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.

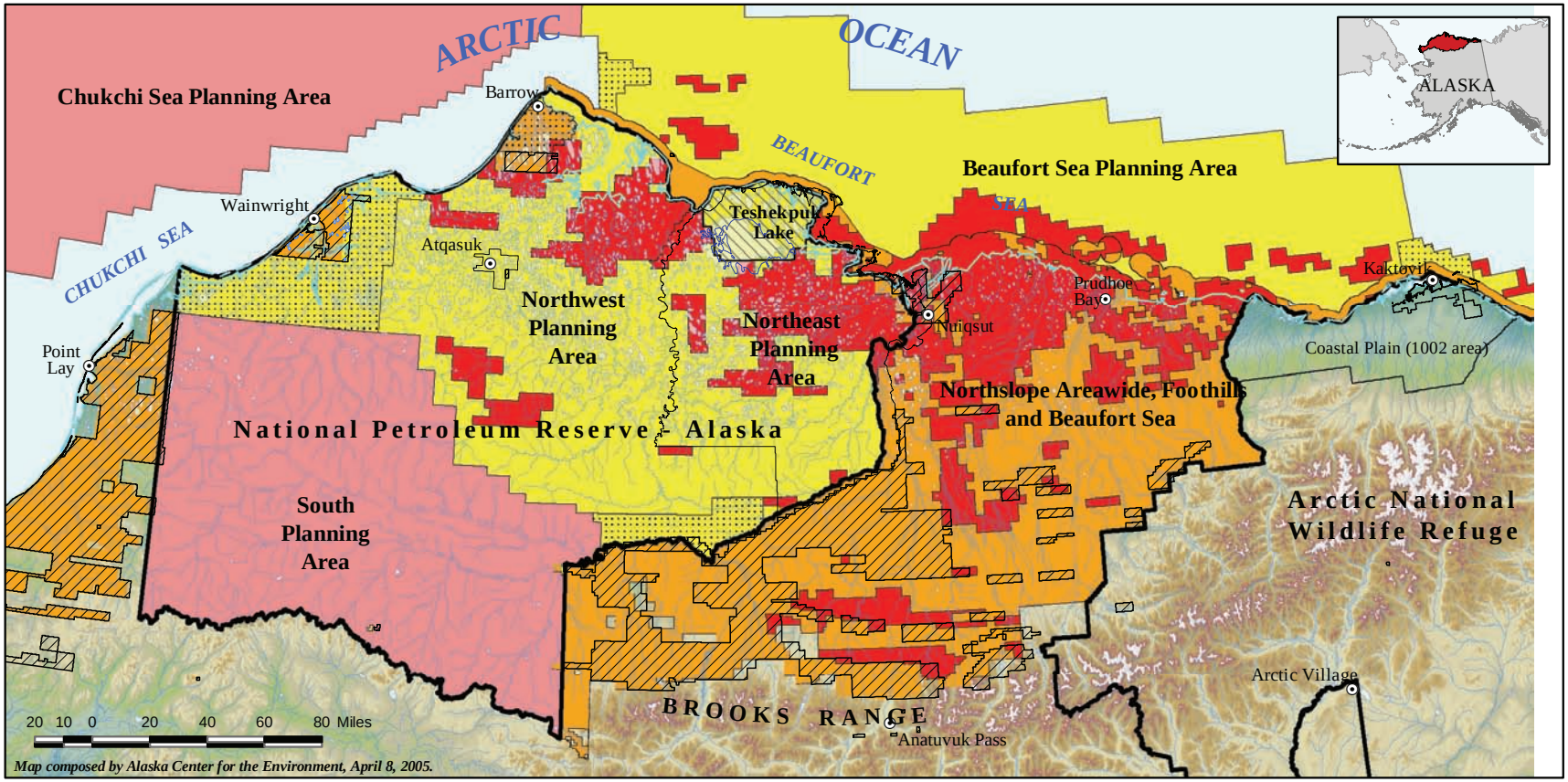
Oil and Gas Industry

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

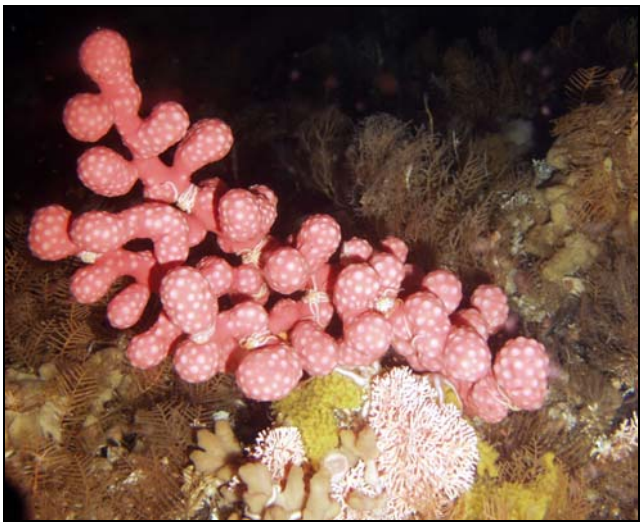
Most commercial agricultural in Alaska is located within the Matanuska-Susitna Valleys, Tanana Valley and Kenai Peninsula. Most of these operations are small-scale, and habitat impacts tend to be local. The most widespread impacts are related to land conversion and the loss of native vegetation. This 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

[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.

Introduced Arctic fox with least auklet
A. DeGange, USFWS

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.

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).

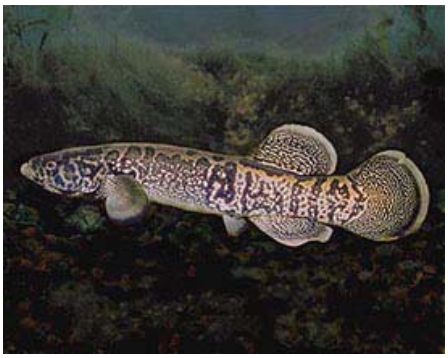
One species group for which experts raised potential overharvest as a concern was the smelts. These forage fish form the base of the food chain for many marine and terrestrial species. Although the most significant smelt fisheries in the state are monitored, experts expressed concern that few studies 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.