of coastal temperate rain forests for one species, the Marbled Murrelet (*Brachyramphius marmoratus*); the health of its Alaska population is closely tied to health of this particular biome and the adjoining marine environment.

Juvenile Marbled Murrelet
R. MacIntosh, USGS

The Marbled Murrelet is a small seabird that ranges along the northwestern coastline of North America, from central California to Alaska's Aleutian Islands. It spends most of its life at sea, but unlike other seabirds, flies inland to nest in the forest on mossy platforms near the tops of old-growth trees (Nelson 1997). Marbled Murrelets are currently listed as a threatened species in California, Oregon, Washington, and British Columbia, but are relatively abundant in Alaska, where an estimated 91% of the world's population exists (McShane et al. 2004). Estimates of the Alaska population are driven in large part by a single at-sea survey conducted by the USFWS in 1994, which placed the population in Southeast Alaska at 687,061 (±201,162) *Brachyramphus* murrelets (Agler et al. 1998). By these estimates, Southeast Alaska alone contains approximately 65% of the world's Marbled Murrelets, making it the geographic and demographic epicenter of the bird's range.

A number of studies have demonstrated that Marbled Murrelets have declined dramatically in the southern half of their range, primarily due to loss of suitable nesting habitat from logging (Bryant et al. 1997; McShane et al. 2004). In the Pacific Northwest, approximately 5% of the original, coastal, old-growth forest remains. Other factors that may contribute to the decline include increased predation (by crows, jays, and other corvids), entanglement in gillnets, and oil pollution.

Like other seabirds, the Marbled Murrelet has low fecundity, becoming sexually mature between 3 and 5 years old, and then laying only a single egg per year. Because it nests in trees, it is exposed to avian predators in the form of ravens, crows, Steller's Jays, Northern Goshawks, Peregrine Falcons, and various owls. Preferred nesting habitat is 20–40 meters up in old-growth trees. Murrelets prefer to nest near the tops of trees but beneath overhanging limbs to provide cover from overhead predators. The bird does not add material to a nest, but looks for a broad, mossy platform that occurs naturally in these wet forests. Because the platform must be broad to support the bird, it nests primarily in older trees that have had time to develop these structures.

Research on nesting habits of these birds suggests that within forest stands, Marbled Murrelets tend to select for older, larger trees (Hamer and Nelson 1995). Older trees tend to have larger limb structures and larger moss platforms, which provide more suitable nesting sites for the birds. The disproportionate logging emphasis on larger trees (e.g., high-grading) in Southeast Alaska may be having a disproportionately high impact on the nesting habitat of these birds.

One of the essential attributes of old-growth forest is the existence of gaps in the canopy that allows Marblet Murrelets to access nest stands and fly below the canopy. Conservation of these types of forest stands is important for the long-term conservation of murrelet nesting habitat.

Other species

In the case of the Marbled Murrelet, coastal old-growth forests provide important structural attributes needed for nesting and reproduction. Other species, including many woodpeckers and owls, depend on large-diameter snags for excavating cavities for nesting and roosting, or in the case of the Rufous Hummingbird, build their nests from the mosses and lichens they find in old-growth forests. Other species depend on coastal forests because their primary food lives in the forest. Examples include the Northern Goshawk, which hunts beneath the overstory and captures a variety of old-growth associated birds and small mammals, or the brown creeper, which forages in the bark crevices of larger, old-growth trees. Still other animals are dependent on the perpetually moist, humid environment of the rain forest, including species like the rough-skinned newt, the wood frog, and long-toed salamander.

The coastal, old-growth rain forest is an extraordinarily complex, stable habitat type. Over thousands of years, many wildlife species have evolved in special ways to exploit this forest for food, shelter, and security. The ecological web of interactions in the coastal rain forest is rich, and understanding of its complexities is only now starting to emerge through ongoing scientific study.

Coastal Temperate Rain Forest Conservation Status

Coastal temperate rain forests are rare worldwide. Only 30–40 million ha (2–3%) of the world's estimated 1.3 billion ha of temperate forest can be classified as coastal temperate rain forest (Ecotrust et al. 1995). Alaska contains approximately 6,649,460 ha of coastal temperate rain forest, of which about 800,000 ha has been altered by human impacts (Ecotrust et al. 1995). Most of this development has come in the form of clearcut logging and associated road building, especially on the more productive forest lands in Southeast Alaska.

Some of the more intensively logged areas in Southeast Alaska include the northern half of Prince of Wales Island, northern Kuiu Island, Northeast Chichagof Island, North Baranof Island, Zarembo Island, Mitkof Island, Heceta Island, Tuxekan Island, and Long Island. Heavily logged areas overlap to a great extent with underlying calcium carbonate soils, or karst, which allows for good drainage and more productive tree growing conditions. There has been less logging in Southcentral Alaska and the Kodiak Archipelago, primarily because tree size and growth rates diminish with increasing latitude (Farr and Harris 1979). Logging on private, Native corporation lands has been significant throughout this biome, accounting for approximately half of all logged areas.

Over 95% of the coastal temperate rain forest land lies within the Tongass and Chugach National forests—two of the largest national forests in the United States. These lands are managed for multiple uses, including a mix ranging from wilderness to intensive development. The allocation of lands to conservation or development status is governed by a comprehensive Forest Plan, which is developed through a public process, and revised every 10–15 years. The Tongass is currently managed under a Forest Plan that was finalized in 1997. The Chugach is managed under a Forest Plan that was revised in 2001. About 22% of the Tongass National Forest is zoned for development, and about 18 % of the forested acres of the Tongass are currently available for commercial timber harvest purposes (http://www.fs.fed.us/r10/TLMP/ROD/ROD_COV.PDF). About a third of that available forested acreage has been harvested since the 1950s.

Although a relatively small percentage of the forest area has been logged, much of the logging to date has been concentrated in the most productive stands with the largest trees. Not only are "big-tree" forests unique structurally and functionally (Kirchhoff and Schoen 1987), but they tend to occur in certain landscape positions that make them especially valuable to particular wildlife species. For example, big tree forests are often found on alluvial soils (the flood plain of rivers and streams), or on colluvial soil types (the toe slopes of steep hill sides), where species like brown bears (*Ursus arctos*) and Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) find preferred habitat (Schoen et al. 1988). These floodplains and alluvial soils are often also associated with highly productive streams and aquatic habitats.

The disproportionate harvest of relatively rare, "big-tree" stands has been a primary conservation concern in Southeast Alaska for decades (Kirchhoff 1989; Keister and Eckhardt 1994). Maintaining sustainable and well-distributed populations of all fish and wildlife species should focus on preserving the natural diversity of forest conditions (species, structure, and landscape position) within this biome.

Threats to Alaska's boreal forest and coastal temperate rain forest habitat range from minor, short-term impacts that may occur in association with virtually any forestland use activity, to the potentially significant loss of habitat due to the conversion of forestlands to other uses. These losses may be partial or complete, but they are often permanent changes to the landscape.

Timber harvesting activities, if properly planned and implemented, should result in only short-term impacts to the forest habitat. If, however, harvest activities are not conducted in accordance with appropriate best management practices (BMPs), such as those found in regulation under the Forest Resources and Practices Act, there is the possibility that they will affect slope stability or disrupt soil regimes. These in turn could lead to such impacts as increased soil erosion or even mass wasting, reduced natural regeneration or shifts in vegetative species composition, impacts to water quality, excessive windthrow, and increased fire risk.

Many timber roads and landings constructed for harvest are temporary or seasonal. If properly constructed with issues such as drainage adequately addressed, they represent short-term impacts. Permanent roads, however, can lead to long-term impacts associated with habitat fragmentation.

The fragmentation of forest habitats is a more significant threat to wildlife because it tends to be long term. The construction of permanent roads, and the installation of pipelines and other utilities impact forested areas via ground disturbance, the clearing of trees and understory species, as well as the bisecting of habitats.

Habitat fragmentation from road construction and pipeline installation occurs on lands that are open to development activities regardless of ownership. These impacts can be local, such as for a subdivision road or oil pad development, or regional as is the case for many oil and gas pipelines. The construction of roads often opens areas for additional settlement or development and can lead to the loss of habitat through conversion to other uses.

In May 2005 the Roadless Area Conservation Rule was repealed by the Bush Administration. This rule was issued by the USFS in January 2001 to protect areas within national forests that were currently roadless. “Roadless areas” are places where no roads have been constructed, and where as a result, no logging or other development has occurred. These areas provide unfragmented habitats that support fish and wildlife species under unaltered conditions, an increasingly rare situation.

Large-scale land conversion for development and settlement is the single greatest threat to Alaska’s forest habitats. The loss of forest habitat through conversion to another use often results in a permanent loss of that habitat. Many of these land use conversions are relatively unregulated, at least in comparison to timber harvest activities. The FRPA (Forest Resources and Practices Act) does not apply to the clearing of timber in order to convert the land to another use, and there is no comparably comprehensive act that addresses the development of land for uses such as agriculture, golf courses, mining, subdivision development, or other commercial uses.

Mining activities in Alaska threaten forest habitats by conversion, and may contribute pollution to associated waters from mine tailings and chemicals used during the extraction process. Recent advances in technology have allowed for the use of lower grade ores and spurred renewed interest in mining operations.

Lastly, impacts such as insect infestation, similar to the spruce bark beetle that may flourish under warming climatic conditions, will likely continue to alter Alaska’s forest habitats.

The Alaska FRPA and its associated regulations govern commercial timber harvest activities on state, municipal, and private forestlands. This statue identifies and requires the use of specific best management practices (BMPs) for timber harvest activities. The Alaska Department of Natural Resources Division of Forestry (DOF) administers the provisions of the act and provides oversight of commercial forest harvest activities pursuant to FRPA.

The Department of Environmental Conservation (DEC) and DNR’s Office of Habitat Management and Permitting (OHMP) coordinate with the DOF in implementing FRPA and perform specific oversight roles themselves. DEC is given deference in matters related to water quality issues, and the OHMP receives deference in regard to the protection of riparian buffers within harvest areas.

Timber harvest activities on federal forestlands are not subject to FRPA; however, the management standards on federal land generally meet or exceed the FRPA standards. Most timber harvest occurs on Alaska’s 2 national forests, and falls under the regulatory jurisdiction of the USFS. The forest planning process allows for public review and has a large public involvement component.

The State of Alaska owns approximately 24.9 million acres of forested lands (Department of Commerce Community and Economic Development 2005). The use of these lands is regulated by area or regional plans. Generally, regional plans have been developed, or will be developed under the sustainable yield and multiple use principles and for consistency with AS 41.17. Regional plans have been completed for about two-thirds of all state land. Where no plan exists, a site-specific plan must be adopted under AS 38.04.065(h) to classify the land before a timber sale can occur.

Approximately 2 % of the state's forested lands, or just over 2 million acres, is within 2 designated state forests. The 247,000-acre Haines State Forest, established by the legislature in 1982, includes the Chilkoot, Chilkat and Ferebee drainages in the northern portion of Southeast Alaska. In Interior Alaska, the 1.8 million-acre Tanana Valley State Forest, which extends from Manley to Tok, was created in 1983. The primary purpose in establishing state forests is to provide for the production, utilization, and replenishment of timber resources while allowing other beneficial uses of public land and resources (AS 41.17.200[a]).

The DOF manages forests on state land that have been classified as timberlands via implementation of the FRPA. The FRPA delineates 3 management regions: Region I, Region II, and Region III. These regions correlate with the Southeast, Southcentral, and Northern areas of the state. The FRPA establishes district riparian standards for each of these regions.

The DOF plans for timber management on state lands by first reviewing existing regional plans to ensure that proposed actions are consistent, and then preparing a Five-Year Schedule of Timber Sales. These schedules are prepared annually by each of the DOF's 10 area offices, and provide the public, the timber industry, and agencies with an overview of proposed timber harvest areas, timber sale access and reforestation plans.

The next step is preparation of a Forest Land Use Plan (FLUP) for each proposed timber sale or personal use harvest area on state lands. FLUPs provide information on the location, access, harvest methods, duration, and proposed reforestation for individual sale. FLUPs are required to follow the multiple use and sustained yield principles. Consideration must be given to current, past, and potential uses of the land, including timber harvesting for commercial and personal use; fish and wildlife habitat; water bodies, water quality and watersheds; riparian, wetland and ocean shoreline vegetation; recreation and tourism; agriculture and grazing; mining and material extraction; and soil characteristics. FLUPs are subject to public and agency review for sale approval or denial. Current FLUPs exist for Fairbanks, Delta, Kenai-Kodiak (combined), Northern Southeast (Haines), southern Southeast (Ketchikan), and the Matanuska-Susitna areas.

Once a timber sale is adopted, a contract is issued either through the bid process or via negotiations. The FRPA requires that timber operators submit a Detailed Plan of Operation (DPO) for timber harvest activities that are subject to the Act. In addition to state lands, this includes harvests on municipal and private forestland.

State timber sales with the Coastal Zone must be consistent with the ACMP and local Coastal Zone Management Plans. The standards contained in the FRPA are the coastal standards for timber harvesting, so if timber sales comply with the act, they are consistent. The DOF must issue proposed and final coastal consistency determinations under the timelines set by 11 AAC 150.

As mentioned above, timber harvests on municipal and private lands are also subject to provisions found in the FRPA. These provisions apply to the harvest activities themselves; municipal and private lands do not typically have a planning process that is analogous to that for state lands. The FRPA does treat municipal and private lands differently from state lands with regard to riparian standards. Public lands typically have stricter riparian standards than private lands, including having wider riparian buffers with wider no-cut zones adjacent to water bodies.

In Alaska, private forestlands include those owned by Native corporations, universities, the Alaska Mental Health Trust Authority, and private citizens. Approximately 30 million acres of Alaska's forestlands are privately owned (Department of Commerce Community and Economic Development 2005). Timber harvests on municipal and privately owned forestlands within the coastal zone are regulated in the same manner as state lands. DPOs must be submitted, and the DOF is responsible for ensuring consistency by regulating adherence to the FRPA standards. Forest habitats within legislative designated Special Areas are afforded some protection from development under management plans specific to those areas.

Federal forested lands fall under the jurisdiction of federal management agencies. Approximately 77 million acres of Alaska's forests are federally owned (Department of Commerce Community and Economic Development 2005). The USFS is responsible for Alaska's 2 national forests, the Chugach and the Tongass. The Tongass National Forest is the largest single forest ownership in the state. It is located in Southeast Alaska and contains 46% of Alaska's timberland. The Tongass National Forest consists of 16.9 million acres, of which 4% is available for commercial timber harvest. The second largest federally owned forest is the Chugach National Forest. Located in Southcentral Alaska, this forest encompasses much of the Prince William Sound area and consists of 5.3 million acres.

Federal lands managed by agencies other than the USFS are not typically managed for commercial timber harvest. There are 17 units of the National Park System in Alaska under the management of the National Parks Service; 10 were created in the 1980s through ANILCA. The USFWS manages the 16 national wildlife refuges in Alaska. The BLM manages its own lands specific to their land-use plans developed to sustain the health and diversity of natural resources.

Recommended conservation actions for Alaska's forest habitats include the establishment and maintenance of protected areas, forest practices that provide for sustainable timber harvest in designated areas, support for efforts to eliminate wasteful consumption and lastly, where needed, appropriate forest restoration programs.

Projects involving the development of protected forested areas, understanding species/habitat relationships and sustainable forest management are critical to the conservation of Alaska's boreal forests and coastal temperate rain forests.

Monitoring and research efforts that reduce impacts to forest habitats from mining operations, road construction, and timber harvest should be emphasized.

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Appendix 5.2 Tundra Habitats

Featured Species-associated Tundra Habitats: Arctic, Alpine and Maritime Tundra

Tundra refers to a cold-climate landscape that has vegetation but is devoid of trees. The absence of trees is typically related to regional climatic conditions. Alaska has 3 major types of tundra that can be generally described by the topographical and geographical location in which they occur. They include: 1) Arctic (high latitude) tundra, 2) alpine (high altitude) tundra, and 3) the maritime tundra present on Alaska's western and southwestern coast. The dominant plant species of tundra habitats are sedges, low and dwarf shrubs, and graminoids interspersed with forbs, in addition to mat and cushion-forming plants and scattered bryophytes (nonvascular plants).

Alaska's tundra climates are characterized by a short growing season, long, cold, dark winters, and low precipitation with strong, bitter, dry winds. Snow accumulation, where present, provides an insulating layer to the ground surface benefiting plant and animal communities. The number of plant species on the tundra is few, and their growth is minimal, with most of the biomass concentrated in the root system. Due to the short growing season, plants often reproduce by division, in addition to seed production.

Arctic Tundra

Arctic tundra is generally distributed above the latitudinal tree line in Alaska. This is the area from the crest of the Brooks Range northward to the Arctic Ocean known as the Arctic Slope. The Arctic Slope includes the north side of the mountains, northern foothills, and the flat coastal plain; it is the only truly Arctic biogeographic province in the United States. As a result of the Arctic region's high latitudinal position, it experiences less intense solar radiation and an exaggerated seasonal variation. Arctic tundra persists under cold air conditions originating off the permanent sea ice pack. This air has low moisture-holding capacity combined with minimal precipitation. The dominant vegetation type across the foothills and much of the coastal plain is tussock tundra, with willows in the small drainages, wet sedge tundra in old drained lakes, and *Dryas* tundra on drier ridges. Tussocks are formed of cottongrass and other sedges and forbs, with scattered dwarf shrubs. Prostrate woody shrubs, mosses, sedges, and lichen cover the mountainsides and valleys. The flat areas of the coastal plain are sporadically covered with small thaw lakes and ponds and rock polygons. These landforms are due to a continuous layer of underlying permafrost. Ice-rich permafrost is an important feature of Alaska's landscape that is not found elsewhere in the United States (Batten 1986). Trees are generally unable to establish in Arctic tundra habitats due to an underlying impermeable permafrost layer complemented by thin soils. These thin tundra soils trap moisture, holding it close to the surface, creating a tundra complex of wet and dry habitats. Relative to other locations of the state, regions where Arctic tundra habitat exists receive less annual snow and rainfall—less than 20 inches annually (Interagency Arctic Research Policy Committee 2002).

Arctic tundra plant communities found in mesic (dry) and hydric (wet) soil conditions include wet graminoid herbaceous types dominated by sedges or grasses. Areas of drier soils along the riverbanks, lakes, and coastal bluffs support dwarf scrub communities.

Typical mesic sedge communities are dominated by the water sedge (*Carex aquatilus*) and tall cottongrass (*Eriophorum angustifolium*). Mosses, usually consisting of *Scorpidium* spp. or *Drepanodadus* spp., may be common. Grass communities are dominated by tundra grass (*Dupontia fischeri*) and alpine foxtail (*Alopecurus alpinus*), with the emergent pendent grass (*Arctophila fulva*) prevailing where surface water is 15–200 cm deep.

Common dwarf scrub communities found in the more xeric (desert-type) soils of the Arctic tundra include entire-leaf mountain-avens (*Dryas integrifolia*), mountain-cranberry (*Vaccinium vitis-idaea*), four-angled cassiope (*Cassiope tetragona*), bearberry (alpine bearberry [*Arctostaphylos alpina*]and red-fruit bearberry [*A. rubra*]), and prostrate willows (netleaf willow [*Salix reticulata*] and skeleton leaf willow [*S. phlebophylla*]).

In addition, mesic graminoid herbaceous communities dominated by tussock-forming sedges are widespread. Typical species include tussock cottongrass (*Eriophorum vaginatum*) and bigelow sedge (*Carex bigelowii*).

Low shrubs, such as dwarf arctic birch (*Betula nana*), crowberry (*Empetrum nigrum*), narrow-leaf Labrador tea (*Ledum decumbens*), and mountain-cranberry (*Vaccinium vitis-idaea*) are frequently present and may be codominant with sedges. Mosses, such as the feather moss, *Hylocomium splendens,* and *Sphagnum* spp., as well as lichens, such as *Cetraria cucullata*, *Cladonia* spp., and reindeer lichen (*Cladina rangiferina*), are common between tussocks. Dwarf scrub communities are dominated by mat-forming *Dryas* species and ericaceous species, for example, blueberry (*Vaccinium* spp.), four-angled cassiope (*Cassiope tetragona*), bearberry (*Arctostaphylos* spp.), and prostrate willows (netleaf willow [*Salix reticulata*] and skeleton leaf willow [*S. phlebophylla*]). Open low scrub communities are codominated by the American green alder (*Alnus crispa*) and willows (Richardson willow [*Salix lanata*], diamond leaf willow [*S. planifoli*], and gray leaf willow [*S. glauca*]). Mosses (*Tomenthypnum nitens* and *Drepanocladus* spp.) may be common.

In the valley and lower hill slope areas, the drier, xeric soils support dwarf scrub communities, while mesic, graminoid, herbaceous communities inhabit the wet to mesic soils. Dwarf scrub communities are dominated by ericaceous species; an example community would consist of alpine bearberry (*Arctostaphylos alpina*), red-fruit berry (*A. rubra*), blueberry (*Vaccinium* spp.), narrow-leaf Labrador tea (*Ledum decumbens*), crowberry (*Empetrum nigrum*), four-angled cassiope (*Cassiope* *tetragona*), mountain-avens (white mountain-avens [*Dryas octopetala*] and entire-leaf (*D. integrifolia*]), and willows, such as least willow (*Salix rotundifolia*), arctic willow (*S. arctica*), and polar willow (*S. polaris*).

Herbaceous species (*Carex* spp., for example) and fructicose lichens, such as *Cladina* spp. and *Cetraria* spp., may codominate with shrubs in some of these areas. Graminoid, herbaceous communities of the Arctic tundra are dominated by sedges (e.g., water sedge [*Carex aquatilis*] and bigelow sedge [*C. bigelowii*]) and willows (e.g., diamondleaf willow [*S. planifolia*] and Richardson willow (*S. lanata*]). Mosses (e.g., *Tomenthypnum nitens*, *Distichium capillaceum*, *Drepanocladus* spp., and *Campylium stellatum*) are often abundant (Gallant et al. 1995). Other common mosses making up Arctic tundra vegetation include *Tomentypnum nitens*, ditrichum moss (*Ditrichum flexicaule*), distichium moss (*Distichium capillaceum*), and *Hypnum bambergeri* (Muller et al. 1999; Kade et al. 2005), as well as reindeer mosses (*Cladonia rangiferina*, *C. stellaris*). Cetraria lichens (*Cetraria cucullata*, *C. islandica*) are also prevalent in drier locations.

Arctic tundra G. Carroll, ADF&G

The Arctic tundra is represented by a low diversity of plant species and low plant biomass. These characteristics, combined with a short growing season, slow rates of growth, and vegetative reproduction, result in delayed recovery from disturbance (Oceanographic Institute of Washington 1979).

Arctic Tundra-associated Species

Snowy Owl, *Nyctea scandiaca*
Gyrfalcon, *Falco rusticolus*
Rough-legged Hawk, *Buteo lagopus*
Peregrine Falcon, *Falco peregrinus*
King Eider, *Somateria spectabilis*
Long-tailed Duck (Oldsquaw), *Clangula hyemalis*
Yellow-billed Loon, *Gavia adamsii*
Smith's Longspur, *Calcarius pictus*
Spectacled Eider, *Somateria fischeri*
Steller's Eider, *Polysticta stelleri*
Buff-breasted Sandpiper, *Tryngites subruficollis*
Brown lemming, *Lemmus trimucronatus*

Alpine Tundra

Alpine tundra, McNeil River State Game Refuge D. Tessler, ADF&G

Alpine tundra occurs above tree line elevations in mountain ranges and exposed ridges in Alaska. Major mountain ranges of Alaska include the Alaska, Brooks, and Chugach ranges. Numerous, smaller ranges also occur throughout the state. At these higher elevations, the landscape is increasingly broken by rock outcroppings. Plant communities consist of prostrate, mat and cushion-forming species and shrubby species that are intermittent in their distribution. Barren and lichen-covered rocky areas are dominated by *Dryas* (mountain-avens) and mountain-heath communities. These plants are adapted to the scouring high winds and widely ranging temperatures of high elevation alpine regions. Due to steep slopes and relatively thin soils at the higher elevations, areas of alpine tundra lack trees and may or may not have permafrost.

Alpine tundra transitions at lower elevations to subalpine forests or meadows and treeline habitats. In many areas, the subalpine region is a broad band where small islands of stunted trees are confined to sheltered sites. Subalpine plants represent the first distinctive type of vegetation below the alpine tundra. The transition to alpine tundra begins with communities dominated by shrubs, heaths and related families. Regeneration of alpine tundra plant species is often very slow following damage by fire or other disturbance.

Mountain-heath dwarf shrub communities are dominated by *Phyllodoce* spp. Associated dwarf shrubs include mertens cassiope (*Cassiope mertensiana*), starry cassiope (*C. stelleriana*), luetkea (*Luetkea pectinata*), bog blueberry (*Vaccinium uliginosum)*, and dwarf blueberry (*V. caespitosum*). Many herbs including nootka lupine (*Lupinus nootkatensis*), Sitka valerian (*Valeriana sitchensis*), and roseroot (*Sedum rosea*) may also occur.

Dryas communities are dominated by species of the genus *Dryas* and codominated by dwarf shrubs, ericads, sedges or lichens. Common dwarf shrubs include ericaceous species, such as mountain-cranberry (*Vaccinium vitis-idaea*), bog blueberry (*V. uliginosum*), four-angled cassiope (*Cassiope tetragona*), crowberry (*Empetrum* *nigrum*), narrow-leaf Labrador tea (*Ledum decumbens*), alpine bearberry (*Arctostaphylos alpina*), red-fruit bearberry (*A. rubra*) and Alaskan cassiope (*S. lycopodioides*), and prostrate willows, such as netleaf willow (*Salix reticulata*) and skeletonleaf willow (*S. phlebophylla*). Other common dwarf willows include least willow (*S. rotundifolia*), polar willow (*Salix polaris*), and arctic willow (*S. arctica*). Common graminoids and herbs of the alpine *Dryas* tundra include meadow bistort (*Polygonum bistorta*), fescue grass (*Festuca altaica*), woodrush*es (Luzula* spp.), alpine holygrass (*Hierochloe alpina*), sandwort (*Minuartia* spp.), *Carex microchaeta*, northern single-spike sedge (*C. scirpoidea*), sedge (*Carex* spp.), black oxytrope (*Oxytropis nigrescens*), saxifrage (*Saxifraga* spp.), downy oatgrass (*Trisetum spicatium*), vetch (*Hedysarum* spp.), Arctic bluegrass (*Poa arctica*), and anemone (*Anemone* spp.). Mosses, such as moss-campion (*Silene acaulis* subspecies), *Tomenthypnum nitens* and *Rhacomitrium* spp., *Dicranum* spp., and *Aulacomnium* spp., may be common. Lichens, such as *Cetraria cucullata*, *Cetraria* spp., *Cladina alpetris*, reindeer lichen (*Cladonia rangiferina*), *C. alpestris*, *Sphaerophorus globosus*, *Thamnolia* spp., and *Sterocaulon* spp., may also be common.

Dryas-sedge communities may be codominant with *Carex* spp., such as northern single-spike sedge (*Carex scirpoidea*), short-leaved sedge (*C. misandra*), and bigelow sedge (*C. bigelowii*), as well as *Kobresia myosuroides* and others. Common mosses, including *Tomenthypnum nitens, Rhytidium rugosum*, and feathermoss (*Hylocomium splendens*), occur with fructicose lichens, such as *Cladonia* spp. and *Certraria* spp.

Dryas communities codominated by lichens include *Alectoria* spp., *Cetraria* spp., *Cladina* spp., and worm lichen (*Thamnolia vermicularis*). Mosses, including *Tomenthypnum nitens*, *Rhacomitrium* spp., and *Polytrichum* spp., may grow within *Dryas* mats (Vierick et al. 1992; Vierick et al. 1972).

Alpine Tundra-associated Species

Golden Eagle, *Aquila chrysaetos*
Rough-legged Hawk, *Buteo lagopus*
Barrow ground squirrel, *Spermophilus parryii kennicottii*
Alaska marmot, *Marmota broweri*
Glacier Bay marmot, *Marmot caligata vigilis*
Bristle-thighed Curlew, *Numenius tahitiensis*
Gyrfalcon, *Falco rusticolus*

Aleutian and Bering Sea Islands Endemic Species

Rock Ptarmigan (*Lagopus mutus evermanni*, *L. m. townsendi*, *L. m. atkhensis*)

Maritime Tundra

Maritime tundra (or heath) is present along the coastal areas of southwestern Alaska and the western Alaska Bering Sea Islands. It is the product of the cool and damp climate generated by the cold waters of the Bering Sea. Seasonal weather patterns produce relatively milder winters, cooler summers and relatively high humidity. A gradual transition occurs from maritime to Arctic tundra in the region of Kotzebue

Sound, and a transition from maritime to alpine tundra occurs where mountains extend into the region. Uplands and mountain slopes support mosses, lichens, and prostrate alpine plants, while lower areas are covered with herbaceous forbs. The latitudinal location, combined with the maritime climate and increased precipitation, generally defines and distinguishes this tundra from Arctic and alpine tundra types.

Maritime tundra is dominated by prostrate heath-scrub type communities interspersed with grass and forb meadows, with willows and alders present in the protected swales. Common heath species include primarily crowberry (*Empetrum nigrum*), along with bog blueberry (*Vaccinium uliginosum*), mountain cranberry (*Vaccinium vitis-idaea*), and alpine azalea (*Loiseleuria procumbens*).

Southwest Aleutian maritime tundra ADF&G

Grass and forb meadows composed of mesic, graminoid, herbaceous communities are dominated by tussock-forming sedges in some areas, or by bluejoint, which forms meadows with codominant herbaceous species, such as sedges (*Carex* spp.), cottongrasses (*Eriophorum* spp.), and fireweed (*Epilobium angustifolium*). Mosses, such as *Pleurozium schreberi*, *Hylocomium splendens*, *Aulacomnium* spp., and *Sphagnum* spp., are abundant with common lichens, including *Cetraria cucullata, C. islandica, Cladonia* spp., reindeer lichen (*Cladina rangiferia*), and *Thamnolia subuliformis*.

Dwarf scrub communities of the maritime tundra are composed of low shrubs, grasses, and lichens. Communities are dominated by mountain-avens (*Dryas octopetala* and *D. integrifolia*) or codominated by a combination of mountain-avens and sedges (northern sickle-spiked sedge [*Carex scirpoidea*], short-leaved sedge (*C. misandra*), and bigelow sedge (*C. bigelowii*]) or mountain-avens and lichen, for example, *Alectoria* spp., *Cetraria* spp., and *Cladina* spp. Other typical shrubs occurring in these communities are prostrate willows (netleaf willow [*Salix reticulata*] and skeletonleaf willow [*S. phlebophylla*]) and ericaceous species, such as four-angled cassiope (*Cassiope tetragona),* crowberry (*Empetrum nigrum*), bearberry (*Arctostaphylos* spp.), mountain-cranberry (*Vaccinium vitis-idaea*), and bog blueberry (*V. uliginosum*). Herbs, such as sedges (*Carex* spp.) and saxifrage (*Saxifraga* spp.), and mosses, including *Dicranum* spp., *Hypnum* spp., *Polytrichum* spp., *Rhacomitrium* spp., and *Aulacomnium* spp., are common. Lichens, including *Alectoria* spp., *Cladonia* spp., *Cladina* spp., and *Cetraria* spp., are also typical. Other mosses, such as *Tomethypnum nitens*, and *Rhytidium rugosum,* may be common.

Tall scrub communities are dominated by willows, including feltleaf willow (*Salix alaxensis*), diamondleaf willow (*S. planifolia)*, and grayleaf willow (*S. glauca*). Also common are alders, such as American green alder (*Alnus crispa*) and Sitka alder (*A. sinuata)*. A mix of ericaceous shrubs, for example, crowberry (*Empetrum nigrum*), narrow-leaf Labrador tea (*Ledum decumbens*), mountain-cranberry (*Vaccinium vitis-idaea*), bog blueberry (*V. uliginosum*), and alpine bearberry (*Arctostaphylos alpina*), with dwarf arctic birch (*Betula nana*) may also occur. A thick herbaceous layer is present in some areas consisting of oxytrope (*Oxytropis* spp.), vetch (*Astragalus* spp.), and bluejoint (*Calamagrostis canadensis*). Mosses, such *as Polytrichum* spp., *Hylocomium splendens*, *Hypnum* spp. and *Drepanocladus uncinatus*, may be abundant (Vierick et al. 1992; Vierick et al. 1972).

Maritime Tundra-associated Species

Bristle-thighed Curlew, *Numnius tahitiensis*
Tule White-fronted Goose, *Anser albifrons gambeli*
Spectacled Eider, *Somateria fischeri*
Steller's Eider, *Polysticta stelleri*
King Eider, *Somateria spectabilis*
Pacific Loon, *Gavia pacifica*
Arctic Loon, *G. arctica*
Rock Sandpiper, *Calidris ptilocnemis*
subspecies Pribilof Sandpiper, *C. p. ptilocnemis*
subspecies Aleutian Sandpiper, *C. p. couesi*
subspecies Northern Rock Sandpiper, *C. p. tschuktschorum*

Bering Sea Island Endemic Species

McKay's Bunting, *Plectrophenax hyperboreus*

Bering Sea and Aleutians Endemic Species

Gray-crowned Rosy Finch, *Leucosticte tephrocotis tumbrina*
Winter Wren, *Troglodytes troglodytes meligerus*
T. t. kiskensis
T. t. alascensis
T. t. semidiensis

Southwest Alaska/Bering Sea insular endemic voles, lemmings, and shrews:

Sorex pribilofensis (hydrodromus)
S. jacksoni
Dicrostonyx groenlandicus stevensoni
D. g. unalascensis
D. g. exul
Lemmus trimucronatus harroldi
L. t. nigripes
Microtus abbreviatus abrreviatus
M. a. fisheri
Microtus oeconomus amakensis
M. o. innuitus
M. o. unalascensis
Clethrionomys rutilus albiventer

Ecological Role of Tundra Habitats

Alaska tundra habitats are somewhat unique relative to the contiguous United States. Although tundra is found in the higher elevations of the Lower 48, it is Alaska's Arctic tundra habitat that may be most familiar to the nation. This is primarily due to the high profile of development issues and concerns in the Arctic region, especially as it relates to the future of the Arctic National Wildlife Refuge (ANWR).

Alaska's tundra supports numerous avian migratory species during the spring, summer, fall and winter seasons, providing important breeding, rearing, staging, refugia, and overwintering habitat. It is one of the most productive and abundant habitats for shorebirds in Alaska and supports a diversity of breeding species. In addition, mammalian species, including muskox, caribou, foxes, wolves, bears, arctic ground squirrels, many small rodents, and raptors are widespread across the Arctic tundra. Nomadic caribou depend on tundra vegetation most of the year for survival, including during annual migrations to their calving grounds. Migratory species, such as falcons and terns, also use this habitat. Five species of raptors that regularly breed in the Arctic tundra region include the Peregrine Falcon, Gyrfalcon, Rough-legged Hawk, Short-eared Owl, and Snowy Owl. Raptors specialize in eating the lemmings, voles and hares that in turn are adapted to eating the tundra vegetation. Rock Ptarmigan breed on the Arctic coastal tundra. They make short migrations in winter to the foothills of the south slopes of the Brooks Range where willows, a primary food source, are more abundant (Johnson and Herter 1989). During spring, thousands of ptarmigan move north across the foothills to reach their breeding areas on the tundra. The Yellow-billed Loon is an Arctic tundra breeder that overwinters in the southern coast of the state. The Buff-breasted Sandpiper nests on the tundra of the Arctic coastal plain, while the Rock Sandpiper nests in the heath of the maritime tundra (Bowman 2004).

Rock Ptarmigan and Blue Grouse feed on seeds and berries of tundra vegetation. The Gray-crowned Rosy Finch feeds in the alpine tundra and subalpine meadows of the Aleutians and Bering Sea Islands eating tiny, wind-borne seeds and insects. Smith's Longspurs nest in the alpine tundra eating mostly plants, as well as invertebrates, including spiders, ants, and beetles. Mountain goats, Dall sheep, and brown bears also depend on alpine and subalpine habitats throughout Alaska.

The maritime tundra of the Yukon-Kuskokwim (Y-K) Delta of western Alaska is one of the nation's most important nesting areas for geese, including the Tule White-fronted Goose. Large numbers of ducks, tundra swans, and sandhill cranes also nest on the maritime tundra of western Alaska, particularly on the Y-K River delta. The Spectacled Eider and Steller's Eider, both federally listed as threatened (in 1993 and 1997, respectively) breed here, although Steller's Eider has become increasingly rare in this area. Most of the world's Bristle-thighed Curlews breed on western Alaska's maritime tundra. The USFWS listed the Bristle-thighed Curlew as a species of concern in 1996. McKay's Bunting is endemic to several Bering Sea Islands, where it breeds on the maritime tundra. This habitat is particularly important in sustaining existing healthy populations of this species.

Conservation Status

Alaska's tundra habitat is generally healthy. Localized development will likely continue to result in habitat alteration. Opportunities should be sought that alleviate negative impacts and maintain connectivity, as well as suitable areas of quality habitat important to the sustainability of species.

Tundra habitats are increasingly susceptible to impacts from oil exploration and development, mining, transportation corridors, and associated human activities. This is particularly true in the Arctic North Slope region, where existing, proposed and active state and federal oil and gas leases continue to influence the Arctic ecosystems. Red Dog Mine, an active operation near the village of Kivalina, is currently the world's largest zinc mine.

Projects with potential impacts to jurisdictional tundra located with the state's designated coastal zone are subject to a review process via the ACMP that has historically been designed to avoid, minimize and mitigate impacts to wetland habitats, including tundra. Much of Alaska's tundra habitats are jurisdictional wetlands (see wetlands conservation status) subject to the regulatory authority of the COE under Section 404 of the Clean Water Act. Any placement of fill for road development, work pads, stream crossings, or material site development requires a permit from the COE which triggers a review by federal and state agencies and a public review under NEPA.

Best management practices and policies to avoid, minimize, and mitigate for unavoidable impacts to tundra habitats should be implemented at all levels of government. Cooperative working relationships, combined with expert knowledge regarding tundra habitats, are an important tool for managing and protecting these areas. Identifying and protecting areas important to maintaining fish and wildlife diversity should continue. In addition, citizens should be involved in the development of management agreements for the conservation and sustainable use of fish, wildlife and tundra landscapes.

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Appendix 5.3 Wetland Habitats

Featured Species-associated Wetland Habitats: Freshwater Grass Wetland, Freshwater Sedge Wetland, Bog, and Salt Marsh (Estuarine)

Wetlands are “edge” communities that contain poor soil drainage and represent a transitional zone between aquatic and terrestrial habitats. Alaska’s wetlands occupy 43.3% of the state’s 403,247,700 acres. This contrasts with the contiguous United States, where only 5.2% of the 1.9 billion acre land surface is composed of wetlands (Society of Wetland Scientists 1998). Wetland habitats in Alaska are numerous and complex; this conservation strategy highlights and provides simplified descriptions of a few of the wetland types found in Alaska. Alaska’s CWCS strategy focuses on 4 main types of wetlands: bog, grass wetland, sedge wetland, and salt marsh. Wetland habitats can be isolated, ephemeral, or located in riparian areas hydrologically connected to surface waters of rivers, streams, and lakes. Small wetlands, even those without visible surface connections, are joined to stream systems by ground water, subsurface flows of water, and periodic surface flows, such as spring runoff. Significant wetlands also occur along the coastline and adjacent to river deltas, and within forests throughout the state.

Wetlands are abundant in the valleys and basins associated with Alaska river systems, including the Yukon, Kuskokwim, Porcupine, Tanana, and Koyukuk Rivers. The major river deltas also possess large wetland areas. One of the world’s largest coastal deltas, the Yukon-Kuskokwim delta, supports several wetland types. Other predominant wetland deltas of Alaska include the Colville River delta on the Beaufort Sea Coast, the Copper River Delta in southcentral Alaska, and the Stikine River Delta in Southeast Alaska (Hall et al. 1994).

Bog habitats represent many thousands of years of wetland succession. In contrast to young freshwater wetland with only shallow organic material overlying mineral substrate, a bog consists of several feet of peat deposits. Bogs are characterized by spongy peat deposits, acidic waters, and an overlying vegetative layer of thick sphagnum moss. Peat forms when decomposing remains of mosses and sedges are left undisturbed and gradually accumulate as deep peat deposits. Bog habitat classifications include shrub-bog and forested-bog types, depending on successional stage of the landscape. Further classifications of Alaska’s bog habitat have been developed based on water supply, distribution, and physiognomy (Batten and Murray 1982). Most of Alaska’s wetlands are bogs, covering approximately 110 million acres.

Bogs receive most of their water from rainfall rather than from runoff, streams or ground water infiltration. As a result of this, and combined with acidic conditions, bogs are low in nutrients necessary for plant growth. Flora and fauna that live in bogs demonstrate many special adaptations to cope with the low nutrient levels, water-logged conditions, and acidic waters. Evergreens and shrubs are the most abundant woody plants found in bog habitats.


Matanuska-Susitna Valley bog pond M. LaCroix, DNR

Because bogs require a persistently wet and cool climate in order to allow the growth of peat-forming sphagnum mosses, they are predominantly found in the Northern Hemisphere. Bogs have recently been recognized for their role in regulating the global climate by storing large amounts of carbon in peat deposits. Bog habitats are particularly susceptible to destruction as they take hundreds of thousands of years to develop, yet they can be destroyed in a matter of days.

Bog habitats often support wetland tree species dominated by dwarf black spruce (*Picea mariana*) (less than 10 ft tall at maturity). Black spruce communities are common near tree line in the Interior, Southcentral, and western Alaska on cold, wet sites just barely capable of supporting trees. Dwarf tamarack (*Larex laricina*) and birch (*Betula papyrifera*) may also occur. Dwarf tree cover is 25–60 percent in these areas.

In Southeast Alaska, common bog tree species include lodgepole pine (*Pinus contorta*), Alaska-cedar (*Chamaecyparis nootkatensis*), and mountain hemlock (*Tsuga mertensiana*). Sitka spruce (*Picea sitchensis*) and western hemlock (*Tsuga heterophylla*) are the dominant bog tree species along the Gulf of Alaska coast.

Other dominant shrubs commonly present in Alaska's bog environs include sweet gale (*Myrica gale*), Alaska bog willow (*Salix fuscescens*), barclay willow (*S. barclayi*), leatherleaf (*Chamaedaphne calyculata*), resin birch (*Betula glandulosa*), and thinleaf alder (*Alnus tenuifolia*). Ericaceous shrubs that form loose mats may include *Kalmia polifolia* in Southeast Alaska and crowberry (*Empetrum nigrum*), bog blueberry (*Vaccinium uliginosum*) and mountain cranberry (*V. vitis-idea*), which are common in Interior, Southcentral and southwestern Alaska. Bog rosemary (*Andromea polifolia*) and bog cranberry (*Vaccinium oxycoccos*) may also be commonly present. Frequently occurring graminoid species include loose flower alpine sedge (*C. rariflora*) (Tande and Lipkin 2003), livid sedge (*Carex livida)*, water sedge

(*C. aquatilis*), many-flower sedge (*C. pluriflora*), mud sedge (*C. limosa*), Sitka sedge (*C. sitchensis*), boreal bog sedge (*C. magellanica*), gray sedge (*C. canescens)*, Lyngbye's sedge (*C. lyngbyaei*), and tufted bulrush (*Trichoporum caespitosum*). Other commonly occurring species include marsh five finger (*Potentilla palustris*), buckbean (*Menyanthes trifoliata*), and mare's tail (*Equisetum* spp.). In addition, species such as russet cottongrass (*Eriophorum russeolum*), cordroot sedge (*C. chordorrhiza*), and pond lily (*Nuphar polysepalum*) may also be present. Plant cover is generally complete, or nearly so, in bog habitats (Viereck 1972, 1992). Mosses (*Sphagnum* spp.) may account for 50–100% of the ground cover. Lichens may be present or absent.

Bog-associated Species

Olive-sided Flycatcher, *Contopus cooperi*
Rusty Blackbird, *Euphagus carolinus*
Solitary Sandpiper, *Tringa solitaria; T. s. cinnamomea* race breeds in Alaska
Lesser Yellowlegs, *Tringa flavipes*
Dragonflies and damselflies (Odonata)
Dragonflies, Suborder Anisoptera
Damselflies, Suborder Zygoptera
Wood Frog, *Rana sylvatica*

Grass wetlands are dominated (50% or greater) by water-tolerant grass species. The grasses may occur in clumps or tussocks and may be intermixed with pure stands of sedges, subjected to fluctuating water regimes. The wetter sites generally are hummocky. Woody plants and lichens are absent. Aquatic mosses may occur seasonally. The soil substrate associated with grass wetlands is generally organic or mineral rich. In addition to providing important wildlife habitat, they perform as ground water recharge areas, storing storm and floodwaters that help maintain minimum base flows critical for downstream aquatic resources.

Dry Creek grass wetlands, Matanuska-Susitna region
B. McCracken, ADF&G

Alaska's grass wetlands plant communities are classified as mesic graminoid herbaceous by Viereck et al. (1992). Examples include bluejoint-small bedstraw

(*Calamagrostis canadensis-Galium trifidum)* and Pacific reed grass-red fescue (*Calamagrostic nutkaensis-Festuca rubra)* dominated communities.

Grass Wetland-associated Species

Northern Harrier, *Circus cyaneus*
Short-eared Owl, *Asio flammeus*
Dragonflies and damselflies (Odonata)
Dragonflies, Suborder Anisoptera
Damselflies, Suborder Zygoptera
Water fleas - *Daphnia* spp. (Copepoda)
Western Toad, *Bufo boreas*
Columbia Spotted Frog, *Rana pretosia*
Wood Frog, *Rana sylvatica*

Southeast Alaska Endemic Species

Sitka tundra vole, *M. oeconomus sitkensis*
Long-tailed vole, *Microtus longicaudus/coronarius* complex
Admiralty Island meadow vole, *M. pennsylvanicus admiraltiae*
Admiralty Island beaver, *Castor canadensis phaeus*
Revillagigedo Island meadow jumping mouse, *Zapus hudsonicus*
Montane shrew, *Sorex monticolus complex*

Sedge wetland habitats are dominated (50% or greater) by tall sedges (*Carex* spp.), cottongrasses (*Eriophorum* spp.), rushes (*Juncus* spp.), or bulrushes (*Scirpus* spp.) and are typically inundated with water. Trees, shrubs, and lichens are absent, but aquatic mosses may be present (Viereck et al. 1992). Sedges make up the largest genus of plants in Alaska and consist of erect, rooted, water-loving vegetation. The USDA-NRCS (Tande and Lipkin 2003) National Plants Database identifies 155 species, subspecies and varieties of sedges in Alaska, of which 113 can be found in wetlands.

Spring Creek sedge wetland M. LaCroix, DNR

Sedge wetlands occur in very wet areas of floodplains, slow-flowing margins of ponds, lakes, streams, and sloughs and in depressions of upland areas throughout western, Interior, Southcentral, and Southeast Alaska and the Aleutian Islands

(Viereck et al. 1992), generally in organic-rich muck substrate. Common plant communities occurring in these areas include a list mainly from the species *Carex*, *Eriophorum*, or *Juncus.*

Other plant communities of sedge wetlands commonly found in Southcentral, Interior and Southeast Alaska include spike rush-mare's tail (*Eleocharis palustris-Hippuris vulgaris*), spike rush-spike watermilfoil (*Eleocharis palustris-Myriophyllum spicatum*), and spike rush-swamp horsetail-marsh horsetail (*Eleocharis palustris-Equisetum fluviatile-E. palustre*).

In the southern areas of the state sedge mats in water-filled lakes, ponds, and depressions are common and may consist of communities such as Russet cottongrass-white cottongrass (*Eriophorum russeolum-E. scheuchzeri*), cottongrass-buckbean (*Eriophorum* spp.- *Menyanthes trifoliata*), Russet cottongrass-Kellogg's sedge-bluejoint reedgrass (*Eriophorum russeolum-Carex kelloggii-Calamagrostis canadensis*), Russet cottongrass-mud sedge-bluejoint reedgrass (*Eriophorum russeolum-Carex limosa-Calamagrostis canadensis)*, mud sedge-creeping sedge (*Carex limosa-C. chordorrhiza*), mud sedge-hair-like sedge (*Carex limosa-C. capillaries*), many-flowered sedge-Russett cottongrass (*Carex pluriflora-Eriophorum russeolum*), Kellogg's sedge-silvery sedge (*Carex kelloggii-C. canescens*), and livid sedge-buckbean (*Carex livida-Meyanthes trifoliata*).

Sedge Wetland-associated Species

Red-necked Grebe, *Podiceps grisegena*
Horned Grebe, *Podiceps auritus*
Dragonflies and damselflies, Odonata
Dragonflies, Suborder Anisoptera
Damselflies, Suborder Zygoptera
Western Toad, *Bufo boreas*
Water fleas - *Daphnia* spp. (Copepoda)
Alaska blackfish, *Dallia pectoralis*
Threespine stickleback, *Gasterostius aculeatus*
Ninespine stickleback, *Pungitius pungitius*

Salt marshes are intertidal wetlands vegetated with sedges (*Carex* spp.), goose-tongue (*Plantago* spp.) and other salt-tolerant plants. The salt marsh ecosystem falls between the mean high watermark and the lower intertidal zone. Alaska has 345,000 acres of salt marsh wetlands (Doyle 1998) and has 33,000 miles of coastline. Yet salt marsh habitat in Alaska represents only two-tenths of one percent of the state's total wetlands, and only 4% of the total vegetated tidal marshes in the United States.

Salt marshes are typically located at river mouths; behind barrier islands, coves, and spits; and on tide flats where low energy wave action and fine sediment deposits provide elevated land for marsh vegetation to establish. They are located at mid to upper intertidal elevations and characterized by salt-tolerant plant communities such as certain types of sedges and grasses. Species composition and distribution patterns of salt marsh vegetation communities can vary distinctly based on differences in elevation, drainage, and soil type. Some of the nation's most extensive complexes of salt marsh habitat occur along the Alaska coast of the Beaufort Sea, Chukchi Sea, Bering Sea and the Gulf of Alaska (Society of Wetland Scientists 1998).

Common Alaska salt marsh species include hairgrass (*Deschampsia* spp.), and usually Bering hairgrass (*D. beringensis*). Hair grass communities are often found in the coastal areas of southern Alaska, typically in well-drained areas with mesic to dry soil characteristics. Salt-tolerant species of creeping alkali grass (*Puccinellia* spp.) and other halophytic forbs found along coastal marshes statewide include beach sandwort (*Honckenya peploides*), sea arrowgrass (*Triglochin maritimum*), sea plantain or goose-tongue (*Plantago maritima*), saltbush (*Atriplex* spp.), sand spurry (*Spergularia canadensis)* and scurvey grass (*Cochlearia officinalis*). These species are often codominant in their representation (Tande and Lipkin 2003; Viereck et al. 1992; Adam 1990).

Salt marsh, Knik Arm M. LaCroix, DNR

Lyngbye's sedge (*Carex lyngbyaei*) and many-flower sedge (*C. pluriflora*) represent the southern part of the state's coastal marsh habitat. Four-leaf marestail (*Hippuris tetraphylla*) and other salt-tolerant species such as fennel-leaf pondweed (*Potamogeton pectinatus*), ditch grass (*Ruppia spiralis*), or horned pondweed (*Zannichellia palustris*) may be present.

Coastal marshes in the northern part of the state support sedge species such as Ramensk's sedge (*Carex ramenskii*), Hoppner's sedge (*C. subspathacea*) and looseflower alpine sedge (*C. rariflora*).

Salt Marsh-associated Species

Zooplankton:
Copepods:
- *Neocalanus* spp.
- *Calanus* spp.
- *Acartia* spp.
- *Pseudocalanus* spp.
- *Oithona* spp.
- *Metridia* spp.
- *Podon* spp.
- *Evadne* spp.

Chaetognaths:
Sagitta elegans
Euphausiids
Amphipods
Pteropods
Cladocerans
Cnidarian medusae
Ctenophores
Meroplankton (benthic invertebrate larvae)
Merlin, *Falco columbarius*
Short-eared Owl, *Asio flammeus*
Tule White-fronted Goose, *Anser albifrons gambeli*
Lesser Yellowlegs, *Tringa flavipes*
Solitary Sandpiper, *Tringa solitaria*
Threespine stickleback, *Gasterostius aculeatus*
Ninespine stickleback, *Pungitius pungitius*
Broad whitefish, *Coregonus nasus*
Bering cisco, *Coregonus laurettae*
Pacific sand lance, *Ammodytes hexapterus*
Capelin, *Mallotus villosus*

Ecological Role of Wetlands

Local landscape features, including the hydrology, water quality, vegetation communities, soil features, and invertebrate communities, determine the biogeography of Alaska's wetland-associated species. Species differ in their resource requirements for the completion of life stages as well as in their spatial and temporal patterns of wetland use. Many species use more than one type of wetland habitat due to resource limitations of one that are offered by another.

Wetlands are one of the most productive habitats and are important in preserving the state's biological diversity. Alaska's wetland habitats are heavily used as summer staging and breeding grounds for hundreds and thousands of migratory birds that use all 4 North American flyways to reach their wintering grounds. The expansive and varied wetland habitats of the Copper River Delta (CRD), for example, are of international importance as staging areas for millions of migrating shorebirds. Large wetland areas such as the CRD are extremely valuable because they provide large, whole, and intact complexes. The Lesser Yellowlegs Sandpiper and Solitary Sandpiper eat freshwater aquatic insects, such as diving beetles, dragonfly nymphs, and flies, as well as sand fleas and intertidal amphipods provided by salt marsh wetlands. Waterfowl and waterbirds are wetland-dependent, and many species of songbirds nest and/or feed in wetland habitats. Numerous birds and small mammal species survive on the variety of seeds provided by wetland plants. Raptors and owls often frequent wetlands to forage. For example, species such as the Great Gray Owl search for unsuspecting prey in the clearings of bog habitat. Threespine and ninespine stickleback provide an essential prey source for piscivorous birds such as grebes. Fish use wetland habitat for spawning, rearing, and refugia. In turn, brown bears forage for returning salmon in these same locations. Amphibians breed in wetlands, and many spend their entire lives in wetlands.


Copper River Delta wetland B. McCracken, ADF&G

Damselflies and dragonflies also use wetlands as their breeding and feeding grounds, as well as for cover. They are impressive predators on insects, such as aphids and mosquitoes. The olive-sided flycatcher feeds almost exclusively on flying insects, especially bees, wasps, winged ants, aphids and beetles. Voles are year round meadow residents that eat meadow grasses and seeds. They build distinctive runways crisscrossing through the area. They also dig underground tunnels, where they construct food and nesting chambers. During the winter in snow-covered areas, the voles make runways beneath the snow and feed on the snow-flattened grasses. Voles and other small rodents are the staple foods of weasels, martens, foxes, coyotes, all owls, most hawks, inland breeding gulls, jaegers, and occasionally Great Blue Herons, domestic cats, northern pike, and other voles (Osborn 1994). Blue Grouse forage in bogs for berries and insects. Wetland grasses and sedges provide habitat structure for production of invertebrates, crustaceans, and insect larvae that many species of animals depend on.

Salt marsh habitat provides marine, freshwater and terrestrial species a host of resources that may vary with tidal stage. For some species, access to the salt marsh is essential to a life function, while other species use salt marshes more opportunistically. Salt marsh wetlands provide spawning and nursery habitat for many marine invertebrates and fishes, including forage fish species, such as stickleback, and commercially sought species, such as Dungeness crab and Pacific herring. Salt marsh zooplankton, such as copepods, play an essential role in the food web conversion between phytoplankton and larger animals. Copepods feed on most phytoplankton species and occasionally on the juvenile stages of smaller copepods. Herring and smelt feed on copepods and amphipods provided by the salt marsh. Across the state, salt marshes provide resting habitat for geese, ducks, and shorebirds during migration. Raptors, such as Merlin, search for small mammals seeking refuge in the salt marsh.

Although the salt marsh environment is harsh with regular fluctuations in salinity and water inundation, it provides a constant source of differing foods due to differential decomposition rates of resident plant species. This is an important difference not afforded by habitats having more seasonal availability of resources. Plant and animal species' ecological interaction plays a vital role in the healthy function of all wetland habitats. For example, wetland fauna facilitate decomposition of organic matter and enhance nutrient regeneration; they also serve as food for a variety of higher trophic levels.

Conservation Status

Alaska's wetland habitat is generally healthy. Localized development will likely continue to result in habitat alteration. Opportunities should be sought that alleviate negative impacts and maintain connectivity, as well as suitable areas of quality habitat important to the sustainability of species.

Threats to Alaska's wetlands include filling and dredging activities that fragment and block hydrologic processes and result in the elimination of and/or degradation of wetland habitat. These impacts are largely associated with transportation corridor construction, utility installation, natural resources extraction, and other development projects that result in wholesale wetland conversion.

Wetlands in Alaska are regulated through a permitting process administered under the Clean Water Act (CWA) by the EPA, through the COE. Pursuant to Section 404 of the CWA and Section 10 of the Rivers and Harbors Act, the COE regulates the placement of fill and certain ground-disturbing activities within jurisdictional wetlands. Under Section 404 any unauthorized discharge of dredged or fill materials from a point source into navigable waters of the United States is prohibited. The specific intent of Congress in implementing Section 404 of the CWA is to address wetland alteration. EPA investigates potential illegal wetlands destruction and permit violations. In addition, Section 301 of the CWA prohibits any person from discharging pollutants from a point source without a permit. The issuance of individual and "nationwide" permits for these activities is subject to public review. If a project in wetlands requires an individual permit and is also located within the state's designated coastal zone, then that project is also subject to a state coastal review. The state's review of federal authorizations is coordinated by DNR's Office of Project Management and Permitting (OPMP). The COE cannot issue an individual permit until the state has itself issued a determination that the proposed project is consistent with the state's own coastal standards (found in 11 Alaska Administrative Code [AAC] 112) and any applicable local coastal district standards (adopted pursuant to 11 AAC 114).

The Alaska Coastal Management Program is predicated upon and made possible by the federal Coastal Zone Management Act (CZMA) of 1972 (16 USC 1451-1465). The CZMA provides funding and regulatory structure for Alaska's program. The purpose of the state's program as articulated by its mission statement is to "provide stewardship for Alaska's rich and diverse coastal resources to ensure a healthy and vibrant Alaskan coast that efficiently sustains long-term economic and environmental productivity." Along the way, it provides the state and local coastal districts with the necessary tools to avoid, minimize, and mitigate for impacts to important and productive coastal resources, such as wetlands.

For federal regulatory and permitting purposes, the COE defines wetlands as "those areas that are inundated or saturated at a frequency and duration sufficient to support, and under normal conditions do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."

An important conservation action for Alaska's wetland habitat is to continue the effort of wetland mapping. Although wetlands are the predominant habitat in the state, wetland mapping and inventory status in Alaska is substantially behind efforts elsewhere in the nation. The USFWS National Wetlands Inventory (NWI) has finalized mapping for approximately 35% of Alaska's wetlands (W. Pearson, USFWS National Wetlands Coordinator, Anchorage, personal communication) (See NWI Region 7 map on page 14 of this appendix). The USFWS is required by Section 401 of the Emergency Wetlands Resources Act of 1986 to report each decade to Congress on the status and trends of the nation's wetlands. The USFWS published a report in 1994 entitled the *Status of Alaska's Wetlands* (Hall et al. 1994). This report is currently due for an update. Currently there are no statewide efforts to inventory and monitor the health of the state's wetland resources in terms of water quality. The USFWS defines wetlands as "lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. The single feature that most wetlands share is soil or substrate that is at least periodically saturated with or covered by water. The water creates severe physiological problems for all plants and animals except those that are adapted for life in water or in saturated soil."

The NWI mapping has limitations in that some wetland habitats are excluded from the NWI report including seagrasses or submerged aquatic vegetation found in the intertidal and subtidal zones of estuaries and nearshore coastal waters (i.e., salt marsh). In addition, Alaska's NWI is conducted at a 1:60,000 scale (G.F. Tande, personal communication); thus, many small yet important wetlands are undetected in the survey. These are important details to note as Alaska looks forward to the assessment of its own wetland resources.

The most recent wetlands status report, entitled *Status and Trends of Wetlands in the Conterminous United States,* covers the timeframe of 1986 to 1997 (Dahl 2000). A 2005 update to this report is scheduled for release by early 2006; however, neither Alaska nor Hawaii are included (G.F. Tande, personal communication). The information presented in this report provides a means to evaluate existing federal programs and policies, identify national or regional wetlands issues, and increase public awareness of and appreciation for wetlands. Alaska's wetlands losses continue to be unmonitored, and the state's baseline inventory has yet to be completed. Given the predominance of wetland habitats in Alaska and their value as essential habitat for many species, the completion of the state's wetland mapping inventory should be considered one of the most important conservation measures for implementation. An Alaska NWI would be instrumental in analyzing government policy, establishing state policy and legislation for the protection of wetland resources, and setting internal guidelines.

In addition to completing the state's wetland mapping inventory, wetland conservation actions should be created for activities such as timber harvesting and road construction, transportation corridors, grazing, development and recreation, agriculture, and mining. To complement the conservation measures, a robust mitigation plan should be developed and implemented for all unavoidable impacts that occur to wetland habitats. The mitigation plan should address 5 basic type of compensatory mitigation, including restoration, creation, enhancement, exchange, and preservation. Land acquisition is a beneficial means to protect wetland areas; however, it does not account for potential net loss of wetland habitat. Landowner incentives to protect wetland habitats should be encouraged.

Best management practices and policies to avoid, minimize, and mitigate for unavoidable impacts to wetland habitats should be implemented at the State and local government planning levels. Alaska's Duck Stamp Program, for example, provides annual funding for wetland acquisition and enhancement projects through the sale of state duck stamps and prints to the public. This program established in state law (AS 16.05.130) directs that money accruing to the state from hunters' waterfowl conservation tag fees may not be diverted to a purpose other than 1) the conservation and enhancement of waterfowl; 2) the acquisition, by lease or otherwise, of wetlands that are important for waterfowl and public use of waterfowl in the state; 3) waterfowl related projects approved by the commissioner; 4) the administration of the waterfowl conservation program, and 5) emergencies in the state as determined by the governor (The Biodiversity Partnership 2003).

Because Alaska's land ownership remains mostly in large blocks of state and federal holdings (approximately 64% federal, 25% state, 0.7% private, and 10% Native corporation; U.S. Department of the Interior 2004), it is conducive to implementing large-scale conservation efforts that minimize wetland loss and avoid disruption of drainage patterns and habitat fragmentation. In addition, best management practices adapted at the local and regional level can be particularly effective in protecting habitats under immediate pressure from developmental impacts.

Government agencies with water rights jurisdiction should strive to set minimum flow rates and levels for streams and lakes that maintain ecologically viable aquatic systems, including wetlands.

Wetland conservation actions that develop a better understanding of wetland-associated functions and the importance of wetlands to fish and wildlife species should include the efforts to identify the state's wetland-dependent species, including the less mobile species, for example, amphibians versus waterfowl. In addition, Alaska's should identify specific wetland habitats required of the associated species and focus on protection and restoration of these wetland types in complexes that account for the spatial requirements of species. Lastly, wetland studies that identify the specific hydrologic and ecologic role(s) of individual wetlands should be conducted.

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Appendix 5.4 Marine and Coastline Habitats

Featured Species-associated Intertidal Habitats: Rocky Intertidal, Mudflats and Beaches, and Eelgrass Beds

A swath of intertidal habitat occurs wherever the ocean meets the shore. At 44,000 miles, Alaska's shoreline is more than double the shoreline for the entire Lower 48 states (ACMP 2005). This extensive shoreline creates an impressive abundance and diversity of habitats. Five physical factors predominantly control the distribution and abundance of biota in the intertidal zone: wave energy, bottom type (substrate), tidal exposure, temperature, and most important, salinity (Dethier and Schoch 2000; Ricketts and Calvin 1968). The distribution of many commercially important fishes and crustaceans with particular salinity regimes has led to the description of "salinity zones," which can be used as a basis for mapping these resources (Bulger et al. 1993; Christensen et al. 1997). A new methodology called SCALE (Shoreline Classification and Landscape Extrapolation) has the ability to separate the roles of sediment type, salinity, wave action, and other factors controlling estuarine community distribution and abundance.

This section of Alaska's CWCS focuses on 3 main types of intertidal habitat: rocky intertidal, mudflats and beaches, and eelgrass beds. Tidal marshes, which are also intertidal habitats, are discussed in the Wetlands section, Appendix 5.3, of the CWCS.

Rocky intertidal habitats can be categorized into 3 main types: (1) exposed, rocky shores composed of steeply dipping, vertical bedrock that experience high-to-moderate wave energy; (2) exposed, wave-cut platforms consisting of wave-cut or low-lying bedrock that experience high-to-moderate wave energy; and (3) sheltered, rocky shores composed of vertical rock walls, bedrock outcrops, wide rock platforms, and boulder-strewn ledges and usually found along sheltered bays or along the inside of bays and coves.

Rocky substrate, moderate to strong wave and surf exposure, and a visible, vertical zonation pattern characterize rocky intertidal habitat. Colorful communities of invertebrates and algae grow in distinct horizontal bands dominated by rockweed, mussels, or barnacles. These species' physiological tolerance to desiccation and their competitive and predatory interactions with other species largely determine their vertical distribution. Although extensive research has been done on intertidal community structuring processes in temperate regions, including zonation patterns, disturbance processes, and adaptations of organisms, relatively little work has been done in sub-Arctic regions. One difference between temperate and sub-Arctic ecological processes is the pronounced seasonality of intertidal community composition and biomass. Dramatic seasonal changes, such as the cold winter air, shorter daylight, and long winters at or above 59 degrees north latitude (delineation of sub-Arctic), all contribute to the distribution and composition of the intertidal communities. Low light conditions in winter sharply reduce algal growth, which is dependent on sunlight, nutrient availability, length and time of immersion, air temperature, and wave action. Stress from temperature changes causes high interannual variability in living biomass. The effects of these changes range from annual senescence of kelp and other macrophytes (many of which live throughout the year in temperate climates) to extreme intertidal mortality of flora and fauna.


Rocky intertidal habitat at low tide, Port Graham T. Thompson, ADF&G

Macroalgal species grow in abundance during the spring and summer when extended daylight creates intense primary productivity. Their biomass supports communities that inhabit not only the rocky intertidal habitat, but also those of soft-bottom habitats (Lees et al. 1980). Direct consumers in the rocky intertidal habitat include chitons (*Mopalia muscosa*, *Tonicella lineata*), sea urchins (*Strongylocentrotus droebachiensis*), and grazing snails (*Littorina* spp. and *Siphonaria thersites*). After macroalgae die, they decompose and become detritus. Detritus forms the base of the food chain for soft-bottom habitats, and it serves as food for filter feeders, such as barnacles, in other habitats. Deposit- and filter-feeding worms, clams, and other invertebrates are food for birds and fish. The transfer of biomass from the rocky intertidal habitat to other habitats ties the health and productivity of kelp and rockweed in the rocky intertidal area to that of soft-bottom dwellers, such as Dungeness crabs (*Cancer magister*), and flatfish, such as halibut (*Hippoglossus stenolepis*) (Lees et al. 1980; Sanger and Jones 1984; ADF&G 1993).

The diversity and highly structured zonation of rocky intertidal communities fascinates researchers and tide-pool visitors. With ample primary productivity forming the basis of an abundant food supply, space is usually the most limiting resource in rocky intertidal communities (Ricketts and Calvin 1968). The distribution of species is governed by the competition for living space and the need to find food and shelter while avoiding predators and without drying out or suffering from intolerable extremes in heat or cold. For example, competition for space among mussels, barnacles, and rockweed leads to the formation of distinct bands dominated by these species. Although consolidated substrates do not allow animals to burrow, as they do in soft-bottom habitats, the cracks, crevices, overhangs, and rock bottoms create microhabitats in which to hide from predators, minimize wave shock, and avoid desiccation.

Rocky Intertidal–associated Species

Black Scoter, *Melanitta nigra Americana*
Surf Scoter, *Melanitta perspicillata*
White-winged Scoter, *Melanitta fusca deglandi*
Black katy chiton, black leather chiton, bidarki, urriitaq in Alutiiq, *Katharina tunicata*
Northern abalone, pinto abalone, Alaskan abalone, Japanese abalone, *Haliotis kamtschatkana*
Northern sea otter, *Enhydra lutris*
Black Oystercatcher, *Haematopus bachmani*
Sculpins (Cottid, Hemipterid, Rhamphocottid, Stichaeid, and Pholid families)
Pricklebacks
Gunnels


Shorebirds feeding in mudflat habitat ADF&G/KBRR

Mudflats and beaches are intertidal unconsolidated substrate habitats ranging from sheltered tidal flats to steep cobble beaches exposed to pounding waves. Each type of substrate supports a distinct biological community, including numerous species of clams, polychaete worms, amphipods, and other invertebrates. Sand and gravel beaches host similar taxa (with gravel-inhabiting forms adapted to coarser substrate), as well as sand dollars (*Echinarachnius parma*) and sand lance (*Ammodytes hexapterus*). Cobble beaches are subject to greater wave exposure, and fewer species are adapted to survive the stress of pounding waves and grinding substrate. However, when cobble provides a protective armor over a heterogeneous mixture of silt, sand, and other unconsolidated sediments, a rich infaunal community may live beneath it. Of the unconsolidated habitats, mudflats support the greatest species diversity and biomass, and cobble beaches support the fewest (Lees et al. 1980; Carroll and Highsmith 1994).

There are 5 “soft” intertidal habitat types: fine-grained sand beaches, coarse-grained sand beaches, mixed sand and gravel beaches, exposed tidal flats, and sheltered tidal flats. Fine-grained sand beaches usually are broad and gently sloping. Coarse-grained sand beaches are wide, steep beaches and are generally associated with river or stream mouths. Mixed sand and gravel beaches contain coarse-grained sands, gravel of varying sizes, and possibly shell fragments. Exposed tidal flats are composed of sand and/or gravel, and are associated with lagoons found at the heads of coastal bays. They are exposed to moderate wave and tidal energy and river freshwater inputs. Sheltered tidal flats contain soft mud or muddy sand. They occur at the heads of bays and in estuarine wetlands and are exposed to low wave activity and moderate tidal currents (NOAA 1999).

Mudflat and Beach–associated Species

Solitary Sandpiper, *Tringa solitaria; T. s. cinnamomea* race (breeds in Alaska)
Black Oystercatcher, *Haematopus bachmani*
Marbled Godwit, *Limosa fedoa* and subspecies *L. f. beringiae*
Lesser Yellowlegs, *Tringa flavipes*
Bristle-thighed Curlew, *Numenius tahitiensis*
Buff-breasted Sandpiper, *Tryngities subruficollis*
Rock Sandpiper, *Calidris ptilocnemis* subspecies Pribilof Sandpiper, *C. p. ptilocnemis,* subspecies Northern Rock Sandpiper, *C. p. tschuktschorum*
Long-tailed Duck, *Clangula hyemalis*
White-winged Scoter, *Melanitta fusca deglandi*
Surf Scoter, *Melanitta perspicillata*
Black Scoter, *Melanitta nigra americana*
Arctic Tern, *Sterna paradisaea*
Song Sparrow, *Melospiza melodia maxima*
Pacific sand lance, *Ammodytes hexapterus*
Capelin, *Mallotus villosus*
Eulachon, *Thaleichthys pacificus*
Pacific sandfish, *Trichodon trichodon*
Sculpins (Cottid, Hemipterid, Rhamphocottid, Stichaeid, and Pholid families)
Pricklebacks
Macoma spp.
Clinocardium spp.
Serripes spp.
Mactromeris spp.

Underwater eelgrass beds, Kachemak Bay ADF&G/KBRR

Eelgrass (*Zostera marina*) grows in beds (clusters) in low intertidal and shallow subtidal sandy mudflats. Like a coral reef or kelp forest, the physical structure of the eelgrass beds provides increased living substrate and cover for myriad invertebrates and fish. The beds also generate food and nutrients for the soft bottom community through primary productivity and plant decay. Unlike kelp, eelgrass is a flowering, marine vascular plant. The size, shape, and density of the eelgrass beds vary from season to season. Eelgrass is sensitive to turbidity and changes in water quality. The depth to which it grows is limited by light penetration. The encrusting algae and invertebrates on the eelgrass blades (epibiota) are as important as the plant itself as a food source for other species. Although eelgrass blades die in the fall, the roots and rhizomes remain dormant through the winter. The perennial root and rhizome systems stabilize the fine substrate sediments, buffering the erosive forces of tidal flushing and seasonal storms (McConnaughey and McConnaughey 1985). This interannual stability allows eelgrass to come back in following years, providing a relatively consistent food source and substrate for the seasonal crop of epibiota. In Alaska, eelgrass beds are distributed along sheltered, shallow portions of the coastline, from Southeast Alaska to the Seward Peninsula. Izembek Lagoon, located on the tidelands and submerged lands of the Izembek State Game Refuge (See Figure 35, Page 131 of CWCS), is the site of one of the largest eelgrass beds in the world. The adjacent Izembek National Wildlife Refuge protects the watershed of Izembek Lagoon, including Applegate Cove and Moffet Lagoon.

Eelgrass Bed-associated Species

Black Scoter, *Melanitta nigra Americana*
Helmet crab, *Telmessus cheiragonus*
Surf Scoter, *Melanitta perspicillata*
Kelp crabs, *Pugettia* spp.
White-winged Scoter, *Melanitta fusca deglandi*
Horse clams, *Tresus capax*
Sculpins (Cottid, Hemipterid, Rhamphocottid, Stichaeid, Pholid families)
Spionid polychaetes
Gunnels
Sea cucumbers, *Parastichopus californicus*
Eelgrass shrimp, *Hippolyte clarki*
Nudibranchs: *Melibe leonine*
Hydroids, *Obelia* spp.
Bivalves:
    Macoma spp.
    Mactromeris spp.
Dungeness crab, *Cancer magister*
Snails, *Lacuna* spp.
    Serripes spp.
Caprellid amphipods

Ecological Role of Intertidal Habitats

Alaska's expansive and varied coastline, numerous freshwater sources, and diverse geomorphology combine to form many intertidal habitat types.

Rocky intertidal habitat supports a diverse and conspicuous assemblage of invertebrates and luxuriant macroalgal growth that produce more organic material than almost any other intertidal habitat (Lees et al. 1980). The uppermost intertidal band, the splash zone, is only occasionally wetted by waves. Periwinkle snails (*Littorina scutulata* and *L. sitkana*) characterize the uppermost reach of this zone. They share the splash zone with a few acorn barnacles (*Balanus glandula*) and patches of black lichen (*Verrucaria* sp.). Below the splash zone is the upper intertidal zone with its lower reaches characterized by a thick band of rockweed (*Fucus gairdneri*). The upper intertidal zone is exposed to air daily, so the organisms found here, such as the beach hoppers, periwinkle snails, and acorn barnacles, must be adapted to temperature, desiccation, and other stresses caused by exposure. The next zone, the mid intertidal, is periodically covered by higher low tides, offering plant and animals species here some protection from desiccation. Mussels (*Mytilus trossulus*) dominate here, but they share space with rockweed and both acorn and thatched barnacles (*Balanus cariosus*). Black leather chitons (*Katherina tunicata*) are common grazers, especially in the lower mid intertidal zone. Breadcrumb sponges (*Halichondria panicea*), hermit crabs (*Pagurus* spp.), dogwinkle snails (*Nucella* spp.), sea stars, and limpets (*Cryptobranchia* spp.) are also common in the mid intertidal zone. Thatched barnacles often dominate space in the lower intertidal zone, and black leather chitons are common here as well. Lush kelps (*Alaria fistulosa*), red algae (*Odonthalia* spp.), frilled anemones (*Metridium senile*), Christmas anemones (*Urticina crassicornis*), and sea stars (*Evasterias troschelii*, *Leptasterias polaris*) are commonly found in the lower intertidal zone (Carroll and Highsmith 1994).

Mudflats are an important stopover for migrating birds such as Western Sandpiper (*Calidris mauri*) and Dunlin (*Calidris alpina*), which depend on ice-free foraging grounds during their spring migration. The sandpipers are among the millions of migrating shorebirds that focus on baltic macoma (*Macoma balthica*), a small clam that can provide up to 30 percent of the birds' diet during migration (Senner and West 1978). Clams are also an important food source for waterfowl such as Greater Scaups (*Aythya marila*), Long-tailed Ducks (*Clangula hyemalis*), Surf Scoters (*Melanitta perspicillata*), and Black Scoters (*M. nigra*), which feed on the mudflats throughout the winter (Sanger 1983; Lees et al. 1980). Harbor seals (*Phoca vitulina*) also use mudflats and protected beaches as haulout areas (ADF&G 1993). Mudflats and beaches play an important, but poorly understood, role as nursery and spawning habitat for several commercially and recreationally important fish and invertebrates, including Pacific herring (*Clupea pallasi*), Tanner crabs (C*hionoecetes bairdi*), and Dungeness crabs (*Cancer magister*). Pacific herring spawn in the intertidal mudflats and in the mixed sand, gravel, and mud beaches. They are an important prey for birds, marine mammals, and predatory fish. Sand and gravel beaches provide spawning habitat for capelin (*Mallotus villosus*) and sand lance (*Ammodytes hexapterus*), two primary food sources for seabirds (Sanger 1983).

Dense eelgrass beds serve as a refuge from predators for small fish, such as sculpins and gunnels, and invertebrates, such as kelp crabs (*Pugettia* spp.), helmet crabs *(Telmessus cheiragonus*), spionid polychaetes, sea cucumbers (Parastichopus californicus), eelgrass shrimp (*Hippolyte clarki*), nudibranchs, including *Melibe leonine*, hydroids (*Obelia* spp.), clams (*Macoma* spp., *Mactromeris* spp., *Serripes* spp., *Tresus capax*), snails (*Lacuna* spp.), and caprellid amphipods. Many commercial and recreationally important species, such as herring (*Clupea pallasi*), Dungeness crab (*Cancer magister*), horse crabs (*Telmessus cheiragonus*), and juvenile salmon (*Onchorhynchus* spp.), use eelgrass as a nursery area. Herring spawn on eelgrass, laying as many as 3 million eggs per eelgrass blade in the spring (Hood and Zimmerman 1986). The nutritious eggs attract gulls, scoters (*Melanitta nigra Americana*, *M. perspicillata*, *M. fusca deglandi*), and other birds and fish. Some species of ducks and geese, such as the Pacific brant (*Branta bernicla*), consume the plant directly, while others forage among the leaves for epifauna. Brant depend on eelgrass for food during their long migration from Baja California to Alaska and Canada. Almost the entire population of brant congregates each fall and spring to forage at Izembek Lagoon.

Eelgrass meadows occur in shallow water, near the shore; as a result they are threatened by some types of coastal development activities. The plant is vulnerable because it has a narrow tolerance for turbidity, sediment disturbance, and eutrophication, as well as a need for high ambient light. Sedimentation and water quality impacts from coastal development and logging contribute to turbidity. Excess nutrients from wastes, fertilizers, or other sources promote the growth of epiphytic algae on eelgrass and phytoplankton in the water column. Decreased light penetration reduces eelgrass photosynthesis and growth. Changes in sedimentation patterns, propeller wash from boats, and other physical disturbances can smother or uproot eelgrass from the fine sediments in which it grows. Although these threats have been documented in the Pacific Northwest and on the east coast of the United States (Wyllie-Echeverria and Thom 1994), their potential impacts have received little attention in Alaska.

Intertidal Habitats Conservation Status

While terrestrial ecosystems may contain geographic and other barriers, the seamless nature of the marine environment presents unique management challenges. Marine ecosystems are open, and everything from rich fishery stocks to oil slicks can pass easily from one place to another. Inputs and changes in physical, chemical, and biological interactions affecting the marine ecosystems have spatial scales—ranging from the Pacific Ocean to a local geographic area such as a particular cove—and temporal scales—ranging from decades to one tidal cycle. Environmental changes in the Pacific Ocean affect local fisheries production, offering a prime example of how local issues may be controlled by global processes (Francis et al. 1998; Hare et al. 1999; Anderson and Piatt 1999). No marine organism or part of the ocean can be considered a discrete unit. Conservation actions should carefully consider aggregation sites and convergences that often represent areas of high productivity, including for the transport and dispersal of larva (Beck 2003).

Conservation concerns for intertidal habitats include shoreline development, invasive species, acute and chronic pollution, and overharvest. Shoreline stabilization, residential and commercial shoreline development, dredging to aid marine transportation, and other human activities can destroy intertidal and shallow subtidal habitats and biological communities. Human activities can indirectly impact communities by introducing new species through ballast water, fouled communities on hulls, and aquaculture. Oil spills cause lasting damage to marine communities, as demonstrated by the 1989 Exxon Valdez oil spill. Heavy metals and other toxins accumulate in filter-feeding invertebrates, such as clams and mussels, and make their way up the food chain to contaminate humans and other predators. However, air- and sea-borne contaminants reach Alaska from distant shores as well as local sources, making their control difficult. Some biological effects of oiling on Cook Inlet's intertidal environments are discussed in Lees et al. (1980). Complex policy issues, such as protecting sensitive resources from pollution and managing international fisheries, such as salmon and halibut, require a broad biological, legal, political, and economic understanding. However, a general lack of baseline data and a poor understanding of natural variability make it difficult to determine natural versus anthropogenic impacts. While researchers and managers have studied the fisheries of crab, shrimp, and halibut, the dearth of information on noncommercial species in intertidal habitats greatly limits our ability to understand and respond to natural and anthropogenic changes. Large-scale ecosystem monitoring efforts, such as the GEM Program, funded by the EVOS Trustees Council, will increase our understanding of large-scale patterns in the marine environment. Research focused on species assemblages should focus on understanding the links between these large-scale patterns and local community patterns.

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Featured Species-associated Coastal Islands and Sea Cliffs

Alaska has over 5 million of acres of spectacular islands and sea cliffs, spreading along its 64,400 km (44,000 mi) coastline, from the Alaskan Panhandle in the southeast, around the Gulf of Alaska, across the Aleutian Islands, and north through the Bering Sea to above the Arctic Circle. Past and present volcanic activity shapes these islands, creating features such as calderas, craters, cone-shaped peaks, hot springs, ash falls, and lava flows.

The islands of Southeast Alaska are part of the temperate rain forest region, receiving close to 700 cm (300 in) of rain annually. At elevations below 500 m, dense conifer forests cloak the islands with lush undergrowth of ferns and mosses. The climate becomes harsher toward the north, and the islands are treeless. The Aleutian Island chain extends from the Alaska Peninsula almost 1500 km to the west. Located between the Bering Sea and the Gulf of Alaska, it is composed of sedimentary islands capped by steep volcanoes, with elevations ranging from sea level to more than 1900 m. The higher volcanoes are glaciated (World Wildlife Fund 2001). Dwarf willow shrubs occur on some islands, their prostrate form gripping the ground because of the strong winds. Carpets of tiny wildflowers also bloom close to the ground. The marine tundra Aleutian vegetation is composed of species from both the North American and Asian continents, dominated by heath, grass and composite families. In general, 3 plant communities can be distinguished: beach communities, lowland tundra, and upland tundra (UNESCO 2005). Seals, sea lions, walruses, sea otters and seabirds (over 40 million of 30 different species) make Alaska's coastal islands their home for at least part of the year, taking advantage of protection from predators and abundant forage fish in the surrounding oceans.

Coastal Island and Sea Cliff-associated Species

Red-legged Kittiwake, *Rissa brevirostris*
Red-faced Cormorant, *Phalacrocorax urile*
Black-legged Kittiwake, *Rissa tridactyla*
Pacific Common Eider, *Somateria mollissima v-nigra*
Common Murre, *Uria aalge*
King Eider, *Somateria spectabilis*
Thick-billed Murre, *Uria lomvia*
Spectacled Eider, *Somateria fischeri*
Leach's Storm-Petrel, *Oceanodroma leucorhoa*
Steller's Eider, *Polysticta stelleri*
Fork-tailed Storm-Petrel, *Oceanodroma furcata*
Black Scoter, *Melanitta nigra Americana*
Least Auklet, *Aethia pusilla*
Surf Scoter, *Melanitta perspicillata*
Crested Auklet, *Aethia cristatella*
White-winged Scoter, *Melanitta fusca deglandi*
Black Swift, *Cypseloides niger*
Marbled Murrelet, *Brachyramphus marmoratus*
Sculpins (Cottid Hemipterid, Rhamphocottid, Stichaeid, Pholid families)
Kittlitz' Murrelet, *Brachyramphus brevirostris*
capelin, *Mallotus villosus*
Arctic Tern, *Sterna paradisaea*

eulachon, *Thaleichthys pacificus*
Aleutian Tern, *Sterna aleutica*
Gunnels
Pacific sand lance, *Ammodytes hexapterus*

Ecological Role of Coastal Islands and Sea Cliff Habitats

St. Lazaria Island USFWS

Abundant forage fish, such as Pacific sand lance, juvenile Pacific herring, juvenile walleye pollock, smelts, and juvenile salmonids, provide ample food supplies for the seabirds and marine mammals that make the coastal islands their home. Forage fish provide an important link in the marine food web by transferring energy from the ocean's rich plankton populations to top predators, such as seabirds and larger fish.

The many cliffs and islands serve as protected habitat for nesting seabirds and marine mammals. About 50 million seabirds nest in more than 2500 colonies on Alaska's coast each summer. This is 87% of all the seabirds in the United States. Most seabirds rest and sleep on the rolling waves, but some roost on land for a few hours a day. They gather their food from the sea either as individuals or in large feeding flocks. All seabirds lay their eggs and raise their young on land. The seas near Alaska supply rich sources of food for the birds and their offspring (USFWS 2005). Many bird species, such as Red-legged Kittiwakes, nest only in Alaska and nearby Siberia. The Pribilof Islands provide breeding habitat for virtually all of the world's 250,000 Red-legged Kittiwakes (*Rissa brevirostris*). The Aleutian Islands provide nesting habitat for more than 21 kinds of seabirds, including the Aleutian Cackling (Canada) Goose *(Branta canadensis leucopareia),* an endemic that nests only there. The Aleutians also host the world's largest nesting populations of Least Auklets and Northern Fulmars. The only northern fur seal breeding beaches in the United States are on the Bogoslof Island in the Aleutians and in the Pribilof Islands. Many of the Aleutian Islands also support the Pribilof Island shrew (*Sorex hydrodromus*) and the endangered Aleutian shield fern (*Polystichum aleuticum*), both of which are endemic to the islands.

Coastal Islands and Sea Cliffs Conservation Status

The Alaska Maritime National Wildlife Refuge (AMNWR) encompasses many of Alaska's coastal islands, headlands and reefs. Almost all of the Aleutian Islands are included in the refuge, and many areas are also included in the Aleutian Islands

Wilderness. Small areas already developed were excluded from AMNWR or wilderness designation. The Aleutian Islands, a group of more than 200 islands, were designated a Biosphere Reserve—an international recognition given by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1976. Despite the protected status of the land, many of the animal species that live on the islands are threatened by potential or actual threats to the surrounding marine environment on which they are intrinsically dependent. The conservation problem of most concern is the decline in almost all species of fish-eating seabirds in the Aleutians. Mortality and population declines of numerous fish-eating seabird populations has been linked to trophic changes in the Bering Sea ecosystem due to commercial harvests of fish and whales over the last 4 decades, according to a study by the National Research Council (1996). The recent oil spill resulting from the grounding of the Selendang Ayu, off of Unalaska Island in the Aleutians, reminds us of the real threats these remote islands face from marine pollution. Other threats to Alaskan coastal islands and cliff habitats include habitat degradation and conversion from cattle and reindeer introduced for ranching; and predation on seabird colonies by foxes, also introduced for ranching. ANMWR engages in continuing efforts to eradicate rats, which are introduced predators of seabird colonies. Pollutants, associated primarily with military development, are locally acute. According to studies conducted by Greenpeace in 1996, radioactivity persists from the nuclear testing on Amchitka Island in 1971.

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Featured Species-associated Marine Water Habitats: Nearshore, Shelf, Oceanic and Benthic

Marine water habitats are typically subdivided into pelagic, meaning the water column from the surface to the greatest depth, and benthic, encompassing the sea floor. The pelagic environment can be further divided into the nearshore, which includes everything inshore from 20 m depth; the shelf, which includes everything from 20 to 200 m in depth; and the oceanic, which encompasses the ocean deeper than 200 m. Alaska’s vast offshore waters are located in subpolar and polar regions; these areas are characterized by extreme seasonal variation in light availability, generally low surface water temperatures, and seasonal variability of sea ice cover. At the low temperatures found off Alaska, salinity generally controls the density structure. Cooling of surface water temperatures and vigorous wind mixing caused by storms promote vertical mixing. This creates an environment where nutrients are generally abundant, especially in surface waters of upwelling regions.

Phytoplankton, or microscopic marine plants, are the driving force of marine productivity, providing 99% of the direct food consumed by marine organisms. There are tens of thousands of species of phytoplankton. A sampled phytoplankton assemblage always consists of many species; however, one species is often dominant. Individual phytoplankton species favor slightly different light intensity levels, temperatures, and nutrient concentrations. Under favorable conditions, one or more species may reproduce rapidly (within hours or days) and become dominant. When conditions change, another species may prosper, so that phytoplankton communities can vary dramatically in composition and density within very short time frames. With nutrients generally available due to upwelling, phytoplankton are able to grow quickly and are abundant when light is available. However, in Alaska light availability exhibits extreme seasonal variability in intensity and duration so that the period of ideal growing conditions for phytoplankton may be limited to a few weeks or months. The upwelling and wind mixing that supply the nutrients to surface waters may also be a limiting factor for the residence time of phytoplankton in the surface waters, by dispersing patches of phytoplankton.

The unique physical characteristics of polar marine environments have resulted in many species of fish, marine mammals, and birds sharing certain life-history characteristics. Many animals migrate seasonally, taking advantage of the highly productive short summer season and moving to other environments during the winter. Many polar marine animals are long-lived and have only 1–2 offspring per year. This ensures that the species will persist during periods of low food supply, even if no offspring survive. Another common characteristic of Alaskan marine animals is the capacity to store energy, commonly as fat, to survive periods when food is unavailable.

This section of Alaska’s CWCS focuses on 4 main types of pelagic habitat: the nearhore, shelf, and oceanic environments; and the benthic environment.

Nearshore habitat is the water column between the sea surface and seafloor in water depths up to 20 m. It includes the subtidal area adjacent to the intertidal zone. Nearshore areas have greater variability in salinity, temperature, suspended sediment concentrations, and ice scouring than shelf or oceanic habitats. Wave energy is generally higher in the nearshore than in the deeper ocean because of breaking waves. Winds, freshwater input, ice current patterns, and tides drive seasonal cycles of mixing and turnover in the water column; the column may be strongly stratified during one season and strongly mixed during another, depending on environmental conditions. Fresh water from glacial rivers carries a heavy load of fine sediments that decreases light penetration and biological productivity in turbid areas. Where waters with contrasting density, salinity, and other characteristics meet, floating debris and kelp may mark a rip line. Such boundary areas often contain a greater abundance of fish, birds, and marine mammals.

Nearshore kelp forest ADF&G/KBRR

Kelp forests growing in the nearshore habitat provide habitat structure, living substrate, cover, and microhabitats, as well as primary productivity to fuel growth. Some kelp species are perennials; however, many are annuals that die back during the dark, long winters. Although the extent of these forests varies from year to year, kelp contributes substantial primary productivity and habitat complexity to the marine ecosystem. The seasonal die-off contributes a strong pulse of detritus to the ecosystem during low-light winter months, supporting detritivores and upper trophic levels when primary productivity in the water column wanes. Eelgrass beds, which may also be considered part of the nearshore habitat, are discussed in the Intertidal Section of this appendix.

Nearshore Marine-associated Species

Red-legged Kittiwake, *Rissa brevirostris*
Red-faced Cormorant, *Phalacrocorax urile*
Black-legged Kittiwake, *Rissa tridactyla*
Pacific Common Eider, *Somateria mollissima v-nigra*
Common Murre, *Uria aalge*
King Eider, *Somateria spectabilis*
Thick-billed Murre, *Uria lomvia*
Spectacled Eiders, *Somateria fischeri*
Leach's Storm-Petrel, *Oceanodroma leucorhoa*
Steller's Eider, *Polysticta stelleri*
Fork-tailed Storm-Petrel, *Oceanodroma furcata*
Surf Scoter, *Melanitta perspicillata*
Least Auklet, *Aethia pusilla*
White-winged Scoter, *Melanitta fusca deglandi*
Crested Auklet, *Aethia cristatella*
Pacific sand lance, *Ammodytes hexapterus*
Marbled Murrelet, *Brachyramphus mamoratus*
Capelin, *Mallotus villosus*
Kittlitz' Murrelet, *Brachyramphus brevirostris*
Eulachon, *Thaleichthys pacificus*
Pacific sandfish, *Trichodon trichodon*
Arctic Tern, *Sterna paradisaea*
Aleutian Tern, *Sterna aleutica*
Leatherback Seaturtle, *Dermochelys coriacea*
Northern abalone, pinto abalone, Alaskan abalone, Japanese abalone, *Haliotis kamtschatkana*
Sculpins (Cottid, Hemipterid, Rhamphocottid, Stichaeid, and Pholid families)
Pricklebacks
Gunnels
Prowfish, *Zaprora silenus*
Arctic cod, *Boreogadus saida*
Copepods: *Neocalanus* spp., *Calanus* spp., *Acartia* spp., *Psuedocalanus* spp., *Metridia* spp., *Podon* spp., *Evadne* spp., *Oithona* spp.
Euphausiids
Amphipods
Cladocerans
Cnidarian medusae
Ctenophores
Gray whale, *Eschrichtius robustus*
Northern sea otter, *Enhydra lutris*
Cook Inlet beluga whales, *Delphinapterus leucas*
Polar bear, *Ursus maritimus*
Walrus, *Odobenus rosmarus*
Bearded seal, *Erignathus barbatus*

Shelf habitat refers to the continental shelf that lies at the edge of the continent; it includes waters greater than 20 m but less than 200 m deep. Continental shelves are nearly flat borders of varying widths that slope very gently toward the ocean basins. The width of the continental shelf varies. Shelf widths are typically greater in areas of passive continental margins, where there is little seismic or volcanic activity, because these areas are where continents are rifted apart, creating an ocean basin between them. Narrower continental shelves occur in areas of active continental margins, where plate convergence and subduction are occurring. Alaska has relatively narrow continental shelf habitat from Southeast to the southern boundary of the Aleutian Islands, and relatively wide continental shelf habitat in the Bering, Chukchi and Beaufort Seas. Shelf habitats are characterized by high productivity that supports a wide range of animals.

Continental Shelf-associated Species

Red-legged Kittiwake, *Rissa brevirostris*
Black-legged Kittiwake, *Rissa 'tridactyla*
Common Murre, *Uria aalge*
Thick-billed Murre, *Uria lomvia*
Leach's Storm-Petrel, *Oceanodroma leucorhoa*
Fork-tailed Storm-Petrel, *Oceanodroma furcata*
Least Auklet, *Aethia pusilla*
Crested Auklet, *Aethia cristatella*
Marbled Murrelet, *Brachyramphus mamoratus*
Kittlitz' Murrelet, *Brachyramphus brevirostris*
Arctic Tern, *Sterna paradisaea*
Aleutian Tern, *Sterna aleutica*
Myctophids (lantern fish), Myctophidae
Prowfish, *Zaprora silenus*
Arctic cod, *Boreogadus saida*
Copepods:
Neocalanus spp.
Calanus spp.
Acartia spp.
Metridia spp.
Oithona spp.
Psuedocalanus spp.
Chaetognaths:
Sagitta elegans
Euphausiids
Polar bear, *Ursus maritimus*
Cnidarian medusae
Walrus, *Odobenus rosmarus*

Jellyfish under Arctic ice
Oceanic and Atmospheric Research (OAR)
National Underseas Research Program

Pteropods
Bearded seal, *Erignathus barbatus*
Amphipods
North Pacific right whale, *Eubalaena japonica*
Ctenophores
Ringed seal, *Phoca hispida*
Blue whale, *Balaenoptera musculus*
Spotted seal, *Phoca largha*
Humpback whale, *Megapetera novaeangliae*
Gray whale, *Eschrichtius robustus*
Sei whale, *Megaptera novaeangliae*
Bowhead whale, *Balaena mysticetus*

Oceanic habitats begin at the abrupt change in slope that occurs at the boundary of the continental shelf on the ocean side. The steep slope extending to the ocean basin floor is called the continental slope. Oceanic habitats include several layers of water that each has distinct characteristics of salinity, temperature, and light intensity. The epipelagic zone, which extends between the surface and 200 m depth, is the only area where food can be directly produced by photosynthesis in the open ocean. Below this, the source of food is primarily from detritus falling from the epipelagic zone. Minor additional food sources include vertically migrating animals and chemosynthesis at hydrothermal vents. Alaska has vast oceanic habitats associated with its extensive coastline.

Oceanic-associated Species

Red-legged Kittiwake, *Rissa brevirostris*
Black-legged Kittiwake, *Rissa tridactyla*
Common Murre, *Uria aalge*
Thick-billed Murre, *Uria lomvia*
Leach's Storm-Petrel, *Oceanodroma leucorhoa*
Fork-tailed Storm-Petrel, *Oceanodroma furcata*
Least Auklet, *Aethia pusilla*
Crested Auklet, *Aethia cristatella*
Marbled Murrelet, *Brachyramphus mamoratus*
Kittlitz' Murrelet, *Brachyramphus brevirostris*
Arctic Tern, *Sterna paradisaea*
Aleutian Tern, *Sterna aleutica*
Leatherback Seaturtle, *Dermochelys coriacea*
Copepods:
Neocalanus spp
Calanus spp.
Psuedocalanus spp.
Acartia spp.
Metridia spp.
Oithona spp.
Amphipods
North Pacific right whale, *Eubalaena japonica*
Baird's beaked whale, *Berardius bairdii*

Underwater humpback whale
OAR, National Undersea Research Program; University of South Carolina at Wilmington

Chaetognaths: *Sagitta elegans*
Bowhead whale, *Balaena mysticetus*
Sagitta elegans
Ctenophores
Euphausiids
Blue whale, *Balaenoptera musculus*
Humpback whale, *Megapetera novaeangliae*
Cnidarian medusae
Cuvier's beaked whale, *Ziphius cavirostris*
Sperm whale, *Physeter macrocephalus*
Sei whale, *Megaptera novaeangliae*
Fin whale, *Balaenoptera physalus*
Stejneger's beaked whale, *Mesoplodon stejnegeri*

Benthic habitats include all of the seafloor environments, extending from edge of the land to the deepest ocean trench. For the purposes of the CWCS, we are only including the benthic environment between the continental shelf break, (200 m water depth) and the low-tide zone. This part of the benthic area is called the "sublittoral zone" by oceanographers. The benthic area between low tide and the high tide line is covered under the Intertidal section of this plan. The habitat of the sublittoral zone environment can be soft-bottom (mud, sand, shell, gravel) shell debris or rocky. Benthic communities include infauna, which are organisms that live within sediments, and epifauna, which are organisms that live on sediments. In general, benthic mapping information for Alaska is very limited.

Cold-water corals form important benthic habitat in the Gulf of Alaska and off the coast of the Aleutian Islands. These coral gardens include more than 100 species of coral and are comparable in size and structure to tropical coral reefs. The Aleutian Islands have the highest coral diversity of Alaska's waters. Some of these corals have a tree-like structure and can reach heights of 3 m and widths of 7 m. Unlike many other corals, deep-sea Alaska corals don't need light to grow. Growing on the ocean floor in depths of 200 m or more, the corals acquire all the nutrients they need directly from the water column.

Benthic Habitat–associated Species

Pacific sand lance,
 Ammodytes hexapterus
Capelin, *Mallotus villosus*
Eulachon, *Thaleichthys pacificus*
Pacific sandfish,
 Trichodon trichodon
Sculpins (Cottid, Hemipterid, Rhamphocottid,
Stichaeid, and Pholid families)

Typical bottom view of urchins and mussels at 25 m.
Yury A. Zuyev, Hydrometeorological Institute, St. Petersburg, Russia

Pricklebacks
Class Bivalvia:
 Macoma spp.
 Clinocardium spp.
 Serripes spp.
Corals, Tunicates and Sponges:
 Phylum Porifera
  Mactromeris spp.
 Phylum Cnidaria:
  Octocoral Families: Corallidae, Isididae, Paragorgiidae, Pennatulidae, Primnoidae
  Hexacoral Families: Antipathidae, Oculinidae, Caryophylliidae
  Hydrocoral Family: Stylasteriidae

Ecological Role of Marine Water Habitats

The pelagic open water environment of nearshore, shelf, and oceanic habitats provides important nursery, feeding, and resting habitat for numerous seabirds, fishes, marine mammals, and of course, plankton. In the shallower waters of the nearshore, photosynthesis may take place on the seafloor. In both locations, primary production by benthic organisms creates some food, but the vast majority of food in the pelagic zone is produced by phytoplankton through the act of photosynthesis. These phytoplankton are grazed upon by zooplankton, which in turn are consumed by carnivores and omnivores. Common zooplankton in these habitats include species of *Neocalanus*, *Metridia*, *Acartia, Pseudocalanus, Calanus,* plus euphausiids, amphipods, cnidarians, ctenophores, and cladocerans. The chaetognath *Sagitta elegans* occurs mainly in the shelf environment (K. Coyle, pers. comm.). Fish such as Pacific sand lance (*Ammodytes hexapterus*), capelin (*Mallotus villosus*), eulachon (*Thaleichthys pacificus*), Pacific sandfish (*Trichodon trichodon*), sculpin (Cottid, Hemipterid, Rhamphocottid, Stichaeid, and Pholid families), lantern fish (myctophids), prowfish (Myctophidae), and Arctic cod (*Boreogadus saida*) are common. These fish are eaten by seabirds such as Red-legged Kittiwake, (*Rissa brevirostris*), Black-legged Kittiwake (*Rissa tridactyla,* Common Murre (*Uria aalge*), Thick-billed Murre (*Uria lomvia*), Leach's Storm-Petrel (*Oceanodroma leucorhoa*), Fork-tailed Storm-Petrel (*Oceanodroma furcata*), Least Auklet (*Aethia pusilla*), Crested Auklet (*Aethia cristatella*), Marbled Murrelet (*Brachyramphus mamoratus*), Kittlitz' Murrelet (*Brachyramphus brevirostris*), Arctic Tern (*Sterna paradisaea*) and Aleutian Tern (*Sterna aleutica*). Some marine mammals (e.g., whales) feed directly on plankton, while others, such as seals, feed on fish.

The water column community changes constantly as species move in to follow feeding, spawning, and seasonal migration patterns. Some species remain in the same general area, while others migrate on daily and seasonal cycles. In general, summer is the peak of fish activity and fish abundance in nearshore areas. Even species that remain in the same general location throughout the year are more active and may be more conspicuously colored during summer mating or nest-guarding periods. Over longer time scales, community composition also varies in response to prey availability, water temperatures, fishing, and other factors.

Benthic habitats are diverse. The grain size of the substrate is a significant factor in determining which communities develop. Along the continental shelf in the eastern Bering Sea and much of the Gulf of Alaska, the seafloor is soft and covered with sand, mud, silt, bits of broken shell, and other fine materials. These soft sediments are rich in life and often inhabited by many organisms living within the upper layers of the seafloor (infauna) or on the surface of these seafloor substrates (epifauna). Typical benthic communities contain a diversity of deposit and suspension feeders, as well as predators and scavengers, but suspension feeders dominate. Prominent species include barnacles, king crab, bryozoan and other hydroids, shrimp, ascidians, anemones, sea pens, sea whips, brittle stars, sea cucumbers, sponges, gastropods, urchins, and shrimp. Soft-bottom communities recycle nutrients from the water column and rocky habitats. Organic detritus from kelp and other macroalgae, dead animals, zooplankton, phytoplankton, and other sources of nutrients and carbon rain to the bottom. Contaminants in the water column also settle and accumulate in soft sediments; therefore, benthic communities are often used to the assess presence of pollution in the water column. As burrowing species churn the sediments, they incorporate nutrients into the sediments that feed deposit feeders. Bottom-dwelling fish, invertebrates, decomposers, and microbial life consume the contaminants and other organic materials, converting it to living biomass. These processes link the health and productivity of the soft and hard substrate communities with those communities living in the water column. In addition to physical factors—such as light penetration, depth, and temperature—predators influence the community by selectively targeting certain prey species. Some large fish such as rays (Raja spp.) physically disturb the sediments by digging pits. This behavior can smother or expose other buried infauna and open new areas for species to colonize, influencing community composition through disturbance.

The deep-sea coral reefs, composed of cold-water corals, black coral, gorgonian corals, stony corals, sea whips, sea pens, and sponges (Corallidae, Isididae, Paragorgiidae, Pennatulidae, Primnoidae; Antipathidae, Oculinidae, Caryophylliidae, Stylasteriidae) near the Aleutians provide nurseries, places to feed, shelter from currents and predators, and spawning areas for fish and many other species of marine life (NOAA 2005). Corals have a calcium carbonate skeleton that supports colonies of individual polyps. The polyps use stinging cells to capture plankton. Many of the cold-water corals are believed to be hundreds of years old, with very low reproductive and growth rates, making them especially vulnerable to disturbance. Sea stars, basket stars, polychaetes, snails, sponges, anemones, rockfish, shrimp, and crabs are known to inhabit Alaska's cold-water coral gardens.

Marine Water Habitat Conservation Status

Alaska's marine waters and associated habitats are generally healthy. Localized development will likely continue to result in habitat alteration. Opportunities should be sought that alleviate negative impacts and provide suitable areas of quality habitat important to the sustainability of species.

Alaska marine habitats provide food for marine plants and animals, shelter from predators, and a refuge in which to reproduce. The extensive and seamless nature of marine ecosystems puts them at risk for water pollution, which can travel far from its original source, making it difficult to regulate. Pollution from the oil industry is a major concern in Alaskan marine waters, especially since the oil tanker Exxon Valdez spilled 11 million gallons of oil, causing extensive damage to marine habitats in the Gulf of Alaska. The Exxon Valdez spill resulted in the death of thousands of marine mammals and seabirds and long-term damage to coastal marine habitats. The recent oil spill from the shipping vessel Selendang Ayu in the Aleutian Islands (January 2005) reminds us that the threat of oil contamination is always near because of extensive coastal shipping. Other threats to marine waters from oil exploration include the disposal of toxic drilling muds, and noise pollution.

Increases in marine water transport activities related to recreational, commercial and industrial uses place additional stress on the health of Alaska's marine waters. The growing presence of large cruise ships, bulk cargo ships, and oil carriers to Alaska's developing port facilities poses concerns related to the proper disposal of solid waste and gray water. Gray and black water disposal from recreational boating activities into marine waters goes essentially unregulated.

Proliferation of invasive species is a significant concern relating to Alaska's marine environment. Several species, including Atlantic salmon (*Salmo salar*), Chinese mitten crab (*Eriocheir sinensis*), and the European green crab, (*Carcinus maenas*), have been identified as real or potential threats to Alaskan ecosystems in Alaska's *Aquatic Nuisance Plan* (ADF&G 2002). Southern marine areas are generally in more danger of invasive species than northern marine areas because most invasive species originate from southern areas, and there is more commerce (shipping, ports, etc) in the south (ADF&G 2002). However, climate change will bring greater levels of coastal shipping to and through the Arctic in coming decades, increasing the likelihood of such problems as invasive species and spills. Biological regime shifts leading to ecological shifts as a result of a warming climate are increasingly being documented for marine species from phytoplankton to marine mammals (Mantua and Hare 2002).

Other conservation concerns for Alaska's marine environment include adverse impacts from fishing techniques, in particular on-bottom trawling (NRC 2002). Some marine habitats under federal jurisdiction are protected by the Marine Protected Areas (MPAs) initiative. MPAs are year-round closures designated to enhance conservation of marine or cultural resources. In Alaska, MPAs in federal waters include the Nearshore Bristol Bay Crab Protection Zone, the Pribilof Islands Habitat Conservation Area, and the Southeast Alaska Trawl Closure. Since 1987, the North Pacific Fishery Management Council has closed 2 areas around Kodiak Island to bottom trawling and scallop dredging because of their designation as important rearing habitat and migratory corridors for juvenile and molting crabs. The closures are intended to assist rebuilding severely depressed Tanner and red king crab stocks. In addition to crab resources, the closed areas and areas immediately adjacent to them have rich stocks of groundfish, including flathead sole, butter sole, Pacific halibut, arrowtooth flounder, Pacific cod, walleye pollock, and several species of rockfish (NMFS 2005). In 1996 Congress added new habitat provisions to the Magnuson-Stevens Fishery Conservation and Management Act, the federal law that governs U.S. marine fisheries management. The new provisions require each fishery management plan to describe and identify essential fish habitat for the fishery, minimize to the extent practicable the adverse effects of fishing on those habitats, and identify other actions to encourage the conservation and enhancement of those essential habitats (NMFS 2005). An area known as the Sitka Pinnacles, located off Cape Edgecumbe in the Gulf of Alaska, has been closed to all bottomfishing and anchoring since 1999 to protect lingcod, rockfish, and corals (NMFS 2005). Steller sea lion critical habitat has been defined as 20 nautical mi from 39 rookeries and 83 haulouts, it also includes 3 foraging areas: Seguam Pass, Bogoslof Island, and Shelikof Straits. These areas are off limits for commercial fishing.

Activities that might affect Alaska's marine waters and submerged lands are regulated by both state and federal agencies. Marine waters and submerged lands that are under state jurisdiction extend from the mean high tide line of the state's coastline to 3 nautical mi seaward. Beyond this 3-mi limit, marine waters and habitats are under federal jurisdiction for another 197 nautical mi, the full extent of our nation's Exclusive Economic Zone (EEZ). International law extends the OCS to 200 nautical mi seaward form the coastline, but does not take into account the state/federal boundary. Generally referred to as "federal waters," the federal OCS begins at the state submerged lands line and extends seaward to the 200-mi legal limit.

While coastal states have primary jurisdiction and control over the first 3 mi of the EEZ and the federal government has primary jurisdiction over and controls the remaining 197 mi, the Coastal Zone Management Act (CZMA) provides Alaska with substantial authority to influence federal actions beyond 3 nautical mi. The CZMA is the federal legislation that authorized the Alaska's Coastal Management Program (ACMP).

DNR is responsible for implementing the CZMA within state waters and submerged tidelands. DNR develops statewide standards for the ACMP and coordinates individual project review among natural resources agencies to facilitate responsible development within Alaska's coastal zone.

DEC administers the state's water quality laws. DEC has broad authority to adopt pollution standards and to determine what water properties indicate a polluted condition. In addition, DEC establishes marine water quality criteria for 7 aquatic uses: aquaculture; seafood processing; industry; contact recreation; non-contact recreation; growth and propagation of fish, shellfish, other aquatic life and wildlife; and harvesting for consumption of raw mollusks or other raw aquatic life.

Federal authority regarding discharges to marine waters from marine vessels are regulated by EPA. In addition to DEC and the EPA, the International Convention for the Prevention of Pollution from Ships, known as MARPOL (for "marine pollution"), establishes standards for protecting the marine environment from ship pollution. MARPOL regulations are aimed at preventing pollution from oil, chemicals, harmful substances in packaged form, sewage and garbage (IMO 2002).

The United States Coast Guard (USCG) enforces MARPOL standards and also regulates surface activities on marine waters, while both the USCG and the COE are responsible for activities affecting navigable waters. Activities pertaining to the marine bed are jurisdictional to the U.S. Department of Interior's Minerals Management Service. The USFWS regulates activities regarding marine mammals, and NMFS has authority over activities pertaining to marine fish.

One of NMFS's primary responsibilities is implementing and enforcing the Magnuson-Stevens Act. The Magnuson-Stevens Fishery Conservation Act is the governing authority for all fishery management activities that occur in federal waters within the United States 200 nautical mi limit, or EEZ.

The Magnuson-Stevens Act mandates the identification of Essential Fish Habitat (EFH) for managed species as well as measures to conserve and enhance the habitat necessary for fish to complete their life cycles. Congress has defined EFH as waters and substrate necessary for fish to spawn, breed, feed, or grow to maturity. The Magnuson-Stevens act requires that federal agencies consult with NMFS and consider NMFS conservation recommendations for any action they fund, authorize or undertake that may reduce the quality or quantity of designated EFH (NOAA 2001).

Marine waters conservation actions that focus on the protection of habitats and biota, water quality, sound science, partnering, and education and outreach will be most efficient at sustaining Alaska's marine habitats. Conservation recommendations for marine habitats include protecting habitats from human activities that cause degradation and habitat loss; designing and implementing local and regional projects that sustain natural processes; surveying and mapping marine resources and physical characteristics of marine habitats via GIS; and making policy and scientifically based recommendations regarding appropriate management tools to protect marine habitats.

Conservation recommendations for marine biota include making efforts to sustain healthy populations and carrying out actions to protect and restore species of concern, including mammals, birds, fish, shellfish, and other invertebrates; designing and implementing projects that sustain native marine plant and animal populations and prevent the introduction and spread of invasive species; rebuilding depleted populations of fish species, particularly bottomfish, shellfish and forage fish; and making policy and scientifically based recommendations about appropriate management tools to sustain species.

Protecting Alaska's marine water quality is essential to the sustainability of its aquatic resources. Conservation actions that promote maintaining water quality include reducing the input of contaminants, such as toxic substances, to Alaska's marine waters; promoting management actions to restore areas of degraded water quality; and designing and supporting projects that will sustain healthy and functioning marine waters.

The continued development and implementation of sound science to promote understanding of marine waters and habitats are priorities for Alaska. Recommended conservation actions toward this end include collecting high quality data and encouraging its use and dissemination through the development of protocols for collection, analysis and use of scientific data that support Alaska's goals; identifying and striving to fill data gaps that limit protection and restoration efforts; promoting the development of comprehensive, accessible, marine resource databases; promoting the consistent collection and coordination of data to assist the efforts of Alaska and its partners to protect marine habitats and species of concern; and circulating scientific information about local marine resources to management agencies, as well as to the public.

Education and outreach efforts that promote stewardship and understanding of Alaska's marine resources are needed to inform the public about threats to the state's marine resources, and provide practical measures to prevent additional impacts. This should include coordinating outreach and education programs with other organizations and monitoring their effectiveness, and engaging the public in active stewardship opportunities through workshops, restoration projects, citizen-science and educational programs. Lastly, communication regarding the status of Alaska's habitats and resources to regional policymakers and resource managers and property owners is crucial to acquiring support for programs that help protect marine habitats and its resources.

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Appendix 5.5 Sea Ice Habitats

Featured Species-associated Ice Habitats: Fast Ice and Pack Ice

Ice in the Arctic environment consists of both “fast ice” and “pack ice.” Shore-fast ice forms in place and is attached “fast” to the coastline or to large floes or pressure ridges that are grounded. Fast ice forms annually and may contain icebergs and floes of older pack ice. It can extend for a few meters from a shore, ice front, shoal, or grounded iceberg, or may extend for several hundred kilometers from such attachment points, depending on water depth. Fast ice is generated in the shallow coastal waters of the northern Bering, Chukchi and Beaufort seas. Its formation depends on a combination of air and water temperatures and wind direction over the continental shelf. Sea ice is dynamic and variable with many cracks or openings.

Walrus on pack ice Lori Quakenbush, ADF&G

Pack ice is not anchored to land and moves with the ocean’s currents and winds. It forms annually and can include old sea ice, as well as ice that has formed elsewhere and has floated off with the winds and currents. Under present climatic conditions, pack ice persists in the Arctic Ocean all year. It is extremely heavy and has the effect of dampening sea swells. The rolling motion of the sea can be considerably moderated by a relatively narrow band of pack ice only 100 m or so wide. The result is that where pack ice persists in reasonable quantity, the sea calms down sufficiently for low temperatures to freeze it more easily than moving water. The southern edges of this loose moving ice, called the fringe, are subject to dispersal by wind and currents and are broken by the vertical motion of swells from the open sea. Generally, multiyear pack ice in the Arctic has a 3- to 5-year “life” expectancy.

Due to its movements with ocean currents and wind, pack ice is not continuous; instead pond-like open water refuges called polynyas and long, linear cracks called leads are created. Polynyas are created where winds and currents combine to produce open areas where there is no ice, or comparatively thin ice, during the winter. Some reoccur year after year in the same places, although the exact boundaries vary annually with prevailing environmental conditions. Extensive polynyas are found in the Bering Sea. Other open areas, such as leads, are created when weak ice is broken by wind stress, initially forming a crack, and then widened by the wind or currents. The maximum southerly extent of the ice pack occurs in April, typically extending no farther south than the Pribilof Islands in the Bering Sea. By September, the ice reaches its maximum northward retreat in the Arctic Ocean (Gibson and Shullinger 1988).

Ice-associated Species

Polar bear, *Ursus maritimus*
Walrus, *Odobenus rosmarus*
Bearded seal, *Erignathus barbatus*
Ribbon seal, *Phoca fasciata*
Ringed seal, *Phoca hispida*
Spotted seal, *Phoca largha*
Bowhead whale, *Balaena mysticetus*
Common Murre, *Uria aalge*
Thick-billed Murre, *Uria lomvia*
Spectacled Eider, *Somateria fischeri*
Arctic cod, *Boreogadus saida*

Ecological Role of Sea Ice Habitats

Nine species of mammals are strongly and positively linked with the occurrence of sea ice in western and northern Alaska. These are the arctic fox; polar bear; beluga and bowhead whales; the walrus; and the bearded, ringed, spotted, and ribbon seals (Burns et al. 1980). Each species of marine mammal requires a certain type of sea ice for resting, molting, socializing, breeding, rearing, migration, and access to prey.

Predator-prey interactions within this marine ecosystem are dictated by spatial and temporal availability of sea ice. Marine mammals such as the polar bear and seals depend almost entirely on sea ice for their habitat. Among the ice-associated seals, ringed seals occur in all habitats offered by sea ice, but are the only seal to inhabit the stable land-fast ice along Alaska's northern shorelines. They make and maintain breathing holes through ice that may be 6 ft thick, and the pups are born in snow caves or lairs excavated in snowdrifts on the ice. Ringed seals do not dive to great depths and make particular use of ice over shallow waters by preying on Arctic cod during their nearshore migration (Burns et al. 1980). Bearded seals typically occur in all but the shore-fast ice, while ribbon seals and spotted seals are generally found only in the ice front from February to late April. Although some spotted seals occur on the ice fringe, as well as deep into the pack ice, they are not typically found in open seas or consolidated ice in the early spring (Trukhin and Kosygin 1988). Spotted seals take advantage of shorefast ice only when the ice front (10- to 20-m rectangular floes with brash ice or open water between) has dispersed in late spring–early summer or in fall before the ice front forms. Polar bears use the sea ice as a platform from which to hunt ringed and bearded seals. They wait for seals to return to air holes, capturing and pulling them through the ice hole as they come up for air. Alternatively, polar bears will slowly stalk and catch seals as they rest on the ice surface. Without sufficient ice, bears may become stranded onshore, unable to access and successfully hunt their usual prey.

Many polar bears den offshore on the pack ice of the Beaufort Sea region during November through March, when they give birth and nurse their young (Amstrup 1988). Walrus calves are usually born on the pack ice in late April–early June. The calf subsists solely on milk for the first 6 months or so, before beginning to eat solid foods. Nursing takes place primarily in the water, but also sometimes on land or ice. Sea ice allows seals and walruses to rest near food resources: It provides spacious habitat, is remote from shore-based predators, is relatively sanitary, and may offer shelter from the wind. The ice edge is also important habitat for birds and marine mammals that are less ice-adapted and cannot feed within the more continuous fast ice zone. These animals are often found feeding and resting in leads and divergence zones near the ice edge.

Quality and quantity of the ice is an important variable in local habitat selection of ice-dependent species. Seasonal environmental change dictates larger scale changes in species abundance and distribution patterns. For example, migrations of sub-Arctic seabirds (e.g., Thick-billed Murres), water birds, fish, and marine mammals follow the retreating ice northward. The reproductive success and spatial distribution of ice-dependent species also vary between warm and cool environmental conditions. For example, seals and walruses haul out on sea ice to sleep and bear young. Walruses mainly occupy a narrow band of the ice edge in the Chukchi Sea in summer and open water and polynyas throughout the range of sea ice in the Bering Sea in winter and spring.

Leads and polynyas provide migration routes from summer feeding grounds to wintering areas. Whales, walruses, and certain seals depend on polynyas for winter survival. During this time their presence in other areas of the Arctic is restricted for lack of places to breathe due to thick ice cover on the sea. The survival of animals overwintering in polynyas depends on the water remaining open, in order to minimize energy used to maintain breathing holes. Migratory sea ducks such as the federally listed Spectacled Eiders move far offshore to waters during the months of October through March, where they sometimes gather in dense flocks in polynyas located amid nearly continuous sea ice.

The presence and condition of sea ice plays a broader and more complex role in the Arctic ecosystem than simply providing a platform and transportation routes. During the winter, tiny marine ice algae populate the lower surface of the sea ice. This ice algae is thickest where openings or thinner ice allow more light penetration. By spring, the algae forms a thin, dense layer. The algae are the food for an under-ice community of diverse biota. Crustaceans and other small sea life feed on these plants, and are in turn, food for fish. Arctic cod are a staple food source for other fish, birds, seals, and beluga whales. Fish species such as herring, capelin, eelpout, sand lance, and pollock, as well as octopus and shrimp, are significant prey species of arctic seals (Quakenbush 1988). As spring approaches, most of the plankton sinks to the sea bottom and supports important benthic communities, including clams, amphipods, worms, snails, sea cucumbers and mollusks, including crab (Gibson and Shullinger

1998). In turn, these bottom-dwelling populations support large resident marine mammals, such as walruses and bearded seals.

Beyond the maximum extent of the pack ice (i.e., in open water), a bloom of phytoplankton occurs later, followed by a bloom of zooplankton that graze on these tiny algae plants. The northern Bering and southern Chukchi Seas provide dense summer concentrations of zooplankton. Whales such as the bowhead, the only baleen whale with a range restricted to the icebound seas, thrive on the zooplankton. Other baleen whales, including gray whales, migrate to this area in the summer and feed on the zooplankton.

Effects of diminished sea ice include potential changes in the timing, migration routes, and numbers of marine mammals. A change in the status, health, or accessibility of marine mammal populations will affect the human coastal and island communities' subsistence activities, economics, and cultural traditions.

Conservation Status

Although diminishing in annual depth and extent, Alaska's sea ice habitat is otherwise generally healthy. Localized development will likely continue to result in habitat alteration. Opportunities should be sought that alleviate negative impacts and maintain connectivity, as well as suitable areas of quality habitat important to the sustainability of species.

Currently, Arctic sea ice habitats are impacted by global warming, offshore oil and gas development activities, and pollution and contaminant transport. Each of these conservation concerns has associated transboundary, regional and international implications that harbor significant threat to Arctic marine and coastal ecosystems in Alaska. Of great concern for Arctic habitats are the ecological implications of reductions in sea ice extent and duration.

In 2000 the Arctic Climate Impact Assessment (ACIA) study was commissioned via a special initiative of the Arctic Council and the International Arctic Science Committee at a ministerial meeting of the Arctic Council in Point Barrow, Alaska. The purpose of the ACIA was to evaluate and synthesize knowledge on climate variability, climate change, and increased ultraviolet radiation and associated consequences. Developed by more than 300 international scientists, the ACIA report documents a 4-year study on the rapid warming of the Arctic. In November 2004, the scientists released a 144-page summary of their findings at a press conference in Washington, D.C. This study reports a dramatic reduction in the extent of the summer ice pack in the Arctic Ocean. Specifically, late summer ice coverage has declined by as much as 20 percent in the past 3 decades and is projected to shrink by another 10 to 50 percent by the end of this century (Spotts 2004). These findings point to a real loss of sea ice habitat that Arctic marine mammals depend on. For more information on findings of the ACIA report, see CWCS Section IVA, pages 83–88.

International efforts to protect the Arctic and its biota are occurring under the auspices of the Arctic Council, an intergovernmental forum for addressing common concerns and challenges faced by the Arctic states of Canada, Denmark, Finland, Iceland, Norway and the Russian Federation, Sweden, and the United States. Two Arctic Council programs, in particular, focus on the needs of Arctic marine species; these are the Program for Conservation of Arctic Flora and Fauna (CAFF, described in more detail in Section VIII), which promotes conservation of biodiversity and the sustainable use of living resources, and the Program for the Protection of the Arctic Marine Environment (PAME). PAME addresses policy and nonemergency pollution prevention and control measures related to the protection of the Arctic marine environment from land and sea-based activities, including marine shipping, offshore oil and gas development, land-based activities, and ocean disposal. Established in 1993, the PAME program works closely with CAFF scientists and also with representatives of the other 3 Arctic Council programs: Sustainable Development Working Group (SDWG), which explores the economic, social, and cultural aspects of sustainable development; AMAP, which identifies pollution risks and their impact on Arctic ecosystems and assesses the effectiveness of international agreements on pollution control; and Emergency, Prevention, Preparedness and Response (EPPR), concerned with sharing information and methods for spill prevention and control.

All offshore oil and gas developments require a means of bringing hydrocarbons to the international market. With one exception this requires onshore infrastructure. The exception is offshore oil transfer, which is the single biggest source of oil pollution in the Arctic (Smith 2004).

To date, fast ice has provided a useful platform on which to construct temporary roads and conduct onshore exploratory seismic and drilling operations. Fast ice used for seismic exploration may impact denning polar bears that construct dens where sufficient snow accumulation provides cover. Additionally, seismic exploration has been documented to alter bowhead whale migration routes, as well as to displace ringed seals (Burns et al. 1980).

Alaska’s Arctic waters have experienced an increase in use by maritime traffic in recent years, and this trend will likely continue. Based on current activity levels of oil exploration, production, and transportation, Cook Inlet and the Beaufort Sea are the state’s areas of highest concern regarding protection from oil spills. Unfortunately, there continues to be no significantly effective method for containing and cleaning up fuel spills that may occur in icy waters (DF Dickins Associates Ltd. 2004). Booms and lenses are ineffective in broken ice and unusable in closed ice conditions. State oil spill contingency plans fall short of the ability to protect Alaska’s marine environments. This is particularly troubling because contaminants remain toxic longer and are more difficult to clean up once trapped in ice. They also take longer to break down in the Arctic’s colder temperature regime. An additional concern is that fuel spills concentrate in open waters in the sea ice and in breathing holes where animals surface and congregate.

Currently, 30 miles of Arctic Ocean coastline is federally designated as wilderness. This area is known as the Arctic National Wildlife Refuge. It is here, on the coastline of this refuge that more polar bears den than along any other stretch of Alaska's coast. Other important polar bear denning habitat occurs within the Western Arctic Reserve (National Petroleum Reserve-Alaska).

Marine waters within 3 miles of Alaska's coast are under jurisdiction of the DNR's Division of Mining, Land and Water. Waters beyond the 3-mile limit are managed by the NOAA. The COE regulatory jurisdiction under the Clean Water Act and the Rivers and Harbors Act also includes all ocean and coastal waters within a zone 3 miles seaward from the line on the shore reached by the ordinary low tides.

Programs that monitor sea ice in Alaska's waters are important. Such programs should receive support in order to allow for regional assessments and integration with other Arctic and global monitoring programs. Research to develop credible and effective response to spilled oil in moving, broken, pack ice in the ocean, lakes, or rivers is also a high priority. These projects require consistent, long-term funding to be effective and meaningful.

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Appendix 5.6 Karst Cave Habitats

Featured Species-associated Karst Cave Habitats: Entrance Zone, Twilight Zone, and Deep Cave Zone

Karst landscape is an area of underlying limestone (carbonate bedrock) in which erosion and dissolution by ground water/chemical weathering has produced fissures, sinkholes, underground streams, and caverns. The high soil acidity and damp conditions of temperate rain forests and muskeg are ideal for creating interconnected dissolved features in alkaline calcium carbonate bedrock. This network of caves and tunnels is a distinct habitat type located underground but connected, in varying degrees, to the overlying landscape through sinkholes (also called dolines or collapse pits), cave entrances, and subsurface hydrology.

In Alaska, karst landscape is primarily located in the Alexander Archipelago, which includes Prince of Wales, Dall, Coronation, Sumez, Heceta, Baker, Kosciusko, Kuiu, Long, Etolin, Revillagigedo, Kupreanof, and Chichigof Islands (Baichtal 1996; Experts group). The mainland near Haines, Haines State Forest in Southern Chilkat Valley (Streveler and Brakel 1993), and the Wrangell-St. Elias Mountains also contain areas of karst. Outside of Southeast Alaska, the only other karst landscapes overlain by temperate rain forest are located in Chile and Tasmania. Other karst areas in Alaska include the Lime Hills on the west side of Cook Inlet, the Jade Mountains in northwest Brooks Range (sinkholes, springs, and underground streams) and the White Mountains in the Interior. The karst cave systems in Southeast Alaska are the most extensively studied; very little is known about the extent and ecology of Alaska’s northern and western karst areas. The following habitat descriptions address karst cave conditions in Southeast, in the coastal areas of Canada, or generalized cave conditions.

Within the karst cave system are several zones of differential habitat use and characteristics. The “entrance zone” is located immediately around the cave or tunnel opening and is the most influenced by surface conditions. The “twilight zone” extends from the entrance to mid-depth and is best characterized by decreasing light levels and connectivity to the exterior. The final zone is the “deep cave” area, which is almost entirely isolated from exterior conditions. Within and between these zones are a range of characteristics that affect species distribution: light level; temperature; the range of temperature variation; air flow patterns; cavern size; the cave’s depth below land surface and elevation relative to sea level; humidity; substrate type; connectivity to surface water/flow levels; level of human disturbance; turbidity, pH, and conductivity of water; nutrient input to the system; and thickness of epikarst (Aley and Aley 1997). The one factor that influences all of these habitat characteristics is the degree of connectivity between the surface and subsurface. In a karst cave system, the speed and magnitude of transfers between surface and subsurface is controlled by sinkholes and hydrologic flows (Karst Task Force for the Resources Inventory Committee 2001; Baichtal 1993).

Nutrient input to cave systems depends on surface organics being transported through connections from the surface. These nutrient sources may take the form of debris falling into sinkholes or being washed into cave systems by sinking streams (streams descending through the cave system).

Karst cave inhabitants can be obligate, opportunistic, or accidental. Accidental inhabitants are those organisms introduced into the systems through sinkholes or flushed in by water flow. While accidental species rarely survive, they present an important influx of nutrients to the system. Opportunistic use is generally limited to terrestrial or littoral openings, but this use does represent a wide range of taxonomic groups.

Starlight Cove, Prince of Wales Island T. Heaton, University of South Dakota

Obligate cave inhabitants consist of troglobite (terrestrial cave dwellers) and stygobite (aquatic cave dwellers) invertebrates and bats. The most extensive invertebrate surveys to date were conducted in 1992 and 1995. Collections from over 300 cave and resurgence sites in Southeast yielded at least 5 troglobitic and 40 troglophilic invertebrate species (Carlson 1997a). Another extensive survey of cave invertebrates conducted in 1997 on Vancouver Island initially identified 192 taxa. Investigators in this study found "remarkable" similarities between cave fauna compositions on Vancouver Island and in Southeast (Shaw and Davis 2000).

Entrance Zone

The entrance zone is characterized by lower light levels and higher relative humidity than exterior conditions, and more dramatic temperature variations and higher nutrient availability than interior areas of caves. Davis et al. (2000) defined the entrance zone as 0–10 m from the entrance of the caves, but actual entrance zone parameters may exist in varying locations depending on cave entrance size.

Terrestrial openings are used by various species of bats for swarming and feeding activities. Temporal, gender, and life cycle differences in cave use relate to the elevation, temperature, variation of temperature, humidity, and size of the cave. Caves at lower elevations are used by *Myotis* spp. females and juveniles in late summer months (Davis et al. 2000).

Aquatic invertebrate accidentals washed into Vancouver Island cave habitat are mostly from the taxonomic groups Plecoptera, Ephemeroptera, and Trichoptera. Terrestrial beetles and mosquitoes also use cave entrances. The highest invertebrate diversity occurs in the entrance area, and the composition is dominated by taxa that would likely be found elsewhere in similar surface environments. Near-entrance fauna is dominated by a number of flies and associated predators, such as spiders and weevils (Shaw and Davis 2000).

Additional habitat functions of the entrance zone include denning by black and brown bears, river otters, wolves and mustelids, although there is uncertainty about the extent of this use (Streveler and Brakel 1993). Sitka black-tailed deer use the thermal buffering effects of air currents at cave entrances both summer and winter (Baichtal and Swanston 1996). This effect has been called “cave breath” and may allow some species or individuals to live at the temperature limits of their distribution (Streveler and Brakel 1993). Both songbirds and seabirds use openings for nesting and feeding depending on proximity to shore (Baichtal 1995).

California myotis (*Myotis californicus*)
M.R. Stromberg, University of California, Berkeley

Entrance Zone-associated Species:

Little brown bat, *Myotis lucifugus*
Keen's bat, *Myotis keenii*
California myotis, *Myotis californicus*
Long-legged bat, *Myotis volans*
Silver-haired bat, *Lasionycteris noctivagans*

Twilight Zone

The “twilight zone” extends from the entrance to mid-depth; it has sheltering characteristics but is not completely isolated from the surface. Most invertebrates found in caves reside in the twilight zone. Few true obligate troglobites occur here, but there is large potential for finding as yet undescribed and unidentified species. Other species may have certain portions of their life cycle that necessitate different zones of the caves. The twilight zone is the area of a cave used by roosting bats (Davis et al. 2000).

Twilight Zone-associated Species

Little brown bat, *Myotis lucifugus*
Keen's bat, *Myotis keenii*
California myotis, *Myotis californicus*
Long-legged bat, *Myotis volans*
Silver-haired bat, *Lasionycteris noctivagans*

Deep Cave Zone

The deep-cave zone is a very stable, insulated habitat, but this stability is a function of a very narrow range of habitat conditions. Deep cave invertebrates (hypogean invertebrates) are highly specialized to cave conditions, with extremely limited tolerance for light, humidity, temperature, and pH variations, but with the ability to exploit low nutrient and oxygen levels (CWCS Expert Group 2004). The interior of a deep cave generally has little organic debris, no light, temperatures slightly above freezing, high humidity (100%), a pH near neutral (a consequence of the buffering effects of the dissolved calcium carbonate), and a very limited input of new species, predators, or competitors. One possible example of a hypogean adaptation is amphipod development of reduced metabolic rates compared to their epigean counterparts in response to limited food availability or low oxygen conditions (Spicer 1998).

In deep-cave habitats, collections of invertebrates were dominated by collembola, symphyla and diplura with infrequent captures of other taxa, such as acarina (*Robustocheles occulta*), diptera or siphonaptera. In the Lower 48, for both stygobites and troglobites, only number of caves (in a system) was a significant predictor of distribution (Culver et al. 2003). For example, the more extensive a system, the more cave-adapted species it supports.

Myotis spp. use deep cave areas of high elevation caves (800 m) as hibernacula. These hibernating locations are characterized by temperatures close to freezing, with a small range of temperature variation and high humidity levels (Davis et al. 2000). However, *Myotis* spp. depend on caves of varying depths and locations at different points in the species’ lifecycle.

Deep Cave Zone-associated Species

Collembola
- *Arrhopalites hirtus*

Arachnida
- Acarina
  - *Robustocheles occulta*

Crustacea
- *Stygobromus quatsinensis*

Hydaticus larvae
Rhynchelmis spp.
Polycelis spp.
Candona spp.
Acanthocyclops spp.
Dacylclops spp.

Keen's bat, *Myotis keenii*

Interactions with Overlying Landscape

The connectivity between karst systems and the overlying landscape also benefits the overlying forest. In Southeast Alaska, karst areas are better drained and have less acidic soil, promoting growth of larger trees than in nonkarst areas. Dissolved fissures in the bedrock allow deep root growth making large trees more windfirm. The underground portions of streams can provide buffers for water pH, water temperature, and flood discharges. For example, acidic water (pH 2.4–5.8) flowing into karst areas may exit the cave system with a pH of 7.5–9.0 (Aley et al. 1993; Baichtal and Swanston 1996). Water with dissolved minerals from contact with a karst system typically has a higher specific conductance than waters from nonkarst systems (Karst Task Force for the Resources Inventory Committee 2001). Compared with other North American karst systems, Southeast karst landscapes in particular have mid-range conductance values and high runoff values, accelerating dissolution and cave formation processes (Aley et al. 1993). These dissolved minerals represent an important source of calcium and carbon for use in biological systems.

On Your Knees Cave inside Bear Passage. Sedimentary layers and spring.
T. Heaton, University of South Dakota

Ecological Role of Karst Caves

Protection of the karst landscape is important to preserve the state's species biodiversity. The narrow range of interior conditions supports communities of species that are specifically adapted to unique environmental conditions. In addition, these environmental conditions generally occur in isolated pockets that preclude migration of individuals between habitat patches. As a result, obligate cave fauna, especially deep-cave inhabitants, have population characteristics of a species highly susceptible to rapid evolutionary change via endemism (Culver et al. 2003).

Locations of invertebrates and bats in Southeast karst caves often represent the northernmost known extent of these species' distribution. Prince of Wales Island holds records for northernmost locations of *Stygobromus* sp. and the bats *M. keenii* and *M. volans* (Baichtal 1996).

Bats are particularly vulnerable to human disturbance while hibernating. Bats do not store a lot of fat in preparation for hibernation (as bears do), and disturbance and rousing of hibernating bats can cause 10–30 days of fat to be metabolized (Brady 1982). Southeast karst caves may be extremely important to the perpetuation of bats in general in the state of Alaska. Of the 5 species of bats in the state only one, *M. lucifugus,* has a range extending northward of Southeast. *M. lucifugus* is widely distributed, with its summer range extending into the Yukon Territory. However, little is known about where the species overwinters. The Yukon Government theorizes that *M. lucifugus* migrate to the Alaskan coast to hibernate for the winter. Northern populations of *M. lucifugus* have larger females than males (southern populations do not have this sexual dimorphism). One suggested explanation for this is that juvenile bats must be larger at birth to have sufficient body resources to survive their first winter of hibernation. This may represent an adaptation unique to northern areas.

Karst caves are used as birthing dens by otters, and resting and denning sites for deer, bears, wolves and small mammals. Some bird species, including dippers, thrushes, and swallows, are known to use cave entrances for nesting and feeding.
Aquatic habitats associated with karst landscapes are more productive than nonkarst aquatic habitats (USFS 1997). Streams flowing through karst areas support larger coho salmon fry and parr than Southeast streams without karst. Higher alkalinities of karst streams are positively correlated with higher fish densities (Bryant 1997).

A consideration for preserving biodiversity in karst caves is the potential to discover previously undescribed species. A 2002 article in *Acta carsologica* identified the world's most diverse caves as having 41 to 84 species of stygobites and troglobites (Culver and Sket 2002). Meanwhile, a study of cave fauna on Prince of Wales Island preliminarily identified 77 invertebrate taxa even without many samples being identified to the species level (Carlson 1997b).

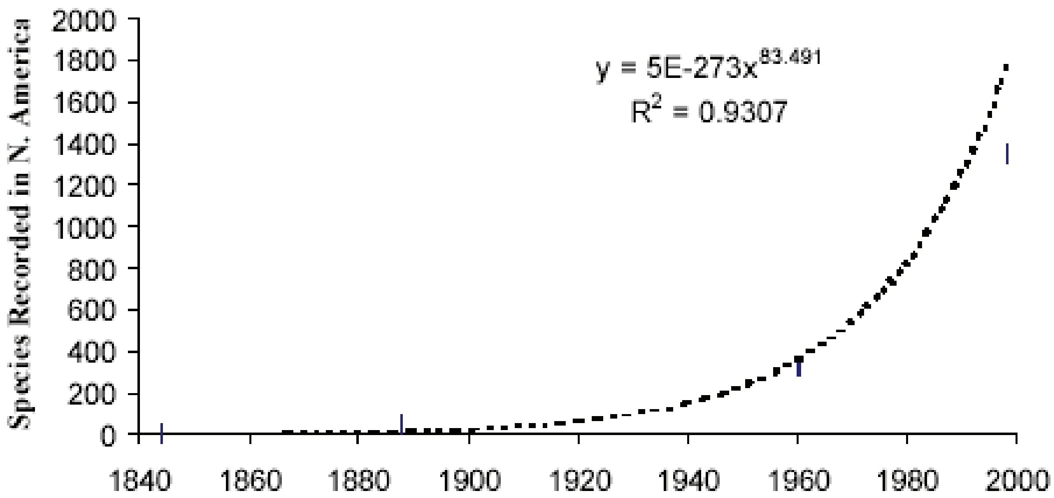

Figure 5.2. Graph showing exponential increase in the number of known obligate, cave-dwelling species in North America (DeKay, 1844; Nicholas, 1960; Packard, 1888; Peck, 1998) and a power function trend line fitted to the data.

From SUBTERRANEAN BIODIVERSITY PROJECT, Research Proposal Submitted to the Arkansas Game and Fish Commission. A.V. Brown and G.O. Graening, March 6, 2000.

Conservation Status

Alaska's karst cave habitat is generally healthy. Localized development will likely continue to result in habitat alteration. Opportunities should be sought that alleviate negative impacts and maintain connectivity, as well as suitable areas of quality habitat important to the sustainability of species.

The conservation of both karst cave habitats and associated species communities is complicated by the limited knowledge of the cave ecology in Alaska. Many unknown or poorly understood variables could impact species survival. Some of these variables include identifying links to the overlying landscape and connections to ground water and surface water systems. Hydrologic systems expand the area of impact and effects far beyond the physical limits of a cave. Habitat assessment can be complicated because karst drainage does not coincide with surface drainage patterns or even watershed or hydrologic unit boundaries (Karst Task Force for the Resources Inventory Committee 2001). Significantly, karst formation processes are impacted by both glaciers and permafrost. In Arctic regions, ground water circulation can be impeded by static ice masses (glaciers) that form in caves (Ford 1993). Little study has yet been conducted on the effects of climate change and karst cave fauna. To fully conserve karst caves and their resources, the caves and their karst landscapes must be managed as a whole.

Road development, land clearing, timber harvest, and mining activities all have the potential to alter subsurface water and nutrient flows. Timber harvest and related road construction in the vicinity of caves increase runoff and sedimentation, which may flood, scour, or fill previously stable cave environments. Debris accumulates and blocks cave entrances and exits through practices of disposing of slash and rerouting of surface flows into sinkhole ponds or dry sinkhole pits. Recreational users pose another, more direct, risk to cave habitat. A high volume of visitors can destroy terrestrial habitat in caves by compacting cave sediments (IUCN 1997). Bats are susceptible to human disturbance; caves can be gated with “bat friendly” gates to exclude human disturbance, but these can unintentionally exclude other nonhuman species that depend on, or opportunistically use, karst caves.

Karst caves have high value for paleontological research because fossils preserved in caves create records of species distribution through the last millennia and provide insight into the location and extent of glacial refugia during the last Ice Age. Species distribution may also provide insight into climate conditions when early bands of humans may have migrated through the area (Heaton 2002). There is an ongoing study funded by the National Science Foundation, National Geographic Society, Tongass National Forest, and University of South Dakota to inventory and identify paleontological deposits in caves in the Tongass National Forest.

El Capitan Cave. Female black bear skeleton radiocarbon-dated to be 10,750 years old (Late Pleistocene Epoch)
T. Heaton, University of South Dakota

The protection of a karst cave is very much dependent on the ownership of the overlying land. On state and private lands there is minimal to no protection. As of January 2005, the State of Alaska Division of Forestry did “not recognize karst topography as a significant resource to be managed on the State’s limited land base in southeast. The DOF will protect karst formations that affect water quality as per the Alaska Forest Resources and Practices Act and Regulations. If significant recreational activity is found to be dependent on a karst resource, it will be taken into account during the development and implementation of the Forest Land Use Plan (FLUP) process for a proposed timber sale (Division of Forestry, Coastal Region).” In 1992 the state legislature attempted but failed to pass an Alaska State Cave Protection Act.

El Capitan Cave fish fossils; otoliths, vertebrae, spines and jaws dated to the early Holocene
T. Heaton, University of South Dakota

There is a higher level of protection for caves on federally owned lands due to the Federal Cave Resources Protection Act of

1988. This act applies to listed “significant caves” on federal lands. The significance is determined by criteria established by the Secretary of the Interior or his/her delegates. In Alaska, a large amount of the karst landscape is located on federal lands: Portions of the White Mountains are under BLM management; many of the caves in the Alexander Archipelago are in the Tongass National Forest; karst landscape is located in Wrangell–St. Elias National Park and Glacier Bay National Park; and the Lime Hills and the Jade Mountains are both located on a mixture of federally owned and Native-owned or -selected lands.

The 1997 Tongass Forest Plan Cave Standards and Guidelines (USFS 1997) implemented a karst resources management strategy that included developing an inventory of caves and hydrologic systems and protecting and maintaining significant caves and cave resources to the extent feasible. These guidelines fulfill responsibilities under the Federal Cave Resources Protection Act. The Forest Service in the Ketchikan area has developed a cooperative effort with the Alaska Cavers Association to inventory and document caves. The Thorne Bay Ranger District has developed trails and viewing platforms and tours for 2 of the larger caves in Southeast. Even within the Tongass National Forest, different land designations (monuments, wilderness areas, etc.) may affect the degree of cave protection (Streveler and Brakel 1993).

There are no species-specific legal protections for obligate cave inhabitants on nonfederal lands. *M. keenii* is on the “Red List” of potentially endangered species in Canada. Many troglobite invertebrates in the Lower 48 states are listed as endangered species due to their high degree of endemism and limited distributions.

One of the most important aspects of conserving karst caves is the preservation of aquatic systems. Currens (2001) documented changes in ground water flow after applying best management practices for protection of a karst aquifer similar to riparian best management practices instituted to protect ground water quality. Sinkholes should be recognized as a direct link to underground streams and vegetated buffer zones required around the sinkhole, as well as surface use restrictions in the immediate drainage area. Rapid transmission of ground water with little filtering through external vegetation and karst makes underground aquatic systems susceptible to pollution inputs (IUCN 1997).

Conservation actions that focus on cooperative working relationships between land managers and speleologists regarding karst cave habitats are an important tool for managing and protecting these areas. Identifying areas important to maintaining species diversity should continue.

Recommended conservation actions for karst caves include the inventory of caves in northern and western Alaska to acquire basic knowledge, such as extent, location, and any ecological use. Efforts toward achieving protected species status for rare, endemic cave fauna, such as the identification and description of Southeast invertebrate species and their associated habitat, should be supported. Research regarding the effectiveness of best management practices in karst areas to protect hydrology and prevent introduction of debris and contaminants is critical to sustaining healthy karst cave habitats. In addition, investigation of the use of instream flow reservations for ground water and subsurface ownership to protect cave resources should be considered. Final recommendations include support for identification of caves, and the establishment of guidelines for recreational use through working relationship with Alaska Caver's Association.

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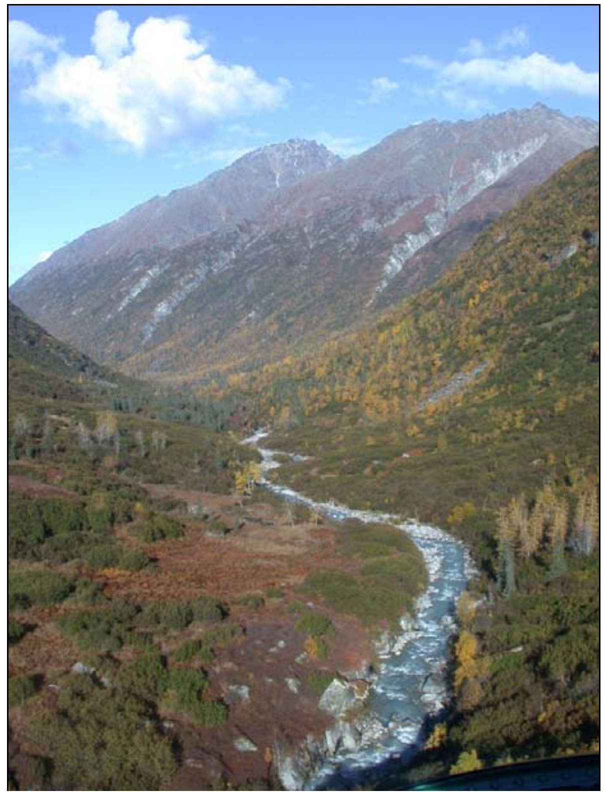
Appendix 5.7 Aquatic Habitats

Featured Species-associated Freshwater Aquatic Habitats: Glacial Waters, Clear Waters, and Riparian Zones

Alaska has more than 40% of the entire nation's surface water resources. Approximately three-fourths of all freshwater resources in Alaska are stored as glacial ice covering about 5% of the state. Alaska has more than 3 million lakes greater than 5 acres (Harle et al. 1993), over 12,000 rivers, thousands of streams and creeks, and an estimated 100,000 glaciers. Alpine glaciers, lakes, groundwater, glacial and clearwater rivers, streams, springs and ice fields connect the uplands to Alaska’s estuarine ecosystem.



Kashwitna River D. Ryland, ADF&G

Alaska’s largest rivers include the Yukon, Kuskokwim, Susitna, and the Copper. The state’s longest river is the Yukon. At over 2000 miles long it is the third longest river in North America. It flows for 1280 miles through Alaska and drains a 204,000- mi^2 area. Alaska’s rivers support many aquatic species including both anadromous and resident fish, and serve as migratory corridors to the many smaller tributaries and waterways that support spawning, rearing, and overwintering habitats. These same tributaries provide protective vegetative cover, a significant source of detritus, and terrestrial wildlife riparian migration corridors.

Lake Iliamna is Alaska’s largest lake covering an area of approximately 1000 mi^2. It is 75 mi long and 20 mi wide. Other lakes of size include Lake Clark and Becharof, Naknek, Ugashik, Teshekpuk, Tustumena and Kenai lakes. The Wood-Tikchik Lakes system in Southwest Alaska consists of 13 lakes that range in length from 15 to 45 mi.

Alaska’s freshwater ecosystems are found across the state from the temperate coastal rain forest of the Southeast region with maritime climate and dense riparian vegetation, to the boreal forest of Interior Alaska, with continental climate and modest riparian vegetation, to the Arctic tundra of the North Slope, with sparse riparian vegetation (Reynolds 1997). In terms of elevation, freshwater habitats are found from the highest alpine glacier and cirque lakes down to sea level, and flowing waters effectively connect the mountains to the sea.

Alaska freshwater resources are distributed throughout the state, from the mountains to the coastal plain, and they provide a wide variety of habitats. Aquatic habitats are complex and range from small, ephemeral streams to large, braided glacial systems that flow across entire regions of the state. Still water habitats range from tiny ponds to some of the very large lakes mentioned above. Headwater streams include pool, riffle, side channel, isolated pool and stream margin and backwater habitats. Floodplain characteristics include main channel, side channel, oxbow lake, backwater lake, meander, scroll depression, and backwater wetlands habitats. Lake and pond habitats include typical shoreline, pelagic and benthic areas.

Flow regime

The flow regimes of Alaska's rivers and lakes include those influenced by glacial melt, snowmelt, precipitation, and ground water, including springs and upwelling areas. Three common types of streams occur in Alaska: ephemeral, intermittent and perennial streams. Directly correlated with precipitation, ephemeral streamflow is limited to short periods of a few hours or days immediately after storms and floods. In intermittent streams, flow occurs for several weeks or months each year when precipitation and ground water input is relatively high. Perennial streams have a well-defined channel that contains water at least 90 percent of the time. They receive substantial ground water input and generally flow continuously throughout the year. Annual flows can vary widely and streams may be dry during periods of low precipitation, although ground water is generally near the surface. Water supply to Alaska's ponds and lakes is governed by the same types of flow regimes as for these 3 stream types.

Substrate and Morphology

The type and ratio of substrate materials offered by a waterway determines the habitat suitability for associated aquatic species. This is particularly true for aquatic species during differing life stages. Stream and riverbed substrates vary from large boulders to glacial silt or flour, clay, and mud. Large boulders provide resting areas for fish, while smaller cobbles and gravels allow for the required aeration and subsequent development of eggs buried in the streambed. Larger substrates provide greater surface area for aquatic invertebrate

Spawning gravels, Susitna Basin M. LaCroix, DNR concentration and for the establishment of algae and mosses. Boulder and cobble bed streams are usually found in the upper portion of a watershed. These streams often have pockets of gravel and fines in the pools, behind large rocks, and on the inside of bends and other areas of reduced velocity. Mud, silt, or clay substrates are often represented in shallower and slower waters, or at the terminus of a waterway.

Large boulders, Little Willow Creek D. Ryland, ADF&G

Many other physical factors contribute to the complexity of aquatic habitats, and channel morphology characteristics provide additional habitat diversity for aquatic species. Straight and meandering channels are both common, with extent of meandering largely determined by the stream gradient and underlying soils. Meandering waterways typically contain deeper areas of swift flow near the eroding outer edge of the meander, and areas of deposition and shallower water on the opposite bank. In broad valleys of major rivers, extensive meanders create oxbow lakes in abandoned channels. Braided channels are formed as a result of erosional and depositional processes, and are typical of large glacial rivers. Morphologic complexity, along with substrate material that provides channel roughness, contributes substantially to the habitat quality and quantity of a system for aquatic species.

River meanders and abandoned channels
M. LaCroix, DNR

Lake and pond habitats also vary with substrate, bathymetry, and shoreline contour. Flow regimes and depth contours are also important influences on nutrient cycling, hydraulic retention time and biological productivity in the relatively still waters of lakes and ponds. As with flowing waters, the origin of a lake basin determines its contour and morphometry.

Microhabitat

Differing hydrologic energy dissipation as a result of substrate conditions causes specialized microhabitats to develop in waterways. For example, riffles form in river and stream reaches where flow is slowed by rocks, gravel, or sand bars. In a healthy system, these features are interspersed with pools of deeper, slower water. Intermediate runs of moderate current are often found in larger streams and rivers. In the lower stream reaches, deep pools near undercut banks, and large woody debris are common. The representative biota residing in pool and riffles often contrasts sharply due to differing habitat niches offered by each. In lower elevation areas, backwater sloughs and their associated floodplains and wetlands provide some of the most physically protected and biologically productive freshwater aquatic habitats.

Large woody debris (LWD) is an important component of rivers and streams that helps to stabilize banks and substrate material, and provide cover from terrestrial predators. It also fosters formation of pool habitats and provides spawning bed integrity and habitat for aquatic invertebrates, elevating in-stream productivity. In large rivers, LWD groundings often lead to formation of downstream islands, bars and slough habitats. In smaller streams, lakes, and ponds, LWD plays an important role in habitat creation immediately adjacent to the point of input. Decaying terrestrial debris also tends to accumulate near LWD, providing a food source for aquatic invertebrates. In Alaska, nutrient input from both allochonthous (originating outside the system) and autochonthous (originating within the system) sources contributes significantly to fresh waters, whether flowing or still (e.g., lake and pond habitats).

Cumulatively, stream- or riverbed material, channel morphology, and microhabitat characteristics increase the quantity of available aquatic habitat and the diversity of the aquatic environment. Similarly, pond and lake habitat are further diversified by the occurrence of differing substrates, depths, and contours.

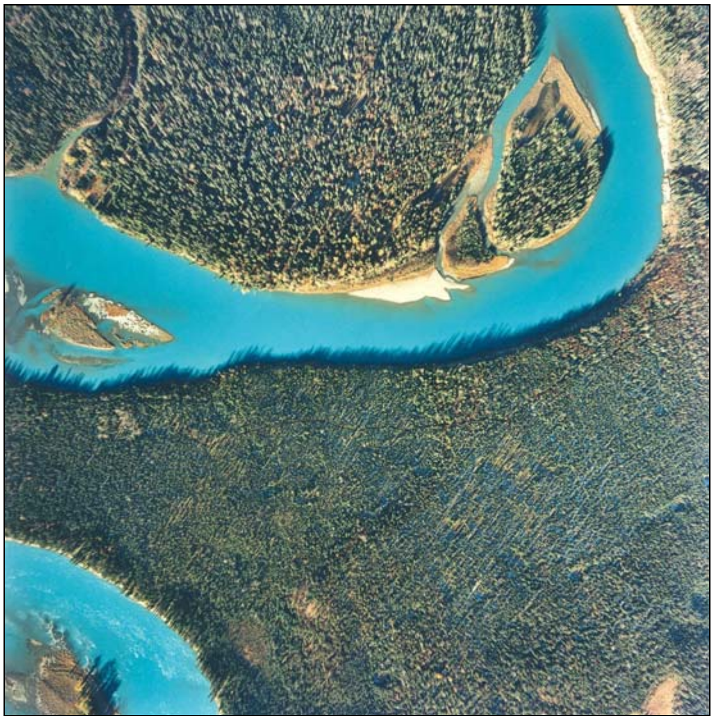
GLACIAL WATERS

Glacially influenced rivers and streams

The extent to which Alaska is covered with glaciers significantly influences its freshwater habitats. The area of glacier coverage in other states is less than 200 mi^2, and the glacier ice in the rest of the United States combined totals less than the area of a single large Alaska glacier (Molnia 2001). In Alaska, glaciers develop in high mountainous areas and often flow out of ice fields that span several peaks or an entire mountain range. Alaska’s 300 mi^2 Harding Icefield, located in the mountains of the Kenai Peninsula, is the largest in North America and one of only four remaining ice fields in the United States. Thirty-five of Alaska’s glaciers, some among the largest mountain glaciers in the world, stem from the Harding Icefield.

Glacially influenced waterways are those where glacial input is the dominant channel- or floodplain-forming mechanism, dictating the chemical and physical hydrology of the water itself. Glaciers feed and influence nearly all major rivers in Alaska and provide the headwaters to some of the state’s largest rivers, including the Copper, Susitna and Tanana.

Alaska's glacially driven rivers exhibit high and variable rates of fluvial activity and channel adjustments from erosional and depositional processes (Wooster 2002). Rivers originating from glaciers tend to have high discharges, and generally have pronounced daily and seasonal stream flow fluctuations near the glacier and large year-to-year fluctuations in stream flow. Peak glacial river flows occur during the warmest months of the year, typically May through August. However, even during summer, water temperatures are measurably lower near a glacier than farther downstream. Glacial rivers tend to transport large volumes of fine-grained sediment and have steep channel slopes. In response to these conditions, braided river channels may develop containing multiple channels separated by bars or islands. During the colder winter temperatures, when base flow is derived entirely from ground water, glacial rivers generally run clear and low.



Glacial waters of the Kenai River with sandbars, islands and side channel habitats Kenai River Center

Depending on the channel slope and bed composition, glacial systems may show pronounced accumulation of deposited materials (i.e., aggradation) in their streambeds and valleys. Large, unstable, braided channels occur where the rate of aggradation is high (e.g., Matanuska glacier/ Matanuska River), and single channels occur were rates are low (e.g., Mint glacier/ Little Susitna River). Where they are associated with rivers, glacier-dominated lakes regulate the flow moving downstream and reduce the amount of sediment transported to the river's lower reaches.

Alaska's glacial hydrologic systems differ from clearwater systems in terms of runoff, water quality, and volume. The volume of flow from glacial rivers can be 10 times as much as that from clearwater rivers. The water quality difference between these streams is mainly expressed as turbidity: Glacial rivers and streams carry a large sediment load of clay and silt, giving the waters a cloudy-gray opaque color. Other glacially influenced rivers and lake waters appear turquoise blue-green in color. This is due to their absorption of all the colors of the spectrum except blue, which is reflected off the glacial sediments in the upper reaches of the system. Kenai Lake and the upper Kenai River demonstrate this phenomenon. Dissolved oxygen, conductivity, and pH of glacial versus clearwater systems are roughly equal.

Glacial River and Stream-associated Species

Rainbow smelt, *Osmerus mordax*
Eulachon, *Thaleichthys pacificus*
Longfin smelt, *Spirinchus thaleichthys*
Pygmy whitefish, *Prosopium coulteri*

Glacially Influenced Lakes and Ponds

Lakes form in glacier-dominated watersheds as a result of glacial advance and subsequent retreat. Most of the state's larger lakes, particularly those in Southwest and Southcentral Alaska, resulted from glaciation and are important to both resident and anadromous fish species for overwintering. Kenai Lake has glacial tributaries, while Iliamna Lake has clearwater tributaries. Both of these lakes are connected to rivers that support large and valuable runs of salmonids.

Crescent Lake M. Wiedmer, ADF&G

Two types of floods are common in Alaska's glacial waters, yet rarely occur in the rest of the United States. These are floods caused by the release of water from glacier-dammed lakes and by ice jams on rivers. Approximately 750 glacier-dammed lakes have been identified in Alaska. These lakes are formed in areas where glaciers flow across tributary valleys and trap runoff. Catastrophic flooding occurs when the ice dams fail. In some places, the dams fail predictably and/or annually. Others fail unexpectedly due to geomorphic glacial changes, with sudden outbursts resulting in floods (Snyder 1993). An ice jam is an accumulation of broken river ice in a narrow, shallow, or blocked part of the river channel. Backwater pooling from an ice jam can cause flooding upstream. When an ice jam suddenly releases, river discharge increases rapidly and causes downstream flooding.

Glacially Influenced Lake and Pond-associated Species

Pygmy whitefish, *Prosopium coulteri*

CLEAR WATERS
Clearwater Rivers and Streams

Clearwater rivers and streams are also common throughout Alaska. In contrast to glacial systems, these waterways exhibit low turbidity, high clarity and flow derived primarily from ground water and precipitation. Clear waters maintain less dynamic annual flows than glacial waters.

Clearwater systems have relatively narrower channel widths, stable well-defined beds and banks, relatively low sediment loads, and increased habitat complexity in the form of pools, riffles and LWD. Relative to glacial waters, clear waters generally are narrower, as a result, freeze up earlier in the winter months.

Overwintering

Katalla River M. LaCroix, DNR

Aquatic overwintering habitats in Alaska are often limited. Many lakes and streams often freeze to the bottom during winter. As the temperatures decrease in the fall, Alaska's freshwater fish usually move from summer habitats to overwintering areas. In winter, fish and other aquatic species may become concentrated in small areas of rivers and at the bottoms of lakes. In clearwater streams, overwintering habitat can be reduced due to the smaller volume of water available in contrast to glacial river systems. Often a river's edge or floodplain offers some of the best available overwintering habitat. Upwelling areas in groundwater-fed streams and perennial spring pools also provide some of the most important winter habitats for freshwater aquatic species in Alaska. This is particularly true in the Arctic areas where groundwater sources are dominant throughout the year. Spring-fed streams, deep pools of large rivers, and deeper lakes connected to rivers offer additional winter habitats for freshwater aquatic species in Alaska. Winter habitat in upper stream reaches is limited to sites of groundwater discharge or springs; otherwise these areas freeze solid (Reynolds 1997).

In addition to the reduced presence of water in winter months, water quality is an important limiting factor and can further reduce survival success of overwintering fish in an already limited habitat (Morris 2000).

Clearwater River and Stream-associated Species

Stoneflies (Plecoptera)
Mayflies (Ephemeroptera),
Rhithrogena n. sp.
Caddisflies (Trichoptera)
Freshwater clams (Pelecypoda):
Western pearlshell, *Margaritifera falcata*
Yukon floater, *Anodonta beringiana*
Western floater, *Anondonta kennerlyi*
Arctic Tern, *Sterna paradisaea*
Aleutian Tern, *Sterna aleutica*
Rusty Blackbird, *Euphagus carolinus*
Tule White-fronted Goose, *Anser albifrons gambeli*
Osprey, *Pandion halieatus*
Alaska blackfish, *Dallia pectoralis*
Pacific lamprey, *Etosphenus tridentatus*
Arctic lamprey, *Lampetra camtschatica*
River lamprey, *Lampetra ayresi*
Western brook lamprey, *Lampetra richardsoni*
Alaskan brook lamprey, *Lampetra alaskense*
Siberian brook lamprey, *Lethentron kessleri*
Broad whitefish, *Coregonus nasus*
Bering cisco, *Coregonus laurettae*
Threespine stickleback, *Gasterostius aculeatus*
Ninespine stickleback, *Pungitius pungitius*
Western Toad, *Bufo boreas*
Wood Frog, *Rana sylvatica*
Columbia Spotted Frog, *Rana pretosia*

Yukon River Endemic Species

Trout-perch, *Percopsis omiscomaycus*

Clearwater Lakes and Ponds

As with flowing waters, the amount and quality of available habitat for biota in and around lakes depends on connections of the lake with surface and/or ground waters. Lake water level is related to the flow regime and can be perennial, with surface waters present year-round, or intermittent with water present seasonally. Lake level, thermal regime, and chemical composition may fluctuate depending on the groundwater source and connectivity.

Clearwater Lake and Pond-associated Species

Dragonflies, Suborder *Anisoptera*
Damselflies, Suborder *Zygoptera*
Mayflies (Ephemeroptera), *Rhithrogena n.* sp.
Water fleas - *Daphnia* spp. (Copepoda)
Arctic Tern, *Sterna paradisaea*
Red-throated Loon, *G. stellata*
Pacific Loon, *G. pacifica*
Arctic Loon, *G. arctica*
Common Loon, *G. immer*
Red-necked Grebe, *Podiceps grisegena*
Horned Grebe, *Podiceps auritus*
Surf Scoter, *Melanitta perspicillata*
White-winged Scoter, *Melanitta fusca deglandi*
Black Scoter, *Melanitta nigra Americana*
Tule White-fronted Goose, *Anser albifrons gambeli*
Osprey, *Pandion halieatus*
Yukon floater, *Anodonta beringiana*
Western floater, *Anondonta kennerlyi*
Alaska blackfish, *Dallia pectoralis*
Threespine stickleback, *Gasterostius aculeatus*
Ninespine stickleback, *Pungitius pungitius*
Western Toad, *Bufeo boreas*
Wood Frog, *Rana sylvatica*
Northwestern Salamander, *Ambystoma gracile*
Rough-skinned Newt, *Taricha granulose*
Long-toed Salamander, *Ambystoma macrodactylum*
Columbia Spotted Frog, *Rana luteiventris*

Isolated Lakes and Ponds

Many lakes in Alaska are not connected to a river or stream via an inlet or outlet. For example, lakes and ponds of thermokarst, fluvial, and volcanic origin generally lack connecting tributaries. Isolated or landlocked lakes can also be extremely shallow during the winter.

Although landlocked ponds and lakes may appear to lack connections to surface waters, many "isolated" waterbodies are hydrologically connected to other lakes, wetlands, streams, or rivers by subsurface flows. For example, the state's Arctic region is dotted with shallow ponds and lakes that were created during deglaciation of the area. These ponds are hydrologically linked via the underlying permafrost.

Because of their relative isolation, lakes and ponds with no surface connection to another water body are more likely to contain unique biota due to temporal isolation. A lake or pond may have either been originally connected to a river or stream, or created during deglaciation with no surface connection to other water bodies. Other lakes, such as isolated oxbow lakes on former floodplains, were once inundated by seasonal river flows but due to changes in river courses may be isolated beyond the active floodplain.

Isolated ponds M. LaCroix, DNR

RIPARIAN ZONES

The riparian zone is the area adjacent to the bank of a water body where terrestrial processes influence the aquatic environment. With few exceptions, mostly related to altitude and/or recent deglaciation, the banks of Alaska's lakes, rivers, and streams are vegetated, and the term riparian zone is most commonly used to refer to the vegetated corridor adjacent to a water body. Riparian zones provide the interface between terrestrial and aquatic habitats, and like all "edge" habitats, they support a wide diversity of wildlife. In spite of the large quantity and diversity of aquatic resources in our state, these important habitats make up only a small percentage of the total landscape. Although the majority of riparian areas in Alaska are in their natural condition, many areas of core development and resource extraction have compromised riparian zones.

In 1999 the National Research Council (NRC) developed the following definition of riparian area (NRC 2002).

> Riparian areas are transitional between terrestrial and aquatic ecosystems and are distinguished by gradients in biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology connect waterbodies with their adjacent uplands. They include those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e., a zone of influence). Riparian areas are adjacent to perennial, intermittent, and ephemeral streams, lakes and estuarine-marine shorelines.

Riparian zone with stream pool, riffle, waterfall habitat, and LWD in unnamed tributary, Little Susitna River drainage. D. Ryland, ADF&G

Riparian zones provide several functions directly related to aquatic habitats. They contribute LWD, provide leaf litter for primary consumer production, filter sediments and pollution, reduce wind, and regulate water temperature through shading and heat retention. They also provide streambank and floodplain integrity and stability via vegetative root systems. Although the functional boundary of a riparian area adjacent to a waterbody varies in relation to local flow regime, elevation, soils and vegetation, the overall importance of riparian zones for fish and wildlife is undisputed.

In Alaska, the distribution and abundance of plant species in riparian zones is dictated by geographic location, elevation, and soil characteristics. Generally speaking, emergent vegetation occurs in the hydric (wet) soils along relatively slow-flowing open water of streams or lakes. Shrubs, willows, grasses, and sedges dominate hydric-mesic (wet) soils and seasonally moist mesic (damp, moist) soils where water levels fluctuate. Mesic-xeric (drier) soils in uplands support species such as spruce, birch, dwarf dogwood, highbush cranberry, and lingonberry.

Riparian-associated Species

Rusty Blackbird, *Euphagus carolinus*
Blackpoll Warbler, *Dendroica striata*
Tule White-fronted Goose, *Anser albifrons gambeli*
Barn Swallow, *Hirundo rustica*
Bank Swallow, *Riparia riparia*
Cliff Swallow, *Petrochelidon pyrrhonota*

Southeast Endemic Species

Glacier Bay water shrew, *Sorex alaskanus*
Keen's mouse, *Peromyscus keeni* complex
Dusky shrew, *Sorex monticolus* complex

Ecological Role of Freshwater Aquatic Habitats

Alaska's waterways, riparian zones, and their resources sustain large and diverse populations of fish and wildlife. For aquatic species water provides migratory routes, spawning and rearing habitats, overwintering habitat, and refugia. Terrestrial wildlife also derive numerous benefits from freshwater aquatic habitats and riparian areas, including water itself, shelter, nesting and breeding areas, and important seasonal or daily transportation/migration corridors.

Rivers, Streams, Lakes and Ponds

The importance of quality fresh water to obligate aquatic species, such as fish, is apparent. However, the value of quality microhabitats or niches within the aquatic environment is central to the water's integrity, function, and purpose for other biota as well. For example, niche habitats provided by the streambed substrate and gradient are key in determining the types of organisms present and their distribution and abundance.

Alaska's resident and anadromous fish use distinct microhabitats and often move between them with regular periodicity. This movement can occur seasonally, annually, or be associated with different life stages. For example, depending on species and life stage, fish use different habitats as juveniles (i.e., for rearing) than they do as adults for spawning (Schlosser 1991). Shifts in use can also be related to water temperature, water level and photoperiod. As temperatures decrease in the fall, for example, Alaska's freshwater fish usually move from summer habitats to overwintering areas offering different habitats.

The size and stability of bed material usually dictates the presence or absence of benthic invertebrate communities. For example, boulder, cobble, and gravel beds support a high diversity of benthic organisms. In streams, aquatic invertebrates drift downstream with the current. Most of these drifting organisms are immature aquatic stages of insects that later metamorphose into winged terrestrial adults, the main groups being mayflies, stoneflies, caddisflies, and midges. Immature mayflies spend from a few months to several years in streams before they metamorphose and emerge as terrestrial adult insects. During a brief few days the adults mate in swarms near the stream, lay eggs in the water, and die (Stolz et al. 1991).

Many of the small invertebrates found in lakes and ponds differ from those found in streams. Aquatic insects or benthic invertebrates that live in the bottom sediments or on aquatic plants are the dominant species in lakes and ponds, and they provide a main food source for fish. Cladocera ("water fleas") are the dominant plankton found in freshwater habitats and are also an important food source for fish and predatory insects.

Cobble and gravel substrate provides spawning habitat for fish species that construct redds and for broadcast spawners as well. Fish species foraging in cobble-boulder substrates either use isolated pockets of gravel for spawning, or they spawn in tributaries or reaches that have spawning gravels. Redd-building females generally select a site at the tail-out of a pool or head of a riffle area where there is good circulation of oxygenated water through gravel substrate. Pockets of relatively stable gravels help protect the redds from the scouring effects of high flows. Upon their emergence from the gravel, juveniles may move into the boulder-cobble reaches to seek refuge. Large woody debris and boulders provide streambank structure that decreases sediment input to redds, and offer additional refugia for juveniles and smaller species. Sand and gravel bars and secondary channels provide additional specialized habitats to the aquatic environment.

Anadromous species such as eulachon, rainbow smelt, and longfin smelt exhibit a somewhat unique developmental egg stage whereby the female's recently released eggs fall to the stream bottom and immediately adhere to the substrate. The outer cover of the egg subsequently ruptures and turns inside out, forming a short stalk that holds the egg fast to the bottom substrate. These smelt species prefer spawning in substrate composed of coarse sand and gravel. In addition to spawning in stream habitats, rainbow smelt are also known to spawn in the shallows of lakeshores.

Lamprey species depend on muddy bottoms, backwaters, and low gradient areas during juvenile life stages. Substrate material is particularly important in the life cycle of juvenile lamprey as they stay burrowed in the mud for 4–6 years, moving only rarely to new areas. Larval lamprey occupy a special niche in the stream system, filtering microscopic plants and animals from mud on the bottom. However, adult lamprey spawn in gravelly substrates, similar to those required by Pacific salmon. Because lamprey species exhibit freshwater, anadromous and marine forms, they are important forage fish for marine mammals, birds, and freshwater fish.

Alaskan blackfish prefer muddy substrates in quiet waters in densely vegetated areas of wetlands, ponds, rivers, and lakes. They are spring spawners whose eggs are demersal and stick to available vegetation. Blackfish have a unique modified esophagus capable of gas absorption, which allows them to breathe air. This ability enables them to live in small, stagnant tundra pools that are almost devoid of oxygen in summer and to survive in moist tundra mosses during extended dry periods.

The trout-perch (*Percopsis omiscomaycus*), Alaska's sole percopsid species, occurs only in the mainstem of the state's longest waterway, the Yukon River. Trout-perch typically reside in deep lakes or in long deep pools of streams and are an important forage fish for larger species. They move into shallower waters to spawn where their eggs sink and stick to substrate, woody debris, or vegetation.

Sticklebacks often dominate lower elevation ponds, lakes, and streams in Alaska. They are an important forage fish for other fish species and for piscivorous birds, such as loons, terns, and gulls. Besides other zooplankton and insects, cladocera are an important food source of stickleback. Stickleback are represented by freshwater, anadromous, and marine forms, the ninespine stickleback being a freshwater inhabitant while the threespine stickleback is found in both marine and fresh waters. The presence of aquatic vegetation plays an important role in this fish's selection of spawning habitat because the male builds a nest of sand and vegetation to house the fertilized eggs. Freshwater stickleback spawn in shallow well-oxygenated waters, including isolated ponds. Most isolated ponds and lakes provide the same functions as ponds with hydrologic connectivity to other waters, i.e., providing breeding grounds for aquatic insects, invertebrates, amphibians, and waterfowl. However, they restrict fish passage and limit distribution, setting the stage for population endemism due to geographic isolation. Because of this, many populations of stickleback in the Cook Inlet area are considered to be different subpopulations that have evolved over time.

Invertebrate species, including bivalve mollusks, are often associated with ponds and lakes, whether isoloated or not. The western floater and the Yukon floater, 2 types of mollusks, are associated with sand and gravel substrates of lakes, ponds, and slow-moving streams. Another invertebrate species of concern, the western pearlshell, prefers gravel substrates in rivers.

Many avian species overwinter in other areas of the country or in other habitats within the state, yet spend their summers in ponds and lakes across Alaska. Loons, grebes, waterfowl, and shorebirds are all found throughout lake and pond habitats during the summer mating, nesting, and rearing season. Although loons spend their winters offshore, they spend summers inland in close proximity to the ponds and lakes where they nest and rear their young. In summer, waterbirds such as grebes prefer secluded habitats in ponds and lakes. During winter and on their migration journeys grebes prefer large lakes, coastal bays, and estuaries. Many gulls and terns nest in the coniferous tree tops surrounding isolated ponds, eating insects and forage fish. Summer breeding areas for Aleutian Terns, however, include the matted dry grass near riverine habitat. Black Scoters and Surf Scoters nest in the riparian zone of lakes, ponds, or rivers in tundra or forests, while the White-winged Scoter prefers breeding grounds near streams and lakes.

Glacial Systems

Glacial rivers are important migratory corridors for both aquatic and terrestrial wildlife. They provide access to the clearwater systems elsewhere in a drainage that are ideal for spawning and rearing. In addition, many glacial river drainages contain associated large lake systems. Mainstem spawning does occur in some glacial rivers in Alaska. Onset of migratory movements in fish is induced by water temperature and level. Consequently, migratory and spawning timing in glacial waters can be significantly impacted in years of high glacial melt and can result in flooding and destruction of spawning beds. Regulated primarily by ground water, clearwater systems exhibit less dynamic annual flows.

Glacially influenced and clearwater lakes Alaska USGS

Significant eulachon runs are associated with some of Alaska's glacial rivers, including the 20 Mile River in the Turnagain Arm area, the Susitna River, the Kenai River on the Kenai Peninsula, and the Eyak River in the Copper River Delta of Prince William Sound. Pygmy whitefish are generally associated with postglacial lakes and are largely considered a glacial relict species. Streams they inhabit are of moderate to swift current and may be silty or clear. Pygmy whitefish are frequently found in deep, unproductive lake waters.

Glacial advances formed 2 large glacial lakes within the Kenai River watershed, Kenai and Skilak Lakes. These lakes provide important overwintering habitat for aquatic species and improve downstream habitats by trapping coarse sediment, increasing water temperatures, and regulating downstream flow (Dorava 1998). These lakes significantly influence the downstream habitats of the watershed.

Riparian Zone

The riparian zone adjacent to rivers, streams, lakes, and ponds plays a critical role in nutrient cycling between terrestrial and aquatic habitats. Nutrient and organic-matter input from the riparian zone has a direct influence on food availability and growth rates of fish in both upstream and floodplain habitats (Schlosser 1991). The influence of the riparian zone vegetation is greater in headwater streams due to the high ratio of shoreline to stream bottom area. Riparian vegetation along rivers, streams, and lakes is a critical food source to primary producers, such as invertebrates, including filter feeders, shredders, scrapers, and predators. Riparian vegetation provides shade that limits in-water plant growth, but it provides substantial organic inputs, such as leaves, needles, twigs, nuts, and flowers. This dead plant material is the dominant detritus that constitutes up to 90 percent of the organic matter supporting headwater stream communities (Cummins et al. 1978), including insect larvae, such as caddisflies, stoneflies, mayflies and black flies. It also provides substrates for emerging adult insects, such as stoneflies and mayflies.

The riparian zone influences fish habitat by regulating water temperature through shading effects, by providing inputs of food supply and large woody debris, by providing channel structure through maintaining bank stability, and by preventing sedimentation and erosion (NRCC 2002). Riparian zone variables, such as width, density of vegetation, and season, regulate inputs and effectiveness. For example, diversity and density of aquatic invertebrates available as fish food is higher in streams (Newbold et al. 1980) and lakes (Christiansen et al. 1996) with wider riparian zones. In upstream habitats, seasonal variations exist related to detritus input in the fall, leaf processing in the winter and spring, and reduced organic inputs during the summer. Similarly, the growth rate of fish in large river floodplain habitats is linked to food availability provided by headwaters associated with seasonal water fluctuations.

The varied structural integrity and diversity of plant species present in the riparian zone also provide habitat for other wildlife. Amphibians, such as the Wood Frog and the Columbia Spotted Frog, require water to complete their life cycles and are closely linked to riparian areas year-round. Wood Frog eggs are found either free floating or attached to vegetation in shallow areas of ponds, lakes, and/or slow-moving streams. Juveniles disperse to surrounding uplands but return annually at adulthood to these aquatic breeding areas. The Northwestern Salamander lives under logs and rocks of the coastal forests next to freshwater ponds or lakes. Its eggs are found attached to vegetation or submerged trees in slow-moving streams, ponds, or lakes. Rough-skinned Newts are found in the coastal forest around permanent ponds and lakes or in slow-moving streams with large amounts of vegetation. They attach their eggs to vegetation or between pieces of vegetation, making them difficult to spot. Both the Rough-skinned Newt and the Northwestern Salamander have extended periods of metamorphosis within the aquatic environment taking approximately 2 years.

Small terrestrial rodents such as the Glacier Bay water shrew and Keen's mouse preferentially use riparian zones. Small mammals may be year-round residents of riparian floodplain forest (Hanley 1999). Water shrews can dive to the bottom of a water body. Air trapped in the small mammal's fur pops it to the water's surface like a cork. This trapped air also allows the water shrew to float on the surface. Water shrews eat mayfly and caddisfly nymphs, as well as terrestrial invertebrates (National Wildlife Federation 2003). In addition to providing food resources, riparian vegetation provides shrews with cover from predators, while providing easy access to water.

Riparian vegetation also provides feeding, breeding, and nesting areas for all types of birds. Many of the nation's migratory birds depend on riparian areas of lakes, ponds, rivers, and streams to supply food resources such as insects, nuts, and berries, as well as protective sites and materials for nesting. Bird density, species richness, biodiversity, number of rare species, and number of breeding pairs are often elevated within riparian habitat.

Large terrestrial mammals also benefit from intact riparian zones by using them as protected corridors for daily or seasonal movements, and as a means to facilitate gene flow (seek out mates in new areas).

The riparian zone provides connectivity to the multitude of habitat types required to maintain species productivity, sustainability, and biodiversity. As a whole, the riparian zone typically becomes wider as one moves from a water body's headwaters to the floodplain. The width of the riparian zone may be the most important feature for species dynamics, with connectivity, sinuosity, and network pattern also playing a role (Malanson 1993). Mammals that search the waters for fish often bring their catch inland to consume. Leftover carcasses decompose and feed terrestrial plants that are the mainstay of the riparian habitat, providing shade, sediment filtration, and woody debris. Fallen leaves and large woody debris enter the waters, providing both food for primary producers and enhancing fish spawning habitat. Spawned-out fish carcasses provide food sources for juvenile fish and for scavenging birds and mammals. These activities provide inputs to the aquatic system that contribute to its health and maintain its cyclic nature.

Conservation Status

Alaska's freshwater habitat is generally healthy. Localized development impacts will likely continue to result in habitat alteration. Opportunities should be sought that alleviate negative impacts and maintain connectivity and quality habitat important to the sustainability of species.

Threats to freshwater habitat include point and nonpoint source pollution, development and associated sediment erosion and removal of riparian vegetation, blockages, diversions, channelization, dams, unmonitored water withdrawals, natural resources extraction, mixing zones, ice export, invasive species, and global warming.

Regulatory responsibilities over fresh waters in Alaska involve both state and federal agencies. DNR is the state agency responsible for water data collection and for planning and administering the appropriation of water. The Water Resources Section of DNR's Division of Mining, Land, and Water regulates water withdrawals and adjudicates water right applications. As the state's land manager, DNR holds land and water under the public trust doctrine and is responsible for maintaining these resources in an unimpaired state for the use of future generations. Alaska's laws guarantee the public's access to and use of state waters.

Water withdrawals may also be jurisdictional to DNR's Office of Habitat Management and Permitting (OHMP), which regulates activities that result in the physical alteration of, or have the potential to adversely affect, anadromous waterbodies. The OHMP also regulates activities in resident fish streams that might block fish passage.

The OHMP holds the state's regulatory authority over anadromous and resident fish and aquatic insect streams. Effective May 1, 2003, fish habitat permitting, Forest Resource and Practices Act review, and other project review functions were transferred from the Habitat and Restoration Division of ADF&G to the Alaska Department of Natural Resources' OHMP. Specifically, the OHMP's statutory responsibilities are to protect freshwater anadromous fish habitat under the Anadromous Fish Act (AS 41.14.870) and to provide free passage of anadromous and resident fish in freshwater bodies (AS 41.14.840).

ADF&G regulates activities within the state's refuges, critical habitat areas, and sanctuaries. ADF&G also reviews proposed water withdrawals and appropriations, and works to determine appropriate instream flow reservations important to aquatic and riparian habitat functions. In addition, ADF&G also reviews projects under federal jurisdiction requiring a Federal Energy Regulatory License (FERC) for protection of fisheries resources. OHMP and ADF&G's Sport Fish Division work jointly to produce the State's Anadromous Waters Catalog.

DEC implements the State's Water Quality Standards and programs to address both point source discharges and nonpoint source pollution. Under section 401 of the Clean Water Act, the DEC also issues certifications for activities authorized by the COE. The COE regulates structures in navigable waters and the placement of fill within waters of the United States.

In addition to DEC's programs, most point source discharges to surface waters are also regulated by the EPA, which administers the National Pollution Discharge Elimination System (NPDES) program. The state is currently seeking to receive primacy in the administration of this program to the federal government.

Activities within the state's designated Coastal Zone that require state or federal authorizations are reviewed by state agencies for consistency with the standards of the Alaska Coastal Management Program (ACMP).

The state's ACMP standard for habitats, 11 AAC 112.300, requires that rivers, streams, and lakes shall be managed to avoid, minimize, or mitigate significant adverse impacts to: (A) natural water flow, (B) active floodplains, and (C) natural vegetation within riparian management areas.

According to the definitions found in 11 AAC 112.300, a riparian management area means:

(A) along the braided portions of rivers and streams, 500 feet on either side of the waterbody;

(B) for split channel portions of rivers and streams, 200 feet on either side of the waterbody;

(C) for single channel portions of rivers and streams, 100 feet on either side of the waterbody;

(D) for lakes 100 feet of the waterbody; distances in this paragraph are measured from the outermost extent of the ordinary high water mark.

This definition applies to water bodies located within the state's coastal zone, but the state does not have a legal definition of riparian zone that is consistently applied statewide. The Forest Practices Act, implemented by DNR, requires riparian buffers of varying size depending on land ownership and region of timber harvest. The definition of riparian zone developed by the NRC, referenced earlier in this appendix, is not a definition that is consistently applied by federal agencies. This hinders the ability of state and federal programs to best protect riparian areas. Alaska has a unique opportunity to study and protect river corridors uninterrupted over the whole of the river continuum from headwaters to mouth.

Specific recommended conservation actions for freshwater aquatic habitats include developing and integrating biodiversity conservation and sustainable use objectives into water and land use and natural resource use management plans. The conservation and management of existing freshwater ecosystems should be a priority. Maintaining aquatic systems and natural hydrologic functions is preferred over the need for costly restoration through engineered solutions. For example, specific conservation actions directed at maintaining hydrological regimes that sustain suitable spawning and rearing habitats for aquatic species in quality and quantity are in the state's best interests. Government agencies with water rights jurisdiction should strive to set minimum flow rates and levels for streams and lakes that maintain ecologically viable aquatic systems, including wetlands. Recent GIS capability of the National Hydrography Dataset (NHD) will facilitate water management and aquatic conservation goals. The NHD is a comprehensive set of digital, spatial data that contains information about surface water features, such as lakes, ponds, streams, rivers, springs, and wells. The NHD allows analysis and display of these water-related data in upstream and downstream order (USGS 2005). In Alaska, the USGS topographic maps were used to develop the NHD dataset at a scale of 1:63,360. Hydrologic processes regulate the quality and quantity of available habitat for aquatic species. Understanding these processes within a given system may help identify critical habitats necessary for overwintering and egg survival success of obligate aquatic species. Tools such as an appropriate aquatic habitat classification and GIS mapping would enhance efforts to identify and conserve important areas.

Additional recommended conservation actions include studies directed at identifying links between landscape processes, such as geological and climatic history; the habitat process, such as the development and dynamics of riparian areas and their vegetation; and the ecology and population dynamics of the dominant fish species that occur in the different ecoregions of Alaska. This will further our understanding of how human-induced changes affect the species composition and population dynamics of each species.

Other steps toward conservation include land planning and platting efforts that protect riparian areas adjacent to important aquatic habitats. Implementation of conservation efforts should focus initially on core areas of development around the state, such as in Fairbanks, Anchorage, and the Matanuska-Susitna Borough. Effective incentives to minimize habitat fragmentation, encroachment, and pollution to aquatic ecosystems, as well as establishing long-term cost recovery mechanisms and financial assistance for sustainable use, should be implemented. Incentive-based approaches that encourage private landowners to protect Alaska's water and riparian areas and provide for their sustainable use should be developed. These may include resources such as farm bills, cost-share programs, tax incentives, conservation easements, and restoration programs. Although these types of approaches are costly, they are also cost effective; it is much cheaper to protect and sustain than to restore.

Continued cooperating efforts among state and federal agencies, NGOs, and local watershed groups on existing water resources programs that protect water quality through incorporating point and nonpoint source pollution prevention strategies should be encouraged and strengthened. These same groups should develop and/or improve mitigation policies that address negative impacts to aquatic resources with the goal of maintaining connectivity and productivity of habitats.

Lastly, cooperative relationships with local watershed and citizen monitoring groups, including outreach and education opportunities, should be fostered. This should include long-term projects and long-term partnerships with local communities. Grass-roots efforts have great potential to improve the quality of local freshwater habitats by advocating awareness and enlisting volunteers.

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Appendix 6. Public Comment Summary – 2003 and 2005

Results of 2005 Public Review

ADF&G conducted a 60-day public review period for the draft CWCS that ended on April 18, 2005. The overwhelming majority of more than 100 comments received from the public, other agencies, and organizations supported the draft CWCS and the importance of working toward the goal of conserving all of Alaska's wildlife and fish. Commenters included members of the public and the academic community, consultants, borough, state and federal agencies, tribal groups, a mining association, local Fish and Game Advisory Committee members, as well as hunting and conservation organizations.

During the CWCS planning effort, ADF&G hosted a website that served as the principal means for sharing information with the public about the draft strategy. During the public review period, the draft strategy could be viewed or downloaded from the website at http://www.sf.adfg.state.ak.us/statewide/ngplan/. Many people used the online comment form to submit input. Over 1600 unique visitors accessed the CWCS website during the public review period, making over 3600 visits. ADF&G also hosted an intranet CWCS website that could be accessed only by ADF&G staff.

Public comments arrived by email, fax, and sometimes as multi-page letters. Suggestions for changes ranged from minor edits to major rewrites or reorganization of the Strategy's chapters. Some commenters brought up important issues, such as if or how "game" species could be addressed, and whether or not habitat should be the focus of the Strategy. Due to the length of the draft strategy and the volumes of material included in its appendices, most reviewers were not expected to fully evaluate the entire document, and some of the submitted comments raised issues or made points that were clearly addressed or covered elsewhere in the draft. At other times, commenters made valuable suggestions about both the style and content of the Strategy, and the planning team incorporated such changes in the final CWCS.

A few commenters suggested the draft strategy should take more of an ecosystem-level approach toward the conservation of species. ADF&G revised the Strategy to include more mention of the value of ecosystem concepts in species conservation and management. We added an internet link to the Ecological Society of America's site, as well as numerous links to sites describing ecosystem-level work going on in, or otherwise of benefit to, Alaska. While the Strategy's conservation action plans (Appendix 4) continue to be primarily species-based, ecosystem considerations are presented throughout the final Strategy and are anticipated to play an important role during its implementation.

Several people suggested the CWCS focus more on the habitats needed by species, instead of directly on the species themselves, as a means to ensure sustainable wildlife and fish populations. Even though the emphasis remains on species, ecosystem and habitat information and related considerations are included as part of the final Strategy.

Some commenters suggested adding one or more game species or populations to the Strategy's featured species list. Another commenter requested that the Strategy be rewritten to address only nongame species. The final CWCS includes a very limited number of game populations that experts identified as being of conservation concern, using criteria developed during the planning process. Although hundreds of specific conservation actions presented in the Strategy are aimed at addressing the conservation needs of species that are not commercially or recreationally hunted, trapped, or fished, many activities will also benefit species harvested in these ways.

In response to several commenters, we added language highlighting the economic value of Alaska's species, both for wildlife-related tourism and as foundations of food chains supporting commercially or recreationally valuable species. We also added a brief description of ADF&G's existing nongame and marine mammal programs, and text about the role of enforcement in conservation.

A couple of commenters expressed concern that there appeared to be a lack of involvement by representatives of the hunting community, and this lack could weaken the overall Strategy. The outreach effort for this project from the beginning was open and inclusive. ADF&G developed and used a contact list of about 600 names or organizations that included the Alaska Outdoor Council, Alaska Bowhunters Association, Alaska Flyfishers, Ducks Unlimited, Trout Unlimited, and the nearly 80 local ADF&G Fish and Game Advisory Committees spread across the state.

Literally hundreds of other suggestions for improving the draft were incorporated into the Strategy—far too many to include in this general summary about public input. The general and very detailed input submitted by the various reviewers contributed to a greatly improved final Strategy.

Results of 2003 Public Scoping:

Public outreach and scoping efforts in October 2003 generated the following list of issues.

1. Habitat
   - Factors and areas of concern
     - Climate change
     - Road development
     - Fragmentation
     - Oil development
     - Coal bed methane
     - Logging
     - Poorly planned development degrading water quality
     - Ocean changes

        - Housing developments
        - Human pollution
        - Human use of habitat
        - Human recreation
        - Development in general
        - All-terrain vehicles
        - Areas of concern
            - Ponds by Woodriver Elementary
            - Soccer fields by Davis Rd.
            - Cook Inlet
            - Old-growth forest sites in Southeast Alaska
            - Teshekpuk Lake
                - Wetlands
            - North Slope
            - Kenai Peninsula
            - Rainforests in Southeast Alaska
            - Prince William Sound
                - Oil turbines
                - Boats
                - Cruise ships
            - Kodiak
                - Cruise ships
                - Longline fishing
        - “Aquatic organism” passage (not just game fish passage)
    - Need a commitment to protect, and just as important, enhance habitat
2. Policy and politics
    - Public indifference and apathy
    - Ignorance
    - No say in management
3. Research needs
    - State forests research natural areas
        - Study importance of cavities for nesting
    - Population monitoring for land snails
    - Utilize local nonprofits and universities for monitoring
4. Invasive species
    - Sharks
        - Salmon sharks
        - Pacific Sleeper sharks
    - Lancet Fish
5. Species selection criteria
    - Ecological keystone species should be considered as a first priority
    - Priorities should be ranked by:
        - (1) first and second priorities
        - (2) number of organizations cross-listing
        - (3) weight of data used by the listing organization

- ➢ Take a landscape and habitat approach.
- ➢ First priority list should be more specific in species.
- ➢ Some of the codes should be corrected
- ➢ BPIF monitor list should be shown strongly
- ➢ Uncommon species should be first priority
- ➢ Second priority identifying “species status is unknown” should put inventories as a top priority.
- ➢ Second priority too broad
- ➢ Consider evolutionary criteria—how long has this species been genetically diverging from other forms, i.e., how unique is it in an evolutionary sense?
- ➢ Game species are dependent on nongame species

6. Predation
   - ➢ Martens killing off grouse on (Southeast) islands
7. Game vs nongame conflicts
8. Get harvesting stations
9. Not enough management of nongame species
10. Lack of knowledge on specific habitats types, locations and functions.
11. Education
    - ➢ Educating areas about loons in jet-ski areas
    - ➢ Educational funding
    - ➢ Lack of information on specific species
12. Don’t use fish and game funds unless there is a demonstrable benefit to hunters and game species
13. Tourism/Viewing
    - ➢ Build a constituency for these species
14. Process
    - ➢ Keep broad mailing list, use NGOs
      - ▪ All active advisory committee members should be on mailing list
    - ➢ Native concerns
      - ▪ Calls and community meetings with Natives are good
      - ▪ Allow time for postal limitations in rural areas
    - ➢ [Utilize] statewide news releases to local papers, radio, TV with a way to contact the department
    - ➢ Strong public outreach

Appendix 7. Nominee Species List

This list of species nominated for consideration as potential planning targets was derived from various conservation plans, lists, and organizations, as well as expert and public comments. For the purposes of developing a Comprehensive Wildlife Conservation Strategy for the State of Alaska, we consider this list to represent our species of greatest conservation need. We will consider adding and deleting species as plans and lists of other organizations are updated.

Conservation Status:

A Key to Abbreviations (with organizations listed in alphabetical order)

AA WATCH LIST. Audubon's Alaska WatchList.

PT – population trend
RA – relative abundance
BD – breeding distribution
TB – threats during breeding season
ND – nonbreeding distribution (migration & winter)
(ND) – nonbreeding distribution primarily outside Alaska
TN – threats during nonbreeding season
(TN) – threats during nonbreeding season are outside Alaska
* – species also recognized by National Audubon Society

ABC GREEN LIST. American Bird Conservancy.
Green List species are those with scoring sums (i.e., Population Trend + Population Size + Maximum Threat score [breeding or nonbreeding) + Maximum Distribution score (breeding or nonbreeding]) > 14, or those with a sum of 13 with a Trend score of 5. Details of scoring can be found in the Species Assessment Handbook by Arvind Panjabi, located on the Rocky Mountain Bird Observatory web site (http://www.rmbo.org/)

Across-the-board high scores put birds in the highest concern category. High trend and threat scores with low size and distribution scores put birds into the widespread but vulnerable list, while the opposite, high size and distribution and low (or unknown) trend and threats, constitute the third category. The “rules” that govern what is or is not “high” are not set in stone, but were open to interpretation by knowledgeable ornithologists. American Bird Conservancy took these rules developed by Partners in Flight for landbirds and applied them to the entire North American avifauna (D. Pashley, pers. comm.).

Green List species are shown with codes indicating the factor(s) that contribute(s) to their need for conservation action:

D – declines
HCC – highest continental concern
HT – high threats
LPS – low population size
MA – moderately abundant
RD – restricted distribution

AFS. American Fisheries Society.

Conservation Dependent – reduced but stabilized or recovering under a continuing conservation plan

Endangered – high risk of extinction in the wild in the immediate future (years)

Vulnerable – a decline in productivity over the longer of 10 years or 3 generations—with the percent decline that triggers the vulnerable status calibrated to the productivity of the species

ASCP. Alaska Shorebird Conservation Plan (March 2000).

SOHC – Species of High Concern: Populations of these species are known or thought to be declining, and have some other known or potential threat as well. Species are identified as SOHC using the following criteria:

PT = 4 or 5 and either RA, BD, TB, or TN = 4 or 5

RA = 4 or 5 and either TB or TN = 4 or 5

AI = 5 and RA >3 for regional lists only

PT = Population trend and population trend uncertainty; a measure of the component of vulnerability reflected by the direction and magnitude of changes in population size over the past 30 years. 4 = Apparent population decline, or significance test has medium or low power (<0.8) and comprehensiveness is low; or, no date but informed estimates about population trend possible; 5 = Significant population decline (p<0.10), or no information about population trend.

RA = Relative abundance; a measure of the component of vulnerability that reflects the abundance of breeding individuals of a species, within its range, relative to other species. 4 = 25,000 - < 150,000 individuals; 5 = < 25,000 individuals.

BD = Breeding distribution; a measure of the component of vulnerability that reflects the global distribution of breeding individuals of a species during the breeding season. 4 = 2.5-4.9% of North America; 5 = <2.5% of North America (212,880 square miles).

TB = Threats during breeding season; an evaluation of the component of vulnerability that reflects the effects of current and future extrinsic conditions on the ability of a species to maintain healthy populations through successful reproduction. 4 = Significant potential threats exist (e.g., oil spills) but have not actually occurred; 5 = Known threats are actually occurring (e.g., significant loss of critical habitat), and can be documented.

TN = Threats during nonbreeding season; an evaluation of the component of vulnerability that reflects the effects of current and future extrinsic conditions on the ability of a species to maintain healthy populations through successful survival over the nonbreeding season. 4 = Significant potential threats exist (e.g., oil spills) but have not actually occurred. Concentration results in high potential risk. 5 = Known threats are actually occurring (e.g., significant loss of critical habitat) and can be documented. Concentration results in actual risk.

AI = Area importance; scores are based on knowledge of distributions, expert opinion, and data on distributions for species where they are available. Species are ranked on a relative scale within each Bird Conservation Region. The regional prioritization system uses the same criteria as for national priorities, with the additional rule that species can be assigned to a different category based on their area importance within the region. Species that are highly imperiled are included wherever they occur.

BC. British Columbia, Provincial Red and Blue List (2002)

RED – extirpated, endangered, or threatened
BLUE – vulnerable
YELLOW – not at risk
ACC – accidental

BPIF. Boreal Partners in Flight

Species of conservation priority are those species ranking > 17 using the species prioritization process found in Landbird Conservation Plan for Alaska Biogeographic Regions, Version 1.0 (October 1999), pp. 10–13. Species of conservation priority are shown with a letter indicating the factor(s) that contribute(s) to their need for conservation action:

B – boreal North America monitoring responsibility
F – potential negative response to loss of forest cover
G – global monitoring responsibility
T – decreasing population trend
W – nonbreeding habitat threats

BLM. Bureau of Land Management, U.S. Department of Interior

S–Sensitive: BLM Manual Section 6840 defines sensitive species as ". . . those species that are: (1) under status review by the FWS/NMFS; or (2) whose numbers are declining so rapidly that Federal listing may become necessary; or (3) with typically small and widely dispersed populations; or (4) those inhabiting ecological refugia or other specialized or unique habitat."

CITES. Convention on International Trade in Endangered Species of Wild Fauna and Flora (as of July 2002)

Protection Status: Value assigned to the species from the Protective Appendix according to the Convention on International Trade in Endangerment of Species (CITES). Values include: A1 = Appendix I (species that are most endangered, threatened with extinction, and for which commercial international trade is generally prohibited), A2 = Appendix II (species that are not necessarily threatened with extinction at this time, but that may become threatened unless commercial international trade is controlled), A3 = Appendix III (species included by request of a country that regulates its trade, and for which cooperation of other countries is needed to prevent exploitation).

COSEWIC. Committee on the Status of Endangered Wildlife in Canada (as of November 2002)

(for definitions, see www.cosewic.gc.ca/eng/sct0/Assessment_process_tbl2_e.cfm)

XT – extirpated; a species no longer existing in the wild in Canada, but occurring elsewhere

E – endangered; a species facing imminent extirpation or extinction

T – threatened; a species likely to become endangered if limiting factors are not reversed

SC – special concern; a species that is sensitive to human activity or natural events

NAR –not at risk

DD – data deficient

C – candidate; a species that is suspected of being in some COSEWIC category of risk of extinction or extirpation at the national level, before being examined through the status assessment process

PS – partial status (applies only to portion of species' range)

GRANK. NatureServe, a network of natural heritage programs, and The Nature Conservancy (as of November 2001) Global Status (throughout its range)

GX - presumed extinct - not located despite intensive searches and virtually no likelihood of rediscovery

GH - possibly extinct - missing; known from only historical occurrences but still some hope of rediscovery

G1 – critically imperiled - at very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors

G2 – imperiled - at high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors

G3 – vulnerable - at moderate risk of extinction due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors

G4 – apparently secure - uncommon but not rare; some cause for long-term concern due to declines or other factors

G5 – secure - common; widespread and abundant

GNR – unranked - global rank not yet assessed

GU – unrankable - currently unrankable due to lack of information or due to substantially conflicting information about status or trends. Whenever possible, the most likely rank is assigned and the question mark qualifier is added (e.g., G2?) to express uncertainty, or a range rank (e.g., G2G3) is used to delineate the limits (range) of uncertainty.

G#G# - range rank - A numeric range rank (e.g., G2G3) is used to indicate the range of uncertainty in the status of a species or community. Ranges cannot skip more than one rank (e.g., GU should be used rather than G1G4).

G#? – inexact numeric rank—denotes inexact numeric rank (e.g., G2?)

G#Q - questionable taxonomy - taxonomic distinctiveness of this entity at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or the inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority conservation priority

G#T# - infraspecific taxon (trinomial) - The status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' global rank. Rules for assigning T-ranks follow the same principles outlined above for global conservation status ranks. For example, the global rank of a critically imperiled subspecies of an otherwise widespread and common species would be G5T1. A T-rank cannot imply the subspecies or variety is more abundant than the species as a whole-for example, a G1T2 cannot occur. A vertebrate animal population, such as those listed as distinct population segments under the U.S. Endangered Species Act, may be considered an infraspecific taxon and assigned a T-rank; in such cases a Q is used after the T-rank to denote the taxon's informal taxonomic status. At this time, the T rank is not used for ecological communities.

IUCN. International Union for Conservation of Nature and Natural Resources (as of 2002)

IUCN Conservation Status: EX = extinct, EW = extinct in wild, CE = critically endangered, E = endangered, VU = vulnerable, LR = lower risk, DD = data deficient, NE = not evaluated, CD = conservation dependent, NT = near threatened, LC = least concern. According to the IUCN Red List Categories and Criteria, Version 3.1 (found at http://www.iucn.org/themes/ssc/redlists/RLcats2001booklet.html), a taxon is Critically Endangered "when the best available evidence indicates that it meets any of the criteria A to E for Critically Endangered (see Section V), and it is therefore considered to be facing an extremely high risk of extinction in the wild." Similarly a taxon is Endangered "when the best available evidence indicates that it meets any of the criteria A to E for Endangered (see Section V), and it is therefore considered to be facing a very high risk of extinction in the wild. A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for, or is likely to qualify for, a threatened category in the near future."

NAWCP. Waterbird Conservation for the Americas: The North American Waterbird Conservation Plan, Version 1 (2002).

Highly Imperiled – This includes all species with significant population declines and either low populations or some other high risk factor. Species are identified as Highly Imperiled using the following criteria:

PT = 5 and either PS, TB, TN, or BD = 5.

High Concern – Species that are not Highly Imperiled. Populations of these species are known or thought to be declining, and have some other known or potential threat as well. Species are identified as of High Concern using the following criteria: PT = 4 or 5 and either PS, TB, TN, or BD = 4 or 5; or PS = 4 or 5 and either TB or TN = 4 or 5

PT = Population trend. 4 = apparent population decline; 5 = biologically significant population decline.

PS = Population size. 4 = 480–5800 individuals; 5 = up to 480 individuals.

TB = Threats to Breeding. 4 = Significant potential threats exist, but have not actually occurred; concentration not a risk; 5 = Known threats are actually occurring and can be documented; concentration results in actual risk.

TN = Threats to Nonbreeding. This factor rates the threats know to exist for each species during their nonbreeding season. The scores are the same as for the Threats to Breeding factor, but without the additional risk due to concentration during breeding.

BD = Breeding Distribution. 4 = local (450,000 km^2 - 1,500,000 km^2); 5 = highly restricted (up to 450,000 km^2)

NOAA. National Oceanic Atmospheric Administration – Fisheries (Formerly called National Marine Fisheries Service).

Same as USFWS (below) Under the Endangered Species Act of 1973, as amended, NOAA – Fisheries is responsible for listed anadromous and marine fishes and marine mammals other than sea otter, manatees, and dugongs.

<u>SOA. State of Alaska</u>.

E = Endangered. A species or subspecies of fish or wildlife is considered endangered when the Commissioner of the Department of Fish and Game determines that its numbers have decreased to such an extent as to indicate that its continued existence is threatened. In making this determination the commissioner shall consider:

1–the destruction, drastic modification, or severe curtailment of its habitat;
2–its overutilization for commercial or sporting purposes;
3–the effect on it of disease or predation;
4–other natural or man-made factors affecting its continued existence.

SSOC = State Species of Concern. On May 25, 1993, the commissioner of the Alaska Department of Fish and Game established a new administrative list of Species of Concern to complement the Alaska Endangered Species List. A State Species of Concern is defined as any species or subspecies of fish and wildlife native to the State of Alaska that has entered a long term decline in abundance or is vulnerable to a significant decline due to low numbers, restricted distribution, dependence on limited habitat resources, or sensitivity to environmental disturbance.

<u>SRANK. NatureServe, a network of natural heritage programs, and The Nature Conservancy (as of November 2001) subnational/state status (status in Alaska)</u>

SX – presumed extirpated; not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that species will be rediscovered

SH – possibly extirpated; some possibility that species may be rediscovered, but its presence may not have been verified in the past 20–40 years

S1 – critically imperiled; extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making species especially vulnerable to extirpation

S2 – imperiled; rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making species very vulnerable to extirpation

S3 – rare or uncommon; restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making species vulnerable to extirpation

S4 – not rare, long-term concern; uncommon but not rare; some cause for long-term concern due to declines or other factors

S5 – widespread, abundant, secure

SNR - species not ranked; conservation status not yet assessed

SU - unrankable due to lack of information or due to substantially conflicting information about status or trends

S#S# - a numeric range rank (e.g., S2S3) is used to indicate any range of uncertainty about the status of the species

S#B - conservation status refers to the breeding population of the species

S#N – conservation status refers to the breeding population of the species

Note: A breeding status is only used for species that have distinct breeding and/or nonbreeding populations in the state. A breeding-status S-rank can be coupled with its complementary nonbreeding-status S-rank if the species also winters in the state.

S#? – inexact or uncertain; the ? qualifies the character immediately preceding it in the S-rank.

S#Q – questionable taxonomy that may reduce conservation priority. Distinctiveness of this entity as a taxon at the current level is questionable; resolution of this uncertainty may result in change from a species to a subspecies or hybrid, or inclusion of this taxon in another taxon, with the resulting taxon having a lower-priority (numerically higher) conservation status rank.

S#T# – infraspecific taxon (trinomial) – the status of infraspecific taxa (subspecies or varieties) are indicated by a "T-rank" following the species' state rank. Rules for assigning T-ranks follow the same principles outlined above. For example, the state rank of a critically imperiled subspecies of an otherwise widespread and common species would be S5T1. A T subrank cannot imply the subspecies or variety is more abundant than the species; for example, a S1T2 subrank should not occur. A vertebrate animal population (e.g., listed under the U.S. Endangered Species Act or assigned candidate status) may be tracked as an infraspecific taxon and given a T rank; in such cases a Q is used after the T-rank to denote the taxon's informal taxonomic status.

USFS. United States Forest Service, U.S. Department of Interior.

Sensitive – Designated due to conservation threat.

SSI – Species of Special Interest, selected due to rarity; lack of information or knowledge; suspected conservation concerns; or unique habitat characteristics, and not otherwise captured as a Management Indicator Species.

TNF – Tongass National Forest

CNF – Chugach National Forest

USFWS. U.S. Fish and Wildlife Service, U.S. Department of Interior.
[http://Alaska.fws.gov/fisheries/endangered/pdf/AK%20SPP%20List%206-04.pdf]

BCC – Bird of Conservation Concern

LE – Listed Endangered. An "endangered species" is one that is in danger of extinction throughout all or a significant portion of its range.

LT – Listed Threatened. A "threatened" species is one that is likely to become endangered in the foreseeable future.

PS – Partial Status (applies only to portion of species' range; typically indicated in a "full" species record where an intraspecific taxon or population has U.S. ESA status, but the entire species does not; see www.natureserve.org/explorer.) See associated footnotes in table below to determine if the Alaska population is included.

C – Candidate species. A "candidate species" is one for which there is sufficient information on biological vulnerability and threat(s) to support proposals to list as threatened or endangered.

PT – Proposed threatened

To help conserve genetic diversity, the ESA defines "species" broadly to include subspecies, and (for vertebrates) "distinct populations."

Fish Nominees								
Group	Common Name	Scientific Name	GRANK	SRANK	COSEWIC	IUCN	BLM	AFS
Freshwater Fish	Pacific lamprey	*Entosphenus tridentatus*	G5	S4S5				
Freshwater Fish	river lamprey	*Lampetra ayresi*	G4	S3				
Freshwater Fish	western brook lamprey	*Lampetra richardsoni*	G5	S1?			Sensitive	
Freshwater Fish	Alaskan brook lamprey	*Lampetra alaskense*	GNR	SNR				
Freshwater Fish	Siberian brook lamprey	*Lampetra kessleri*	GNR	SNR				
Freshwater Fish	Arctic lamprey	*Lampetra japonica*	G4	S4S5				
Saltwater Fish	big skate	*Raja (Dipturus) binoculata*	G4	SNR	C	LR		Vulnerable
Freshwater Fish	green sturgeon	*Acipenser medirostris*	G3	S4N				Endangered
Freshwater Fish	white sturgeon	*Acipenser transmontanus*	G4	S3S4				Not assessed
Freshwater Fish	lake chub	*Couesius plumbeus*	G5	S4S5				
Freshwater Fish	longnose sucker	*Catostomus catostomus*	G5	S5				
Freshwater Fish	Alaska blackfish	*Dallia pectoralis*	G5	S5				
Freshwater Fish	pond smelt	*Hypomesus olidus*	G5	S5				
Saltwater Fish	surf smelt	*Hypomesus pretiosus*	G5	S5				
Saltwater Fish	capelin	*Mallotus villosus*	GNR	SNR				
Saltwater Fish	rainbow smelt	*Omersus mordax*	G5	S5				
Saltwater Fish	longfin smelt	*Spirinchus thaleichthys*	G5	S4S5				
Saltwater Fish	eulachon	*Thaleichthys pacificus*	G5	S3S4				
Freshwater Fish	Bering cisco	*Coregonus laurettae*	G4	S4	SC			
Freshwater Fish	broad whitefish	*Coregonus nasus*	G5	S4S5		DD		
Freshwater Fish	humpback whitefish	*Coregonus pidschian*	G5	S5		DD		
Freshwater Fish	pygmy whitefish	*Prosopium coulteri*	G5	S4				
Freshwater Fish	round whitefish	*Prosopium cylindraceum*	G5	S4				
Freshwater Fish	trout-perch	*Percopsis omiscomaycus*	G5	S3				
Saltwater Fish	Arctic cod	*Boreogadus saida*	GNR	S4S5				
Freshwater Fish	threespine stickleback	*Gasterosteus aculeatus*	G5	S5				
Freshwater Fish	threespine stickleback, Cook Inlet	*Gasterosteus aculeatus*	G5T1Q	S1				
Freshwater Fish	ninespine stickleback	*Pungitius pungitius*	G5	S4S5				
Saltwater Fish	sharpnose sculpin	*Clinocottus acuticeps*	G5	S5				
Freshwater Fish	coastrange sculpin	*Cottus aleuticus*	G5	S5				
Freshwater Fish	prickly sculpin	*Cottus asper*	G5	S5				

Group	Common Name	Scientific Name	GRANK	SRANK	COSEWIC	IUCN	BLM	AFS
Freshwater Fish	slimy sculpin	*Cottus cognatus*	G5	S5				
Freshwater Fish	Pacific staghorn sculpin	*Leptocottus armatus*	G5	S5				
Saltwater Fish	fourhorn sculpin	*Myoxocephalus quadricornis*	G5	S5				
Freshwater Fish	shiner perch	*Cymatogaster aggregata*	G5	S4S5				
Saltwater Fish	prowfish	*Zaprora silenus*	GNR	SNR				
Saltwater Fish	Pacific sandfish	*Trichodon trichodon*	G5	S5				
Saltwater Fish	Pacific sand lance	*Ammodytes hexapturus*	GNR	SNR				
Saltwater Fish	Forage fish	Cottid Family[1]						
Saltwater Fish	Forage fish	HemipteridFamily[1]						
Saltwater Fish	Forage fish	Rhamphocottid Family[1]						
Saltwater Fish	Forage fish	Stichaeid Family[1]						
Saltwater Fish	Forage fish	Pholid Family[1]						
Saltwater Fish	Forage fish	Myctophidae[2]						

[1] See Forage Fish Occurring in Intertidal/Shallow SubtidalAreas template in Appendix 4
[2] See Nearshore Occurrence of Pelagic Forage Fish template in Appendix 4

Amphibian Nominees					
Group	Common Name	Scientific Name	GRANK	SRANK	IUCN
Amphibian	Columbia spotted frog	*Rana luteiventris*	G4	S2?	
Amphibian	Long-toed salamander	*Ambystoma macrodactylum*	G5	S2?	
Amphibian	Northwestern salamander	*Ambystoma gracile*	G5	S2?	
Amphibian	Rough-skinned newt	*Taricha granulosa*	G5	S2?	
Amphibian	Western toad	*Bufo boreas*	G4	S2?	NT
Amphibian	Wood frog	*Rana sylvatica*	G5	S3S4	

Reptile Nominees

Group	Common Name	Scientific Name	GRANK	SRANK	NOAA	COSEWIC	IUCN	CITES	BC
Sea turtle	Green seaturtle	*Chelonia mydas*	G3		LT		E	A1	
Sea turtle	Leatherback seaturtle	*Dermochelys coriacea*	G2	SAN	LE	E	CE	A1	RED
Sea turtle	Loggerhead seaturtle	*Caretta caretta*	G3	SAN	LT		E	A1	ACC
Sea turtle	Olive Ridley seaturtle	*Lepidochelys olivacea*	G3		LT		E	A1	

Bird Nominees														
Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Loons	Red-throated Loon	*Gavia stellata*	G5	S3B, S3?N		BCC	NAR	Sensitive			PT, TN			
Loons	Arctic Loon	*Gavia arctica*	G5	S5B										
Loons	Green-throated Arctic Loon	*Gavia arctica viridigularis*	G5T2?	S3?B										
Loons	Pacific Loon	*Gavia pacifica*	G5	S?B										
Loons	Common Loon	*Gavia immer*	G5	S4			NAR							
Loons	Yellow-billed Loon	*Gavia adamsii*	G4	S3B, S3N		BCC		Sensitive			RA, TB, TN			
Grebes	Pied-billed Grebe	*Podilymbus podiceps*	G5	S3										
Grebes	Horned Grebe	*Podiceps auritus*	G5	S3						MA, D, HT				
Grebes	Red-necked Grebe	*Podiceps grisegena*	G5	S4S5B, S4?N			NAR							
Albatrosses	Laysan Albatross	*Phoebastria immutabilis*	G3	S3N									High Concern	
Albatrosses	Black-footed Albatross	*Phoebastria nigripes*	G5	S5N									Highly imperiled	
Albatrosses	Short-tailed Albatross	*Phoebastria albatrus*	G1	S1N	E	LE							High Concern	
Shearwaters and Petrels	Pink-footed Shearwater	*Puffinus creatopus*	G1G2Q	S2N									High Concern	
Shearwaters and Petrels	Buller's Shearwater	*Puffinus bulleri*	G3	S2S3N										
Storm-Petrels	Fork-tailed Storm-Petrel	*Oceanodroma furcata*	G5	S5B, S3N										
Storm-Petrels	Fork-tailed Storm-Petrel	*Oceanodroma furcata furcata*	GNR	SNR										
Storm-Petrels	Fork-tailed Storm-Petrel	*Oceanodroma furcata plumbea*	GNR	SNR										
Storm-Petrels	Leach’s Storm-Petrel	*Oceanodroma leucorhoa*	G5	S5B										
Storm-Petrels	Leach’s Storm-Petrel	*Oceanodroma leucorhoa leucorhoa*	GNR	SNR										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Cormorants	Brandt's Cormorant	*Phalacrocorax penicillatus*	G5	S3B						MA, D, HT			High Concern	
Cormorants	Double-crested Cormorant	*Phalacrocorax auritus*	G5	S3B										
Cormorants	Red-faced Cormorant	*Phalacrocorax urile*	G5	S3S4B, S3S4N		BCC				RD, LPS	RA, BD, ND, *		High Concern	
Cormorants	Pelagic Cormorant	*Phalacrocorax pelagicus*	G5	S5						MA, D, HT			High Concern	
Frigatebirds	Magnificent Frigatebird	*Fregata manificens*	G5	SAN									High Concern	
Herons and Bitterns	American Bittern	*Botarus lentiginosus*	G4	S3B										
Herons and Bitterns	Pacific Great Blue Heron	*Ardea herodias fannini*	G5T4	S3?B										
Ducks, Geese and Swans	Tule White-fronted Goose	*Anser albifrons elgasi*	G5T2T3	S3?B										
Ducks, Geese and Swans	Aleutian Canada Goose	*Branta canadensis leucopareia*	G5T4	SNR	SSOC									
Ducks, Geese and Swans	Steller's Eider	*Polysticta stelleri*	G3	S2B, S3?N	SSOC	PS:LT[1]				HCC				
Ducks, Geese and Swans	Spectacled Eider	*Somateria fischeri*	G2	S2B	SSOC	LT				HCC				
Ducks, Geese and Swans	King Eider	*Somateria spectabilis*	G5	S2S3B,S2S3N										
Ducks, Geese and Swans	Pacific Common Eider	*Somateria mollissima v-nigra*	GNR	SNR										
Ducks, Geese and Swans	Surf Scoter	*Melanitta perspicillata*	G5	S2S3B,S2S3N										
Ducks, Geese and Swans	White-winged Scoter	*Melanitta fusca deglandi*	G5	S2S3B,S2S3N										
Ducks, Geese and Swans	Black Scoter	*Melanitta nigra americana*	GNR	SNR										
Ducks, Geese and Swans	Long-tailed Duck	*Clangula hyemalis*	G5	S2B,S2N										
Grouse and Ptarmigan	Prince of Wales Spruce Grouse,	*Falcipennis canadensis isleibi*	GNR	SNR										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Grouse and Ptarmigan	Evermann's Rock Ptarmigan	*Lagopus mutus evermanni*	G5T2T3	S2S3										
Grouse and Ptarmigan	Townsend's Rock Ptarmigan	*Lagopus mutus townsendi*	G5T2T3	S2S3										
Grouse and Ptarmigan	Turners Rock Ptarmigan	*Lagopus mutus atkhensis*	G5T2T3	S2S3										
Grouse and Ptarmigan	Blue Grouse	*Dendragapus obscurus*	G5	S5										
Hawks and Eagles	Osprey	*Pandion haliaetus*	G5	S3B					Sensitive					
Hawks and Eagles	Osprey	*Pandion haliaetus carolinensis*	G5T2T3	S3B										
Hawks and Eagles	Bald Eagle	*Haliaeetus leucocephalus*	G4	S3B, S3N					Sensitive					
Hawks and Eagles	Northern Bald Eagle	*Haliaeetus leucocephalus alascanus*	G4T3	S3										
Hawks and Eagles	White-tailed Eagle	*Haliaeetus albicilla*	G4G5	S1B										
Hawks and Eagles	Northern Harrier	*Circus cyaneus*	G5	S4?B			NAR							
Hawks and Eagles	Sharp-shinned Hawk	*Accipiter striatus*	G5	S4B, S3N										
Hawks and Eagles	Northern Goshawk	*Accipiter gentilus*	G5	S4					Sensitive					
Hawks and Eagles	Northern Goshawk	*Accipiter gentilus atricapillus*	GNR	SNR										
Hawks and Eagles	Queen Charlotte Northern Goshawk	*Accipiter gentilus laingi*	G5T2	S2B, S2N	SSO C			Sensitive	Sensitive	RD, LPS	BD, TB, ND			
Hawks and Eagles	Swainson's Hawk	*Buteo swainsoni*	G5	S3B, SAN										
Hawks and Eagles	Red-tailed Hawk	*Buteo jamaicensis alascensis*	G5T3?	S3?										
Hawks and Eagles	Rough-legged Hawk	*Buteo lagopus*	G5	S5B			NAR							
Hawks and Eagles	Golden Eagle	*Aquila chrysaetos*	G5	S4							RA, (TN)			
Falcons	Merlin	*Falco columbarius*	G5	S3S4B										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Falcons	Black Merlin	*Falco columbarius suckleyi*	G5T2?	S3?B, S3?N										
Falcons	Gyrfalcon	*Falco rusticolus*	G5	S3								B		
Falcons	Peregrine Falcon	*Falco peregrinus*	G4	S3B										
Falcons	American Peregrine Falcon	*Falco peregrinus anatum*	G4T3	S3B	SSOC	Delisted		Sensitive			RA, (TN)			
Falcons	Peale's Peregrine Falcon	*Falco peregrinus pealei*	G4T3	S3				Sensitive	Sensitive		RA, (TN)			
Falcons	Arctic Peregrine Falcon	*Falco peregrinus tundrius*	G4T3T4	S3S4B	SSOC	Delisted		Sensitive			RA, (TN)			
Rails and Coots	Sora	*Porzana carolina*	G5	S3B										
Rails and Coots	American Coot	*Fulica americana*	G5	S3N										
Plovers	Black-bellied Plover	*Pluvialis squatarola*	G5	S5B						??				
Plovers	American Golden-Plover	*Pluvialis dominica*	G5	S5B, SAN		BCC				MA, D, HT				
Plovers	Pacific Golden-Plover	*Pluvialis fulva*	G5	S5B, SAN		BCC				RD, LPS	RA, BD, ND, *			SOHC
Plovers	Mongolian Plover	*Charadrius mongolus*	G4G5	S3B										
Plovers	Eastern Mongolian Plover	*Charadrius mongolus stegmanni*	G4G5T4	S3B										
Plovers	Killdeer	*Charadrius vociferous*	G5	S3B, S3N										
Plovers	Eurasian Dotterel	*Charadrius morinellus*	G5	S3B										
Oystercatchers	Black Oystercatcher	*Haematopus bachmani*	G5	S3S4B, S3?N		BCC				RD, LPS	RA, TB, ND, *			SOHC
Sandpipers	Common Greenshank	*Tringa nebularia*	G5	S2N										
Sandpipers	Lesser Yellowlegs	*Tringa flavipes*	G5	S5B						MA, D, HT				

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Sandpipers	Solitary Sandpiper	*Tringa solitaria*	G5	S4B		BCC				MA, D, HT				
Sandpipers	Solitary Sandpiper	*Tringa solitaria cinnamonea*	G5	S4B										
Sandpipers	Wandering Tattler	*Heteroscelus incanus*	G5	S3S4B							RA			SOHC
Sandpipers	Gray-tailed Tattler	*Heteroscelus brevipes*	G4G5	S3N										
Sandpipers	Common Sandpiper	*Actitis hypoleucos*	G5	SAB, S3N										
Sandpipers	Upland Sandpiper	*Bartramia longicauda*	G5	S3B		BCC				MA, D, HT				
Sandpipers	Eskimo Curlew	*Numenius borealis*	G1	SH	E	LE				HCC				
Sandpipers	Whimbrel	*Numenius phaeopus*	G5	S5B		BCC				MA, D, HT				SOHC
Sandpipers	Bristle-thighed Curlew	*Numenius tahitiensis*	G2	S2B		BCC		Sensitive		RD, LPS	RA, BD, (TN), *			SOHC
Sandpipers	Black-tailed Godwit	*Limosa limosa*	G5	S2N				Sensitive						
Sandpipers	Hudsonian Godwit	*Limosa haemastica*	G4	S3B		BCC		Sensitive		RD, LPS	RA, BD, (TN), *			SOHC
Sandpipers	Bar-tailed Godwit	*Limosa lapponica*	G5	S3B		BCC				RD, LPS				
Sandpipers	Bar-tailed Godwit	*Limosa lapponica baueri*	GNR	SNR										
Sandpipers	Marbled Godwit	*Limosa fedoa*	G5	S3B		BCC		Sensitive		MA, D, HT				
Sandpipers	Beringian Marbled Godwit	*Limosa fedoa beringiae*	G5T3?	S3?B							RA, (TN)			SOHC
Sandpipers	Black Turnstone	*Arenaria melanocephala*	G5	S5B, S3N		BCC				RD, LPS	RA, BD, (TN), *			SOHC
Sandpipers	Surfbird	*Aphriza virgata*	G5	S5?B, S3?N				Sensitive		RD, LPS	RA, TN, *			SOHC
Sandpipers	Red Knot	*Calidris canutus*	G5	S2B		BCC		Sensitive		RD, LPS				
Sandpipers	Red Knot	*Calidris canutus roselaari*	GNR	SNR										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Sandpipers	Sanderling	*Calidris alba*	G5	S4B, S3N						MA, D, HT				
Sandpipers	Semipalmated Sandpiper	*Calidris pusilla*	G5	S5B						MA, D, HT				
Sandpipers	Western Sandpiper	*Calidris mauri*	G5	S5B						MA, D, HT				
Sandpipers	Temminck's Stint	*Calidris temminckii*	G5	S2N										
Sandpipers	Long-toed Stint	*Calidris subminuta*	G4G5	S2N										
Sandpipers	White-rumped Sandpiper	*Calidris fuscicollis*	G5	S3B										
Sandpipers	Baird's Sandpiper	*Calidris bairdii*	G5	S3B										
Sandpipers	Sharp-tailed Sandpiper	*Calidris acuminata*	G5	S3B										
Sandpipers	Rock Sandpiper, Aleutians	*Calidris ptilocnemis couesi*	SNR	SNR										SOHC
Sandpipers	Rock Sandpiper, Pribilofs	*Calidris ptilocnemis ptilocnemis*	G5T3T4	S3S4B, S3N							RA, ND, TN, *			SOHC
Sandpipers	Rock Sandpiper, Bering Sea	*Calidris ptilocnemis tschuktschorum*	SNR	SNR										SOHC
Sandpipers	Dunlin	*Calidris alpina*	G5	S5B, S3N		BCC				MA, D, HT				
Sandpipers	Arctic Dunlin	*Calidris alpina articola*	G5	S5B, S3N							PT, BD, (TN)			SOHC
Sandpipers	Pacific Dunlin	*Calidris alpine pacifica*	GNR	SNR										
Sandpipers	Curlew sandpiper	*Califris ferruginea*	G5?	S3B										
Sandpipers	Stilt Sandpiper	*Calidris himantopus*	G5	S3B						MA, D, HT				
Sandpipers	Buff-breasted Sandpiper	*Tryngites subruficollis*	G4	S2B		BCC		Sensitive		RD, LPS	RA, PT, TB, (TN), *			SOHC
Sandpipers	Ruff	*Philomachus pugnax*	G5	S1B										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Sandpipers	Short-billed Dowitcher	*Limnodromus griseus*	G5	S5B						MA, D, HT				
Sandpipers	Short-billed Dowitcher	*Limnodromus griseus caurinus*	GNR	SNR										SOHC
Sandpipers	Common Snipe	*Gallinago gallinago*	G5	S5B, S3N										
Sandpipers	Wilson's Snipe	*Gallinago delicata*	G5	SA						MA, D, HT				
Sandpipers	Red-necked Phalarope	*Phalaropus lobatus*	G5	S5B, S3N										
Sandpipers	Red Phalarope	*Phalaropus fulicarius*	G5	S5B						MA, D, HT				
Skuas, Gulls, Terns	South Polar Skua	*Stercorarius maccormicki*	G5	S3N										
Skuas, Gulls, Terns	Black-headed Gull	*Larus ridibundus*	G5	S3N										
Skuas, Gulls, Terns	California Gull	*Larus californicus*	G5	S2N										
Skuas, Gulls, Terns	Glaucous Gull	*Larus hyperboreus*	G5	S3B, S5N										
Skuas, Gulls, Terns	Ring-billed Gull	*Larus delawarensis*	G5	S3N										
Skuas, Gulls, Terns	Ross's Gull	*Rhodostethia rosea*	G3G4	S3N										
Skuas, Gulls, Terns	Slaty-backed Gull	*Larus schistisagus*	G5	S2N										
Skuas, Gulls, Terns	Black-legged Kittiwake	*Rissa tridactyla*	G5	S5B, S3N										
Skuas, Gulls, Terns	Black-legged Kittiwake	*Rissa tridactyla pollicaris*	GNR	SNR										
Skuas, Gulls, Terns	Red-legged Kittiwake	*Rissa brevirostris*	G2	S2S3B, S2N		BCC				RD, LPS	RA, BD		High Concern	
Skuas, Gulls, Terns	Aleutian Tern	*Sterna aleutica*	G4	S4B		BCC				RD, LPS	RA, TB		High Concern	
Skuas, Gulls, Terns	Arctic Tern	*Sterna paradisaea*	G5	S5		BCC							High Concern	
Skuas, Gulls, Terns	Caspian Tern	*Sterna caspia*	G5	S3B										
Skuas, Gulls, Terns	Common Tern	*Sterna hirundo*	G5	S2N										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Auks, Murres, Puffins	Dovekie	*Alle alle*	G5	S1				Sensitive						
Auks, Murres, Puffins	Common Murre	*Uria aalge*	G5	S5										
Auks, Murres, Puffins	Thick-billed Murre	*Uria lomvia*	G5	S5										
Auks, Murres, Puffins	Black Guillemot	*Cepphus grylle*	G5	S2B				Sensitive						
Auks, Murres, Puffins	Pigeon Guillemot	*Cepphus columba*	G5	S5						MA, D, HT				
Auks, Murres, Puffins	Marbled Murrelet	*Brachyranphus marmoratus*	G3G4	S2S3		PS:LT[2]	T	Sensitive	SSI - CNF	HCC	PT, TB		High Concern	
Auks, Murres, Puffins	Kittlitz's Murrelet	*Brachyranphus brevirostris*	G3G4	S2B, S2N		C		Sensitive		RD, LPS			High Concern	
Auks, Murres, Puffins	Ancient Murrelet	*Synthliboramphus antiquus*	G4	S4						RD, LPS			High Concern	
Auks, Murres, Puffins	Least Auklet	*Aethia pusilla*	G5	S5										
Auks, Murres, Puffins	Whiskered Auklet	*Aethia pygmaea*	G5?	S3		BCC				RD, LPS	RA, BD, *			
Auks, Murres, Puffins	Crested Auklet	*Aethia cristatella*	G5	S5										
Pigeons	Band-tailed Pigeon	*Columba fasciata*	G5	S3B										
Owls	Western Screech-Owl	*Megascops kennicottii*	G5	S3?B										
Owls	Great Horned Owl	*Bubo virginianus*	G5	S5										
Owls	Snowy Owl	*Bubo scandiacus*	G5	S4								B		
Owls	Northern Hawk Owl	*Surnia ulula*	G5	S4										
Owls	Northern Pygmy-Owl	*Glaucidium gnoma*	G5	S3										
Owls	Barred Owl	*Strix varia*	G5	SNA										
Owls	Great Gray Owl	*Strix nebulosa*	G5	S3								B		
Owls	Short-eared Owl	*Asio flammeus*	G5	S4S5B		BCC				MA, D, HT				
Owls	Boreal Owl	*Aegolius funereus*	G5	S4								B, F		
Owls	Northern Saw-Whet	*Aegolius acadicus*	G5	S4										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Owls	Western Screech-Owl	*Megascops kennicottii*	G5	S3?B								F		
Swifts	Black Swift	*Cypseloides niger*	G4	S3?B										
Swifts	Black Swift	*Cypseloides niger borealis*	G4	S3?B							RA, PT, (ND), *	T		
Swifts	Vaux's Swift	*Chaetura vauxi*	G5	S3?B								F		
Hummingbirds	Anna's Hummingbird	*Calypte anna*	G5	S3N										
Hummingbirds	Rufous Hummingbird	*Selasphorus rufus*	G5	S3B						MA, D, HT		F		
Kingfishers	Belted Kingfisher	*Ceryle alcyon*	G5	S5										
Woodpeckers	Yellow-bellied Sapsucker	*Sphyrapicus varius*	G5	S3B										
Woodpeckers	Red-breasted Sapsucker	*Sphyrapicus ruber*	G5	S3B								F		
Woodpeckers	Hairy Woodpecker	*Picoides villosus*	G5	S4										
Woodpeckers	American Three-toed Woodpecker	*Picoides dorsalis*	G5	S4										
Woodpeckers	Black-backed Woodpecker	*Picoides arcticus*	G5	S4								G		
Woodpeckers	Northern Flicker	*Colaptes auratus*	G5	S5B										
Flycatchers	Eastern Kingbird	*Tyrannus tyrannus*	G5	S2N										
Flycatchers	Hammond's Flycatcher	*Empidonax hammondii*	G5	S5B								G		
Flycatchers	Olive-sided Flycatcher	*Contopus cooperi*	G4	S3S4B	SSOC			Sensitive		MA, D, HT	RA, PT	F, T		
Flycatchers	Pacific-slope Flycatcher	*Empidonax difficilis*	G5	S5B								F		
Flycatchers	Western Wood-Pewee	*Contopus sordidulus*	G5	S3?B								T		
Shrikes	Northern Shrike	*Lanius excubitor*	G5	S4B, S4N								B		
Vireos	Cassin's Vireo	*Vireo cassinii*	G5	SNR										
Vireos	Red-eyed Vireo	*Vireo olivaceus*	G5	S3B										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Jays	Steller's Jay	*Cyanocitta stelleri*	G5	S5								G		
Crows	American Crow	*Corvus brachyrhynchos*	G5	S2										
Crows	Northwestern Crow	*Corvus caurinus*	G5	S5								G		
Larks	Sky Lark	*Alauda arvensis*	G5	S1B										
Swallows	Violet-green Swallow	*Tachycineta thalassina*	G5	S5B										
Swallows	Northern Rough-winged Swallow	*Stelgidopteryx rufficollis*	G5	S3B										
Swallows	Bank Swallow	*Riparia riparia*	G5	S5B										
Swallows	Cliff Swallow	*Petrochelidon pyrrhonota*	G5	S5B										
Swallow	Barn Swallow	*Hirundo rustica*	G5	S5B										
Chickadees	Chestnut-backed Chickadee	*Poecile rufescens*	G5	S5								G		
Chickadees	Boreal Chickadee	*Poecile hudsonica*	G5	S5										
Chickadees	Gray-headed Chickadee	*Poecile cincta*	G5	S3										
Nuthatches	Red-breasted Nuthatch	*Sitta canadensis*	G5	S4										
Creepers	Brown Creeper	*Certhia americana*	G5	S4										
Wrens	Pribilof Winter Wren	*Troglodytes troglodytes alascensis*	G5T3	S3										
Wrens	Kodiak Winter Wren	*Troglodytes troglodytes helleri*	G5T3	S3										
Wrens	Kiska Winter Wren	*Troglodytes troglodytes kiskensis*	G5T3	S3										
Wrens	Attu Winter Wren	*Troglodytes troglodytes meligerus*	G5T3	S3										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Wrens	Unalaska Winter Wren	*Troglodytes troglodytes petrophilus*	G5T3	S3										
Wrens	Sedimi Winter Wren	*Troglodytes troglodytes semidiensis*	G5T3	S3										
Wrens	Stevenson's Winter Wren	*Troglodytes troglodytes stevensoni*	G5T3	S3										
Wrens	Tanaga Winter Wren	*Troglodytes troglodytes tanagensis*	G5T3	S3										
Dippers	American Dipper	*Cinclus mexicanus*	G5	S5								B		
Kinglets	Golden-crowned Kinglet	*Regulus satrapa*	G5	S5								F		
Thrushes	Arctic Warbler	*Phylloscopus borealis*	G5	S5B										
Thrushes	Siberian Rubythroat	*Luscinia calliope*	G5	S2N										
Thrushes	Bluethroat	*Luscinia svecica*	G5	S3B										
Thrushes	Mountain Bluebird	*Sialia currucoides*	G5	S3B										
Thrushes	Townsend's Solitaire	*Myadestes townsendi*	G5	S3B, SAN										
Thrushes	Gray-cheeked Thrush	*Catharus minimus*	G5	S3B	SSOC			Sensitive				G		
Thrushes	Swainson's Thrush	*Catharus ustulatus*	G5	S3B										
Thrushes	Hermit Thrush	*Catharus guttatus*	G5	S4B										
Thrushes	Eyebrowed Thrush	*Turdus obscurus*	G5	S2N										
Thrushes	American Robin	*Turdus migratorius*	G5	S5B, S3N										
Thrushes	Varied Thrush	*Ixoreus naevius*	G5	S5								F, G		
Wagtails, Pipits	Black-backed Wagtail	*Motacilla lugens*	G5?	SAB, S3N										
Wagtails, Pipits	White Wagtail	*Motacilla alba*	G5	S3B										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Wagtails, Pipits	Eastern Yellow Wagtail	*Motacilla tschutschensis*	G5	S5B										
Waxwings	Bohemian Waxwing	*Bombycilla garrulus*	G5	S5B, S5N								B		
Wood Warblers	Blackpoll Warbler	*Dendroica striata*	G5	S3B	SSO C			Sensitive			PT, ND	G		
Wood Warblers	MacGillivray's Warbler	*Oporornis tolmiei*	G5	S4B								W		
Wood Warblers	Tennessee Warbler	*Vermivora peregrina*	G5	S3B										
Wood Warblers	Townsend's Warbler	*Dendroica townsendi*	G5	S3B	SSO C			Sensitive	SSI - CNF			F		
Wood Warblers	Wilson's Warbler	*Wilsonia pusilla*	G5	S3B										
Wood Warblers	American Redstart	*Setophaga ruticilla*	G5	S3B										
Wood Warblers	Northern Waterthrush	*Seiurus noveboracensis*	G5	S3B										
Tanagers	Western Tanager	*Piranga ludoviciana*	G5	S3B										
Sparrows	American Tree Sparrow	*Spizella arborea*	G5	S5B, S3N										
Sparrows	Fox Sparrow	*Passerella iliaca*	G5	S3N, S5N										
Sparrows	Giant Song Sparrow	*Melospiza melodia maxima*	G5T4	S4										
Sparrows	Amak Island Song Sparrow	*Melospiza melodia amaka*	G5T2	S2										
Sparrows	Harris's Sparrow	*Zonotrichia querula*	G5	S3N										
Sparrows	White-crowned Sparrow	*Zonotrichia leucophrys*	G5	S5B, S3N										
Sparrows	Golden-crowned Sparrow	*Zonotrichia atricapilla*	G5	S5B, S3N								G		
Sparrows	Dark-eyed Junco	*Junco hyemalis*	G5	S5B, S3N										
Sparrows	Smith's Longspur	*Calcarius pictus*	G5	S3S4B							RA, (ND), *	G, W		

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	COSEWIC	BLM	USFS	ABC Green List	AA WatchList	BPIF	NAWCP	ASCP
Sparrows	Rustic Bunting	*Emberiza rustica*	G5	S2N										
Sparrows	McKay's Bunting	*Plectrophenax hyperboreus*	G3	S3				Sensitive		RD, LPS	RA, BD, *	G		
Grosbeaks	Pine Grosbeak	*Pinicola enucleator*	G5	S5B,S5N										
Blackbirds	Brown-headed Cowbird	*Molothrus ater*	G5	S3B, SAN										
Blackbirds	Red-winged Blackbird	*Agelaius phoeniceus*	G5	S3B, S2N										
Blackbirds	Rusty Blackbird	*Euphagus carolinus*	G5	S4B						MA, D, HT		G, T		
Finches	Brambling	*Fringilla montifringilla*	G5	S2N										
Finches	Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*	G5	S5B, S3N										
Finches	Red Crossbill	*Loxia curvirostra*	G5	S5										
Finches	White-winged Crossbill	*Loxia leucoptera*	G5	S5								B		
Finches	Hoary Redpoll	*Carduelis hornemanni*	G5	S5B, S5N								B		
Finches	Pine Siskin	*Carduelis pinus*	G5	S5		LC								

[1]Alaska's population of Steller's Eider is part of this listing.
[2]Alaska's population of Marbled Murrelet is not part of this listing.

Mammal Nominees

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	NOAA	COSEWIC	IUCN	CITES	BLM	USFS
Shrews	dusky shrew	*Sorex monticolus*	G5	SNR								
Shrews	dusky shrew, Yakutat	*Sorex monticolus alascensis*	G5	SNR								
Shrews	dusky shrew, Queen Charlotte Islands	*Sorex monticolus ellassodon*										
Shrews	dusky shrew, Warren Island	*Sorex monticolus malitiosus*	G5T3Q	S3Q								
Shrews	Pribilof Island shrew	*Sorex pribilofensis (hydrodromus)*	G3	S3					E			
Shrews	pygmy shrew	*Sorex hoyi*	G5	SNR								
Shrews	St. Lawrence Island shrew	*Sorex jacksoni*	G3	S3					E			
Shrews	tiny shrew	*Sorex yukonicus*	GU	SNR								
Shrews	tundra shrew	*Sorex tundrensis*	G5	SNR								
Shrews	water shrew	*Sorex palustris*	G5	SNR								
Shrews	Glacier Bay water shrew	*Sorex alaskanus*	G5THQ	SH								
Bats	big brown bat	*Eptesicus fuscus*	G5	S2?								
Bats	California myotis	*Myotis californicus*	G5	S1S3B							Sensitive	
Bats	Keen's myotis	*Myotis keenii*	G2G3	S1S3				DD	LR		Sensitive	
Bats	little brown myotis	*Myotis lucifugus*	G5	S3S4								
Bats	long-legged myotis	*Myotis volans (longicrus)*	G5	S2?								
Bats	silver-haired bat	*Lasionycteris noctivagans*	G5	S1S3B							Sensitive	
Canids	gray wolf, Alexander Archipelago	*Canis lupus ligoni*	G4T2T3Q	S2S3Q						A2		
Mustelids	sea otter	*Enhydra lutris*	G4	S4	SSOC							
Mustelids	northern sea otter, Southwest Alaska population	*Enhydra lutris kenyoni*	G4T4	S2S3		PT		T				
Mustelids	river otter, Prince of Wales	*Lontra canadensis mira*	G5T3T4	S3S4						A2		
Mustelids	wolverine, Kenai	*Gulo gulo katschemakensis*	G4T3?	S3?								
Mustelids	marten, Kenai	*Martes americana kenaiensis*										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	NOAA	COSEWIC	IUCN	CITES	BLM	USFS
Mustelids	marten	*Martes caurina caurina*										
Mustelids	ermine	*Mustela erminea alascensis*										
Mustelids	ermine, Prince of Wales	*Mustela erminea celenda*	G5T4?	S4?								
Mustelids	ermine	*Mustela erminea initis*										
Mustelids	ermine, Kodiak	*Mustela erminea kadiacensis*	G5T4?	S4?								
Mustelids	ermine	*Mustela erminea salva*										
Mustelids	ermine, Suemez Island	*Mustela erminea seclusa*	G5T2?Q	S2?Q								
Walrus	walrus	*Odobenus rosmarus*	G4	S4				NAR	LR	A3		
Seals	bearded seal	*Erigrathus barbatus*	G4G5	SNR								
Seals	elephant seal	*Mirounga angustirostris*	G5	SNR						A2		
Seals	northern fur seal	*Callorhinus ursinus*	G3	S3								
Seals	harbor seal , Pacific	*Phoca vitulina richardsi*	G5T5Q	S4S5	SSOC						Sensitive	
Seals	ribbon seal	*Phoca fasciata*	G5	SNR								
Seals	ringed seal	*Phoca hispida*	G5	SNR								
Seals	spotted seal	*Phoca largha*	G4G5	SNR								
Seals	Steller's sea lion, Western Alaska Population	*Eumetopias jubatus*	G3	SNR	SSOC		LE	NAR				
Seals	Steller's sea lion, Eastern Alaska Population	*Eumetopias jubatus*	G3	S2	SSOC		LT	NAR				
Bears	brown bear, Kenai population	*Ursus arctos kenai*			SSOC							
Bears	polar bear	*Ursus maritimus*	G4	S3				SC	LR	A2		
Whales	beluga whale, Cook Inlet	*Delphinapterus leucas*, pop. 4	G4T1	S1	SSOC		C					
Whales	blue whale, North Pacific	*Balaenoptera musculus*, pop. 2	G2	S2B	E		LE					
Whales	bowhead, Western Arctic	*Balaena mysticetus*, pop. 2	G2	S2	SSOC		LE	E				
Whales	fin whale, Northeast Pacific	*Balaenoptera physalus*, pop. 2	G3G4	S2B			LE					
Whales	gray whale, Eastern Pacific	*Eschrichtius robustus*, pop. 4	G4	S3B			Delisted	XT, NAR				
Whales	humpback whale, Western and Central North Pacific	*Megaptera novaeangliae*, pop. 1	G3	S2B	E		LE					
Whales	minke whale, Northern	*Balaenoptera acutorostrata*	G5	SNR						A1		

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	NOAA	COSEWIC	IUCN	CITES	BLM	USFS
Whales	northern right whale, North Pacific	*Eubalaena glacialis*, pop.2	G1	S1	E		LE	E				
Whales	sei whale, North Pacific	*Balaenoptera borealis*	G3	S2B			LE					
Whales	sperm whale, North Pacific	*Physeter catodon*	G3G4	S2S3			LE					
Whales	Baird's beaked whale	*Berardius bairdii*	G4	SNR								
Whales	Stejneger's beaked whale	*Mesoplodon stejnegeri*	G3	SNR								
Whales	Cuvier's beaked whale	*Ziphius cavirostris*	G4	SNR								
Whales	killer whale	*Orcinus orca*	G4	SNR								
Porpoises	harbor porpoise	*Phocoena phocoena*	G4G5	S2S3								
Deer	woodland caribou, Chisana herd	*Rangifer tarandus caribou*	G5T4	SNR		PS:LE						
Rodents	Alaska marmot	*Marmota broweri*	G4	S4								
Rodents	hoary marmot, Glacier Bay	*Marmota caligata vigilis*	G5T3?	S3?					DD			
Rodents	hoary marmot, Montague Island	*Marmota caligata sheldoni*	G5T2T3	S2S3					DD			SSI - CNF
Rodents	arctic ground squirrel	*Spermophilus parryii*	G5	SNR								
Rodents	arctic ground squirrel	*Spermophilus parryii ablusus*										
Rodent	arctic ground squirrel, Barrow	*Spermophilus parryii kennicottii*										
Rodents	arctic ground squirrel, Kodiak Island	*Spermophilus parryii kodiacensis*	G5T3	S3					DD			
Rodents	arctic ground squirrel, St. Lawrence Island	*Spermophilus parryii lyratus*	G5T3	S3					DD			
Rodents	arctic ground squirrel, Shumagin Islands	*Spermophilus parryii nebulicola*	G5T3	S3					DD			
Rodents	arctic ground squirrel, Osgood's	*Spermophilus parryii osgoodi*	G5T3?	S3?								
Rodents	red squirrel, Kupreanof	*Tamiasciurus hudsonicus picatus*	G5T3?	S3?								
Rodents	red squirrel, Kenai	*Tamiasciurus hudsonicus kenaiensis*	GNR	SNR								
Rodents	northern flying squirrel	*Glaucomys sabrinus alpinus*										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	NOAA	COSEWIC	IUCN	CITES	BLM	USFS
Rodents	northern flying squirrel, Prince of Wales	*Glaucomys sabrinus griseifrons*	G5T2?Q	S2?Q					E			
Rodents	beaver, Admiralty	*Castor canadensis phaeus*	G5T3	S3								
Rodents	meadow jumping mouse	*Zapus hudsonius*	G5	S5?								
Rodents	southern red-backed vole	*Clethrionomys gapperi*	G5	SNR								
Rodents	southern red-backed vole	*Clethrionomys gapperi phaeus*	GNR	SNR								
Rodents	southern red-backed vole, Revillagigedo Island	*Clethrionomys gapperi solus*	G5T3Q	S3Q					DD			
Rodents	southern red-backed vole, Gapper's	*Clethrionomys gapperi stikinensis*	G5T2T3	S2S3								
Rodents	southern red-backed vole, Wrangell Island	*Clethrionomys gapperi wrangeli*	G5T2T3	S2S3								
Rodents	northern red-backed vole	*Clethrionomys rutilus*	G5	SNR								
Rodents	northern red-backed vole	*Clethrionomys rutilus insularis*	G5T3	S3								
Rodents	northern red-backed vole	*Clethrionomys rutilus orca*	G5T3	S3								
Rodents	northern red-backed vole, Glacier Bay	*Clethrionomys rutilus glacialis*	G5T3	S3								
Rodents	northern red-backed vole, St. Lawrence Island	*Clethrionomys rutilus albiventer*	G5T3	S3								
Rodents	brown lemming	*Lemmus trimucronatus*	G5	SNR								
Rodents	brown lemming, Nunivak Island	*Lemmus trimucronatus harroldi*	G5T4	S4								
Rodents	brown lemming, black-footed	*Lemmus trimucronatus nigripes*	G5T3	S3								
Rodents	northern bog lemming	*Synaptomys borealis*	G4	S4								
Rodents	collared lemming	*Dicrostonyx groenlandicus*	G3	S3								
Rodents	collared lemming, St. Lawrence Island	*Dicrostonyx groenlandicus exsul*	G5T4	S4					DD			
Rodents	collared lemming	*Dicrostonyx groenlandicus peninsulae*										
Rodents	collared lemming, Stevenson's	*Dicrostonyx groenlandicus stevensoni*	GNR	SNR								
Rodents	collared lemming, Unalaska	*Dicrostonyx groenlandicus unalascensis*	G5T3	S3					DD			

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	NOAA	COSEWIC	IUCN	CITES	BLM	USFS
Rodents	insular vole	*Microtus abbreviatus*	G3Q	S3								
Rodents	insular vole, Hall Island	*Microtus abbreviatus abbreviatus*	G3QT3	S3Q					DD			
Rodents	insular vole, St. Matthew Island	*Microtus abbreviatus fisheri*	G3QT3	S3Q					DD			
Rodents	long-tailed vole	*Microtus longicaudus*	G5	SNR								
Rodents	long-tailed vole, Coronation Island	*Microtus longicaudus coronarius*	G5T3Q	S3Q					DD			
Rodents	long-tailed vole	*Microtus longicaudus littoralis*	G5	SNR								
Rodents	singing vole	*Microtus miurus*	G4	S4								
Rodents	tundra vole	*Microtus oeconomus*	G5	SNR								
Rodents	tundra vole, Amak Island	*Microtus oeconomus amakensis*	G5T2Q	S2Q					DD			
Rodents	tundra vole, Montague Island	*Microtus oeconomus elymocetes*	G5T2	S2					DD			Sensitive - CNF
Rodents	tundra vole, Punuk Island	*Microtus oeconomus punukensis*	G5T1	S1					DD			
Rodents	tundra vole, St. Lawrence Island	*Microtus oeconomus innuitus*	G5T3	S3					DD			
Rodents	tundra vole, Shumagin Island	*Microtus oeconomus popofensis*	G5T3	S3					DD			
Rodents	tundra vole, Sitka	*Microtus oeconomus sitkensis*	G5T3	S3					DD			
Rodents	tundra vole, Unalaska	*Microtus oeconomus unalascensis*	G5T3	S3								
Rodents	tundra vole, Yakutat	*Microtus oeconomus yakutatensis*	G5T4	S4								
Rodents	meadow vole	*Microtus pennsylvanicus*	G5	SNR								
Rodents	meadow vole, Admiralty Island	*Microtus pennsylvanicus admiraltiae*	G5T3	S3								
Rodents	yellow-cheeked vole (Taiga vole)	*Microtus xanthognathus*	G5	SNR								
Rodents	forest deer mouse, Keen's mouse	*Peromyscus keeni*	G5	S3								
Rodents	forest deer mouse	*Peromyscus keeni algidus*										

Group	Common Name	Scientific Name	GRANK	SRANK	SOA	USFWS	NOAA	COSEWIC	IUCN	CITES	BLM	USFS
Rodents	forest deer mouse	*Peromyscus keeni hylaeus*										
Rodents	forest deer mouse	*Peromyscus keeni macrorhinus*										
Rodents	forest deer mouse	*Peromyscus keeni oceanicus*										
Rodents	forest deer mouse	*Peromyscus keeni sitkensis*										
Pikas	collared pika	*Ochotona collaris*	G5	S5								
Hares	tundra hare	*Lepus othus*	G3G4	S3S4Q								
Hares	tundra hare	*Lepus othus othus*										
Hares	tundra hare	*Lepus othus poadromus*										

Invertebrate Nominees					
Group	Common Name	Scientific Name	GRANK	SRANK	COSEWic
Worms	Round, whip, lung, hook, and eel[1]	Nematoda			
Worms	Leeches, earthworms, bristle worms[1]	Annelida			
Amphipod	A cave obligate amphipod	*Stygobromus quatsinensis*	G2G3	S2S3	
Arthropoda	Crustaceans, Spiders, Insects[1]	Arthropoda			
Insect	Mayflies	Ephemeroptera			
Insect	A mayfly	*Brachycercus arcticus*	G1	S?	
Insect	A mayfly	*Ephemerella lacustris*	G1	S?	
Insect	A mayfly	*Acentrella feropagus*	G3	S?	
Insect	A stonefly	*Isoperla katmaiensis*	G2	S?	
Insect	Stoneflies	Plecoptera			
Insect	A stonefly	*Mesocapnia bergi*	G1	S?	
Insect	A stonefly	*Nemoura normani*	G1	S?	
Insect	A stonefly	*Isocapnia agassizi*	G3	S?	
Insect	A stonefly	*Podmosta weberi*	G3	S?	
Insect	A stonefly	*Alaskaperla ovibovis*	G3	S?	
Insect	A stonefly	*Isoperla decolorata*	G3	S?	
Insect	A stonefly	*Isoperla sordida*	G3	S?	
Insect	A stonefly	*Pteronarcella regularis*	G3	S?	
Insect	Caddisflies	Trichoptera			
Insect	Eskimo arctic	*Oeneis alpina*	G3G4	S?	
Insect	Alaskan orange tip	*Anthocharis sara alaskensis*	G5T1T2	S?	
Insect	Bog fritillary	*Boloria eunomia denali*	G5T2T3	S?	
Insect	Uhler's arctic	*Oeneis uhleri cairnesi*	G5T2T3	S?	
Insect	Astarte fritillary	*Boloria astarte distincta*	G5T3	S?	
Insect	Field crescent	*Phyciodes pratensis totchone*	G5T3T4	S?	
Insect	Western bumblebee	*Bombus occidentalis*	GNR	SNR	
Insect	Dragonflies and Damselflies[2]	Odonata			
Insect	Water fleas	Cladocera			
Mollusc	Clams and Mussels[3]	Pelecypoda			

Group	Common Name	Scientific Name	GRANK	SRANK	COSEWic
Mollusc	Western pearl shell	*Margaritifera falcata*	G4	SNR	
Mollusc	Yukon floater	*Anodonta beringiana*	G4	S3S4	
Mollusc	Western floater	*Anodonta kennerlyi*	G4	SNR	
Mollusc	Snails, Slugs, Limpets[1, 4, 8]	Gastropoda			
Mollusc	Attenuate fossaria	*Fossaria truncatula*	G1G2Q	S?	
Mollusc	Rams-horn valvata	*Valvata mergella*	G2	S?	
Mollusc	Fringed valvata	*Valvata lewisi*	G3?	S?	
Mollusc	Frigid lymnaea	*Lymnaea atkaensis*	G3?	S?	
Mollusc	Hanna's vertigo	*Vertigo hannai*	GH	S?	
Mollusc	Undescribed snail	*Vertigo* sp. *nov*	G?	S?	
Mollusc	Black Katy chiton	*Katharina tunicata*	G5	S5	
Mollusc	Gumboot chiton	*Cryptochiton stelleri*			
Mollusc	Pinto (Northern) abalone	*Haliotis kamtschatkana*	GNR	SNR	T
Mollusc	Intertidal and shallow subtidal bivalves[4]	various			
Various	Eelgrass-associated invertebrates[4]	various			
Various	Corals, tunicates, sponges[5]	various			
Various	Salt marsh-associated invertebrates[6]	various			
Various	Zooplankton[7]	various			
Various	Benthic grazers[8]	various			
Various	Cave-dwelling species[9]	various			

[1] See Terrestrial Invertebrates Introduction in Appendix 4 for complete list of orders
[2] See Freshwater Invertebrates: Dragonflies and Damselflies template in Appendix 4 for complete list of species
[3] See Freshwater Invertebrates: Mollusca in Appendix 4
[4] See Nearshore Soft Benthic Ecosystems templates in Appendix 4
[5] See Deep Benthic Ecosystems template in Appendix 4
[6] See Salt Marsh Ecosystems template in Appendix 4
[7] See Pelagic Ecosystems template in Appendix 4
[8] See Nearshore Rocky Reef Ecosystems template in Appendix 4
[9] See Karst Cave Dwelling Aquatic Invertebrates template in Appendix 4

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The nudibranch *Janolus fuscus* incorporates stinging cells from hydroid prey into its own defense system.

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Appendix 9. Alaska's Population by Community and Ecoregion

This Appendix includes two sets of tables[1]:

[1] Tables include population estimates for a defined community or census designated place (CDP). Approximately 7.5% of Alaska's population in 2004 (49,328) is located in rural areas not assigned to a designated place. The Fairbanks/North Star Borough contains 64% (31,570) of the "remainder" population in Alaska, followed by the Matanuska-Susitna Borough.

Table 9.1. Population of Alaska communities and census designated places (CDPs) 2000 through 2004.

Place Name/Census CDP	Census 2000	2001[a]	2002[a]	2003[a]	2004[a]
Adak Station	316	152	149	74	69
Afognak	0				0
Akhiok	80	57	49	51	56
Akiachak	585	597	624	633	618
Akiak	309	301	345	346	367
Akutan	713	707	749	787	771
Alakanuk	652	651	658	663	667
Alatna	35	37	24	36	32
Alcan Border	21	11	10	15	19
Aleknagik	221	221	219	235	219
Aleneva	68	88	96	59	40
Allakaket	133	135	130	131	124
Alpine	0	0	0	0	0
Ambler	309	282	295	291	274
Anaktuvuk Pass	282	299	302	319	300
Anchor Point	1845	1809	1784	1812	1792
Anchorage	260283	265286	268347	273602	277498
Anderson	367	376	366	377	344
Angoon	572	559	544	507	481
Aniak	572	563	540	541	532
Annette Island Reserve	1447	1416	1418	1397	1370
Anvik	104	102	107	105	101
Arctic Village	152	158	169	162	146
Atka	92	92	102	94	92
Atmautluak	294	302	291	279	285
Atqasuk	228	234	231	228	218
Attu	20	25	26	24	17
Ayakulik[b]					
Barrow	4581	4441	4434	4412	4351
Bear Creek	1748	1836	1832	1835	1897
Beaver	84	80	75	64	67
Belkofski	0	0	0	0	0
Beluga	32	24	25	27	26
Bethel	5471	5459	5733	5886	5888
Bettles	43	41	32	32	31
Big Delta	749	788	778	718	736
Big Lake	2635	2613	2702	2889	2912
Bill Moores	0	0	0	0	0
Birch Creek	28	36	37	32	43

[a] Alaska Dept. of Labor estimates available at: http://www.labor.state.ak.us/research/pop/estimates/
[b] Not a Census CDP or city in 2000--no population data available.

Place Name/Census CDP	Census 2000	2001[a]	2002[a]	2003[a]	2004[a]
Boundary[b]					
Brevig Mission	276	284	308	313	319
Buckland	406	404	426	409	437
Buffalo Soapstone	699	724	730	740	744
Butte	2561	2735	2773	2919	2963
Candle[b]					
Cantwell	222	221	216	226	220
Cape Lisburne[b]					
Cape Yakataga[b]					
Central	134	135	120	110	102
Chalkyitsik	83	80	85	83	84
Chase	41	33	35	34	27
Chefornak	394	397	420	434	439
Chena Hot Springs[b]					
Chenega Bay	86	85	87	96	81
Chevak	765	832	854	883	899
Chickaloon	213	265	265	280	298
Chicken	17	18	24	21	21
Chignik	79	76	77	91	92
Chignik Lagoon	103	104	88	92	81
Chignik Lake	145	140	115	113	113
Chilkoot	338	307	331	357	349
Chiniak	50	53	56	49	51
Chisana	0	12	12	12	9
Chistochina	93	92	86	85	101
Chitina	123	111	136	134	118
Chuathbaluk	119	108	98	102	105
Chuloonawick	0	0	0	0	0
Circle	100	94	82	94	99
Circle Hot Springs[b]					
Clam Gulch	173	168	173	176	164
Clark's Point	75	69	65	66	62
Coffman Cove	199	175	160	164	177
Cohoe	1168	1175	1209	1206	1312
Cold Bay	88	75	116	95	89
Coldfoot	13	14	11	15	11
College	11402	12039	11913	11989	12186
Cooper Landing	369	391	372	358	351
Copper Center	492	515	489	559	530
Copperville (Tazlina Pt)	179	157	193	189	201
Cordova	2454	2382	2305	2298	2298
Council	0	0	0	0	0
Covenant Life	102	116	126	126	220
Craig	1725	1592	1544	1495	1475
Crooked Creek	137	134	146	146	147
Crown Point	75	89	88	78	89
Cube Cove	72	68	30	0	0
Deadhorse[b]					

Place Name/Census CDP	Census 2000	2001[a]	2002[a]	2003[a]	2004[a]
Deering	136	137	129	131	145
Delta Junction	885	873	887	963	984
Deltana	1570	1632	1656	1700	1777
Diamond Ridge	1802	1812	404	306	761
Dillingham	2466	2460	2465	2390	2422
Diomede	146	139	128	137	141
Dot Lake	57	56	55	68	62
Dry Creek	128	132	123	109	105
Eagle	129	142	152	126	115
Eagle Village	68	63	64	59	68
Edna Bay	49	40	40	45	44
Eek	280	271	290	290	292
Egegik	116	80	87	82	76
Eielson AFB	5400	5153	5839	4434	4587
Eklutna	394	415	438	419	371
Ekuk	2	2	5	0	0
Ekwok	130	119	116	128	127
Elfin Cove	32	28	32	32	26
Elim	313	317	339	342	318
Emmonak	767	764	744	758	762
Ester	1680	1683	1834	1812	1811
Evansville	28	27	20	21	21
Excursion Inlet	10	15	10	12	9
Eyak	168	158	153	142	132
Fairbanks	30224	29580	29829	29002	29954
False Pass	64	69	79	69	62
Farm Loop	1067	1082	1164	1161	1138
Ferry	29	32	33	35	32
Fishhook	2030	2179	2233	2335	2606
Flat	4	1	0	0	0
Fort Glenn[b]					
Fort Greely	461	71	0	0	185
Fort Yukon	595	565	569	560	594
Four Mile Road CDP	38	42	39	38	33
Fox	300	310	314	325	348
Fox River	616	594	574	572	587
Fritz Creek	1603	1662	1735	1744	1732
Funny River	636	624	688	707	727
Gakona	215	219	241	217	222
Galena	675	675	698	744	717
Gambell	649	643	640	647	648
Game Creek	35	35	35	36	26
Gateway	2952	3117	3213	3305	3554
Georgetown	3	3	3	3	3
Glacier View	249	238	250	250	266
Glennallen	554	547	528	585	548
Golovin	144	155	149	156	160
Goodnews Bay	230	228	234	244	236
Grayling	194	202	188	162	182

Place Name/Census CDP	Census 2000	2001[a]	2002[a]	2003[a]	2004[a]
Gulkana	164	194	159	186	198
Gustavus	429	418	421	438	473
Haines	1811	1744	1762	1704	1562
Halibut Cove	35	29	28	27	26
Hamilton	0	0	0	0	0
Happy Valley	489	505	521	505	525
Harding-Birch Lakes	216	197	206	217	233
Healy	1000	1015	998	1013	994
Healy Lake	37	39	42	33	34
Hobart Bay	3	0	0	0	0
Hollis	139	154	149	175	165
Holy Cross	227	227	227	204	206
Homer	3946	4065	5527	5865	5332
Hoonah	860	875	877	850	841
Hooper Bay	1014	1042	1074	1109	1124
Hope	137	145	152	161	165
Houston	1202	1160	1262	1351	1368
Hughes	78	75	68	64	72
Huslia	293	279	282	284	269
Hydaburg	382	353	364	369	349
Hyder	97	102	89	77	83
Iditarod[b]					
Igiugig	53	55	43	50	54
Iliamna	102	95	98	92	90
Ivanof Bay	22	13	3	3	5
Juneau	30711	30371	30899	31246	30966
Kachemak	431	426	433	478	475
Kaguyak[b]					
Kake	710	697	701	683	663
Kaktovik	293	278	306	295	284
Kalifornsky	5846	6011	6153	6249	6617
Kaltag	230	224	219	223	211
Karluk	27	27	24	24	26
Kasaan	39	46	57	57	60
Kasigluk	543	541	528	528	526
Kasilof	471	451	504	568	473
Kenai	6942	6870	7071	7123	6809
Kenny Lake	410	412	364	373	392
Ketchikan	7922	8455	8372	7989	7691
Kiana	388	404	400	408	394
King Cove	792	693	786	725	723
King Island[b]					
King Salmon	442	388	397	385	404
Kipnuk	644	621	644	649	660
Kivalina	377	385	383	388	388
Klawock	854	865	860	847	848
Klukwan	139	126	112	120	119
Knik	582	624	635	676	626

Place Name/Census CDP	Census 2000	2001[a]	2002[a]	2003[a]	2004[a]
Knik-Fairview	7049	7636	7997	8561	9223
Kobuk	109	94	106	125	128
Kodiak	6334	6062	6109	6113	6199
Kodiak Station	1840	1758	1939	2190	1750
Kokhanok	174	172	179	181	166
Koliganek	182	177	187	199	187
Kongiganak	359	372	372	404	411
Kotlik	591	626	632	605	588
Kotzebue	3082	3068	3073	3070	3130
Koyuk	297	326	329	341	348
Koyukuk	101	94	99	108	109
Kupreanof	23	23	23	30	38
Kwethluk	713	690	695	709	695
Kwigillingok	338	358	337	343	361
Lake Louise	88	101	91	111	99
Lake Minchumina	32	21	24	23	19
Lakes	6706	6812	6923	7053	7467
Larsen Bay	115	113	107	96	96
Lazy Mountain	1158	1177	1192	1202	1233
Levelock	122	107	83	71	57
Lime Village	46	49	41	43	34
Livengood	29	32	30	21	29
Lowell Point	92	96	108	89	74
Lower Kalskag	267	256	262	267	262
Lower Tonsina[b]					
Lutak	39	44	40	36	35
Manley Hot Springs	72	73	72	71	73
Manokotak	399	412	407	405	405
Marshall	349	357	358	365	358
Marys Igloo	0	0	0	0	0
McCarthy	42	45	51	54	66
McGrath	401	437	398	405	367
McKinley Park	142	133	138	134	133
Medfra[b]					
Meadow Lakes	4819	5040	5274	5579	5945
Mekoryuk	210	214	204	205	198
Mendeltna	63	68	59	68	73
Mentasta Lake	142	134	144	144	139
Metlakatla	1375	1346	1348	1329	1302
Meyers Chuck	21	15	14	18	14
Miller Landing	74	70	0	0	0
Minto	258	225	225	228	207
Moose Creek	542	559	628	582	589
Moose Pass	206	206	217	221	220
Mosquito Lake	221	224	211	220	169
Mountain Village	755	749	756	753	769
Nabesna[b]					
Mud Bay	137	158	147	149	147
Naknek	678	657	641	612	601

Place Name/Census CDP	Census 2000	2001[a]	2002[a]	2003[a]	2004[a]
Nanwalek	177	184	219	214	203
Napamiute	0	0	0	0	0
Napakiak	353	370	352	380	360
Napaskiak	390	418	418	424	436
Naukati Bay	135	129	111	109	107
Nelchina	71	67	73	67	61
Nelson Lagoon	83	80	70	64	76
Nenana	402	396	406	385	394
New Stuyahok	471	488	483	491	477
Newhalen	160	156	166	171	183
Newtok	321	321	326	330	308
Nightmute	208	213	224	229	232
Nikiski	4327	4362	4360	4356	4279
Nikolaevsk	345	345	331	312	306
Nikolai	100	101	118	123	121
Nikolski	39	32	34	41	36
Ninilchik	772	758	760	774	783
Noatak	428	438	455	468	448
Nome	3505	3485	3481	3414	3473
Nondalton	221	210	206	216	205
Noorvik	634	643	676	648	609
North Pole	1570	1462	1590	1609	1532
Northway	95	76	82	92	106
Northway Junction	72	75	71	62	71
Northway Village (Northway)	107	123	119	116	89
Nuiqsut	433	426	443	416	430
Nulato	336	354	338	333	320
Sheldon Point	164	166	164	174	172
Nunapitchuk	466	488	512	498	527
Ohogamiut	0	0	0	0	0
Old Harbor	237	236	226	211	196
Ophir[b]					
Oscarville	61	71	65	62	57
Ouzinkie	225	204	189	172	187
Paimiut	2	2	2	2	2
Palmer	4533	4581	4840	5267	5197
Pauloff Harbor[b]					
Paxson	43	42	43	43	40
Pedro Bay	50	50	46	45	47
Pelican	163	161	116	113	118
Perryville	107	114	111	106	110
Petersburg	3224	3218	3148	3079	3123
Petersville	27	25	19	14	15
Pilot Point	100	86	75	70	75
Pilot Station	550	555	546	561	559
Pitkas Point	125	112	102	106	105
Platinum	41	44	37	40	39
Pleasant Valley	623	641	720	687	711
Point Baker	35	34	35	33	24

Place Name/Census CDP	Census 2000	2001[a]	2002[a]	2003[a]	2004[a]
Point Hope	757	714	709	725	726
Point Lay	247	256	256	264	251
Point MacKenzie	111	210	200	201	216
Poorman[b]					
Pope-Vannoy Landing	8	5	5	10	9
Port Alexander	81	84	72	70	69
Port Alsworth	104	105	109	104	113
Port Clarence	21	22	22	22	27
Port Graham	171	178	174	165	153
Port Heiden	119	118	108	85	90
Port Lions	256	246	227	233	238
Port Moller[b]					
Port Protection	63	65	53	57	47
Portage Creek	36	47	48	61	49
Portlock[b]					
Primrose	93	98	92	86	90
Prudhoe Bay	5	5	7	4	3
Quinhagak	555	543	573	578	612
Rampart	45	24	21	21	21
Red Devil	48	31	32	41	35
Red Dog Mine	32	33	35	37	33
Ridgeway	1932	1961	1963	2022	2047
Ruby	188	187	191	165	190
Russian Mission	296	313	327	325	331
Saint George	152	146	147	148	137
Saint Mary's	500	512	546	581	539
Saint Michael	368	377	390	413	409
Saint Paul	532	526	533	539	494
Salamatof	954	894	897	904	900
Salcha	854	902	923	868	931
Sanak[b]					
Sand Point	952	921	919	947	908
Savoonga	643	655	686	704	710
Saxman	431	436	425	424	391
Scammon Bay	465	473	491	467	486
Selawik	772	777	778	820	829
Seldovia	430	435	450	431	426
Seward	2830	2759	2754	2745	2540
Shageluk	129	144	142	141	132
Shaktoolik	230	209	218	223	209
Shemya Station[b]					
Shishmaref	562	586	589	594	591
Shungnak	256	245	249	264	264
Sitka	8835	8724	8799	8897	8805
Skagway	862	837	843	844	870
Skwentna	111	94	88	95	81
Slana	124	104	111	120	110
Sleetmute	100	96	93	72	78

Place Name/Census CDP	Census 2000	2001[a]	2002[a]	2003[a]	2004[a]
Soldotna	3759	3791	3856	3992	3767
Solomon	4	4	8	8	8
South Naknek	137	124	120	102	88
Squaw Harbor[b]					
Stebbins	547	599	587	570	586
Sterling	4705	4753	4771	4880	4940
Stevens Village	87	73	83	83	76
Stony River	61	55	57	49	54
Sunrise	18	16	14	15	19
Susitna	37	40	36	38	31
Sutton	1080	1109	1144	1159	1154
Takotna	50	55	53	62	47
Talkeetna	772	796	861	856	844
Tanacross	140	140	147	143	137
Tanaina	4993	5260	5597	5865	6265
Tanana	308	302	273	283	304
Tatitlek	107	95	103	106	108
Tazlina	339	320	375	380	378
Tazlina	149	157	174	185	170
Telida	3	3	2	2	2
Teller	268	239	247	242	241
Tenakee Springs	104	105	98	106	105
Tetlin	124	147	150	145	137
Thoms Place	22	20	12	12	10
Thorne Bay	557	521	499	481	497
Togiak	809	787	809	820	805
Tok	1393	1411	1449	1431	1439
Toksook Bay	532	546	549	571	561
Tolsona	27	30	27	27	22
Tonsina	92	100	95	107	84
Trapper Creek	423	405	404	425	436
Tuluksak	428	438	463	461	470
Tuntutuliak	370	376	378	381	398
Tununak	325	326	323	307	328
Twin Hills	69	65	77	77	67
Two Rivers	482	541	540	601	595
Tyonek	193	161	181	192	184
Uganik[b]					
Ugashik	11	12	12	12	12
Umkumiute[b]					
Unalakleet	747	737	726	741	728
Unalaska	4283	4249	4033	4374	4366
Unga					
Upper Kalskag	230	252	246	231	263
Uyak[b]					
Valdez	4036	3843	3974	3935	3749
Venetie	202	194	195	193	188
Wainwright	546	562	536	553	531
Wales	152	158	159	158	152

Place Name/Census CDP	Census 2000	2001[a]	2002[a]	2003[a]	2004[a]
Wasilla	5469	5517	5959	6387	6109
Whale Pass	58	53	64	67	81
White Mountain	203	203	210	214	213
Whitestone Logging Camp	116	109	75	60	0
Whittier	182	170	161	173	172
Willow	1658	1665	1719	1813	1856
Willow Creek	201	208	188	178	179
Wiseman	21	25	25	27	24
Womens Bay	690	682	683	671	666
Woody Island[b]					
Wrangell	2308	2220	2175	2123	2023
Yakutat	680	641	664	635	619
Y	956	996	993	1038	1072
Total AK Population[c]	626931	632389	640841	648280	655435

[a] Alaska Dept. of Labor estimates available at: http://www.labor.state.ak.us/research/pop/estimates/

[b] Not a Census CDP or city in 2000--no population data available.

[c] Column does not sum to total Alaska population reported because table lists only populated communities and does not include other rural residents who are not living within a listed place or CDP

Table 9.2. Population of Alaska communities and census designated places (CDP) within identified Alaska ecoregions 2000 through 2004.

Ecoregion	Location/CDP	Census 2000	2001[a]	2002[a]	2003[a]	2004[a]
Ahklun Mountains						
	Togiak	809	787	809	820	805
	Manokotak	399	412	407	405	405
	Goodnews Bay	230	228	234	244	236
	Aleknagik	221	221	219	235	219
	Twin Hills	69	65	77	77	67
	Platinum	41	44	37	40	39
	Total ecoregion population[c]	**1769**	**1757**	**1783**	**1821**	**1771**
Alaska Peninsula						
	Sand Point	952	921	919	947	908
	King Cove	792	693	786	725	723
	Newhalen	160	156	166	171	183
	Kokhanok	174	172	179	181	166
	Chignik Lake	145	140	115	113	113
	Perryville	107	114	111	106	110
	Chignik	79	76	77	91	92
	Iliamna	102	95	98	92	90
	Port Heiden	119	118	108	85	90
	Cold Bay	88	75	116	95	89
	Chignik Lagoon	103	104	88	92	81
	Nelson Lagoon	83	80	70	64	76
	False Pass	64	69	79	69	62
	Igiugig	53	55	43	50	54
	Pope-Vannoy Landing	8	5	5	10	9
	Ivanof Bay	22	13	3	3	5
	Belkofski	0	0	0	0	0
	Pauloff Harbor[b]					
	Port Moller[b]					
	Sanak[b]					
	Squaw Harbor[b]					
	Unga[b]					
	Total ecoregion population[c]	**3051**	**2886**	**2963**	**2894**	**2851**
Alaska Range						
	Healy	1000	1015	998	1013	994
	Chickaloon	213	265	265	280	298
	Cantwell	222	221	216	226	220
	Mentasta Lake	142	134	144	144	139
	McKinley Park	142	133	138	134	133
	Pedro Bay	50	50	46	45	47
	Paxson	43	42	43	43	40
	Total ecoregion population[c]	**1812**	**1860**	**1850**	**1885**	**1871**

[a] Alaska Dept. of Labor estimates available at: http://www.labor.state.ak.us/research/pop/estimates/

[b] Not a Census CDP or city in 2000--no population data available.

[c] Total ecoregion population reported is likely an underestimate because persons living outside communities or recognized CDPs are not counted AND ecoregion boundaries may encompass one or more different census areas/tracts. Total ecoregion population estimates should only be used as indicators of trends within ecoregions.

Ecoregion	Location/CDP	Census 2000	2001[a]	2002[a]	2003[a]	2004[a]
Beaufort Coastal Plain						
	Barrow	4581	4441	4434	4412	4351
	Wainwright	546	562	536	553	531
	Nuiqsut	433	426	443	416	430
	Kaktovik	293	278	306	295	284
	Point Lay	247	256	256	264	251
	Atqasuk	228	234	231	228	218
	Prudhoe Bay	5	5	7	4	3
	Alpine	0	0	0	0	0
	Deadhorse[b]					
	Total ecoregion population[c]	**6333**	**6202**	**6213**	**6172**	**6068**
Bering Sea Islands						
	Savoonga	643	655	686	704	710
	Gambell	649	643	640	647	648
	Saint Paul	532	526	533	539	494
	Mekoryuk	210	214	204	205	198
	Diomede	146	139	128	137	141
	Saint George	152	146	147	148	137
	King Island[b]					
	Total ecoregion population[c]	**2332**	**2323**	**2338**	**2380**	**2328**
Bristol Bay Lowlands						
	Dillingham	2466	2460	2465	2390	2422
	Naknek	678	657	641	612	601
	New Stuyahok	471	488	483	491	477
	King Salmon	442	388	397	385	404
	Koliganek	182	177	187	199	187
	Ekwok	130	119	116	128	127
	South Naknek	137	124	120	102	88
	Egegik	116	80	87	82	76
	Pilot Point	100	86	75	70	75
	Clark's Point	75	69	65	66	62
	Levelock	122	107	83	71	57
	Portage Creek	36	47	48	61	49
	Ugashik	11	12	12	12	12
	Ekuk	2	2	5	0	0
	Total ecoregion population[c]	**4968**	**4816**	**4784**	**4669**	**4637**
Brooks Foothills						
	Point Hope	757	714	709	725	726
	Kivalina	377	385	383	388	388
	Cape Lisburne[b]					
	Total ecoregion population[c]	**1134**	**1099**	**1092**	**1113**	**1114**
Brooks Range						
	Anaktuvuk Pass	282	299	302	319	300
	Wiseman	21	25	25	27	24
	Coldfoot	13	14	11	15	11
	Total ecoregion population[c]	**316**	**338**	**338**	**361**	**335**

Ecoregion	Location/CDP	Census 2000	2001[a]	2002[a]	2003[a]	2004[a]
Chugach-St. Elias Mountains						
	Valdez	4036	3843	3974	3935	3749
	Cooper Landing	369	391	372	358	351
	Chilkoot	338	307	331	357	349
	Moose Pass	206	206	217	221	220
	Tazlina	149	157	174	185	170
	Hope	137	145	152	161	165
	Tonsina	92	100	95	107	84
	Sunrise	18	16	14	15	19
	Total ecoregion population[c]	**5345**	**5165**	**5329**	**5339**	**5107**
Cook Inlet Basin						
	Anchorage	260283	265286	268347	273602	277498
	Knik-Fairview	7049	7636	7997	8561	9223
	Lakes	6706	6812	6923	7053	7467
	Kenai	6942	6870	7071	7123	6809
	Kalifornsky	5846	6011	6153	6249	6617
	Tanaina	4993	5260	5597	5865	6265
	Wasilla	5469	5517	5959	6387	6109
	Meadow Lakes	4819	5040	5274	5579	5945
	Homer	3946	4065	5527	5865	5332
	Palmer	4533	4581	4840	5267	5197
	Sterling	4705	4753	4771	4880	4940
	Nikiski	4327	4362	4360	4356	4279
	Soldotna	3759	3791	3856	3992	3767
	Gateway	2952	3117	3213	3305	3554
	Butte	2561	2735	2773	2919	2963
	Big Lake	2635	2613	2702	2889	2912
	Fishhook	2030	2179	2233	2335	2606
	Ridgeway	1932	1961	1963	2022	2047
	Willow	1658	1665	1719	1813	1856
	Anchor Point	1845	1809	1784	1812	1792
	Fritz Creek	1603	1662	1735	1744	1732
	Houston	1202	1160	1262	1351	1368
	Cohoe	1168	1175	1209	1206	1312
	Lazy Mountain	1158	1177	1192	1202	1233
	Sutton	1080	1109	1144	1159	1154
	Farm Loop	1067	1082	1164	1161	1138
	Y	956	996	993	1038	1072
	Salamatof	954	894	897	904	900
	Talkeetna	772	796	861	856	844
	Ninilchik	772	758	760	774	783
	Diamond Ridge	1802	1812	404	306	761
	Buffalo Soapstone	699	724	730	740	744
	Funny River	636	624	688	707	727
	Knik	582	624	635	676	626
	Fox River	616	594	574	572	587
	Happy Valley	489	505	521	505	525

Ecoregion	Location/CDP	Census 2000	2001[a]	2002[a]	2003[a]	2004[a]
Cook Inlet Basin (cont.)						
	Kasilof	471	451	504	568	473
	Trapper Creek	423	405	404	425	436
	Eklutna	394	415	438	419	371
	Nikolaevsk	345	345	331	312	306
	Glacier View	249	238	250	250	266
	Point MacKenzie	111	210	200	201	216
	Tyonek	193	161	181	192	184
	Clam Gulch	173	168	173	176	164
	Skwentna	111	94	88	95	81
	Susitna	37	40	36	38	31
	Chase	41	33	35	34	27
	Beluga	32	24	25	27	26
	Halibut Cove	35	29	28	27	26
	Petersville	27	25	19	14	15
	Miller Landing	74	70	0	0	0
	Total ecoregion population[c]	**357262**	**364463**	**370543**	**379553**	**385306**
Copper River Basin						
	Glennallen	554	547	528	585	548
	Copper Center	492	515	489	559	530
	Kenny Lake	410	412	364	373	392
	Tazlina	339	320	375	380	378
	Gakona	215	219	241	217	222
	Copperville (Tazlina Pt)	179	157	193	189	201
	Gulkana	164	194	159	186	198
	Chitina	123	111	136	134	118
	Slana	124	104	111	120	110
	Chistochina	93	92	86	85	101
	Lake Louise	88	101	91	111	99
	Mendeltna	63	68	59	68	73
	Nelchina	71	67	73	67	61
	Tolsona	27	30	27	27	22
	Lower Tonsina[b]					
	Total ecoregion population[c]	**5879**	**5869**	**6033**	**6154**	**3053**
Davidson Mountains						
	Arctic Village	152	158	169	162	146
	Total ecoregion population[c]	**152**	**158**	**169**	**162**	**146**
Gulf of Alaska Coast						
	Seward	2830	2759	2754	2745	2540
	Cordova	2454	2382	2305	2298	2298
	Bear Creek	1748	1836	1832	1835	1897
	Yakutat	680	641	664	635	619
	Seldovia	430	435	450	431	426
	Nanwalek	177	184	219	214	203
	Whittier	182	170	161	173	172
	Port Graham	171	178	174	165	153
	Eyak	168	158	153	142	132
	Tatitlek	107	95	103	106	108

Ecoregion	Location/CDP	Census 2000	2001[a]	2002[a]	2003[a]	2004[a]
Gulf of Alaska Coast (cont.)						
	Primrose	93	98	92	86	90
	Crown Point	75	89	88	78	89
	Chenega Bay	86	85	87	96	81
	Lowell Point	92	96	108	89	74
	Cape Yakataga[b]					
	Portlock[b]					
	Total ecoregion population[c]	**9293**	**9206**	**9190**	**9093**	**8882**
Kluane Range						
	Chisana	0	12	12	12	9
	Total ecoregion population[c]	**0**	**12**	**12**	**12**	**9**
Kobuk Ridges and Valleys						
	Noatak	428	438	455	468	448
	Kiana	388	404	400	408	394
	Ambler	309	282	295	291	274
	Shungnak	256	245	249	264	264
	Kobuk	109	94	106	125	128
	Allakaket	133	135	130	131	124
	Hughes	78	75	68	64	72
	Red Dog Mine	32	33	35	37	33
	Alatna	35	37	24	36	32
	Bettles	43	41	32	32	31
	Evansville	28	27	20	21	21
	Total ecoregion population[c]	**1839**	**1811**	**1814**	**1877**	**1821**
Kodiak Island						
	Kodiak	6334	6062	6109	6113	6199
	Kodiak Station	1840	1758	1939	2190	1750
	Womens Bay	690	682	683	671	666
	Port Lions	256	246	227	233	238
	Old Harbor	237	236	226	211	196
	Ouzinkie	225	204	189	172	187
	Larsen Bay	115	113	107	96	96
	Akhiok	80	57	49	51	56
	Chiniak	50	53	56	49	51
	Aleneva	68	88	96	59	40
	Karluk	27	27	24	24	26
	Afognak	0				0
	Ayakulik[b]					
	Kaguyak[b]					
	Uganik[b]					
	Uyak[b]					
	Woody Island[b]					
	Total ecoregion population[c]	**9922**	**9526**	**9705**	**9869**	**9505**

Ecoregion	Location/CDP	Census 2000	2001[a]	2002[a]	2003[a]	2004[a]
Kotzebue Sound Lowlands						
	Kotzebue	3082	3068	3073	3070	3130
	Selawik	772	777	778	820	829
	Noorvik	634	643	676	648	609
	Shishmaref	562	586	589	594	591
	Wales	152	158	159	158	152
	Total ecoregion population[c]	**5202**	**5232**	**5275**	**5290**	**5311**
Kuskokwim Mountains						
	McGrath	401	437	398	405	367
	Crooked Creek	137	134	146	146	147
	Chuathbaluk	119	108	98	102	105
	Sleetmute	100	96	93	72	78
	Takotna	50	55	53	62	47
	Red Devil	48	31	32	41	35
	Georgetown	3	3	3	3	3
	Flat	4	1	0	0	0
	Iditarod[b]					
	Ophir[b]					
	Poorman[b]					
	Total ecoregion population[c]	862	865	823	831	782
Lime Hills						
	Nondalton	221	210	206	216	205
	Port Alsworth	104	105	109	104	113
	Lime Village	46	49	41	43	34
	Total ecoregion population[c]	**371**	**364**	**356**	**363**	**352**
North Coast Mountains						
	Juneau	30711	30371	30899	31246	30966
	Haines	1811	1744	1762	1704	1562
	Skagway	862	837	843	844	870
	Covenant Life	102	116	126	126	220
	Mosquito Lake	221	224	211	220	169
	Mud Bay	137	158	147	149	147
	Klukwan	139	126	112	120	119
	Hyder	97	102	89	77	83
	Lutak	39	44	40	36	35
	Total ecoregion population[c]	**34119**	**33722**	**34229**	**34522**	**34171**
North Ogilvie Mountains						
	Eagle Village	68	63	64	59	68
	Total ecoregion population[c]	**68**	**63**	**64**	**59**	**68**
Nulato Hills						
	Mountain Village	755	749	756	753	769
	Unalakleet	747	737	726	741	728
	Stebbins	547	599	587	570	586
	Pilot Station	550	555	546	561	559
	Saint Mary's	500	512	546	581	539
	Saint Michael	368	377	390	413	409
	Marshall	349	357	358	365	358
	Koyuk	297	326	329	341	348

Ecoregion	Location/CDP	Census 2000	2001[a]	2002[a]	2003[a]	2004[a]
Nulato Hills (cont.)						
	Shaktoolik	230	209	218	223	209
	Grayling	194	202	188	162	182
	Ohogamiut	0	0	0	0	0
	Total ecoregion population[c]	**4537**	**4623**	**4644**	**4710**	**4687**
Ray Mountains						
	Manley Hot Springs	72	73	72	71	73
	Livengood	29	32	30	21	29
	Rampart	45	24	21	21	21
	Total ecoregion population[c]	**146**	**129**	**123**	**113**	**123**
Seward Peninsula						
	Nome	3505	3485	3481	3414	3473
	Buckland	406	404	426	409	437
	Brevig Mission	276	284	308	313	319
	Elim	313	317	339	342	318
	Teller	268	239	247	242	241
	White Mountain	203	203	210	214	213
	Golovin	144	155	149	156	160
	Deering	136	137	129	131	145
	Port Clarence	21	22	22	22	27
	Solomon	4	4	8	8	8
	Council	0	0	0	0	0
	Marys Igloo	0	0	0	0	0
	Candle[b]					
	Total ecoregion population[c]	**5276**	**5250**	**5319**	**5251**	**5341**
Tanana-Kuskokwim Lowlands						
	Fairbanks	30224	29580	29829	29002	29954
	Eielson AFB	5400	5153	5839	4434	4587
	Deltana	1570	1632	1656	1700	1777
	North Pole	1570	1462	1590	1609	1532
	Tok	1393	1411	1449	1431	1439
	Delta Junction	885	873	887	963	984
	Salcha	854	902	923	868	931
	Big Delta	749	788	778	718	736
	Pleasant Valley	623	641	720	687	711
	Moose Creek	542	559	628	582	589
	Nenana	402	396	406	385	394
	Anderson	367	376	366	377	344
	Minto	258	225	225	228	207
	Fort Greely	461	71	0	0	185
	Willow Creek	201	208	188	178	179
	Tanacross	140	140	147	143	137
	Tetlin	124	147	150	145	137
	Nikolai	100	101	118	123	121
	Northway	95	76	82	92	106
	Dry Creek	128	132	123	109	105
	Northway Village (Northway)	107	123	119	116	89
	Northway Junction	72	75	71	62	71
	Dot Lake	57	56	55	68	62

Ecoregion	Location/CDP	Census 2000	2001[a]	2002[a]	2003[a]	2004[a]
Tanana-Kuskokwim Lowlands (cont.)						
	Stony River	61	55	57	49	54
	Ferry	29	32	33	35	32
	Lake Minchumina	32	21	24	23	19
	Telida	3	3	2	2	2
	Medfra[b]					
	Total ecoregion population[c]	**46447**	**45238**	**46465**	**44129**	**45484**
Wrangell Mountains						
	McCarthy	42	45	51	54	66
	Nabesna[b]					
	Total ecoregion population[c]	**42**	**45**	**51**	**54**	**66**
Yukon River Lowlands						
	Galena	675	675	698	744	717
	Nulato	336	354	338	333	320
	Tanana	308	302	273	283	304
	Huslia	293	279	282	284	269
	Kaltag	230	224	219	223	211
	Holy Cross	227	227	227	204	206
	Ruby	188	187	191	165	190
	Shageluk	129	144	142	141	132
	Koyukuk	101	94	99	108	109
	Anvik	104	102	107	105	101
	Four Mile Road CDP	38	42	39	38	33
	Total ecoregion population[c]	**2629**	**2630**	**2615**	**2628**	**2592**
Yukon-Kuskokwim Delta						
	Bethel	5471	5459	5733	5886	5888
	Hooper Bay	1014	1042	1074	1109	1124
	Chevak	765	832	854	883	899
	Emmonak	767	764	744	758	762
	Kwethluk	713	690	695	709	695
	Alakanuk	652	651	658	663	667
	Kipnuk	644	621	644	649	660
	Akiachak	585	597	624	633	618
	Quinhagak	555	543	573	578	612
	Kotlik	591	626	632	605	588
	Toksook Bay	532	546	549	571	561
	Aniak	572	563	540	541	532
	Nunapitchuk	466	488	512	498	527
	Kasigluk	543	541	528	528	526
	Scammon Bay	465	473	491	467	486
	Tuluksak	428	438	463	461	470
	Chefornak	394	397	420	434	439
	Napaskiak	390	418	418	424	436
	Kongiganak	359	372	372	404	411
	Tuntutuliak	370	376	378	381	398
	Akiak	309	301	345	346	367
	Kwigillingok	338	358	337	343	361
	Napakiak	353	370	352	380	360
	Russian Mission	296	313	327	325	331

Ecoregion	Location/CDP	Census 2000	2001[a]	2002[a]	2003[a]	2004[a]
Yukon-Kuskokwim Delta (cont.)						
	Tununak	325	326	323	307	328
	Newtok	321	321	326	330	308
	Eek	280	271	290	290	292
	Atmautluak	294	302	291	279	285
	Upper Kalskag	230	252	246	231	263
	Lower Kalskag	267	256	262	267	262
	Nightmute	208	213	224	229	232
	Sheldon Point	164	166	164	174	172
	Pitkas Point	125	112	102	106	105
	Oscarville	61	71	65	62	57
	Paimiut	2	2	2	2	2
	Bill Moores	0	0	0	0	0
	Chuloonawick	0	0	0	0	0
	Hamilton	0	0	0	0	0
	Napamiute	0	0	0	0	0
	Umkumiute[b]					
	Total ecoregion population[c]	**19849**	**20071**	**20558**	**20853**	**21024**
Yukon-Old Crow Basin						
	Fort Yukon	595	565	569	560	594
	Venetie	202	194	195	193	188
	Central	134	135	120	110	102
	Circle	100	94	82	94	99
	Chalkyitsik	83	80	85	83	84
	Stevens Village	87	73	83	83	76
	Beaver	84	80	75	64	67
	Birch Creek	28	36	37	32	43
	Circle Hot Springs[b]					
	Total ecoregion population[c]	**1313**	**1257**	**1246**	**1219**	**1253**
Yukon-Tanana Uplands						
	College	11402	12039	11913	11989	12186
	Ester	1680	1683	1834	1812	1811
	Two Rivers	482	541	540	601	595
	Fox	300	310	314	325	348
	Harding-Birch Lakes	216	197	206	217	233
	Eagle	129	142	152	126	115
	Healy Lake	37	39	42	33	34
	Chicken	17	18	24	21	21
	Alcan Border	21	11	10	15	19
	Boundary[b]					
	Chena Hot Springs[b]					
	Total ecoregion population[c]	**14284**	**14980**	**15035**	**15139**	**15362**

[a] Alaska Dept. of Labor estimates available at: http://www.labor.state.ak.us/research/pop/estimates/

[b] Not a Census CDP or city in 2000--no population data available.

[c] Total ecoregion population reported is likely an underestimate because persons living outside communities or recognized CDPs are not counted AND ecoregion boundaries may encompass one or more different census areas/tracts. Total ecoregion population estimates should only be used as indicators of trends within ecoregions.

Appendix 10: Alaska's Special Areas: Management Planning Status

Name of Special Area	Date Established	Management Plan Required by Statute		Date of Management Plan
		Yes	No	
State Game Refuges				
Anchorage Coastal Wildlife Refuge	1971/1988	AS 16.20.031 (b)		1991
Cape Newenham State Game Refuge	1972		No	
Creamer's Field Migratory Waterfowl Refuge	1979/1991	AS 16.20.039 (d)		1981 Interim 1993
Goose Bay State Game Refuge	1975		No	
Izembek State Game Refuge	1972	Required by ADF&G-USFWS MOU	No	
McNeil River State Game Refuge	1993		No	1995 (w/ McNeil River State Game Sanctuary)
Mendenhall Wetlands State Game Refuge	1976	AS 16.20.034 (g)		1990
Minto Flats State Game Refuge	1988	AS 16.20.037 (g)		1992
Palmer Hay Flats State Game Refuge	1975/1985		No	1986 2002
Susitna Flats State Game Refuge	1976		No	1988
Trading Bay State Game Refuge	1976		No	1994 (w/ Redoubt Bay Critical Habitat Area)
Yakataga State Game Refuge	1990	AS 16.20.033 (h)		1999
State Game Sanctuaries				
McNeil River State Game Sanctuary	1967/1993		No	1996 (w/ McNeil River State Game Refuge)
Stan Price State Wildlife Sanctuary	1990		No	
Walrus Islands State Game Sanctuary	1960		No	
State Critical Habitat Areas				
Anchor River and Fritz Creek Critical Habitat Area	1985	AS 16.20.605 (d)		1989
Chilkat River Critical Habitat Area	1972		No	1985; revised 2002
Cinder River Critical Habitat Area	1972		No	
Clam Gulch Critical Habitat Area	1976		No	
Copper River Delta Critical Habitat Area	1978		No	
Dude Creek Critical Habitat Area	1988	AS 16.20.610 (c)		
Egegik Critical Habitat Area	1972		No	
Fox River Flats Critical Habitat Area	1972		No	1993
Homer Airport Critical Habitat Area	1996		No	
Kachemak Bay Critical Habitat Area	1974		No	1993
Kalgin Island Critical Habitat Area	1972		No	
Pilot Point Critical Habitat Area	1972		No	
Port Heiden Critical Habitat Area	1972		No	
Port Moller Critical Habitat Area	1972		No	
Redoubt Bay Critical Habitat Area	1989		No	1994 (w/ Trading Bay State Game Refuge)
Tugidak Island Critical Habitat Area	1988	AS 16.20.515 (c)		1995
Willow Mountain Critical Habitat Area	1989	AS 16.20.620 (b)		