ANCHORAGE COASTAL WILDLIFE REFUGE MANAGEMENT PLAN

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Prepared by the Divisions of
Habitat and Wildlife Conservation

Alaska Department of Fish and Game
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The Anchorage Coastal Wildlife Refuge Management Plan has been prepared by the Alaska Department of Fish and Game (ADF&G) biologists Debra Clausen (Habitat Division) and Rick Sinnott (Wildlife Conservation Division) with special assistance from clerical staff Susan Divens and cartographic support from Frances Inoue.

The plan has been developed with the aid of an inter-agency planning team composed of representatives from state, federal, and local agencies with jurisdiction over the refuge. The planning team has participated in the plan's development from its initiation. Planning team members who participated in development of the plan are as follows: Tim Rumfelt, Alaska Department of Environmental Conservation; Janetta Pritchard and Leigh Carlson, Alaska Department of Natural Resources; Jennifer Wilson, Alaska Department of Transportation and Public Facilities; Dave Harkness, ADF&G Wildlife Conservation Division; Phil Brna, ADF&G Habitat Division; Craig Whitmore, ADF&G Sport Fish Division; Bill Hauser, ADF&G Fisheries Rehabilitation, Enhancement, and Development Division; Pat Tilton and Dave Gardner, Parks and Outdoor Recreation Division, Municipality of Anchorage; Tom Bacon, Department of Public Works, Municipality of Anchorage; Gary Wheeler, U.S. Fish and Wildlife Service; and Phil North, Environmental Protection Agency.

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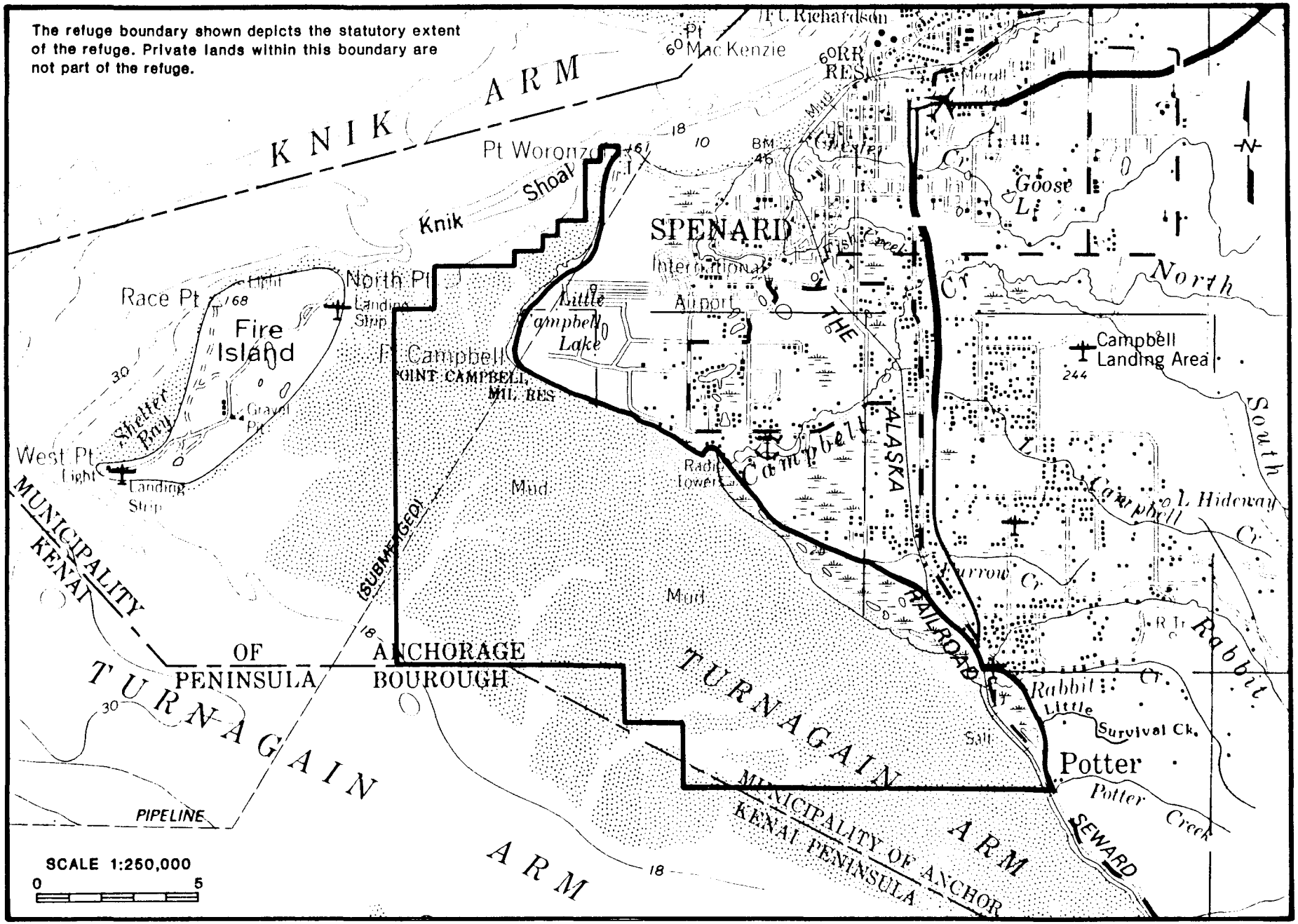
Front Cover Photo Credit: Dan Rosenberg

TABLE OF CONTENTS



ANCHORAGE COASTAL WILDLIFE REFUGE

INTRODUCTION

Anchorage Coastal Wildlife Refuge, extending along Turnagain Arm from Potter Creek northwest to Point Woronzof, was established by the Alaska Legislature in 1988 to protect waterfowl, shorebirds, salmon, and other fish and wildlife species and their habitat, and for the use and enjoyment of the people of the state.

The purpose of the Anchorage Coastal Wildlife Refuge Management Plan is to provide consistent long-range guidance to the Alaska Departments of Fish and Game and Natural Resources, and other agencies involved in managing the refuge.

The Anchorage Coastal Wildlife Refuge encompasses approximately 32,476 acres and is best known for that portion located between the Old and New Seward highways called Potter Marsh. Thousands of people stop to view wildlife at Potter Marsh each year. It is easily Anchorage's most popular wildlife haven. The refuge is also enjoyed by residents for seasonal activities such as waterfowl hunting, cross country skiing, and ice skating. In addition, development around the perimeter has continued to occur as the City of Anchorage has grown. In order to evaluate the compatibility of both recreational uses and perimeter development with the protection of fish and wildlife, their habitats, and public use of the refuge, the Alaska Department of Fish and Game has undertaken this comprehensive refuge management planning process.

The plan presents management goals for the refuge and its resources and identifies policies to be used in determining whether proposed activities within the refuge are compatible with the protection of fish and wildlife, their habitats, and public use of the refuge. The plan will be formally reviewed and, if appropriate, updated every ten years. Public participation will be solicited during the update process. The plan affects state lands only, not private or municipal lands. The plan does not address hunting or fishing regulations which are the authority of the Boards of Fish and Game.

This document is the result of a public planning process led by the Alaska Department of Fish and Game. The plan has been developed by the planning team representing state, federal, and municipal agencies including: the Alaska Departments of Environmental Conservation, Fish and Game, Natural Resources, and Transportation and Public Facilities; the United States Fish and Wildlife Service; the Environmental Protection Agency; and the Municipality of Anchorage.

At the outset of the public planning process, a public meeting was held in Anchorage to explain the planning process and solicit citizen's issues, interests, and concerns for the refuge. The meeting results were used by the planning team to identify a list of issues to be addressed in the plan. At the same time, resource information on refuge fish and wildlife populations and their habitats, other natural resources, existing land use, and land ownership was being collected and synthesized. This information, presented in both map and narrative form, comprises the plan's Resource Inventory.

Management goals and policies for the refuge were developed by the planning team to address the identified issues. All policies were developed with consideration of their ability to meet the management goals.

The draft plan went out for public review. Based on comments received during the public review, final policies were developed. The goals and policies were then adopted by the Commissioner.

The plan is implemented by the Alaska Department of Fish and Game in several ways. A Special Areas Permit is required for any habitat altering activity, including any construction work, in a designated State Game Refuge (5 AAC 95). A Special Areas Permit application form can be obtained from any Alaska Department of Fish and Game office and should be submitted to the Habitat Division Regional Office in Anchorage. The Habitat Division will review all proposed activities for consistency with the goals and policies outlined in this plan. Activities will be approved, conditioned, or denied based on the direction provided in this plan as well as state laws and regulations.

Future refuge management activities of the Alaska Department of Fish and Game will also be directed by this plan. Research programs, public use facilities, and other department projects will be consistent with the goals and policies presented in this plan.

Other state, federal, and local agencies have management responsibilities on refuge lands as well. Any use, lease, or disposal of resources on state land in the refuge requires Alaska Department of Natural Resources authorization. The Mental Health Trust Commission oversees actions on Mental Health Trust lands. Activities affecting air or water quality require authorization from the Alaska Department of Environmental Conservation. The United States Army Corps of Engineers (COE) evaluates applications of the United States Department of the Army permits for discharging dredged and fill material in waters of the United States including wetlands. Federal and state agencies, including the United States Fish and Wildlife Service and National Marine Fisheries Service, along with local governments, review proposals for COE permits, pursuant to the Fish and Wildlife Coordination Act (16 USC 661-666 et.seq.). United States Coast Guard approval is required for certain kinds of work in navigable waters. The Municipality of Anchorage reviews and comments on all permit proposals within the coastal zone, including the Anchorage Coastal Wildlife Refuge, for consistency with the Anchorage Coastal Management Plan.

STATUTES

Alaska statutes which pertain specifically to the establishment and management of the Anchorage Coastal Wildlife Refuge are as follows:

AS 16.20.031(a) The following described state-owned land and water is established as the Anchorage Coastal Wildlife Refuge and shall be managed as a state game refuge for the protection of waterfowl, shorebirds, salmon, and other fish and wildlife species and their habitat, and for the use and enjoyment of the people of the state:

(1) Township 13 North, Range 4 West, Seward Meridian
Section 20: SE¼ seaward of the 20-foot elevation contour
SE¼NE¼ seaward of the 20-foot elevation contour
Section 29: E½ seaward of the 20-foot elevation contour
SW¼ seaward of the 20-foot elevation contour
Section 30: SE¼SE¼
Section 31: All seaward of the 20-foot elevation contour except NW¼NW¼
Section 32: All seaward of the 20-foot elevation contour

(2) Township 13 North, Range 5 West, Seward Meridian
Section 36: S½, S½N½

(3) Township 12 North, Range 4 West, Seward Meridian
Sections 6-9: Seaward of the 20-foot elevation contour
Section 15: NW¼ seaward of the 20-foot elevation contour
SW¼NE¼ seaward of the 20-foot elevation contour
Government Lot 5 and the remainder of the W½SE¼, all SW¼
Section 16: Seaward of the 20-foot elevation contour
Sections 17-22
Section 23: Government Lot 1 and the remainder of the SW¼, all seaward of the 20-foot elevation contour
Government Lot 2 and the remainder of the S½NW¼, all seaward of the 20-foot elevation contour
Government Lots 3 and 4, and the remainder of the SE¼, all seaward of the 20-foot elevation contour
Section 24: Tract A, Shorecrest Subdivision (Plat No. 81-68, Anchorage Recording District)
Section 25: Government Lots 1 and 2, and the remainder of the W½, all
Tract A, Johns Park Estates, and the remainder of the NE¼, excluding Skyway Park Estates, Addition No. 1 all seaward of the 20-foot elevation contour Government Lots 3 and 4, and the remainder of the SE¼, all
Sections 26-36

(4) Township 12 North, Range 5 West, Seward Meridian
Sections 1-2
Sections 11-14
Sections 23-26
Sections 35-36

(5) Township 12 North, Range 3 West, Seward Meridian
Section 29: That portion of the SW¼ southwesterly of the Alaska Railroad right-of-way and southerly of Oceanview Subdivision, Addition No. 6
Section 30: That portion of Tract A, Johns Park Estates, seaward of the 20-foot elevation contour
Government Lot 2 and that portion of the SE¼NW¼ southwesterly of Oceanview West Subdivision, Addition No. 1
Government Lots 3 and 4 and the remainder of SW¼, all
That portion of the SW¼NE¼ and the SE¼ southwesterly of Oceanview Subdivision, Addition No. 4 and Addition No. 6
Section 31
Section 32: All land southwesterly of the Alaska Railroad right-of-way
Section 33: All land westerly of the Alaska Railroad right-of-way

(6) Township 11 North, Range 3 West, Seward Meridian
Section 3: Government Lot 5
Section 4: That portion southwesterly of the Old Seward Highway right-of-way and The Landings Subdivision which is northeasterly of the New Seward Highway right-of-way
That portion southwesterly of the Alaska Railroad right-of-way
Sections 5-8
Section 9: That portion southwesterly of the Alaska Railroad right-of-way
That portion northeasterly of the New Seward Highway right-of-way
Section 10: That portion westerly of the Old Seward Highway right-of-way which is northeasterly of the New Seward Highway right-of-way
That portion southwesterly of the Alaska Railroad right-of-way

(7) Township 11 North, Range 4 West, Seward Meridian
Sections 1-4
Sections 10-12

(b) Except as provided in (d) of this section, the Department of Fish and Game and the Department of Natural Resources shall exercise their respective authorities over the Anchorage Coastal Wildlife Refuge consistent with a management plan prepared by the Department of Fish and Game in consultation with the Department of Natural Resources.

(c) A public right-of-way for surface transportation and a utility corridor are created across state-owned land and water within the Anchorage Coastal Wildlife Refuge between the Anchorage mainland and Fire Island. The management plan prepared under (b) of this section shall identify the actual location on the land and water of the right-of-way and of the utility corridor between the Anchorage mainland and Fire Island.

(d) Land owned by the Municipality of Anchorage that lies within the boundary of the Anchorage Coastal Wildlife Refuge described in (a) of this section may be included in the Anchorage Coastal Wildlife Refuge. An agreement between the Department of Fish and Game and the Municipality of Anchorage for the management of the land within the Anchorage Coastal Wildlife Refuge that is owned by the Municipality of Anchorage shall be approved by the Municipality of Anchorage and by the Department of Fish and Game.

(e) The state or the Municipality of Anchorage may not acquire privately owned land within the Anchorage Coastal Wildlife Refuge described in (a) of this section by eminent domain for inclusion within the Anchorage Coastal Wildlife Refuge. The Department of Fish and Game or the Municipality of Anchorage may acquire privately owned land within the Anchorage Coastal Wildlife Refuge by purchase, exchange, or otherwise, except by eminent domain.

(f) The land and water areas of the Anchorage Coastal Wildlife Refuge are closed to mineral entry under AS 38.05.185 - 38.05.275.

GOALS

Activities which occur within the Anchorage Coastal Wildlife Refuge will reflect the following goals in accordance with the purpose for which the refuge was established (AS 16.20.031(a)). All management decisions in the Anchorage Coastal Wildlife Refuge, whether affecting activities undertaken by the department, other agencies, or the public, will be in accordance with these goals.

I. Fish and Wildlife Populations and Their Habitat

Manage the refuge to maintain and enhance fish and wildlife populations and their habitat.

A. Minimize harmful disturbance to fish and wildlife.

B. Maintain, protect, and where appropriate, enhance the quality and quantity of habitat for resident and migrant wildlife, particularly nesting, rearing, and staging habitat for waterfowl and shorebirds.

C. Protect, and where appropriate, enhance water quality, water quantity, and circulation patterns to maintain growth and propagation of wildlife.

D. Protect, and where appropriate, enhance refuge water quality, quantity, and circulation patterns sufficient for the growth and propagation of fish, shellfish, and other aquatic life in fresh, estuarine, and marine waters.

E. Minimize the degradation and loss of habitat values due to habitat fragmentation.

F. Recognize cumulative impacts when considering effects of small incremental developments and actions affecting refuge resources.

II. Public Use

Allow public use of the refuge where consistent with protection of fish and wildlife populations and their habitat.

A. Maintain and where appropriate enhance legal public access to, through, and within the refuge for refuge use activities consistent with the goals of this management plan.

B. Maintain and where appropriate enhance opportunities for education and study of fish, wildlife and vegetation.

C. Maintain and where appropriate enhance opportunities for viewing, photography, hunting as allowed by the Board of Game, and other forms of recreation consistent with the goals of this management plan.

D. Provide information about the refuge to the public.

POLICIES

The policies provided in this plan will be used to guide decisions on management activities and Special Area Permits in the refuge.

Fish and Wildlife Viewing

A. Maintain, and where appropriate, improve opportunities for fish and/or wildlife viewing.

B. Design and site wildlife viewing facilities to maximize viewing opportunities and minimize harmful disturbance.

C. Develop and implement an effective public information program about fish and wildlife viewing rules and regulations.

Waterfowl Hunting

Manage waterfowl hunting as allowed by the Board of Game to minimize trespass, illegal hunting, and impacts to adjacent property owners and wildlife populations.

Public Access

Where appropriate develop and maintain new and existing public access points, including handicap access, to encourage continuing public use of the wildlife refuge.

Coastal Trail

Coastal Trail access may be allowed within the refuge where disturbance to fish and wildlife populations and their habitat is avoided; where safety considerations and conflicts to existing refuge uses including waterfowl hunting and rifle range use allow; and where compatible with management of refuge public access points and the goals of this management plan.

Information/Education

Inform the public about resource values, rules, and recreational opportunities on the refuge.

Off-road Use of Motorized Vehicles

To ensure the protection of sensitive habitats and avoid harmful disturbance to fish and wildlife, the department will not issue general permits for the off-road use of wheeled, tracked, or other ground-effect motorized vehicles, including aircraft, within the refuge. The department will, in its discretion, issue an individual Special Area Permit under 5 AAC 95 for the off-road use of a wheeled, tracked, or

other ground-effect motorized vehicle if the use is consistent with the goals and policies of this management plan and fulfills a demonstrable need for which there is no feasible alternative. An individual Special Area Permit will not be issued for recreational off-road use of motorized vehicles within the refuge.

Habitat Enhancement

As appropriate, allow wildlife or fish habitat enhancement projects that further refuge management goals, particularly for anadromous fish and waterbird habitat.

Motorized Toys, Bicycles, and Tricycles

To ensure the protection of sensitive habitats and avoid harmful disturbance to fish and wildlife, motorized toys, including remote control model airplanes and boats, are not allowed to be operated within the refuge between April 1 and November 15. Bicycles and tricycles are not allowed on the Potter Marsh boardwalk.

Rifle Range

Manage the refuge to maintain use of the Rabbit Creek Rifle Range. Manage the Rabbit Creek Rifle Range compatible with the goals of the management plan.

Dogs and Bird Dog Training

A. Dogs are not allowed in Potter Marsh from April 1 through November 15 or on the Potter Marsh Boardwalk except that a seeing eye or other guide dog may assist a handicapped person on the boardwalk.

B. Organized bird dog training events may be allowed by special area permit only when compatible with the goals of this management plan.

Land Acquisition

Purchase or trade to acquire private lands or conservation easements within the refuge from willing sellers as time and funding permit. Donation of lands for addition to the refuge will also be considered.

Refuge Management Adjacent to Existing Road Rights-of-Way

Work with Alaska Department of Transportation and Public Facilities (ADOT&PF) to achieve the greatest compatibility between the necessary transportation function of the roadways within the right-of-way corridors and the public use of the refuge abutting the corridors. To the maximum extent feasible, avoid or minimize impacts to the refuge from highway operation. Coordinate with ADOT&PF and the Municipality of Anchorage to

maintain existing public access and identify and develop additional wildlife viewing and access areas within or adjoining the right-of-way corridors, consistent with public safety.

Refuge Management Adjacent to Existing Railroad Right-of-Way

Work with the Alaska Railroad Corporation to develop safe and appropriate public access to the refuge lands across the railroad right-of-way.

Utilities

A new utility will only be allowed to cross the refuge where there is no feasible off-refuge alternative. Utilities will be sited, designed, constructed and maintained to avoid impacts to refuge values to the maximum extent feasible. All unavoidable impacts will be fully mitigated. Existing corridors will be used wherever appropriate. A utility or pipeline will be buried. Any easement issued within the refuge will be non-exclusive use only. Drainage of municipal storm drainage systems into Potter Marsh will be avoided to the maximum extent feasible. When storm drainage into Potter Marsh cannot be avoided, that storm water will be treated.

Water Quality

Water quality in the refuge shall meet or exceed state water quality standards for the growth and propagation of fish, shellfish and other aquatic life as per 18 AAC 70. Cumulative effects of waste discharge shall be considered when determining appropriate activities within the refuge and must meet the above specified standards.

Fire Island Transportation Corridor

The primary and alternate Fire Island Transportation Corridor for road, railroad, and utilities are established as shown on the attached map. Improvements for the transportation corridor will be sited to minimize disturbance of fish and wildlife and use of refuge lands to the maximum extent possible. Particular emphasis will be to minimize disturbance of nearshore high quality wetland areas that provide critical waterfowl habitat. Adverse impacts to refuge fish and wildlife habitat, fish and wildlife populations, and public use will be fully mitigated. The corridor will be constructed to maintain passage of marine mammals and migratory fish. Public access to the refuge will be maintained. Additional refuge lands may be considered for the transportation corridor only if there is a significant public need and that public need cannot feasibly be met within the primary or alternate corridor or outside of the refuge.

Oil and Gas Exploration and Development

Oil and gas leasing may be allowed under terms and conditions compatible with the goals and policies or this management plan provided there is no

surface entry for exploration of development within the refuge.

Grazing

With the exception of incidental grazing of animals while being ridden across the refuge, the grazing of domestic or feral animals within the refuge is prohibited.

Material Extraction

Do not allow material extraction (sand and gravel removal) within the refuge unless for purposes of maintenance or enhancement of the refuge and refuge values. All material extraction activities must be consistent with refuge statutes and the goals and policies of this management plan. This policy is not intended to preclude activities authorized under the Utilities or Fire Island Transportation Corridor policies.

Structures

Allow new permanent structures within the refuge only for the purpose of habitat maintenance and enhancement, public use and enjoyment of the refuge, or essential navigational and avigational aids. Allow new temporary structures only when there is a demonstrable public need for which there is no feasible off-refuge alternative. Duck blinds are allowed provided they are constructed of natural materials and are removed at the end of the hunting season. All structures must be consistent with refuge statutes and regulations and the goals and policies of this management plan.

Land Leases and Permits

Do not allow a new land lease or lease renewal within the refuge unless for purposes which will further refuge management goals except that a public utility lease or permit may be issued or renewed if in the public interest.

Tree Cutting

Tree cutting is not allowed except for purposes of refuge management or authorized construction and maintenance of public utilities or the Fire Island Transportation Corridor.

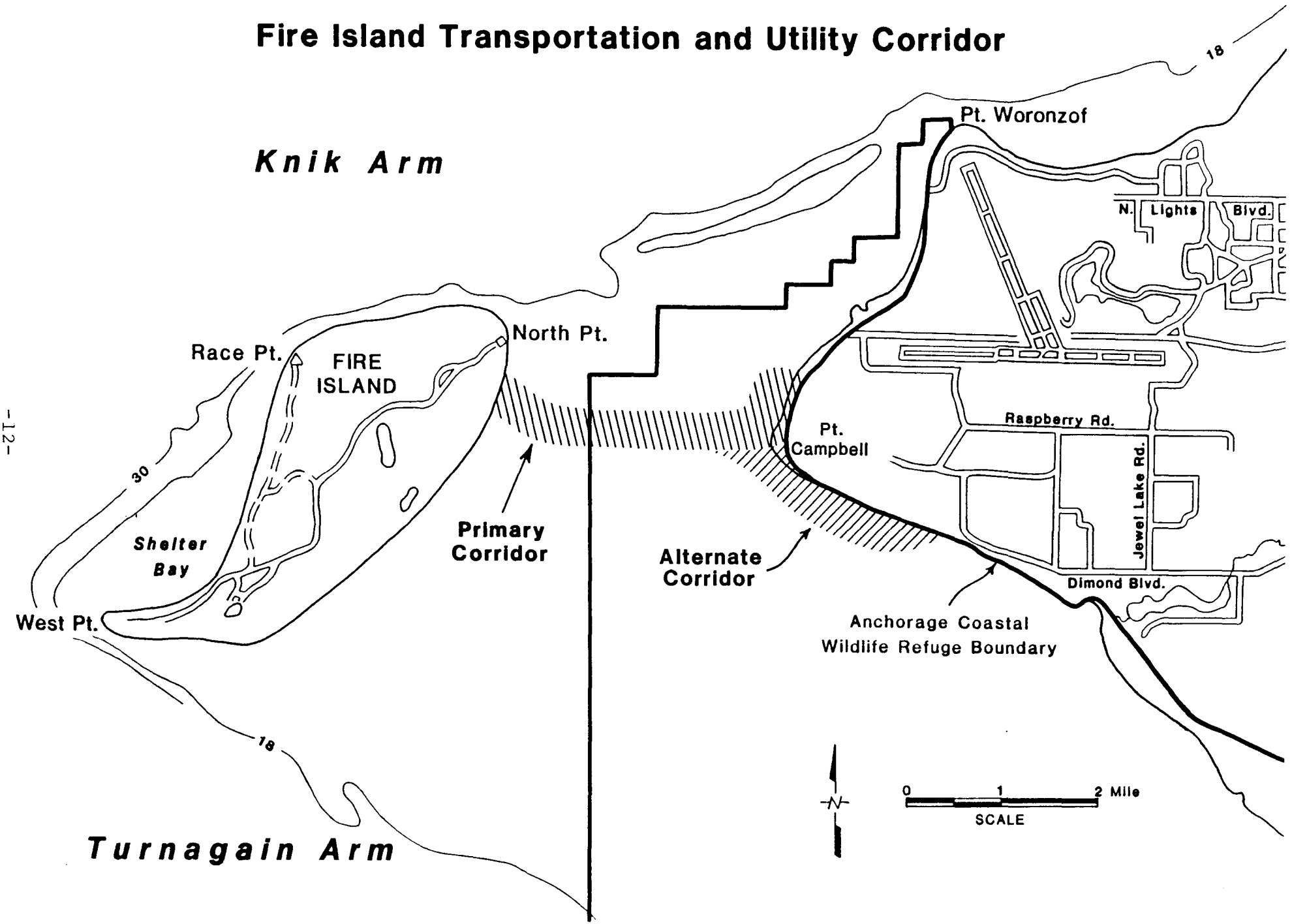
Overnight Camping

Overnight camping is not allowed on the refuge.

Other Uses

To protect refuge habitat and fish wildlife populations, the department may allow by permit only those activities compatible with the purposes for which the refuge was established, terms and standards of 5 AAC 95, and the goals and policies of this plan. Any activity which is not compatible with the purposes for which the refuge was established, terms and standards of 5 AAC 95, and the goals and policies of this plan will not be allowed.

Fire Island Transportation and Utility Corridor



EXPLANATION OF TERMS

Following is an explanation of terms used in the goals and policies of this management plan.

Feasible: capable of being done using sound engineering practices.

Harmful Disturbance: activities which displace animals from their natural habitat or interrupt their seasonal activities at a frequency or duration which causes significant impact to refuge fish and/or wildlife populations. Harmful disturbance does not refer to the legal harvest of fish and/or wildlife.

Minimize: to reduce harmful effects to a level which does not have a significant adverse effect on fish and wildlife populations or their habitat in the refuge or significantly reduce public opportunity for successful harvest and/or non-consumptive use of fish and wildlife.

Motorized Vehicle: a motor-driven land, water, or air conveyance, not including a wheelchair.

Where Appropriate: includes but is not limited to consideration of legal constraints, safety, funding, feasibility, and disturbance to fish and wildlife and their habitat.

IMPLEMENTATION

The Anchorage Coastal Wildlife Refuge Management Plan will be implemented by the Alaska Department of Fish and Game through its day to day on-the-ground management activities, through its annual budgeting process, and through Special Area Permits issued for land use activities within the refuge.

Special Area Permits. A Special Area Permit is required for any habitat altering activity, including construction work, in the Anchorage Coastal Wildlife Refuge. A Special Area Permit application form can be obtained from any Alaska Department of Fish and Game office and should be submitted to the Habitat Division's regional office in Anchorage (5 AAC 95).

Fish and Wildlife Protection. State fish and wildlife protection officers and deputized department biologists patrol the Anchorage Coastal Wildlife Refuge and provide on-the-ground enforcement of harvest regulations, refuge regulations, and permit requirements.

Operational Management Plan. Subsequent to the adoption of this plan, the Alaska Department of Fish and Game will proceed to develop an operational management plan for the refuge. This operational management plan will detail implementation of the policies adopted in this plan and will provide details on the projects, their schedules, staffing requirements, and budgets necessary for management of the refuge. Participation by local, state, and federal agency representatives as well as interested citizens in the development of the plan will be solicited.

Habitat Enhancement Projects. Refuge habitat enhancement projects will be developed in accordance with the goals and policies of this management plan through a public decision making process.

Information/Education. Work with public and private groups and adjacent landowners to develop an information/education program for the refuge which will inform the public about refuge values, rules, and recreational opportunities through signs, bulletin boards, brochures, mailouts, news releases, community presentations, litter cleanup, interpretive signs, and other appropriate means.

Public Access. To encourage public use of the refuge, as appropriate develop the following public access points:

1) South end of Potter Marsh (old weigh station)

2) Mid-marsh paved pull-out

3) North end of Potter Marsh parking area and boardwalk

4) Rabbit Creek rifle range

5) Reef Drive (Oceanview Bluff Park)

6) John's Park (Furrow Creek)

7) Spyglass Circle off of Klatt Road

8) Coastal Trail from Point Campbell to Point Woronzof

9) Point Woronzof

Acquire and develop additional public access where necessary and appropriate. The Department of Fish and Game will work with the Municipality of Anchorage to determine if new public access can be provided in the course of new platting activities adjacent to the refuge.

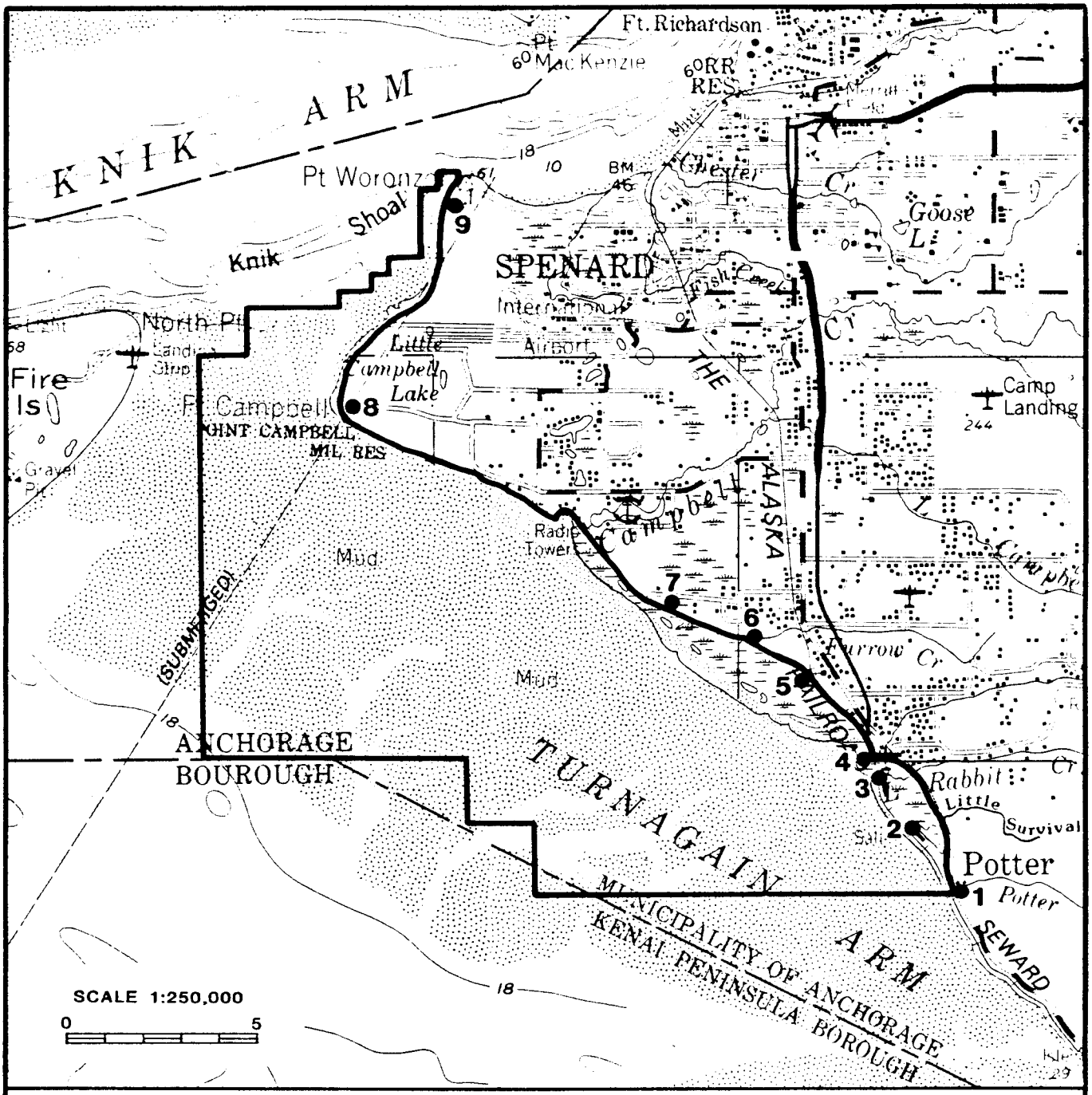
Municipal Lands. Municipal lands within the Anchorage Coastal Wildlife Refuge will be managed as part of the refuge under a cooperative agreement between the Department of Fish and Game and the Municipality of Anchorage. This cooperative agreement will include procedures for notification of new activities. The Department will work with the Municipality to resolve municipal selections at the back of Potter Marsh.

Waterfowl Hunting. To assist the Board of Game in reviewing waterfowl hunting regulations, identify appropriate areas where waterfowl hunting can occur with minimal impacts to public safety, adjacent property owners, and wildlife populations. To minimize trespass, illegal hunting, and impacts to adjacent property owners, develop and implement an effective public information program about waterfowl hunting rules and regulations. Enforce waterfowl hunting regulations.

Citizen's Advisory Committee. Subsequent to the implementation of this plan, the department will establish a citizen's advisory committee to advise the department on issues relating to the protection and management of the refuge. Participation by interested local, state, and federal agency representatives will also be solicited.

Other Agencies' Actions. In is anticipated that this document will also be used by other state, federal, and local decision makers in planning for and making decisions under their respective statutory authorities regarding lands within the Anchorage Coastal Wildlife Refuge.

Refer to the Appendix for resource information pertinent to the implementation of these tasks.



ANCHORAGE COASTAL WILDLIFE REFUGE - MAJOR PUBLIC ACCESS POINTS

1. South end of Potter Marsh (Old weigh station)
2. Mid marsh paved pull-out
3. North end of Potter Marsh parking area and boardwalk
4. Rabbit Creek rifle range
5. Reef Drive (Oceanview Bluff Park)
6. John's Park (Furrow Creek)
7. Spyglass Circle off of Klatt Road
8. Coastal Trail from Point Campbell to Point Woronzof
9. Point Woronzof

Additional public access to the refuge can be found where public lands abut the refuge. It is illegal to cross or walk along the Alaska Railroad right-of-way except at the railroad crossing at the Rabbit Creek Rifle Range. The Anchorage Waste Water Utility facility road from Campbell Lake to the refuge is a private road, with no public access allowed.

The refuge boundary shown depicts the statutory extent of the refuge. Private lands within this boundary are not part of the refuge.

APPENDIX

ANCHORAGE COASTAL WILDLIFE REFUGE
RESOURCE INVENTORY

RESOURCE INVENTORY TABLE OF CONTENTS

LIST OF TABLES

ANCHORAGE COASTAL WILDLIFE REFUGE
RESOURCE INVENTORY

INTRODUCTION

The Anchorage Coastal Wildlife Refuge was created in 1988 by the Alaska Legislature. The bulk of the refuge was previously known as the Potter Point State Game Refuge, which was created by the Alaska Legislature in 1971.

The enabling statute requires that state-owned land and water in the Anchorage Coastal Wildlife Refuge "shall be managed as a state game refuge for the protection of waterfowl, shorebirds, salmon, and other fish and wildlife species, and their habitat and for the use and enjoyment of the people of the state."

AREA DESCRIPTION

The Anchorage Coastal Wildlife Refuge extends approximately 16 miles along the coast of Knik and Turnagain arms of Cook Inlet from Point Woronzof to Potter Creek. The inland boundary is the 20-foot elevation contour (essentially the toe of the coastal bluff) throughout most of the refuge; however, in some areas, notably near the Rabbit Creek Rifle Range and Potter Marsh, the boundary is delineated in terms of subdivision boundaries and the railroad and highway rights-of-way. The offshore boundary follows protracted section lines which encompass the seaward extent of the tide flats. The tide flats extend a considerable distance offshore throughout most of the refuge. The refuge includes approximately 32,500 acres, the bulk of which consists of unvegetated silt which is deposited and shifted by tidal action.

Only state land and water encompassed by the boundary are included in the refuge. Privately owned lands within the refuge boundaries are not managed as refuge lands. Neither are the rights-of-way of the Alaska Railroad and the old and new Seward highways, managed by the Alaska Railroad Corporation and Alaska Department of Transportation and Public Facilities, respectively. The railroad right-of-way is 200 feet wide; the old and new Seward highway rights-of-way are 300 and 235 feet wide, respectively. Municipal lands in the refuge may be managed as refuge lands in accordance with the enabling legislation. The refuge includes most of the coastal marshes and intertidal mudflats in and adjacent to the Anchorage urban area.

Coastal marshes are productive and valuable habitats that have been drained, filled, and otherwise extensively altered in other states. They are not common in Cook Inlet, due to the mountainous terrain, coastal bluffs, ice scour, and glacial silt-laden waters. Many of the inlet's most ecologically valuable saltwater marshes have been designated by the Alaska Legislature as state game refuges or critical habitat areas. Potter Marsh, the wetland area bounded by the old and new Seward highways, is relatively unique. It is one of Cook Inlet's largest coastal, freshwater marshes.

HISTORY

Place Names

The early history of the refuge offers some clues on the uses of the area by previous inhabitants and provides some insights into its ultimate designation as a wildlife refuge. The early history of the Anchorage area, prior to its selection as the headquarters for construction of the railroad in 1915, is not extensively documented. To some extent, however, its history can be traced in the names of prominent features.

Upper Cook Inlet was inhabited by the Dena'ina, members of the Athabaskan family. The Dena'ina may have arrived in the region not long before the first Europeans (de Laguna 1975). The original place names of upper Cook Inlet and their derivations, where known, were compiled by Kari and Fall (1987). The regional band which lived in the Anchorage area was the K'enaht'ana. The name Knik may be derived from their name (K'enaka) for the region around Knik Arm, but the meaning of this term has apparently been lost. The Dena'ina called Turnagain Arm Tutl'uh, meaning "back water" or "headwaters," indicating that they considered it the head of Cook Inlet. The Dena'ina had a great deal of respect for the bore tide, their name for it (nudidghul) being onomatopoetic of the roar of the water. Shem Pete, recounting the early history of the region, stated "That tide killed a lot of people" (Kari and Fall 1987).

Point Woronzof was called Nuch'ishtunt, meaning "Place Protected from Wind." Point Campbell was called Ul/chena (Bada) Huch'ilyut, "Where We Pulled up the Alutiiqs' [boat]." The Alutiiqs, or Chugach Eskimos, had dragged a large umiak through Portage Pass, from Prince William Sound into Turnagain Arm. After raiding a Dena'ina village on upper Knik Arm (probably Old Knik) for women, the Alutiiqs were attacked by the K'enaht'ana from Point Campbell on their return voyage. Campbell Creek was called Qin Cheghitnu, meaning "Crying Ridge Creek." "Crying Ridge" is now called Tanaina Peak. The Dena'ina name implies a place of mourning, although a similar name was used for the sloping ridge south of Mt. Susitna. In the latter instance, Shem Pete observed that the ridge provided a panoramic view, overlooking their homeland, from which the Dena'ina would also conjure up memories of family members. The emotional experience would result in weeping, but perhaps as much in appreciation of the land and its resources as in mourning. Rabbit Creek was named Ggeh Betnu, meaning "Rabbit Creek," one of the few instances where, intentionally or not, the meaning of a native place name was preserved by subsequent inhabitants. The name Rabbit Creek was first recorded in 1906. Potter Marsh was called Hkaditali, meaning "Drift Lumber," because its beach was a good place to collect flotsam and jetsam. Prior to their first contact with Euro-Americans, the Dena'ina found metal which had drifted ashore on planks. Potter Creek was called Hkaditali Betnu, or "Drift Lumber Creek."

There are no known cultural sites in the refuge. Nearby Ship Creek was an important seasonal destination for K'enaht'ana whose villages were further up Knik Arm, because of its early spring run of sticklebacks and abundant

high quality king salmon that were not found in Upper Knik Arm streams (Fall 1987). The refuge was not used by many K'enaht'ana. One or more families used a summer fish camp on the bluff south of the Municipality's waste treatment facility near Point Woronzof. This was probably the same camp identified by de Laguna (1975) as Nuti'ctunt. Nuti, meaning "salt water," was the K'enaht'ana name for Knik Arm and Cook Inlet (Kari and Fall 1987). Each year the people would build a tanik'edi, a fishing platform extending out onto the mud flats. From this rather flimsy structure the people could dipnet king salmon continuously from low to high water. Just like the current residents of Anchorage, when the salmon were running the Dena'ina believed "A person that don't sleep good [in other words, stays awake round the clock] will get most fish those days" (Alexan 1965, cited in Kari and Fall 1987). After the early salmon run, the K'enaht'ana moved back north.

There is little evidence that Russians occupied or explored the upper Cook Inlet region (Kari and Fall 1987). The first Euro- Americans to contact the K'enaht'ana were probably British. Captain Cook visited the region in 1778, looking for the Northwest Passage. The present-day Cook Inlet and Turnagain Arm were mapped and named during this expedition as Cook's River and River Turnagain. The choice of Turnagain reflected Cook's conclusion that it was another dead end, offering no passage from the Pacific to the Atlantic Ocean. In 1794 Captain Vancouver changed the name to Turnagain Arm (Orth 1971). Point Woronzof was named by Lt. Joseph Whidbey, a member of Vancouver's expedition, after the Russian ambassador to the English court (Orth 1971). Point Campbell was also named by Lt. Whidbey, probably for Sir Joseph Campbell, governor of Jamaica when Captain Vancouver was in the West Indies a decade earlier. Campbell Creek was named after its proximity to Point Campbell. It was a local name first recorded in 1906 by the U. S. Geological Survey. Furrow Creek was also a local name, recorded in 1942 by the Army Map Service. The name was probably used in recognition of "Wildcat" Jack Furrow, a trapper whose trapline included the creek (Johns 1989).

Potter Creek was a local name recorded in 1912 by the U. S. Coast and Geodetic Survey (Orth 1971), after a trapper who lived there around the turn of the century (Carberry and Lane 1986). A trail, known as the Potter Creek Trail or Potter Trail, which connected with the Johnson Trail at Potter Creek, crossed the Anchorage Bowl in a north-northeasterly direction (Carberry and Lane 1986). Names of other nearby features were derived from the name of the creek. Potter, a tiny settlement on the Alaska Railroad near the mouth of Potter Creek, was a local name recorded in the 1919 Railway Guide Index. Potter Hill, located along the bluff north of the Rabbit Creek Rifle Range, was adopted as the local name for the neighborhood on the hill. The name of this suburban area was recorded in 1964 by the U. S. Geological Survey. Potter Marsh was probably also named after the creek, but a record of when it was first used has not been found.

Early settlers mostly left their mark on the bluffs above the refuge where they homesteaded. Lorenzo Kincaid filed an application to homestead land near Point Campbell in 1941 and received a patent in 1949 (Nelson 1988). The Kincaid homestead became the core of Kincaid Park, which occupies most

of the bluffs overlooking Point Campbell. Robert Johns homesteaded land along Furrow Creek in 1947. In 1973 he and his wife Milly sold 60 acres to the Municipality for $60,000, considerably less than the $8,000/acre offered by a local developer. The Johns' wanted to ensure that the land would be preserved as a wildlife sanctuary, and the area is now Johns Park (Anonymous 1985).

Alaska Railroad

The Alaska Railroad has had a substantial role in the creation, human use, and, ultimately, preservation of the refuge. Potter Marsh was formed in 1916-17 when construction of the Alaska Railroad embankment limited tidal ingress to a bridge over Rabbit Creek. Between September-November 1916 a steam shovel was used to construct the cut and fill embankment along Potter Hill. An Alaska Railroad report of November 14, 1916, documented grading was completed from Anchorage to a point 10.5 miles south (Alaskan Engineering Commission 1916). The fill was "built narrow so as to discontinue steam shovel work for this season as soon as possible." Workers using wheelbarrows had already constructed a narrow embankment stretching two miles from Potter Creek to Rabbit Creek. A contemporary photograph illustrates this pick-and-shovel excavation (Prince 1964): workers are standing in the sedge meadows digging fill material and running it up to the embankment on planks. The embankment appears to be 6-10 feet wide on top. By November 14th, bridges across Rabbit and Potter creeks were finished. The report predicted the steam shovel and wheelbarrow fills would be connected in three weeks and tracks laid in four. However, a map dated December 31, 1916, indicated grading was still underway across the tideflats north of Potter Creek and track had not yet been laid (Prince 1964). Presumably, the embankments were connected shortly thereafter. After the tracks were laid, the embankment was reinforced with material transported by dump cars (Wilson 1977).

Although the Rabbit Creek bridge allowed the creek to flow through the embankment, freshwater from other sources was impounded, and a freshwater marsh was formed. The holes along the inside of the embankment that supplied fill material, now visible mostly between the railroad and New Seward Highway embankments, added diversity to the marsh, becoming some of the deeper ponds. These ponds can be seen on aerial photographs, although many were filled in by the bed of the new Seward Highway (MOA 1987:figure following page 5.4). Potter Marsh includes only the wetlands bounded by the old Seward Highway and the railroad embankment. The permanent ponds and marsh vegetation of Potter Marsh began to attract more migrating waterfowl and shorebirds in spring and fall and nesting wetland birds through the summer. The construction of the embankment no doubt destroyed existing tidal habitat; but, by impounding freshwater and enhancing habitat diversity, it became perhaps the earliest, albeit unintentional, example of wetlands mitigation in the Anchorage area. With Anchorage still lying far to the north, the area soon became a popular local destination for waterfowl hunters and trappers.

At the same time as the embankment was being built across the tideflats, the Alaska Railroad was building a large camp at Potter Creek (Prince

1964). The camp fielded a baseball team, complete with uniforms, that played Anchorage railroad workers. Excursion trains brought numerous fans from Anchorage, over 400 in one instance, to the official playing field, which is now the Rabbit Creek Rifle Range (Koman 1989). By December 1917 this camp had been moved to Falls Creek. The Potter Section House, built in 1929 to house a section foreman and crew who maintained the track, was not one of the original buildings (Carberry and Lane 1986). The Potter Section House is located on the railroad right-of-way; hence, it is not included in the refuge.

Potter Point State Game Refuge

In 1971 the Alaska Legislature established the Potter Point State Game Refuge, including Potter Marsh and the mudflats and wetlands adjacent to the toe of the bluff which extends from Point Campbell to Potter Creek. Management of the refuge was vested in the Department of Fish and Game.

From the beginning, the department recognized the ability of the refuge to satisfy a variety of user groups. The most popular waterfowl viewing area, Potter Marsh, was closed to hunting in 1972. The rest of the refuge was left open to waterfowl hunting. Trapping was prohibited in the refuge in 1982.

Management of the refuge was complicated by the extensive private inholdings. When it was established, 734 acres of private land were dispersed among 26 parcels owned by 18 individuals or companies, with one individual owning over 250 acres. In 1980 the Legislature appropriated $750,000 to purchase private land within the refuge. Approximately, 366 acres were purchased from 1981-1983 using this original appropriation (Table 1).

Creating the Potter Point State Game Refuge was the first step towards protecting the unique values of the area. But the law that authorized the refuge defined its inland boundary loosely as the toe of the bluff, leaving the area vulnerable to encroachment, and a seaward boundary was not specified.

Rifle Range

In 1954 the newly organized Alaska Range Association (ARA) applied to the Bureau of Land Management (BLM) for a trade and manufacturing site on federal lands near the mouth of Rabbit Creek. These Anchorage sportsmen, frustrated by the lack of a safe, public shooting facility, wanted to locate a rifle range in this area. ARA members cleared the land and opened the range in August 1954. In 1961 the ARA received a patent to the Rabbit Creek Property from the BLM. The patent specified that the 57 acres could only be used for nonprofit recreational uses.

Between 1969 and 1973 supervision of the range deteriorated. Unsafe conditions and residential development on the hills surrounding Potter Marsh threatened continued use of this site. The debate between rifle range proponents and opponents of shooting near residential areas was

often heated. Although both sides agreed a range was needed, they disagreed over whether the existing location was satisfactory. In 1979 Mayor Sullivan appointed a blue-ribbon committee to study the problem. The committee reviewed alternative sites and concluded that the Rabbit Creek site was the best location for developing a range. The committee also stressed the critical need for a range within the city limits.

From 1974-77 the Alaska Department of Fish and Game leased the range from the ARA, with an option to buy. With department staff supervising the range, complaints of unsafe conditions and excessive noise gradually abated.

The state purchased the range in 1980, using $83,000 appropriated by the Alaska Legislature. However, before the state could invest funds on range improvements, several issues had to be resolved: (1) the Municipality had to support the location, which they did; and (2) future development on adjacent private land could not jeopardize the state's investment. In 1981 Senator Pat Rodey and other Anchorage legislators resolved the second issue by securing $750,000 in capital improvement funds. In December 1981, approximately $500,000 was used to purchase 250 acres of private property to provide a buffer along the north edge of the range.

During the next two years considerable time and effort were devoted to planning a new range facility. The department obtained necessary changes in zoning and other municipal, state, and federal permits. The new facility was designed to minimize problems with firearm safety and noise that had plagued the old range.

The new range was constructed from 1982-84, using excess material from a highway project and $300,000 in grant money from the Alaska Legislature for developing rifle ranges. The Rabbit Creek Rifle Range was dedicated on August 11, 1984. A practice range for archery was added in 1987. In addition to providing separate ranges for pistol, large-bore rifle, .22 rimfire, and shotgun practice, the facility has an instructional range and classroom space. The instructional range and classroom are being used by the department for hunter safety education programs and by nonprofit organizations such as the YMCA, Boys Club, National Guard, and police organizations to provide instruction in marksmanship and firearm safety.

Boardwalk

The refuge has long been a popular destination among birdwatchers and other wildlife enthusiasts, with Potter Marsh the focal point of most visits. A common practice among birders, particularly during the colder days of spring migration, was to cruise slowly along the shoulder of the highway, stopping whenever an interesting bird was sighted and traffic conditions allowed.

The ADF&G and Department of Transportation and Public Facilities (DOTPF) were concerned about the safety of this practice. In 1982 three gravel pullouts were provided, two of which were later paved. With the population of Anchorage and the popularity of Potter Marsh both on the rise, the

capacity of these pullouts to accommodate birdwatchers and others was soon exceeded. Congestion of vehicles and pedestrians was intense at times, particularly on weekends in spring and summer when peak numbers of migrating waterfowl and shorebirds or goslings coincided with peak traffic to and from the Kenai Peninsula.

To provide a safe viewing location, the ADF&G proposed to build a large parking lot on the northern edge of the marsh and provide access for visitors via a boardwalk. The boardwalk was begun in March 1985, beginning from the northern paved pullout. Department staff began construction, but the final three extensions were contracted. The parking lot and access road were built north of Rabbit Creek by the DOTPF in cooperation with the ADF&G during the DeArmoun-Rabbit Creek interchange project. Without the 20,000 cubic yards of fill material that was provided without charge, the road and parking lot pad would not have been built. The initial section of boardwalk was connected to the parking lot in summer 1989. The entire span is 1,550 feet in length. The department has erected interpretive signs which identify the most common species of waterfowl, shorebirds, other waterbirds, raptors, and songbirds.

By focusing visitor use in one area of the marsh and removing the need to walk onto the wetlands, the boardwalk has reduced intentional and unintentional harassment of waterfowl. To avoid further disturbance of waterfowl, the department has no plans at this time to extend the boardwalk towards the center of Potter Marsh.

Potter Marsh Day

The boardwalk was dedicated and officially opened on Potter Marsh Day, April 27, 1985. Most of the activities and groups scheduled for the day represented those occurring on the refuge throughout the year: hunting (e.g., duck calling, Alaska Retriever Club, hunter safety) and shooting skills (e.g., muzzleloading, Alaska Bowhunters, trap shooting, rifle instruction, reloading ammunition), nature appreciation (e.g., bird identification marsh walks), and wildlife research (e.g., bird banding, radio-tracking).

One of the highlights of the ceremony was the recognition given Jenny Perham, a student at Rogers Park Elementary, for selecting a name for Little Survival Creek. Hydrological surveys by the Division of Geophysical and Geological Survey had revealed that the small unnamed creek was the major source of surface water in Potter Marsh. As there was no known Dena'ina or local name for the creek, the Potter Marsh Task Force had sponsored a Name the Creek contest for Anchorage elementary students. The task force received 340 nominations. The 3 most commonly recommended names were Wildlife Creek (15), Animal Creek (14), and Marsh Creek (12). Despite some stiff competition, such as Keep-It-Wet Creek ("It keeps Potter Marsh wet."), Tiny Rabbit Creek ("It's smaller than Rabbit Creek and Little Rabbit Creek."), Fist Creek ("Turn it sideways and it looks like a fist."), and Shark Creek ("If it didn't attract attention before, it will now!"), Little Survival Creek ("If not for creek, wildlife would not survive.") was selected by the task force selection committee. The name was subsequently approved by the Alaska State Geographic Names Board in June 1985 and

forwarded to the U. S. Geographic Names Board for their review and approval.

Planning Efforts

Since 1971 the department has initiated several planning efforts for the refuge (Shepherd 1971, Bader 1975, Trasky and Yanagawa 1981), but its increasing popularity among Anchorage residents and tourists, development pressures of a rapidly expanding urban area, and interrelationships with other planning efforts have repeatedly outmoded the scope and objectives of the refuge plans.

Meanwhile, the Municipality of Anchorage was developing its coastal management program, which included Potter Marsh. The municipality also developed an Area Meriting Special Attention plan (MPSA and MOA 1982) for the wetlands between Point Woronzof and Point Campbell, in accordance with the coastal management plan. This plan recommended that these wetlands be incorporated in the Potter Point SGR.

The department suspended long-term planning for the refuge until its future status was resolved. In 1985 a Potter Point State Game Refuge Operational Management Plan was developed to help guide specific projects, such as completion of the boardwalk and parking lot, in the interim.

Transforming the Potter Point State Game Refuge into the Anchorage Coastal Wildlife Refuge was a prolonged, 4-year process, despite widespread support from Anchorage residents and legislators (Lindback 1988). The original bill was introduced in 1985, sponsored by Representative Mike Szymanski in the House and Senator Vic Fischer in the Senate. It was reintroduced in 1987 by Senators Szymanski and Sturgelewski. After numerous setbacks, the bill was finally passed and signed, effective February 27, 1988.

With passage of the bill, the Potter Point State Game Refuge became the Anchorage Coastal Wildlife Refuge: "Anchorage Coastal" because the geographical focus of the refuge had shifted from Potter Point and "wildlife" to acknowledge the importance of wildlife appreciation in addition to protecting game populations for hunting. More substantively, the previous refuge was expanded to include the wetlands and tideflats between Point Woronzof and Point Campbell, and the new boundary was better delineated.

PHYSICAL ENVIRONMENT

The use of the refuge by animals and people is founded on physical factors. Climate, geology, and hydrology have determined soils, which support the vegetation providing food and cover for fish and wildlife populations that, in turn, provide recreational opportunities for humans. The unstable, highly saturated soils have also limited pressures to fill in or build on the wetlands, preserving open space and solitude, until relatively recently.

Climate

The climate of the refuge is presumed to be similar to that recorded at the Anchorage International Airport, which is situated less than 5 miles from most of the refuge's wetlands. The climate is transitional between maritime and continental. Average maximum and minimum temperatures recorded at the airport are 43°F and 28°F, respectively. Highest and lowest recorded temperatures are 86°F and -38°F, respectively. Precipitation is 14.7 inches per year, with July and August typically the wettest months. Annual precipitation includes 75 inches of snow (Selkregg 1972).

Geology

Glaciers and tides are the major forces which have shaped the refuge. Most of the surficial materials comprising the Anchorage lowlands were deposited during the last few glaciations (MOA 1980). These include glacial moraines and the delta and ancestral Cook Inlet deposits of glacial till and silts. Other, lesser deposits of surficial materials include landslide deposits and wind-blown sediments. On the refuge, both of these are also derived primarily from previous glacial activity. The silt and sand which cover the intertidal area are also primarily of glacial origin, deposited by ocean currents and tides. Often materials from different depositional processes are interlayered.

Silt is the dominant surficial deposit in the refuge, covering most of the mudflats and wetlands to the higher high tide (see Vegetation Map). Potter Marsh is no exception, as it was periodically flooded by tides until the railroad embankment was built. Between Point Woronzof and Point Campbell the surficial deposits include clay, similar in nature to Bootlegger Cove clay, but only about 10 feet thick (MOA 1980). Marine sediments tend to become more sandy offshore (Bakus et al. 1979). Higher energy beaches near Point Campbell and Point Woronzof are sandy and gravelly, respectively, due to greater wave action and currents.

The coastal bluffs from Point Woronzof to Little Rabbit Creek consist of colluvium--chiefly gravel, with some sand, silt, and clay. Landslide deposits of this same material occur along the base of the bluff south of Point Campbell and below Potter Hill. South of Little Rabbit Creek are several outcrops of bedrock, which delimit the eastern edge of Potter Marsh. The coastal bluffs are breached in several places by streams. Campbell Creek flows through terraces of alluvium, chiefly gravel. The mouths of other, steeper gradient streams have formed alluvial fans below the bluffs. This is most evident in northern Potter Marsh and the vicinity of the rifle range where the alluvial fans of Rabbit and Little Rabbit creeks are a dominant feature (MOA 1980).

Less is known of the structure of surficial deposits below sea level. In general, surface sediments are over 90 percent fine sand (Sharma and Burrell 1970). A geophysical/geotechnical investigation between Point Campbell and Fire Island's North Point found two major strata (MOA 1989b). The top layer, deposited by tides during the last 10,000 years, contains

loose to medium fine-grained silty sand and nonplastic sandy silt. This layer occurs from 0 to 140 feet below mean sea level. Below it lies a layer of dense to very dense gravelly sand and sandy gravel that was probably deposited as a glacial fan delta over 10,000 years ago. These layers are probably characteristic of marine sediments throughout the refuge.

Oceanography

Cook Inlet is a large tidal estuary. Salinity levels in Turnagain and Knik arms are low. When freshwater influx is lowest, in winter and spring, surface salinities remain relatively constant near 20 parts per thousand (Britch 1976). In summer, surface salinities drop to 6-15 parts per thousand (Britch 1976), depending on tidal stage. In late July 1977 Bakus et al. (1979) measured salinities 20-30 meters deep north of Point Woronzof, and found levels about half as high.

The marine environment in Cook Inlet is cold and silty. Water temperatures in late July range from about 58-61°F at depths of 60-100 feet (Bakus et al. 1979). Suspended sediment levels in refuge waters generally range from 200-1,000 mg/l (MOA 1980), but during periods of high summer stream flows, may exceed 2,000 mg/l in Knik Arm (Britch 1976). Visibility in marine water near Point Woronzof is limited to less than 1 inch in summer (Bakus et al. 1979), and at all times the refuge's saltwater is virtually opaque (Sharma and Burrell 1970).

Low salinity and temperatures promote ice formation. Ice is present in Turnagain and Knik arms for nearly seven months each year. Inlet waters generally begin to freeze in mid- to late October, and ice often persists until April or May (Britch 1976). Knik Arm is generally clogged with floe ice from December to January or February. Floe ice is usually 2-4 feet thick. Shorefast ice, which builds up on the tideflats, seldom gets more than 15 feet thick (Britch 1976). Large piles of ice, stamukhi, are common on the mudflats of the refuge. Stamukhi are formed when broken beach ice is deposited higher on the flats. These chunks freeze to the underlying silt. Ice floes are caught on top as the tide recedes and overhanging pieces break off, leaving stacks of layered ice and silt up to 40 feet thick (Sharma and Burrell 1970, MOA 1980).

The tides are a dominant influence in the refuge. Tidal fluctuations in upper Cook Inlet are among the highest in the world, with an average diurnal range of 29.6 feet at Anchorage. The estimated maximum tide level at Anchorage is 35.5 feet above mean lower low water (0.0 feet), and the estimated lowest tide level is -6.5 feet (Britch 1976). The mean higher high water line extends almost to the base of the bluff in many places; throughout the refuge, the base of the bluff is the boundary of the 100-year flood. Highest tides occur in February, March, August, and September; lowest tidal ranges occur in November, December, May, and June. Tidal currents near Anchorage are moderate because, despite their extreme range, they are not confined. However, the rapid ebb and flow of tides over the mudflats has formed tidal guts.

Tidal currents near Point Woronzof are strongly influenced by the high tides. Currents have been measured approximately 1 mile southwest of Point Woronzof (Britch 1976). At low tide water continues to drain out of Knik Arm, moving west past Point Woronzof, due to draining of extensive tide flats and freshwater flow. Tidal currents in excess of 11 ft/sec have been recorded in the main channel (Britch 1976). In nearshore areas on the refuge, maximum velocities are usually found within 5 feet of the water surface (Britch 1976). An hour after the incoming tide begins to flow, the surface velocity at a point about 1 mile southwest of Point Woronzof reaches 4.6 ft/sec. It peaks at 5.0 ft/sec an hour later, then begins to taper off to high tide. After high tide the currents again move west past Point Woronzof and southwest towards Fire Island, but maximum surface velocity, achieved 2 hours after ebb begins is only 4.3 ft/sec (Britch 1976). An eddy forms southwest of Point Woronzof during ebb tide. Currents within a similar eddy which forms east of Point Woronzof during the incoming tide average about 1 ft/sec (Britch 1976).

The Corps of Engineers recently modelled currents in upper Cook Inlet. Results indicate the primary flow is confined to the main Knik Arm channel during ebb and flood conditions (MOA 1989b). Between Point Campbell and Fire Island the primary currents appear to be due to water moving onto and off of the extensive flats, rather than any significant exchange of water between Knik and Turnagain arms.

Water depths along a line between Point Campbell and Fire Island are less than 20 feet below mean sea level. The deepest channels are immediately adjacent to the headlands. The tideflats slope down towards the north along this transect. Water depths 1/4 mile south of the transect average about 5 feet below mean sea level. About 1/4 mile north of the transect, water depths average about 14 feet below mean sea level (MOA 1989b).

Hydrology and Water Quality

Except for Potter Marsh, the refuge is little affected by local surface and groundwater flows. However, many of the streams flowing through the refuge are migration corridors for anadromous fish. As such, the quantity and quality of water in these streams is worth noting. Based on invertebrate diversity and the distribution and abundance of aquatic invertebrates sensitive to changes in water quality, the water quality of most streams becomes significantly impaired as they flow through the Anchorage metropolitan area (Milner and Oswood 1989). Campbell Creek is an exception; low densities and numbers of invertebrate taxa at a downstream sampling station are attributed to large stream substrate and higher current velocities, rather than reduced water quality. Along some parts of the bluff (e.g., below Potter Hill) ground water escapes laterally through permeable beds in the colluvium, saturating the base of the bluff (Hansen 1965).

Campbell Creek, the largest stream flowing through the refuge, drains 70 square miles (Ott Engineering 1989). Average annual discharge is 65 cubic feet/sec (C. Estes, pers. commun.). The creek flows into Campbell Lake and empties via a spillway a short distance upstream from the refuge.

The USGS has recorded water discharge for the 2 largest creeks entering Potter Marsh. Rabbit Creek had a mean discharge of 17.3 cubic feet/sec from October 1983-September 1984 and 20.8 cubic feet/sec the following water year at a gage 0.2 mile downstream from the Old Seward Highway. The flood of June 23, 1977, had an estimated peak discharge of 500 cubic feet/sec at the Old Seward Highway. The lowest measured minimum daily discharge was about 4.5 cubic feet/sec. Little Rabbit Creek (gage located 0.4 mile above Goldenview Drive) had an average discharge of 5.97 cubic feet/sec from October 1980-September 1985. Maximum and minimum measured discharges were 202 and 1.0 cubic feet/sec, respectively.

Streams flowing into Potter Marsh also provide habitat for spawning and rearing fish; however, a more important function is wetland recharge. Freshwater input to Potter Marsh is thought to depend on three major sources: 1) naturally occurring, channelized flow, the most important of which is Little Survival Creek, followed by Rabbit Creek; 2) surface run-off and overland flow; and 3) subsurface flow that may maintain the water table or erupt in springs along the toe of the bluff or within the marsh itself.

The watershed above the marsh encompasses 25 square miles. Rabbit Creek drains approximately 15 square miles (USGS 1985). Little Rabbit Creek drains approximately 6 square miles (USGS 1983). Little Survival Creek drains approximately 2.5 square miles (Munter 1984). Surface flow from the remaining 1.5 square miles enters through seven additional culverts in the old Seward Highway.

The areas of each watershed do not reflect the importance of each of these streams to the marsh. As much as 78 percent of the standing surface water is provided by Little Survival Creek and several intermittent streams (Munter 1984). This water, in the southern portion of the marsh, maintains most of the ponds used by birds and muskrats. Unfortunately, this source remained undocumented until the mid-1980s, and no water quality or discharge data has been collected. Much of the remaining water comes from Rabbit and Little Rabbit creeks. Rabbit Creek remains relatively channelized as it flows through the marsh. Potter Creek is separated from Potter Marsh by a low ridge; therefore, it contributes no surface water to Potter Marsh.

The department has obtained instream flow reservations for water in Rabbit, Little Rabbit, and Little Survival creeks to maintain fish spawning, rearing, and migratory habitat and for wetland recharge. An application has been submitted to the Department of Natural Resources for an instream flow reservation for Campbell Creek below the dam.

Emanuel and Cowing (1982) summarized water quality entering the lower Potter Marsh basin as good. Additional water quality information is tabulated in the annual USGS publication Water Resources Data for Alaska. Monitoring was discontinued in 1985 and it is not known if the building boom of the early 1980s in the Potter Marsh watershed has adversely affected surface or ground water quality.

The Klatt peat disposal site is currently used by the municipality for snow disposal (Ott Engineering 1989). The meltwater from this site is probably of poor quality due to sediment, road salts, and oils.

Soils

Most of the refuge, which is unvegetated or sparsely vegetated mudflats subject to tidal action, has no soil. Between the mean high tide line and the base of the bluff, the soils are loamy cryaquents (SCS 1979, MOA 1980). These are nearly level, poorly drained sandy, silty, and clayey stratified sediments deposited by coastal tides. Within these areas are patches of deep, very poorly drained peat, a few gravelly beaches, and small areas of moderately well-drained soils on narrow levees bordering stream channels which comprise approximately 20 percent of this category (SCS 1979). The railroad embankment that created Potter Marsh was built on a stable bar of silt that connects the Potter and Rabbit Creek alluvial fans (Ross 1964, MOA 1980).

Soils in Potter Marsh are Salamatof peat (SCS 1979, MOA 1980). This is a very poorly drained soil consisting of fibrous peat material. Typically, the peat consists of dark reddish-brown, coarse sphagnum moss and sedge fibers and is more than 63 inches thick. This soil is saturated to the surface most of the time (SCS 1979). Organic content increases in the upper 10 feet with distance from the railroad embankment (Ross 1964). Near the embankment, soils are 27 percent organic. Soils along a longitudinal transect through the middle of the marsh are 40 percent organic. Marsh soils near the old Seward Highway are 71 percent organic material. Underlying the initial 3-7 feet of nearly solid organic material, the marsh soils are comprised of sandwiched layers of peat and silt. The thickness of the silt layers vary from 1 to more than 6 feet and are interlayered by about 1 foot of peat. Below a depth of about 14 feet the silt layer becomes relatively continuous. This silt was deposited by tidal action before the railroad embankment was built. The railroad embankment raised the water level; due to the low water movement and aeration, peat accumulated rapidly. Early railroad maps show a much larger area of open water than now exists (Ross 1964). The silt bar that supports the railroad embankment does not drop abruptly in Potter Marsh, and the new Seward Highway was built along the inside edge of the bar where soil conditions were more stable than further east.

The outwash plains of Little Rabbit and Rabbit creeks, which bound Potter Marsh to the north, are composed of Moose River and Chena silt loams (SCS 1979, MOA 1980). Moose River silt loam is a nearly level, poorly drained soil. Typically, it consists of dark grey to dark greenish gray stratified silty and sandy sediments more than 40 inches thick over a layer of very gravelly sand. Permeability is moderate, available water capacity is moderate, and surface runoff is low. These soils are frequently flooded for brief periods, and the water table is commonly within a foot of the surface (SCS 1979). The Chena silt loams are similar in many respects; however, as the loamy upper layers are less than 10 inches thick,

permeability is very rapid through the gravelly sand and available water capacity is low (SCS 1979).

The bluff which abuts the refuge, and some of the refuge land adjacent to its base, are composed of a variety of soils. These include Anchorage fine sandy loam (extending from several miles north of Point Campbell to Campbell Creek); Clam Gulch silt loam (near Point Woronzof and Campbell Creek); Cryothents, loamy, smooth (mostly altered areas near the sewage treatment plant, Bayshore land fill, along the railroad tracks between the rifle range and Reef Street, and the rifle range); Homestead silt loams (from Furrow Creek to Reef Street, the hill above the Bayshore landfill, and along most of the bluff south of Rabbit Creek); Doroshin peat and Purches silt loam (south of Klatt Bog); Spenard silt loam (south of Point Woronzof and in the vicinity of Johns Park); and Toumi silt loam (south of Point Woronzof) (SCS 1979, MOA 1980).

The foundation conditions of the tideflats are poor. Foundation conditions along the bluff are generally fair to poor, depending to a large extent on degree of slope. Foundation conditions on the outwash plains of Rabbit, Little Rabbit, and Little Survival creeks are generally good to fair (MOA 1980).

Hazards

The single most catastrophic natural event since the last glaciation was Alaska's "Good Friday" Earthquake of March 27, 1964, which was measured at 8.5 on the Richter scale. As a result, the tideflats from Point Woronzof to Potter Creek subsided from 2 to approximately 4.5 feet, respectively (Plafker 1969). This has had a long-term effect on the wetlands, many of which may still be accreting sediments to reestablish the dynamic equilibrium present before the earthquake.

No studies have been conducted on the effects of the earthquake on accretion rates and vegetation in the refuge. However, Quimby (1972) documented its effects on Chickaloon Flats, a wetland complex similar to refuge wetlands that is located across Turnagain Arm. The subsidence rate at Chickaloon Flats was almost identical (Plafker 1969, Quimby 1972). Subsidence reduced the marsh community (a zone of numerous, brackish, permanent ponds bordered by sedges and bulrushes that is used intensively by ducks for breeding, feeding, and resting) of Chickaloon Flats by 56 percent (Quimby 1972). Quimby measured rates of silt deposition more than six years after the area subsided. Silt deposits were 5/8 inch and 1 inch for 2 sites in shallow depressions and 1/4 inch for a higher site behind a clump of Ramenski sedge during 2 months of peak tides (Quimby 1972). Siltation may have prevented plant establishment by seed--although not by vegetative means--until at least spring 1971 (Quimby 1972).

In addition to subsidence, the earthquake affected the refuge by triggering landslides on the steep bluff between Point Campbell and Campbell Lake and on Potter Hill, just north of the rifle range (Hansen 1965). Along the face of the bluff extending from Point Campbell to Campbell Creek, a distance of about four miles, a thin cover of wind-blown sand and slope

wash had been loosely anchored by trees, shrubs, and grasses. This entire mat slumped a few inches to several feet. In some areas, more intense slides carried material to the foot of the bluff and beyond. In many places, 1 to 3 pressure ridges were formed at the foot of the bluff or out on the flats. Some ridges were more than a thousand feet from the bluff. Because some of the stabilizing vegetation was removed, Hansen (1965) predicted that intermittent sluffing and backwasting would probably continue for a long time. It is not known whether these slopes have stabilized yet. Minor or incipient slumping and cracking occurred from Campbell Creek to Potter Hill.

On Potter Hill, slides carried away several hundred feet of railroad track between mileposts 103 and 104. Many pressure ridges formed on the flats below the slides. Some smaller ridges were as much as 1/3 mile from the base of Potter Hill, but most larger ones were within 400 feet. Potter Hill has a history of landsliding (Hansen 1965). In October 1954, an earthquake triggered slides that destroyed the railroad track in the same area. One slump left 140 feet of track suspended 15 to 20 feet in the air. Heavy rains have also caused slides in this section. About 60 years ago, a failure of cuts in the natural bank material took out over 1,000 feet of track. In September 1989, heavy rains caused a small slide from the railroad right-of-way which flowed into the alder swamp below the bluff.

Landslides are exacerbated in the bluffs surrounding the refuge by steepness of the slopes as well as the loose colluvium. The bluffs at Point Woronzof, Point Campbell, and Potter Hill have precipitous slopes in excess of 100 percent (i.e., over 45°). With few minor exceptions, the entire bluff surrounding the refuge has steep slopes of 25 percent or more (i.e., over 14°). The bluffs extending about a mile south of both Point Woronzof and Point Campbell have the highest known mass wasting potential in the Anchorage metropolitan area (MOA 1980).

There is little chance of being involved in a landslide on the tideflats. However, the flats have their own set of hazards. More than a few waterfowl hunters and adventurers can attest that tides can flow inland quickly due to the great tidal range and relatively flat terrain. Highly saturated silt bears a strong resemblance to quicksand. Several people have had to be rescued after becoming mired and, several years ago, a woman died near the head of Turnagain Arm when rescuers were unable to free her before the tide came in. In the winter and spring, stamukhi can be hazards to navigation.

In the quaking bog below Potter Hill, people have broken through the fragile, floating, organic mat and plunged two to four feet into the underlying water (McCormick and Pinchon 1978; L. Trasky, pers. commun.). Although most wetlands in the refuge are not as hazardous, foundation conditions are generally poor due to highly saturated, silty soils and peat deposits (MOA 1980).

BIOLOGICAL RESOURCES

Marine and Estuarine Flora and Invertebrates

The waters of upper Cook Inlet are relatively unproductive. Primary productivity is limited by cold temperatures and glacial silt (which scours and buries pioneer species, as well as limiting light penetration). Plankton, which form the base of many marine foodchains, are not abundant. The most common phytoplankton are diatoms, predominantly Coscinodiscus, Actinoptychus, Pleurosigma, Rhizosolenia, and Melosira (Kinney et al. 1970, Bakus et al. 1979). Naviculoid diatoms are the dominant phytoplankton genera in Turnagain Arm (U. S. Army Corps of Engineers 1974). Copepods, such as the calanoid Acartia, cyclopods, and harpacticoids, are the most common zooplankton (Kinney et al. 1970, Bakus et al. 1979). Zooplankton in Knik Arm also include many organisms normally associated with fresh water; e.g., protozoans, rotifers, and cladocerans (Bakus et al. 1979).

Macroalgae, or seaweed, is also uncommon in upper Cook Inlet. Only Fucus, Cladophora, and Enteromorpha are known to occur (Jackson 1970, Dames and Moore 1983b). Cladophora has been observed on a sandy beach east of Potter Marsh (R. Shimak, pers. commun. cited in Bakus et al. 1979). None of these seaweeds were found in 3 intertidal samples taken between Point Woronzof and Point Campbell, where the only benthic algae was Vaucheria longicaulis (Bakus et al. 1979). This macroscopic algae forms a green-colored band, usually more than 150 feet wide, on mudflats along the entire shoreline of the refuge.

Few invertebrates are known to occur in the intertidal sediments of the refuge. These organisms are limited by the low primary productivity, silt, ice scour, and fluctuating water temperatures and salinities (Bakus et al. 1979). Clams include Macoma balthica, Mya arenaria, and Clinocardium nuttalli (Bakus et al. 1979). Shimak (pers. commun. cited in Bakus et al. 1979) estimated densities of Macoma of less than 400/ft^2. Periwinkles (Littorina) are found in Turnagain Arm (ADF&G 1977).

Other invertebrates observed at various locations within or very near the refuge include gammarid amphipods (seen at night in mudflat tidepools), minute hydroids (on a boulder over 100 feet deep), harpacticoid copepods, 5 species of polychaetes, and crangonid shrimp (Crangon) (Bakus et al. 1979). Relative abundance of large, bottom-dwelling invertebrates was sampled with beach seines from May-June 1983 in Knik Arm (Dames and Moore 1983b). Crangonid shrimp predominated, both numerically and by weight. Next most abundant were mysids (Mysidacea) and gammarid amphipods, neither of which are probably effectively captured in seines relating to actual abundance. Core samples at several beach areas in Knik Arm were devoid of organisms (Dames and Moore 1983b). Like plankton, the communities of intertidal, bottom-dwelling organisms in upper Cook Inlet are a mixture of marine and freshwater animals (Jackson 1970).

Wetland and Terrestrial Vegetation

The vegetation of the refuge has been studied in more detail than any other aspect. Two excellent studies document wetland vegetation from Point

Campbell to Potter Creek (McCormick and Pinchon 1978) and in Potter Marsh (Batten et al. 1978). Other studies document wetland vegetation from comparable areas in Chickaloon Flats, across Turnagain Arm, and Goose Bay, across Knik Arm (Quimby 1972, Hanson 1951). Each researcher categorized the vegetation communities somewhat differently (Table 2). The saltwater-influenced wetlands from Potter Creek to Point Campbell are comprised of several distinct vegetative communities.

Algae community.-- As one moves from ocean to uplands, the first community is comprised of a dark-green algae (Vaucheria longicaulis). This algae zone varies in width, but is easily identified from vantage points on the bluff. Between this community and the most seaward zone of vascular plants is an unvegetated zone of mud and small ponds.

Puccinellia-Triglochin community.-- Alkali-grass (Puccinellia lucida) and maritime alkali-grass (Triglochin maritima) are the primary species of plants in this community. Plant cover is relatively sparse, often bare mud occupies more area than plants. In the refuge, Ramenski sedge occurs in occasional pure stands and bayonetgrass (Scirpus paludosus) borders ponds and tidal guts, rather than comprising distinct zones as reported by Quimby (1972) in Chickaloon Flats.

Carex community.-- Lyngbye sedge (Carex lyngbei) is the primary species, covering 40-100 percent of the substrate in this community. Other plants frequently associated with this community are silverweed (Potentilla anserina), maritime arrowgrass, and marsh arrowgrass (T. palustris). Fourleaf marestail (Hippuris tetraphylla), bayonetgrass, and great bulrush (S. validus) occupy ponds or pools.

Black spruce (drowned) community.-- The gnarled trunks of dead black spruce trees (Picea mariana) are one of the most persistent reminders of the subsidence which accompanied the earthquake 27 years ago. The seaward edge of this community is dominated by Lyngbye sedge and the inland edge by bluejoint (Calamagrostis canadensis), a salt-tolerant grass. Portions of the drowned forest-Calamagrostis community near the Oceanview landfill appear to be synonymous with Quimby's (1972) floating marsh community.

Calamagrostis community.-- This community occurs between the coastal marsh communities and the upland communities and freshwater marshes further inland. However, along most of the refuge the band is narrow and intergrades with the types on either side. The most extensive stands of bluejoint surround the alluvial fan of Rabbit Creek and west of the old Oceanview sewer outfall. Bluejoint covers 85-100 percent of the ground throughout most of this community. The upland boundary of the Calamagrostis community usually represents the limit of the Corps of Engineers' Section 404 jurisdiction (McCormick and Pinchon 1978).

Potter Marsh is primarily a freshwater marsh, with some tidal influence supporting a Carex community near the culverts. A substantial portion of Potter Marsh along the new Seward Highway is dominated by bulrush (Scirpus lacustris), a plant which is uncommon elsewhere on the refuge. This portion of the marsh is permanently flooded with 20-40 inches or more of water (Batten et al. 1978).

Inland from Potter Marsh and the coastal wetland types are lowland forest and bog communities of black spruce forest, and deciduous woodland.

Shrub bog (Myrica gale type) community.-- This community seems to be a transitory stage in the conversion of a forested bog to a tidal marsh. The most abundant species are sweetgale (Myrica gale), silverweed (Potentilla anserina), and bluejoint, in that order (McCormick and Pinchon 1978).

Shrub bog (Myrica-Sphagnum-spruce type) community.-- This community, like the Myrica gale type, occurs predominantly in Potter Marsh. Sweetgale inhabits very wet sites, but tolerates little salinity (Batten et al. 1978).

Black spruce community.-- Live black spruce trees form an open-canopied forest on a quaking bog near the Oceanview landfill. The understory vegetation is dominated by Sphagnum mosses, an acid- tolerant plant. Dwarf birch (Betula nana), alder, and labrador tea are common woody plants.

Deciduous community.-- In the refuge, the broadleaf forest community occurs in a thin strip along much of the base of the coastal bluff. This strip broadens to encompass large areas north and south of the rifle range and along the north and east edges of Potter Marsh. Paper birch (Betula papyrifera) is the most numerous overstory tree; alder predominates in the understory. Black cottonwood (Populus trichocarpa) is common along Rabbit Creek. White (Picea glauca) and black spruce intermingles with the deciduous vegetation. Highbush cranberry (Viburnum edule), American red currant (Ribes triste), and dwarf birch are common shrubs. Below the toe of the bluff, the forest floor is hummocky, with wet depressions. These forests used to extend considerably further westward; dead stumps have been found, apparently unmoved, as far as 1,145 feet from the existing edge of the deciduous forest. Along the bluff near Point Campbell, balsam poplar (Populus balsamifera) replaces paper birch as the dominant tree in the deciduous community. An alder swamp lies north of the rifle range, along the base of Potter Hill. Seeps in this area cover the bases of trees with as much as 3 feet of water.

Balsam poplar and quaking aspen (Populus tremuloides) seem to be the only trees which can be relied on to indicate upland habitat in the refuge (Batten et al. 1978). White and black spruce and paper birch can grow in freshwater wetlands.

Invertebrates

Almost nothing is known about invertebrates on the refuge. Aquatic insects are assumed to be numerous, because spring migrants and nesting waterfowl are abundant and these insects are an important source of food and calcium for egg formation (Ritchie et al. 1981). Ironically, only Wolf et al. (1983), in studying the stomach contents of juvenile fish, identified some of the freshwater aquatic insects and other arthropods found in the refuge. These include mosquitos (Chironomidae), biting midges (Ceratopogonidae),

shore flies (Ephydridae), predacious diving beetles (Dytiscidae), and spiders (Araneae).

Samples of aquatic invertebrates in Campbell Creek, several miles above Campbell Lake, found relatively low densities of bottom-dwelling invertebrates compared to other streams in the Anchorage area (Milner and Oswood 1989). Mosquitos and stoneflies (Plecoptera) were the most abundant aquatic insects during the ice-free period. Invertebrate orders (and families) present were Diptera (Chironomidae, Empididae), Plecoptera (Taeniopterygidae, Chloroperlidae, Perlodidae, Nemouridae), Ephemeroptera (Baetidae, Ephemerellidae, Heptageniidae), and Trichoptera (Glossomatidae). Worms (Oligochaetes) occurred in low numbers in fall. Aquatic invertebrates have not been sampled below the lake or in other refuge streams. Although relative abundance probably differs, the same families are likely to occur in streams within the refuge. Aquatic invertebrate populations in Anchorage streams with lower water quality and nutrient enrichment are often predominantly mosquitos, midges, and worms (Milner and Oswood 1989).

Frohne (1953) studied mosquito populations in the salt marshes of upper Cook Inlet. Unlike areas further south, mosquitos in Cook Inlet marshes are freshwater species that have adapted to low levels of salinity. Twelve species, about half of those known to occur in Alaska, breed in the salt marshes of upper Cook Inlet. This may come as no surprise to those who have walked the refuge's marshes in summer. The most abundant species are Aedes punctodes and A. punctor; punctodes is most numerous in the most saline waters and punctor in the freshest waters, with the 2 species intergrading at intermediate salinities. Mosquito larvae are evident from mid-April to August, while some adults remain active into September. Unlike areas farther south, mosquitos in Alaskan salt marshes are not controlled by predaceous insects. Stickleback predation controls mosquito populations to some extent in Alaskan salt marshes, in contrast to the situation in Alaska's freshwater marshes, where predation by fish is inconsequential.

Fish

Diversity of estuarine and marine fishes is also low in the refuge. Threespine (Gasterosteus aculeatus) and ninespine (Pungitius pungitius) sticklebacks are common in tidal pools (Bakus et al. 1979), with threespine sticklebacks the most abundant (Frohne 1953, Wolf et al. 1983). Sticklebacks are often stranded in tidal guts and pools by the receding tide (Ritchie et al. 1981, Wolf et al. 1983). Both species spawn in the Triglochin and brackish sedge marsh and feed heavily on mosquito larvae (Frohne 1953). Mosquito larvae comprised more than half of the stomach contents of 6 threespine sticklebacks caught in a tide pool at Potter Marsh (Wolf et al. 1983). Other prey items included amphipods, gastropods, biting midge pupae, shore fly larvae, predacious diving beetle larvae, and spiders. The diet of sticklebacks from Potter Marsh was much less diverse than those collected in China Poot Marsh (Kachemak Bay), and the large number of aquatic insects in the diet of Potter Marsh sticklebacks is probably due to the low salinity of the tidal pools (Wolf et al. 1983).

The threespine stickleback was the most abundant fish caught in beach seines in Knik Arm in May-June (Dames and Moore 1983b). Saffron cod (Eleginus gracilis) were next in abundance. Saffron cod feed primarily on mysids and amphipods, probably following the waterline shoreward during the rising tide. Other marine fish inhabiting refuge waters include ringtail snailfish (Liparis rutteri), yellowfin sole (Limanda aspera), Pacific staghorn sculpin (Leptocottus armatus), starry flounder (Platichthys stellatus), lemon or English sole (Parophrys vetulus), Pacific tom cod (Microgadus proximus), Pacific herring (Clupea harengus) and larval halibut (Hippoglossus hippoglossus) (Bakus et al. 1979, Dames and Moore 1983b).

Large numbers of anadromous fish may migrate through offshore waters of the refuge, particularly near Point Woronzof. Species passing Point Woronzof include chinook (Onchorhynchus tshawytcha), coho (O. kisutch), sockeye (O. nerka), chum (O. keta), and pink salmon (O. gorbuscha); humpback whitefish (Coregonus pidschian); Bering cisco (C. laurettae), longfin smelt (Spirinchus thaleichthys), and eulachon (Thaleichthys pacificus) (Bakus et al. 1979, Dames and Moore 1983b). A few juveniles of all five salmon species were caught in beach seines in Knik Arm in May-June; however, juvenile salmon seem to leave Knik Arm rapidly (Dames and Moore 1983b). The occurrence of humpback whitefish near Point Woronzof reflects the low salinity levels (Bakus et al. 1979). Like saffron cod, the Bering cisco is relatively abundant in Knik Arm and feeds primarily on mysids, and probably follows the rising tide shoreward (Dames and Moore 1983b).

Anadromous fish are found in four refuge streams. Some spawning and rearing occurs on the refuge in Rabbit, Little Rabbit, and Little Survival creeks. The portion of Campbell Creek in the refuge is used as a migration corridor to and from upstream waters. Numbers of anadromous and freshwater fish have been estimated in Rabbit and Campbell creeks (Table 3), the two largest streams. The department stocks rainbow trout in Campbell Creek and is planning to stock coho in Campbell Creek in the future. Little Rabbit Creek supports populations of chinook, coho, and pink salmon and Dolly Varden trout (Salvelinus malma). Little Survival Creek supports Dolly Varden and coho salmon in very low numbers. Potter Marsh is an important rearing and overwintering area for juvenile fish. Round whitefish, sticklebacks, and sculpin are also present in Potter Marsh.

Amphibians

The wood frog (Rana sylvatica) is the only amphibian resident in the Anchorage area (Hodge 1976), and they are found in appropriate habitats within the refuge (D. Clausen, pers. commun.). There are no reptiles in southcentral Alaska (Hodge 1976).

Birds

Birds, particularly waterfowl, loons, grebes, and shorebirds, are the most visible and well-known animals on the refuge (Table 5). Yet, there have been few systematic counts and no long-term research.

Loons and grebes.-- Anchorage is the largest city in North America with nesting loons (N. Tankersley, pers. commun.). Loons tolerate very little human disturbance. One pair of Pacific loons returns annually to a small pond in Potter Marsh, and it is believed they nest there. Two species of grebes inhabit Potter Marsh (Table 5); red-necked grebes are the most common. Both species are easily observed along the new Seward Highway.

Waterfowl.-- Potter Marsh probably has one of the highest densities of breeding ducks in upper Cook Inlet (B. Campbell, pers. commun.). The average annual breeding population on Potter Marsh is about 60-70 ducks, which produce approximately 60-70 juveniles for the fall migration (D. Harkness, pers. commun.). Green-winged teal, northern pintails, mallards, American widgeon, and northern shoveler are the most abundant ducks breeding on the refuge. The first 4 species, ranked in order of highest to lowest abundance, comprise 89% of the breeding ducks on Chickaloon Flats (Quimby 1972), and they are probably similarly predominant in the refuge. Other nesting ducks include gadwalls, greater scaup, and canvasbacks.

Canada geese concentrate to feed on the vegetated tideflats seaward of the railroad tracks along Potter Marsh and near lower Campbell Creek. Several broods of Canada geese which feed near the boardwalk are one of the refuge's most popular attractions. Snow geese are occasionally seen during spring migration west of the rifle range and near Klatt Hill.

The highest concentrations of waterfowl occur from mid-April to late May and early September to mid-October, the exact dates depending on local weather conditions. Duck populations are estimated to average 1,000-1,500 in the spring and 500-800 in the fall. Goose populations are estimated to average 300 Canada, 75 white-fronted, and 75 snow geese in the spring and 50 Canada and 25 white-fronted geese in the fall. Snow geese are rare in fall. Peak populations of both ducks and geese are many times the above estimates. Trumpeter swans and a few tundra swans are observed on parts of the refuge during the spring, but are uncommon during the fall (D. Bader, pers. commun.).

Waterfowl use of the refuge is concentrated in areas of suitable habitat, and these have been determined on Chickaloon Flats (Quimby 1972). Although no habitat-specific surveys have been conducted on the refuge, the same habitats are probably the most valuable. The most valuable habitats for ducks and geese are the marsh, floating marsh, creeping alkali-grass, seaside arrow-grass conglomerate, and seaside arrow-grass/large alkali-grass, and unvegetated mud (type 2) communities. In the spring, Canada and snow geese use the seaside arrow-grass conglomerate community intensively for feeding and resting. Migrating Canada and white-fronted geese used the seaside arrow-grass/large alkali-grass community most intensively during the fall, feeding on the leaves and fruits of seaside arrow- grass. Ducks used the seaward edge of this plant community for resting during the fall migration. Ducks also used the marsh community, and to a lesser extent the floating marsh community, intensively for breeding, feeding, and resting. Ducks use the zone of green algae heavily for feeding and resting during the fall migration, particularly after the

hunting season opens. The bog, alder, and marsh fringe, Ramenski sedge, and unvegetated mud (type 1) communities were seldom used by waterfowl.

The 1964 earthquake considerably altered the dynamics of intertidal wetlands in the Anchorage area; however, Quimby (1972) did not believe total duck and goose use of Chickaloon Flats changed significantly as a result.

Summer and fall foods of mallards and pintails in Cook Inlet include sedges, bullrushes, pondweed (Potamogeton), and marestail (Timm and Sellers 1979). The zone of green algae also appears to be an important source of food for many dabbling ducks in late summer and fall.

The origins and destinations of some local migratory birds are known, at least to some degree. Department of Fish and Game staff banded 399 Canada geese (all but 8 were banded in Potter Marsh and Point Campbell wetlands) in July 1974-78. Department staff banded 160 mallards, 39 northern pintails, 38 American wigeon, and 26 green-winged teal (mostly at Lake Hood and on Fort Elmendorf, but 45 ducks were banded at Potter Marsh) during July and August 1974-78. In January 1982-84, department staff banded 685 mallards on lower Ship Creek. Some of these waterfowl, and other species banded by local researchers and volunteer bird banders, have been resighted in other areas and birds banded in other areas have been observed in Anchorage (Table 6).

The wintering area for most Canada geese banded in Anchorage is the Willamette Valley, Oregon. A few may winter along the lower Columbia River and the eastern shores of Puget Sound, Washington. Banded Canada geese have been observed in Anchorage from late February until early October; in southeast Alaska in October; in the Queen Charlotte Islands, British Columbia, in October and November; and in Washington and Oregon from November until January (Table 6). Canada geese banded in outlying areas, such as the Copper River Delta and Seward Peninsula, occasionally turned up in Anchorage several years later.

Migratory ducks generally show less fidelity to their wintering and breeding areas than geese, and this is reflected in the banding returns. Many mallards banded at Ship Creek appear to be permanent residents of Anchorage and adjacent marshes; however, this may be an artifact of banding mallards that had learned to winter in Anchorage. Mallards that did not winter in Alaska tended to migrate to the Pacific Northwest. Unlike the banded mallards, local green-winged teal, pintails, and wigeons migrated south, and they were seldom found in the Anchorage area after mid-September. Most appear to head for wetlands in the intermontane troughs that extend from Vancouver to southern California, particularly the Sacramento Valley. Some mallards and pintails banded in central Canadian provinces have turned up in Anchorage.

Raptors.-- The most common raptors are the northern harrier (or marsh hawk), great-horned owl, and short-eared owl. Bald eagles and peregrine falcons also frequent the refuge when waterfowl and shorebird populations

are high during spring and fall migration. In 1990 a bald eagle nested in Potter Marsh.

Shorebirds and cranes.-- Shorebird use of wetland habitats on the refuge has received even less scrutiny than waterfowl; however, some indication of use can be obtained from Chickaloon Flats (Quimby 1972). The unvegetated mud (type 3) community is used intensively by the most shorebirds, including northern phalaropes, yellowlegs, dowitchers, and least, western, and semipalmated sandpipers. The unvegetated mud (type 2) community is used most intensively by black-bellied plovers and whimbrels. Snipe are one of the most abundant birds in the bog community. In the refuge, snipe are most common below Oceanview and Potter Hill. Least sandpipers are frequently observed in the Ramenski sedge community, and may nest there. Few shorebirds use the seaside arrow-grass/large alkali-grass, unvegetated mud (type 1), alder, or marsh fringe communities.

Bakus et al. (1979) found the most common shorebirds in late July on both sides of Point Woronzof were least sandpipers, followed by yellowlegs and semipalmated sandpipers. Peak shorebird concentrations occur during the fall migration from early August to early September.

A few sandhill cranes nest in the refuge below Oceanview. Quimby (1972) believed cranes nested in the floating marsh community.

Gulls and terns.-- Gulls and terns known to nest on the refuge include glaucous-winged, mew, and Bonaparte's gulls and arctic terns. Mew gulls, glaucous-winged gulls, and arctic terns used the seaside arrow-grass/large alkali-grass community for breeding and resting. A colony of mew gulls is located near the south end of Potter Marsh. Bonaparte's gulls nest in spruce trees. Gulls and terns feed on sticklebacks in the deeper ponds in the unvegetated mud and creeping alkali-grass communities (Quimby 1972).

Gulls also feed on a wide variety of small crustaceans, molluscs, worms, and insects. Large gulls, such as the glaucous-winged gull, tend to be scavengers. These gulls, because of their ability to scavenge aggressively, are often associated with man. The growing availability of edible garbage in Anchorage has contributed to a rapid increase in glaucous-winged gulls nesting at Potter Marsh. Nesting populations of gulls were observed to have been rapidly increasing throughout the 1960s, probably in response to urbanization of the Anchorage area (Shepherd 1971). Their increase may lead to declines in other nesting birds.

Songbirds.-- Among the most abundant and visible songbirds are tree, violet-green, and bank swallows. These birds feed on the abundant flying insects that hatch from the marshes. Tree and violet-green swallows, which nest in tree cavities and man-made nest boxes, are most numerous at Potter Marsh. Tree swallows, generally the first swallow to return in spring, have been known to survive on berries and some seeds (for example, bulrush and sedges) for a few days during cool and rainy weather when insects are scarce. Bank swallows are most numerous at Point Woronzof, where thousands nest in holes burrowed into the mantle of silt along the top of the bluff.

A unique colony of red-winged blackbirds is located near the south end of Potter Marsh. These birds, so common in marshes in other states, are found at very few sites in Alaska.

Resightings of banded songbirds are too infrequent to allow much speculation on migratory patterns, with one exception. Common redpolls banded in Anchorage in winter were subsequently observed in the upper Midwest in 1978 and 1982 (Table 6). These redpolls, normally permanent residents in the Anchorage area, are known to engage in irregular migratory movements ("irruptions") when winter foods are scarce.

Mammals

A variety of mammals occur in the refuge's terrestrial and freshwater wetland habitats (Table 5). Large mammals, such as moose, coyotes, and black and brown bears, are occasionally encountered. The refuge probably has a small resident population of moose, which is increased substantially each fall and winter as moose move into the Anchorage metropolitan area from the Chugach Mountain foothills. Forested areas of the refuge are consistently visited by moose, but moose are most frequently seen when they feed on shrubs and aquatic vegetation in more open areas of the marsh.

Mammals most commonly seen by visitors are muskrats, red squirrels, and snowshoe hares, but least weasels are also relatively abundant (Harkness 1981). Muskrats and their houses and "pushups" are typically seen in Potter Marsh on both sides of the new Seward Highway. Pushups are piles of frozen aquatic vegetation covering a plunge-hole in the ice in which a muskrat feeds in winter. Muskrat populations fluctuate greatly in response to winter conditions and availability of sedges and other foods. Ice thickness is critical; low temperatures with little or no snowcover result in freeze-outs. Between 1976-1979, muskrat houses and pushups observed from the new Seward Highway increased from 12 to 70 (27 houses) in Potter Marsh south of Rabbit Creek (Bader 1979). A survey of the entire marsh conducted during winter 1978-79 found 110 pushups and houses (D. Harkness, pers. commun.). A beaver lodge is located on Rabbit Creek in Potter Marsh; beavers are sometimes seen from the boardwalk. Weasels often cache voles and other prey in pipes and other man-made crevices at the rifle range.

The distribution and abundance of other small mammals in the refuge is less well known. Small mammals known to occur in forested areas and grassy (Calimagrostis) fields of the refuge are the masked and vagrant shrew (formerly dusky shrew [S. monticolus]), red-backed and meadow vole, and meadow jumping mouse (Cronin 1982; R. Sinnott, pers. commun.). The red-backed vole and masked shrew are probably the two most abundant small mammals on the refuge. No rodents or shrews have been found on the flats. Red-backed voles venture onto the Chickaloon Flats, but are unable to permanently occupy areas which are periodically flooded by high tides (Quimby 1972). Northern flying squirrels (Glaucomys sabrinus) inhabit both black spruce and birch/white spruce forests in the vicinity of Anchorage (Ritchie et al. 1981), and probably occur in similar habitats on the refuge. Tundra voles (M. oeconomus) have been found rarely in lowland forests on the Kenai Peninsula (Fuller 1981), and water shrews (Sorex

palustris) have been observed along Peters Creek (MacDonald and Elliott 1984). Little brown bats (Myotis lucifugus) also occur in the Anchorage area. These species may also occur in the refuge.

Dogs and cats, both feral and domestic, roam the refuge. Cats can have a significant impact on small mammal and bird populations. Dogs have been known to harass large birds, particularly waterfowl, and mammals as large as moose.

Of the marine mammals which occur on the refuge, only the belukha whale has been observed frequently. Cook Inlet is one of eight known belukha wintering areas in the world and is probably geographically and reproductively isolated from the other areas (Morris 1988), possibly for as long as several thousand years (Murray and Fay 1979). The entire Cook Inlet belukha population is estimated to be only 300-500; however, this is probably a very conservative estimate (Morris 1988). Pods of belukhas appear to be absent from the upper Cook Inlet during the winter. They return in April and May, concentrate at river mouths from late May through June, disperse throughout the upper inlet during July and August, and leave in November (Morris 1988). According to this schedule, late summer and fall are the best seasons for observing belukhas on the refuge. As many as several hundred have been observed near Point Woronzof during summer (Bakus et al. 1979). Point Woronzof is the best point in the refuge to see belukhas, as most of the nearshore marine waters in the refuge overlie extensive mudflats and, even at high tide, are very shallow. However, homeowners in the Campbell Lake area report seeing belukhas occasionally in lower Campbell Creek apparently feeding on anadromous fish.

Other marine mammals--for example, harbor seals (Phoca vitulina) and northern sea lions (Eumetopias jubatus)--are uncommon or rare in upper Cook Inlet (Bakus et al. 1979) and, to the best of our knowledge, have not been seen in refuge waters.

LAND OWNERSHIP

All of the tide and submerged lands and most of the uplands within the refuge are state-owned. A portion of these state lands, between Campbell Creek and the Rabbit Creek Rifle Range, is part of the mental health land grant.

Two land leases are located on the refuge. One is a 28-year-old, 34-acre commercial land lease in the southern portion of Potter Marsh that has never been developed. The lease term expires in 2015. The other is a lease for the Anchorage wastewater utility pump station located near the mouth of Campbell Creek. The state has recently issued oil and gas leases in tide and submerged lands off of Point Campbell.

Four parcels of municipal land are located within the refuge: Johns and Oceanview Bluff parks, the old Oceanview sewer outfall, and dedicated open space adjacent to the Edgewater subdivision. A parcel of approved Municipal selection land is located at the back of Potter Marsh.

Private lands extend onto the flats at intervals along the coast from Kincaid Park to Oceanview. Several private parcels also extend into the north and east edges of Potter Marsh. Private lands within the refuge boundary are not part of the refuge and may only be acquired from willing sellers.

PUBLIC ACCESS

Access to the refuge is generally inhibited by the steep bluff, lack of trailheads with parking facilities, and many private parcels. Potter Marsh is focal point of most visits due to the easy vehicular access provided by the old and new Seward highways; however, the department discourages human activity in Potter Marsh, other than along the boardwalk, to minimize disturbance to wildlife, which is easily viewed from the margins of the marsh. The most frequented access point is the new parking lot which connects to the boardwalk. Other access points to Potter Marsh include several shallow turnoffs along the New Seward Highway.

The most popular legal access points to the remainder of the refuge are at the end of Reef Place (Oceanview), and off of the coastal trail segment extending from Pt. Campbell to the Point Woronzof parking lot. Access is also available from the rifle range and by trails through Johns Park.

A less well-known access point is provided by a dedicated pedestrian easement through Edgewater Subdivision at the end of Spyglass Circle. Another future access site may be provided at or near the Klatt peat disposal site, if and when it is developed as a neighborhood park (Ott Engineering 1989).

Some popular access routes are illegal. The refuge is easily reached by crossing the railroad embankment south of the rifle range and along the tracks between the rifle range and Reef Place; however, for safety reasons, the Alaska Railroad does not allow public access across the tracks. The railroad has posted "no trespassing" signs along the tracks to discourage this practice. The only legal access to the refuge across the tracks is via the rifle range parking lot; this route may be used even when the range is closed. The access road from West 100th Avenue to the municipality's sewer lift station is privately owned. Waterfowl hunters, birdwatchers, and others often trespass on private property between the Klatt peat disposal site and Kincaid Park. The refuge boundaries are complex in this area and few signs have been erected to indicate where the refuge ends and private property begins.

EXISTING HUMAN USES

Wildlife Viewing and Education

Wildlife viewing is widespread; however, it is not dispersed evenly throughout the refuge. Most visitors are attracted to relatively few sites. Belukha whales are often spotted from Point Woronzof. Muskrats, the

most visible indigenous mammal, can be observed in Potter Marsh along the new Seward Highway. Five of the 10 best non-winter birdwatching sites in the Anchorage area include portions of the refuge (Scher 1989). These are Potter Marsh, the wetlands south of Point Woronzof, the outlet of Campbell Lake, Kincaid Park, and Johns Park.

Potter Marsh is the premier site for birdwatching (Scher 1989) and general wildlife viewing in the Anchorage area. Abundant birds, proximity to the state's largest population center and airport, location along the only road exiting Anchorage to the south, and easy access contribute to its popularity. A survey conducted in 1981 found an average of 2,082 visitor-days per week during spring when waterfowl migration was at its peak (Meyer 1982). Average visitor-days per week was more than twice as high in summer when goslings were easily visible from the road. These averages are low because visitors were sampled only 13.5 hours per day and no extrapolation was made for early morning and late evening. Most (91 percent) visitors arrived by automobile. Potter Marsh was the primary destination of 76 percent of groups in spring and 66 percent of groups in summer. Most (70 percent) groups visited the marsh primarily to view wildlife and scenery. In spring, a slightly higher proportion of the groups were engaged in birdwatching (37 percent) than less specialized wildlife viewing (33 percent). In summer, when the greatest attraction was groups of Canada goose goslings, more groups were engaged in general wildlife viewing (49 percent) than birdwatching with binoculars (22 percent). Chinook, coho, and pink salmon and Dolly Varden seen from the boardwalk over Rabbit Creek are very popular visitor attractions in July and August. Photography was a primary activity of 16 percent of the groups.

The refuge is among the most popular visitor attractions in the state. No single site was visited by more than half of the state's visitors, but Potter Point State Game Refuge was visited by an estimated 46,100 nonresidents between June-September 1985, 10.7 percent of the total visitors to Alaska (Data Decisions Group 1986). Presumably, Potter Marsh was the focus for almost all of these visits. One of the reasons for the popularity of Potter Marsh is that it is a convenient stop on the way from Anchorage to Portage Glacier, the most popular visitor attraction in the state (Data Decisions Group 1986). In spring and summer 1981, 92 and 78 percent, respectively, of the groups visiting Potter Marsh were from Anchorage (Meyer 1982).

The refuge, particularly Potter Marsh, is used for wildlife education. Youth and wildlife appreciation groups conduct tours. Schools conduct field trips in spring to study birds and the marsh ecosystem. In 1980, 40 groups from public elementary and secondary schools registered for a Potter Marsh field trip (Meyer 1982). Many other teachers organized their own trips.

Such a concentration of people undoubtedly has some detrimental effect on wildlife. Some species probably avoid areas near the boardwalk during high use periods. Also, despite regulations and signs intended to discourage feeding of wildlife, illegal feeding continues to occur. Wildlife feeding can promote spread of disease, attract undesirable as well as desirable

species, and delay migration past optimum departure dates. At the present time, however, benefits of the boardwalk in enhancing public awareness and appreciation of wildlife outweigh other concerns.

Hunting

Outside of the rifle range, the refuge is closed to the discharge of all firearms except shotguns. Shotguns may only be discharged from September 1 through March 31 and only waterfowl and small game may be hunted. Portions of the refuge closed to any type of hunting include Potter Marsh and the strip of marsh landward of the elevated fill covering the municipal sewer line between the Klatt Road peat disposal site and Campbell Creek.

Waterfowl hunting is the most popular hunting activity on the refuge. The number of duck hunters using the refuge and the proportion of the state total increased in the 1980s compared to the 1970s (Table 7). The proportion of ducks harvested on the refuge and the number of ducks taken per hunter day declined in the early 1980s, but appear to be increasing (Table 7). Surveys conducted during the last two decades have estimated an average of 2 percent of the statewide duck hunting effort and 1.2 percent of the state's annual harvest occurs on the refuge. Considering the small size of the refuge relative to the rest of the state, these figures are substantive. The popularity is due to large numbers of migratory ducks that are highly visible from the state's largest population center and easily accessible to walking hunters.

Most of the hunting effort occurs during the first week of the waterfowl season. However, a few hunters can generally be found on the refuge until freeze-up. More hunters are present on weekends and days when high tides of over 30 feet concentrate ducks. The chronology of hunting effort is suggested by records of banded waterfowl turned in by hunters in Anchorage (Table 8). Seventeen banded birds, 37 percent of the total, have been shot on opening day. Two-thirds were shot in the first two weeks of the waterfowl hunting season. These figures are only a rough approximation of actual hunting pressure, because waterfowl species were not banded relative to numbers present; fall migration brings many banded waterfowl into the Anchorage area; and, after opening day, hunters tend to expend additional effort to shoot increasingly wary birds.

Some of the best waterfowl hunting areas are on or adjacent to tracts of private property. These tracts are typically not posted. Consequently, trespass is a significant concern among landowners, particularly in the Bayshore area and near the mouth of Campbell Creek. Some residents along the bluff have also complained of pellets raining down upon their houses during the waterfowl season. Because of public safety concerns, the Alaska Board of Game closed the aforementioned strip of marsh landward of the sewer line to hunting. Although only a small portion of this strip is state land, and the distance between the sewer line and the nearest existing houses along the bluff is 450-500 feet (Ott Engineering 1989), closing this area has clearly not solved the problem.

In addition to waterfowl, the only other small game on the refuge that may be hunted are snowshoe hares, spruce grouse, willow ptarmigan, sandhill

cranes, and common snipe. Of these, only the snipe is seasonally abundant. The others are probably seldom hunted, if at all.

The Waterfowl Hunting Issue - A major issue identified by the public during development of this plan was trespass and safety problems resulting from waterfowl hunting on the refuge. These concerns were not resolved in this plan because regulating hunting is the responsibility of the Alaska Board of Game.

The Board previously attempted to address safety concerns in the refuge. In response to public comments, the Board closed a strip of mostly privately owned and some refuge lands near Bayshore West subdivision to hunting in 1982. Continuing comments, testimony from two public meetings, and a survey of homeowners living along the coastal bluff indicate that concerns with trespass, safety of adjacent households and other refuge users, noise, and unethical behavior remain.

On the other hand, the refuge is a popular area for waterfowl and snipe hunting because of its convenience to Anchorage hunters and suitability for adults to take youngsters on short, supervised hunts. The department seeks to maintain hunting opportunities where hunting can be conducted safely, without threatening wildlife resources, and without creating significant user conflicts.

The department has tried to accommodate both hunters and other refuge users by posting the refuge boundary in some areas and all the major access points and by providing maps of legal access routes. Signs are expensive, difficult to maintain, and do not last long; they are removed or destroyed by refuge users, tidal action, and weathering. They are also widely ignored. Private landowners bear a similar responsibility to post their land, but rarely do so for the same reasons. Nevertheless, the department will continue to manage refuge users by these nonregulatory means.

To help the Board of Game consider changes to refuge hunting regulations that will resolve conflicts between waterfowl hunters, other refuge users, and adjacent homeowners, a wide range of regulatory alternatives have been examined. These alternatives, and their pros and cons, are discussed below. The alternatives are not listed in any order of priority.

1. Close the entire refuge to hunting.

   PRO: This would resolve all existing trespass and public safety concerns associated with hunting on the refuge.

   CON: Hunters were using the refuge before residential subdivisions expanded to the top of the bluff and before the refuge was popular with other users, and the refuge is still a popular hunting area. In many portions of the refuge there are no existing conflicts between hunters and other users.

2. Close portions of the refuge to hunting. Few hunters appear to hunt in the existing closed area; however, shot from shotguns discharged toward the bluff from outside the closed area occasionally reaches houses on the bluff. The existing closed area has not diminished trespassing or other illegal acts. Areas where significant safety and trespass conflicts currently exist between hunters and private property owners are from Shore Drive to Shorecrest Drive. The staff of the rifle range has expressed a desire to formally close down range portions of the refuge to hunting, because hunters occasionally ignore the signs and the range must be shut down until they move on.

   PRO: Depending on which areas are closed, this could resolve some or most of the existing trespass and public safety concerns associated with hunting on the refuge.

   CON: Closing some areas would probably increase hunting pressure on open portions of the refuge, probably creating conflicts among hunters, nonhunters using these areas, and adjacent landowners. Some landowners, antihunters, and nonhunters recreating in and near the remaining open areas might ask the Board to close these areas as well. If there are no significant conflicts, this would unfairly deny use of the areas by hunters.

3. Delay opening hours. Waterfowl hunting currently begins at one-half hour before sunrise (6:21 a.m. on opening day). This could be delayed until 10:00 a.m. or noon on opening day and during the first two weekends, when large numbers of hunters use the refuge.

   PRO: This alternative would significantly help to enforce existing regulations. Enforcing shooting hours and other violations is difficult before legal opening, when it is still dark. Often there are too many hunters and too much distance to cover to positively identify violators. A later opening would allow enforcement officers an opportunity to find and apprehend early shooters and other violators. Other hunters could also locate violators and apply peer pressure. Private landowners would have a better opportunity to control hunters who trespass, because most hunters would be moving onto the refuge when residents are awake rather than at 5 to 6 a.m., and hunters would be less likely to trespass during daylight hours. Delaying opening hour would reduce early morning noise disturbance to nearby residents.

   CON: This alternative would probably not substantially diminish the number of shots fired towards the bluff--a major concern of adjacent homeowners, particularly those living near lower Campbell Creek. The fallout of spent shot is not hazardous to nearby residents, but it is a legitimate cause for anxiety, particularly if property damage is involved.

4. Require hunter education. Hunting so near a populated area is perceived by many nonparticipants as hazardous. Hunter behavior is under a great deal of scrutiny from hunters and nonhunters alike.

Hunting in the refuge is very visible. Inexperienced and unethical hunters are more evident than in most areas, and hunters need to be more safety-conscious and considerate in the urban setting. Before being allowed to hunt in the refuge, hunters could be required to attend either a certified hunter education course or a briefing specific to the refuge. Topics could include firearm safety, bird identification, effective shooting skills, and locations of legal access routes, closed areas and private lands. Hunters on the refuge could be required to carry hunter education cards that could be checked by enforcement officers.

PRO: Actions of inexperienced or unethical hunters are one of the greatest concerns of hunters using the refuge, nonhunters, and adjacent property owners alike. Mandatory hunter education could target behaviors that were most offensive by promoting proper hunting and safety skills. All but six states require some form of mandatory hunter education.

CON: A mandatory course could be perceived as unnecessary to some hunters, and a certified hunter education class would require a two to five-day commitment of time. There is no guarantee that someone attending a hunter education course will apply the lessons taught. A mandatory course has never been required in Alaska, except recently for hunters under 16 years old on Mendenhall Flats State Game Refuge. This alternative would significantly increase the number of people attending the department's hunter education course, overloading existing staff.

5. Issue permits. The number of hunters could be limited by requiring them to have a permit and issuing only a limited number.

PRO: This might reduce the crowding that occurs on opening day and the first two weekends, thereby reducing the magnitude of existing problems.

CON: It would not resolve existing problems as well as some of the other alternatives. It would diminish one of the refuge's chief benefits: its availability to large members of hunters who do not have the time, money, transportation, or inclination to travel to more distant sites. Some hunters complain of crowding; however, illegal and unethical behavior are of greater concern. Issuing permits and conducting a permit hunt consumes a disproportionate amount of the department's time and money.

6. Allow hunting on weekdays only.

PRO: This would reduce the number of hunters using the refuge, because most use now occurs on weekends when most people have available free time.

CON: Same as alternative 5, in addition to eliminating the opportunity to hunt when most people are not working.

7. Limit hunting to youths accompanied by adult. Youths are often introduced to waterfowl hunting in the refuge because it is easy to access. A maximum age limit, for example 16 years old, could be instituted.

   PRO: This would reduce the number of hunters using the refuge. It would encourage early exposure to waterfowl hunting and its traditions, which is a primary factor in maintaining the sport and promoting ethical behavior.

   CON: This would reduce the availability of the refuge to large numbers of adult hunters who either have no children interested in hunting or prefer to hunt alone or with other adults. It would not necessarily reduce trespass and other problems.

8. Prohibit waterfowl hunting but allow hunting of other species. Currently, the only animals that can be hunted on the refuge are waterfowl, sandhill cranes, snipe, and small game (primarily snowshoe hare and ptarmigan). Only waterfowl are hunted by large numbers of people. Of the other species, only snipe are occasionally abundant.

   PRO: This would greatly reduce hunting effort and associated problems. Snipe attract few hunters. Snipe hunters use small shot sizes that have limited range compared with shot sizes needed for ducks and geese. Snipe are only abundant on the refuge for a limited period between September 1 and freeze-up.

   CON: Prohibiting waterfowl hunting would have the same disagreeable effect as alternatives 5, 6, and 7. It might be difficult for enforcement officers to distinguish between a person legally hunting snipe vs. illegally hunting waterfowl without checking shot size and birds in possession.

9. Maintain the status quo.

   PRO: No additional resources would need to be spent on law enforcement, hunter education, or permits.

   CON: All of the existing problems would remain and perhaps even increase.

Target Shooting and Hunter Education

The Rabbit Creek Rifle Range is the only public outdoor shooting range in the Anchorage area, although the Isaac Walton Range near Chugiak is also open to the public. The Rabbit Creek facility includes separate center-fire pistol, center-fire rifle, rim-fire rifle and pistol, shotgun, instructional, and archery ranges. Rifle and pistol range distances are limited to 100 meters (330 feet). The range also provides facilities for hunter education, firearm familiarization and safety training, and marksmanship classes.

Use of the range is declining with greatest declines during the winter and late summer months. The number of shooters during May, June, September, and October has fluctuated, but held relatively constant or even increased. Despite declining use, the range still fills an important role for those wanting to shoot at targets or sight-in a firearm. Without the range, indiscriminate and unsupervised shooting in the Anchorage area could pose a significant risk to public safety.

Transportation and Utility Corridors

A variety of transportation and utility corridors cross the refuge. Most obvious are the railroad and old and new Seward highways that bound Potter Marsh. The new Seward Highway is one of the busiest roads in Anchorage. Average daily traffic passing a vehicle counter located near the southern end of Potter Marsh in 1988 was 5,644 vehicles (MOA 1989a). This was down from a high of 5,692 vehicles in 1986 (a similar decline was observed on almost all major Anchorage roads), but represented an 83 percent increase from 1980 to 1988. The only Anchorage road with a greater increase in the volume of traffic was the Glenn Highway. The Seward Highway was recently designated a National Scenic Byway, an educational program of the U. S. Forest Service (Porco 1990).

The utility corridors are generally buried. A 7-foot-diameter pipe exits the municipality's primary sewage treatment plant on Point Woronzof, runs under the beach at the foot of the bluff, and extends through the refuge approximately 800 feet into Knik Arm from Point Woronzof in a northwesterly direction. The plant, which began operating in 1972, discharges millions of gallons per day. A three-part diffuser was added to the outfall in 1986 to avoid eddies which were carrying wastes shoreward onto the intertidal zone east of Point Woronzof during flood tides. Even before the outfall was modified, water quality problems in refuge waters were minimal because the ebb tide appeared to completely flush nearshore areas (Britch 1976). The Turnagain interceptor, a 24-inch reinforced concrete pipe, is buried near the base of the bluff from Oceanview to Campbell Creek. A lateral sewer line exits the Bayshore Creek notch and connects with the Turnagain interceptor about 600 feet west (Ott Engineering 1989).

Two 12-inch natural gas lines from the Kenai Peninsula, operated by ENSTAR Natural Gas Company, are buried under the sediments of Turnagain Arm, entering the refuge near Potter Section House (Sandstrom 1988, Koman 1989). A submerged liquid petroleum pipeline, operated by Tesoro, crosses Turnagain Arm from Point Possession to just south of Point Campbell (Sandstrom 1988).

A submarine 138 kv transmission line from Beluga to Anchorage, operated by Chugach Electric Association, crosses Knik Arm and passes through the refuge between Point Woronzof and the sewage treatment plant.

Adjacent Development and Water Quality

Residential development during the last decade was intense on the hillsides surrounding Potter Marsh and along much of the coastal bluff. Surface and

groundwater runoff from residential areas has been known to affect the quantity and quality of water in adjacent wetlands. Oils, salts, nutrients (such as fertilizers), other contaminants, and excessive amounts of sediment may be washed into wetlands. The timing and duration of flows may be altered, affecting the timing of fish migration, waterfowl nesting, or other critical events. A storm water drainage system may divert water away from the marsh. Numerous residential septic systems may contaminate ground or surface waters. These concerns are especially relevant in Potter Marsh, which collects most of its surface and ground water from a limited watershed (Munter 1984).

The USGS operates continuous gages on Rabbit and Little Rabbit creeks, maintains precipitation stations in the area, periodically monitors staff gages in Potter Marsh, and collects water quality data (Munter 1984). Water quality of Rabbit Creek was also monitored in 1984 and found to be within natural levels.

Habitat Enhancement

Several attempts have been made to enhance waterfowl habitat on the refuge. The most extensive to date was excavation of a series of ponds and berms on the flats below Bayshore. This project was completed in 1973 to mitigate adverse impacts of burying the Turnagain Trunk Sanitary Sewer near the base of the bluff from Oceanview to Campbell Creek. (The trench and berm of the old Oceanview outfall line, which discharged over 1/2 million gallons of raw sewage daily onto the beach below Oceanview, is still an obvious landmark.) Although some ducks use the ponds and berms, the ponds were initially too deep and their margins too abrupt to encourage growth of aquatic vegetation. In recent years as the ponds have filled in, duck use appears to be increasing.

Other projects have included creating potholes in Potter Marsh and building floating nest platforms. Approximately 6 or 7 potholes were blasted with fuel-soaked ammonium nitrate in early 1978. These were intended to create open water areas in dense sedge vegetation and mounds attractive to waterfowl for feeding, nesting, resting, and brood-rearing. The potholes, in the middle of the marsh about 200 feet from the new Seward Highway, did create some open water, but the experimental effort was discontinued due to public comments. Two small floating platforms were tried about the same time. These were appropriated by nesting gulls, rather than the desired waterfowl.

Other

Other spring and summer activities associated with the refuge included jogging or walking for exercise, walking dogs, cycling, picnics, kite-flying, and sketching (Meyer 1982). In winter, ponds in Potter Marsh are used for skating and some cross-country skiing occurs in various locations.

Some illegal activities occur on the refuge. Off-road vehicles, such as 4-wheeled all-terrain vehicles, and snowmobiles are occasionally operated on the wetlands or beaches. The primary access points are Reef Place, along the railroad tracks between Reef Place and the rifle range, the private road along the south bank of Campbell Creek, the Point Woronzof parking lot, and several locations near the Clitheroe Center.

Illegal wetland fills are another problem. Unauthorized discharges of peat and other material ranging from a few to 20,000 cubic yards have destroyed some wetlands along the base of the bluff and in Potter Marsh. An estimated 50 truckloads of peat were dumped in Potter Marsh in 1983 during construction of the Potter Valley Road.

SURVEY OF ADJACENT PRIVATE LANDOWNERS

As a result of the refuge planning process, the department determined that little was known about the characteristics and concerns of people who owned property adjacent to the refuge. In June 1990, a six-page questionnaire was mailed to all 236 known private landowners who owned property immediately adjacent to the refuge and a random sample of 109 homeowners living one tier further removed from the refuge (approximately half of them, for comparison with adjacent landowners). Names and addresses were taken from municipality property tax records. Of the initial list, 21 properties were eliminated. These included properties whose owners had moved or died before the survey, those owned by financial institutions, those not meeting the criteria for inclusion in survey (e.g., wrong address), and railroad property. Also, responses were combined for any properties adjacent to the refuge in the same subdivision that were owned by the same person or corporate entity.

Numerous reminder letters, telephone calls and, finally, personal interviews resulted in a 91 percent response rate. The 29 nonrespondents included property owners who could not be contacted by mail, phone, or in person; owners who refused to participate; and others who agreed to participate, but did not return completed questionnaires before the September 1 deadline. The responses have not been tested for statistical significance; however, preliminary results are available. Responses to some questions add up to more than 100 percent, because respondents were allowed to report more than one type of activity. Proportions can differ substantially depending on whether or not nonrespondents or those answering "no" or "don't know" are included.

Trespassing.--Trespassing by refuge users is a problem for adjacent landowners. Trespassing occurs on at least 44 percent of the properties. Hunters were observed by the most adjacent landowners (30.5 percent). Many observed trespassers walking (22 percent), walking with a dog (20.5 percent), driving motor vehicles off roads (17.5 percent), and sightseeing from vantage points (15 percent). Only 13.5 percent of the landowners had observed birdwatchers trespassing, but some of the walkers may have been birdwatchers. In comparison, 13 percent of respondents in the second tier had observed trespassers on their property. Most of these homeowners also reported hunters; other frequently observed trespassers were walking,

walking with a dog, or driving motor vehicles off roads. Proximity to the refuge appears to promote trespass; however, it seems that some user groups are prone to trespass, irregardless of their destination.

Inexplicably, 16 percent of adjacent landowners and 29 percent of homeowners in the second tier did not know they lived near a wildlife refuge. Comments from some respondents indicated that one source of confusion was they did not know hunting was allowed on a wildlife refuge.

Hunting.--Many adjacent landowners hunt or have household members who hunt (48 percent). Fewer hunt waterfowl (38 percent) and fewer still hunt waterfowl in the refuge (17 percent). A greater proportion of adjacent landowners hunted waterfowl in the refuge than did those living in the second tier (10 percent). An estimated 19,892 Alaskans are waterfowl hunters (Campbell 1990), about 2 percent of the state's population. Waterfowl hunting is a relatively popular activity for people living near the refuge.

Adjacent landowners distinguished between waterfowl hunting in general (40.5 percent approved, 25.5 percent disapproved, 34 percent neutral or no comment) and waterfowl hunting on the refuge (24.5 percent approved, 61 percent disapproved, 14.5 percent neutral or no comment). As expected, nonhunters expressed the most disapproval of waterfowl hunting in the refuge (9 percent approved, 77 percent disapproved), compared with hunters who do not hunt waterfowl (31 percent approved, 53 percent disapproved) and those who do (52 percent approved, 44 percent disapproved).

Nonconsumptive Users.--Most adjacent landowners visited the refuge for reasons other than hunting (82 percent). The most common activities include birdwatching (68 percent), walking (58 percent), nature photography (33 percent), nature study (31 percent), walking with a dog (31 percent), and cross-country skiing (31 percent).

Landowners felt the best things about living near the refuge were scenery/view/beauty (55 percent), mammals or other wildlife in general (35 percent), birds (especially waterfowl, 33 percent), and quiet/solitude/privacy (26 percent).

Noise.--In addition to trespassing and objections to hunting, almost all adjacent landowners were disturbed by noise from the refuge. On a 4-point scale (never=1, rarely=2, sometimes=3, often=4), the most disturbing noise was shooting during waterfowl hunting season (3.0 average), with airplane and helicopter traffic a close second (2.9 average). Other refuge and neighborhood sounds were averaged as follows: barking or howling dogs (2.4), shooting out of season (2.3), shooting from the rifle range (2.2), snowmachines and other motorized vehicles on the refuge (2.2), road traffic (2.1), trains (1.8), and construction or road repair (1.8). Generally, noise from the refuge was more disturbing than neighborhood sources. It is likely that adjacent homeowners are used to and expect only natural sounds from the refuge. Loud noises from the refuge are usually seasonal (in the case of hunting) or illegal (motorized vehicles, random shooting); therefore, they are more noticeable when they occur.

Noise from legal shooting is a case in point. Respondents often singled out shooting on the opening day of waterfowl hunting season, September 1, and the first two weekends in September as especially disturbing. Safety concerns and some anti-hunting sentiment were also expressed by many landowners, and this undoubtedly figured in the high level of disturbance. For example, more landowners could hear airplanes and helicopters inside their homes (39 percent) than shooting (31 percent), but aircraft noise was generally less disturbing. Similarly, many landowners could hear trains inside their homes (17 percent), but trains scored low for disturbance because many homeowners liked the sound of train whistles. Regardless of the reasons why it is disturbing, however, shooting is obviously a noisy activity, and it should not be dismissed as a legitimate concern.

Motorized Vehicles.--Many landowners observed snowmachines and other motorized vehicles (motorbikes, three- and four-wheelers) trespassing to and from the refuge (17.5 percent) and identified them as a source of noise from the refuge (14 percent). In addition to trespassing, it is illegal to operate motorized vehicles on the refuge without a permit, and no permits have been issued.

Public Safety Concerns.--Many private property owners (38 percent) identified one or more public safety concerns associated with living near the refuge. Sixteen percent were concerned about hunting and carrying loaded firearms through neighborhoods and nearby shooting. Notably, 13 homeowners living next to the refuge (6.5 percent) mentioned shotgun pellets falling on their house or yard while 1 or 2 others had had a window broken by a shotgun pellet or small caliber bullet. All of these occurred from Shore Drive to Shorecrest Drive. An additional 5 homeowners in the second tier reported pellets falling on their house or yard. Respondents seldom mentioned frequency of these events or how recently they had occurred. Of those who did mention frequency, 3 residents of Bayshore West and Resolution Pointe indicated it occurred "frequently," "every year," or "numerous" times, while 1 resident of Shorecrest indicated it occurred "sometimes." No other public safety problems were mentioned by more than 10 percent of respondents.

Additional Comments.--Respondents were encouraged to elaborate or include additional comments. Over half (55 percent) of the adjacent landowners did. Among these respondents, the issue evoking the most comments was hunting on the refuge (9 percent for, 35 percent against). No other issues were raised by more than 10 percent of landowners. However, some of these issues were: coastal trail (3 percent for, 10 percent against), snowmachines (6 percent for, 6 percent against), 3- and 4-wheelers (none for, 10 percent against), aircraft overflights (none for, 6 percent against), rifle range (2 percent for, 6 percent against), and habitat enhancement (6 percent for, 1 percent against).

Demographics.--People owning property adjacent to the refuge are not a cross-section of Anchorage residents. In fact, on average they are older, wealthier, better educated, less transient, and have higher status occupations. Respondents were undoubtedly influenced by who they are and where they live.

Answers to demographic questions were compared to the 1980 census, because no detailed summary of the 1990 U.S. census is available yet. In the intervening decade, the population of Anchorage grew from approximately 174,000 to approximately 230,000.

More adjacent landowners identified themselves as male (54 percent) than female (30.5 percent), but the large number who declined to answer this question (15.5 percent) leave the actual sex ratio in doubt. The male:female ratio of Anchorage residents older than 21 (there were no adjacent respondents under 21) is 54:46. There is no reason to believe sex ratios of those residing near the refuge differ from the Anchorage population; however, males may have been more likely to respond than females in the same household. Overrepresentation of male responses should have little effect on most use-related questions; however, attitudes and opinions, particularly related to hunting, may show a slight male bias.

The age structure of adjacent landowners differs greatly from that of the Anchorage population. Among Anchorage residents older than 21, 67 percent were 21-40 years old. Of those responding, 63.5 percent were over 40 years old. Most houses along the bluff are single-family dwellings, and some of the difference may be explained by the greater age of homeowners relative to renters.

Many adjacent homeowners have resided in the same house for a long time; 68 percent have lived there more than 5 years. In 1980, 68 percent of Anchorage homeowners had occupied their house five years or less.

Adjacent landowners are well educated, on the average. Of persons 25 years or older, more adjacent landowners are high-school and college graduates (97 and 68 percent, respectively), compared to Anchorage residents (89 and 24 percent, respectively).

Adjacent landowners are largely white-collar workers. Almost two-thirds (65 percent) are executives, managers, and professionals, substantially higher than the proportion of Anchorage residents in these occupations (30 percent). Anchorage has a higher proportion of these occupations than the U.S. as a whole (23 percent). Several occupations were represented among all responding households in much higher proportions than in the Anchorage population, including teachers (26, almost half of these were spouses of the following occupations), attorneys (20), engineers (16), physicians (11), land developers and contractors (9), bankers (6), and architects (5).

Properties adjacent to the refuge are generally more valuable than the average residential property in Anchorage. In 1990, the average sales price for single-family houses and lots in Anchorage was about $126,000 (White 1991). Average value of single-family properties and undeveloped tracts large enough for at least one dwelling adjacent to the refuge was about $172,000.

PROPOSED HUMAN USES

Fire Island Causeway

The municipality and other parties have proposed to develop Fire Island. The major plans to date have included a port with adjacent commercial and industrial areas, a home port for the Navy, and residential areas. The only practical way to access Fire Island is by building a causeway from the Anchorage urban area through the refuge. The legislation which created the refuge requires the refuge plan to identify a causeway corridor.

The municipality has investigated six potential alignments, each extensions of major existing roads (MOA 1989b). All of the alignments would cross the tideflats between Point Campbell and North Point. Due to conflicts with established uses, serious objections have been raised over two potential routes through Kincaid Park because they would have a substantial adverse impact to park values. A third route, through the airport, was also an unlikely choice because it would require land needed for airport expansion. The remaining potential routes are an extension of (1) Northern Lights Boulevard which would follow the existing road to the Clitheroe Center, (2) Raspberry Road, and (3) Dimond Boulevard. There are two Dimond Boulevard alternatives; a proposed extension from the intersection of Sand Lake Road which follows the base of the bluff to Point Campbell; and the second which would enter the tidelands west of Jodhpur Drive outside of the primary feeding and migration stopover areas of the refuge.

A change of this magnitude may significantly affect the distribution and abundance of waterfowl and shorebirds in this portion of the refuge. Patterns of deposition and erosion of sediments would probably be altered. Movement of fish and belukha whales in the channel between Fire Island and the mainland, if any, may be affected. The nature of these impacts, whether beneficial or adverse, has not yet been determined. In a detailed study of Knik Arm crossing alternatives, Dames and Moore (1983a) concluded a causeway dam would have a far greater impact to biological resources than a bridge or breached causeway. The extent of impact would depend greatly on its design and other mitigation measures. The Knik Arm crossing study also concluded that secondary impacts to biological resources could be greater than direct impacts of the causeway (Dames and Moore 1985).

Seward Highway Expansion

Soils east of the present New Seward Highway offer a poor foundation for highway expansion (Ross 1964). Soils suitable for highway expansion have not at this point in time been identified and there are no proposals in the ADOT&PF six-year Capital Improvement Program to widen the New Seward Highway at Potter Marsh. No location or environmental studies have been performed to date. Although the highway right-of-way is not in the refuge, highway expansion or construction activities and associated runoff would have the potential to affect the refuge if not carefully monitored and contained.

Sewer Interceptor and Stormwater Drainage

In the early 1980s, the municipality considered building a sewer interceptor between Potter and Rabbit creeks (Young et al. 1983) and a small stormwater detention basin in Potter Marsh (Ott Water Engineers 1985).

Coastal Trail

The original plans for the Tony Knowles Coastal trail included an extension from Point Campbell to Potter Creek. The exact route remains undecided, but alternatives include the base and top of the coastal bluff. Both of these locations are fraught with unresolved complications. The soil mantle along most of the bluff is extremely unstable and would be subject to slumping and erosion. Construction along the top of the bluff requires setbacks of at least 100 feet to avoid continuing erosion; whereas, use of the area below the bluff is restricted in spring by constant mudflows and landslides (MPSA and MOA 1982). An embankment near the toe of the bluff could impound water, which could add to the instability of the bluff by saturating the soils.

Having a bike path below the bluff, where most of the lands are in the refuge, would greatly increase public access in the refuge. Human activity along the trail and concomitant forays into adjacent wetlands by humans and dogs has the potential to be a significant disturbance to nesting and spring migrant waterfowl and shorebirds (Burger 1986). Use of the trail located on the flats by hikers and bikers in fall would be hazardous due to the existing waterfowl hunting. These two activities are incompatible. Similarly, routing the trail anywhere seaward of the rifle range would be hazardous and incompatible with the existing use. Even if the trail were not directly downrange, it would promote exploration of the area by unwitting users. A trail extending across wetlands from Point Campbell to Potter Creek would also require a large quantity of fill, reducing the size and altering functions of existing wildlife habitat.

A trail located along the top of the bluff would be outside of the refuge; here the chief problem, in addition to mass wasting, would be acquiring an easement across the many private parcels. Johns Park may present a problem in routing the trail both below and above the bluff, as stipulations require it to remain undeveloped in perpetuity. Although it would be less scenic, the least objectionable route may be to follow residential streets and traverse municipal parks (except Johns Park) along the top of the bluff, then follow the old Seward Highway east of Potter Marsh.

Visitor Facilities

DOTPF has posted signs discouraging all but emergency use of shoulders along new Seward Highway; parking is restricted to the maintained pullouts. The new parking lot at the north end of Potter Marsh, in concert with closing access to the boardwalk from the new Seward Highway, should provide suitable and safe viewing opportunities for many species of dabbling ducks,

Canada geese and their goslings, and shorebirds. Additional species, including diving ducks and loons, which prefer deeper water, and red-winged blackbirds are more frequently observed at the south end of the refuge. A parking area and short boardwalk may be warranted at the south end. One or more observation blinds, built in accordance with European designs from large mounds of dirt so as to be relatively inconspicuous, could provide excellent viewing opportunities with little disturbance. The municipality has also proposed building observation blinds overlooking the wetlands south of Point Woronzof.

The Anchorage Audubon Society and the Bird Treatment and Learning Center have proposed building a permanent indoor nature center and bird treatment facility near Potter Marsh.

Habitat Enhancement/Mitigation

The ability of habitat to support fish or wildlife can be enhanced, either as an end in itself or to mitigate for adverse impacts of development on or off the refuge. Several previous attempts to enhance wildlife habitat in the refuge have been largely unsuccessful. Future attempts may range from erecting nest boxes for swallows near the Potter Marsh parking lot to major projects to mitigate adverse effects of development. Two major projects being contemplated are feasibility of building a sophisticated pond complex south of Campbell Creek (Ott Engineering 1989) and creating another large impoundment, like Potter Marsh, by building the causeway to Fire Island (MOA 1989b). Any future enhancement efforts must be well planned to enhance fish or wildlife populations or uses without adversely affecting existing populations or uses.

INFORMATION NEEDS

Wildlife and Vegetation Surveys and Studies

Considering the popularity of the refuge and its proximity to Anchorage, relatively little is known of its wildlife or their food resources. Generally, collecting information needed to manage harvested populations of wildlife is given highest priority. This explains why waterfowl habitat and populations have received some attention on the refuge. Surveys and inventories of big game mammals, such as moose and bears, have been conducted at a broader scale. Small mammals are the least well known group. Future wildlife research and inventories should focus on species with high public appeal, such as the Canada goose goslings and loons in Potter Marsh.

User Group Surveys

The refuge contains a very small slice of the wetland and wildlife resources in the state. Thus, its biological importance to survival of wildlife species is less important than its role in promoting public education and appreciation of wetlands and wildlife. The demographics, attitudes, knowledge, and needs of refuge users are relatively unknown.

Only one study (Meyer 1982) has attempted to define some of these characteristics for birdwatchers and other wildlife viewers, and it is becoming outdated. The social characteristics of user groups are just as critical as physical and biological information to understanding and maintaining the refuge. Thus, a more comprehensive survey of birdwatchers and other wildlife viewers is needed.

The other major refuge user group, waterfowl hunters, is even more poorly understood. On-site interviews and counts of waterfowl hunters could be conducted at access points during the waterfowl season. This survey could be conducted in concert with a survey of attitudes among residents along the bluff. Such information could be used to minimize conflicts stemming from one of the refuge's most sensitive management issues: waterfowl hunting near an urbanized area.

Hydrological Monitoring

The hydrologic regime of Potter Marsh is little known, yet this is perhaps the most crucial aspect of understanding and maintaining the marsh (Ford and Bedford 1987). The department has neither the resources nor the expertise to conduct hydrological research. Continuous or scheduled periodic sampling of water quantity and quality by the USGS should be resumed. In lieu of this, the Alaska Division of Geological and Geophysical Survey could be funded to collect pertinent hydrologic data.

Acquisition Priority

There are 11 large private inholdings within the refuge boundaries. None of these private properties are part of the refuge or governed by refuge land use rules and regulations. These properties may be purchased by the state and included in the refuge only if funds are available and a willing seller is found. Other options include land trades or acquiring conservation easements. A prioritized list of private inholdings should be maintained to ensure that the areas important for public access or wildlife are considered first.

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Table 1. Alaska Department of Fish and Game land purchases in the Anchorage Coastal Wildlife Refuge.

Property	Year Purchased	Acres	Cost
Anchorage Rifle Club	1980	57.0	83,000
Hancock	1981	250.5	500,000
Marston	1982	57.86	115,720
Bachner	1982	33.72	67,440
Jarvi	1982	2.4	6,000
Jarvi	1982	1.65	4,125
White	1983	20.0	33,000
Total		423.13	809,285

Table 2. Major plant communities of the Anchorage Coastal Wildlife Refuge as described in various studies.

Plant Community[a]	McCormick & Pinchon (1978)	Quimby (1972)	Batten et al. (1978)
		WETLANDS	
algae	algae (I)	unvegetated mud (type 2)	
Puccinellia-Triglochin	arrowgrass (G), alkaligrass (H)	seaside arrow-grass/large alkali-grass, unvegetated mud (type 1)	coastal marsh (sparse halophytic vegetation)
		Ramenski sedge	
	bayonetgrass (F)	unvegetated mud (type 3)	
		creeping alkali-grass	
Carex	Lyngbye sedge (E)	marsh	coastal marsh (Carex lyngbyaei type)
black spruce (drowned)	black spruce (C)	seaside arrow-grass conglomerate, marsh fringe (1,2)	coastal marsh (inner marsh type)
		floating marsh	
shrub bog (Myrica gale type)	sweetgale (B)	bog	coastal marsh (inner marsh type)
Calamagrostis	bluejoint grass (A)	marsh fringe (3)	coastal marsh (inner marsh type)
Scirpus-Carex marsh			freshwater marsh

Table 2. Continued.

Plant Community[a]	McCormick & Pinchon (1978)	Quimby (1972)	Batten et al. (1978)
	LOWLAND FOREST AND BOGS		
shrub-bog (*Myrica*-*Sphagnum* -spruce type)	black spruce (C)		bog
black spruce (live)	black spruce (C)		
deciduous	broadleaf (D)	alder	forest, alder swamp, willow alder thicket

[a] Refer to map of vegetation communities in map pocket for boundaries of these communities.

Table 3. Estimated numbers of anadromous and freshwater fish in and migrating up the 2 largest streams in the Anchorage Coastal Wildlife Refuge (K. Roth, pers. commun.).

Species	Rabbit Creek	Campbell Creek
Pink salmon	500 - 2,000	few - 200[a]
Coho salmon	50 - 250	100 - 200
King salmon	25 - 100	500 - 1,000
Red salmon	rare	700 - 1,000
Chum salmon	0	present
Dolly Varden	500	700 - 1,200
Whitefish spp.	present	present
Rainbow trout	0	5,000 - 10,000[b]
Stickleback spp.	very numerous	very numerous

[a] Peaks on even-numbered years, very few on odd-numbered years.

[b] Stocked annually by the F.R.E.D. Division, Alaska Department of Fish and Game.

Table 4. Wild mammals known to occur on the Anchorage Coastal Wildlife Refuge.

Common Name	Scientific Name
Masked shrew	Sorex cinereus
Vagrant shrew	Sorex vagrans
Snowshoe hare	Lepus americanus
Red squirrel	Tamiasciurus Hudsonicus
Beaver	Castor canadensis
Red-backed vole	Clethrionomys rutilus
Meadow vole	Microtus pennsylvanicus
Muskrat	Ondatra zibethicus
Meadow jumping mouse	Zapus hudsonius
Porcupine	Erithizon dorsatum
Belukha	Delphinapterus leucas
Coyote	Canis latrans
Red fox	Vulpes vulpes
Black bear	Ursus americanus
Brown bear	Ursus arctos
Short-tailed weasel	Mustela erminea
Mink	Mustela vison
River otter	Lutra canadensis
Lynx	Felis canadensis
Moose	Alces alces

Table 5. Bird species known to occur on the Anchorage Coastal Wildlife Refuge.

Common Name	Scientific Name	Status
Loons and grebes:		
Pacific loon	Gavia pacifica	R*
Red-necked grebe	Podiceps grisegena	C*
Horned grebe	Podiceps auritus	U*
Herons:		
Great blue heron	Ardea herodias	CA
Swans:		
Tundra swan	Cygnus columbianus	U
Trumpeter swan	Cygnus buccinator	R
Geese:		
Canada goose	Branta canadensis	C*
White-fronted goose	Anser albifrons	R
Snow goose	Chen caerulescens	U
Dabbling Ducks:		
Mallard	Anas platyrhynchos	C*
Gadwall	Anas strepera	R
Northern pintail	Anas acuta	C*
Green-winged teal	Anas crecca	C*
Garganey	Anas querquedula	CA
Blue-winged teal	Anas discors	CA
Northern shoveler	Anas clypeata	U*
Eurasian wigeon	Anas penelope	R
American wigeon	Anas americana	C*
Diving and seaducks:		
Canvasback	Aythya valisineria	U*
Redhead	Aythya americana	CA
Ring-necked duck	Aythya collaris	R
Greater scaup	Aythya marila	U*
Lesser scaup	Aythya affinis	R
Common goldeneye	Bucephala clangula	U*
Barrow's goldeneye	Bucephala islandica	U
Bufflehead	Bucephala albeola	R
Oldsquaw	Clangula hyemalis	CA
White-winged scoter	Melanitta fusca	CA
Common merganser	Mergus merganser	U
Raptors:		
Northern goshawk	Accipiter gentilis	U
Red-tailed hawk	Buteo jamaicensis	U*
Swainson's hawk	Buteo swainsoni	CA
Rough-legged hawk	Buteo lagopus	R
Golden eagle	Aquila chrysaetos	R
Bald eagle	Haliaeetus leucocephalus	U
Northern harrier	Circus cyaneus	U

Table 5. Continued.

Common Name	Scientific Name	Status
Raptors:		
Osprey	Pandion haliaetus	R
Merlin	Falco columbarius	U
American Kestrel	Falco sparverius	CA
Peregrine falcon	Falco peregrinus	R
Ptarmigans:		
Willow ptarmigan	Lagopus lagopus	R
Cranes:		
Sandhill crane	Grus canadensis	R*
Coots:		
American coot	Fulica americana	CA
Shorebirds:		
Semipalmated plover	Charadrius semipalmatus	C*
Killdeer	Charadrius vociferus	R
Lesser golden plover	Pluvialis dominica	U
Black-bellied plover	Pluvialis squatarola	R
Hudsonian godwit	Limosa haemastica	R
Whimbrel	Numenius phaeopus	R
Greater yellowlegs	Tringa melanoleuca	C*
Lesser yellowlegs	Tringa flavipes	C*
Solitary sandpiper	Tringa solitaria	U*
Terek sandpiper	Xenus cinereus	CA
Spotted sandpiper	Actitis macularia	U*
Wandering tattler	Heteroscelus incanus	R
Ruddy turnstone	Arenaria interpres	CA
Black turnstone	Arenaria melanocephala	R
Red-necked phalarope	Phalaropus lobatus	U*
Common snipe	Gallinago gallinago	C*
Short-billed dowitcher	Limnodromus griseus	C
Long-billed dowitcher	Limnodromus scolopaceus	U
Surfbird	Aphriza virgata	U
Semipalmated sandpiper	Calidris pusilla	U
Western sandpiper	Calidris mauri	C
Rufous-necked stint	Calidris ruficollis	CA
Least sandpiper	Calidris minutilla	C*
Baird's sandpiper	Calidris bairdii	R
Pectoral sandpiper	Calidris melanotos	U
Sharptailed sandpiper	Calidris scuminota	CA
Dunlin	Calidris alpina	R
Jaegers, gulls, and terns:		
Parasitic jaeger	Stercorarius parasiticus	CA
Glaucous gull	Larus hyperboreus	CA
Glaucous-winged gull	Larus glaucescens	C*
Herring gull	Larus argentatus	U*

Table 5. Continued.

Common Name	Scientific Name	Status
Mew gull	Larus canus	C*
Bonaparte's gull	Larus philadelphia	U*
Arctic tern	Sterna paradisaea	C*
Doves:		
Rock dove	Columba livia	R
Owls:		
Great horned owl	Bubo virginianus	U
Northern hawk owl	Surnia ulula	CA
Short-eared owl	Asio flammeus	R
Boreal owl	Aegolius funereus	CA
Woodpeckers:		
Common flicker	Coaptes auratus	U*
Flycatchers:		
Alder flycatcher	Empidonax alnorum	C*
Olive-sided flycatcher	Contopus borealis	U*
Swallows:		
Violet-green swallow	Tachycineta thalassina	C*
Tree swallow	Tachycineta bicolor	U*
Bank swallow	Riparia riparia	C*
Barn swallow	Hirundo rustica	CA
Cliff swallow	Hirundo pyrrhonota	U
Jays, magpies, and crows:		
Steller's jay	Cyanocitta stelleri	R
Gray jay	Perisoreus canadensis	R
Black-billed magpie	Pica pica	U*
Common raven	Corvus corax	U*
Clark's nutcracker	Nucifraga columbiana	CA
Chickadees:		
Black-capped chickadee	Parus atricapillus	C*
Boreal chickadee	Parus hudsonicus	U*
Thrushes:		
American robin	Turdus migratorius	C*
Hermit thrush	Catharus guttatus	U*
Swainson's thrush	Catharus ustulatus	U*
Gray-checked thrush	Catharus minimus	R
Kinglets:		
Ruby-crowned kinglet	Regulus calendula	C*
Golden crowned kinglet	Regulus satrapus	U
Pipits:		
American pipit	Anthus rubescens	U

Table 5. Continued.

Common Name	Scientific Name	Status
Shrikes:		
Northern shrike	Lanius excubitor	U*
Wood warblers:		
Yellow-rumped warbler	Dendroica coronata	C*
Northern waterthrush	Seiurus noveboracensis	R*
Wilson's warbler	Wilsonia pusilla	U*
Blackpoll warbler	Dendroica striata	U*
Townsend's warbler	Dendroica townsendi	U*
Yellow warbler	Dendroica petechia	U*
Orange-crowned warbler	Vermivora celata	C*
Blackbirds:		
Yellow-headed blackbird	Xanthocephalus	CA
Red-winged blackbird	Agelaius phoeniceus	R*
Rusty blackbird	Euphagus carolinus	U*
Brown-headed cowbird	Molothrus ater	CA
Sparrows and buntings:		
Savannah sparrow	Passerculus sandwichensis	C*
Dark-eyed junco	Junco hyemalis	C*
American tree sparrow	Spizella arborea	R
White-crowned sparrow	Zonotrichia leucophrys	C*
Golden-crowned sparrow	Zonotrichia atricapilla	U*
Fox sparrow	Passerella iliaca	C*
Lincoln's sparrow	Melospiza lincolnii	C*
Song sparrow	Melospiza melodia	R*
Lapland longspur	Calcarius lapponicus	U
Snow bunting	Plectrophenax nivalis	R
Finches:		
Pine grosbeak	Pinicola enucleator	U
Common redpoll	Carduelis flammea	U*
Pine siskin	Carduelis pinus	C*
White-winged crossbill	Loxia leucoptera	U*

Sources: ADF&G report (1970), Anchorage Audubon Seeing Eye Notebook, ADFG staff observations, and T.G. Tobish (pers. commun).

Status

C Common-Species occurs repeatedly in all or nearly all proper habitats; areas of presumed suitable habitat are occupied heavily but some can be occupied sparsely or not at all; and/or the region regularly hosts great numbers of the species.

U Uncommon-Species occurs regularly but may not be observed even in proper habitat; utilizes only some or very little of the suitable habitat; and/or the region regularly hosts relatively small numbers of species.

R Rare-Species occurs, or probably occurs, regularly within the region, but in very small numbers.

CA Casual or Accidental-Species has been recorded no more than a few times, but irregular observations are likely over a period of years or a species so far from its normal range that further observations are unlikely.

* Breeder-Known or probable breeder on the refuge.

Table 6. Movements of banded birds into and out of Anchorage, Alaska: 1932-1990.

Species	Where Banded	Date (Mo-Da-Yr)	Where Resighted	Date (Mo-Da-Yr)
Canada goose	Copper River Delta, AK	7-22-62	Anchorage	9-14-74 *
	Anchorage	8-22-62	Anchorage	2-28-68
	Anchorage	8-15-66	Willamette Valley, OR	12-10-67 *
	central British Columbia	4-20-68	Anchorage	10-10-71 *
	Seward Peninsula, AK	7-11-69	Anchorage	10-03-71 *
	Illinois	1-12-70	Anchorage	3-31-76
	Copper River Delta, AK	7-29-73	Anchorage	..-..-76 *
	Anchorage	7-18-74	Willamette Valley, OR	11-20-74 *
	Anchorage	7-18-74	Willamette Valley, OR	11-21-74 *
	Anchorage	7-18-74	Willamette Valley, OR	11-24-74 *
	Anchorage	7-18-74	Willamette Valley, OR	11-..-74 *
	Anchorage	7-18-74	Willamette Valley, OR	12-11-74 *[a]
	Anchorage	7-18-74	Willamette Valley, OR	12-15-74 *
	Anchorage	7-18-74	Willamette Valley, OR	12-22-74 *
	Anchorage	7-18-74	Willamette Valley, OR	12-..-74 *
	Anchorage	7-18-74	Willamette Valley, OR	11-15-75 *
	Anchorage	7-18-74	Columbia R. mouth, WA	11-22-75 *
	Anchorage	7-18-74	Puget Sound, WA	11-23-75 *
	Anchorage	7-18-74	Willamette Valley, OR	11-29-75 *
	Anchorage	7-18-74	Willamette Valley, OR	11-29-75 *
	Anchorage	7-18-74	Willamette Valley, OR	11-29-75 *
	Anchorage	7-18-74	Willamette Valley, OR	12-13-75 *
	Anchorage	7-18-74	Willamette Valley, OR	12-20-75 *
	Anchorage	7-18-74	Willamette Valley, OR	10-19-76 *
	Anchorage	7-18-74	Queen Charlotte Is., BC	11-..-76 *
	Anchorage	7-18-74	Willamette Valley, OR	12-09-76 *
	Anchorage	7-18-74	Willamette Valley, OR	12-13-76 *[b]
	Anchorage	7-18-74	Willamette Valley, OR	..-..-76 *
	Anchorage	7-18-74	Chickaloon Flats, AK	9-04-77 *
	Anchorage	7-18-74	Willamette Valley, OR	11-05-77 *
	Anchorage	7-18-74	Willamette Valley, OR	12-17-77 *
	Anchorage	7-18-74	Sitka, AK	10-08-78 *

Species	Where Banded	Date (Mo-Da-Yr)	Where Resighted	Date (Mo-Da-Yr)
Canada goose (cont.)	Anchorage	7-18-74	Columbia R. mouth, WA	11-17-78 *
	Anchorage	7-18-74	lower Columbia River, WA	11-18-78 *
	Anchorage	7-18-74	Anchorage	4-16-81
	Anchorage	7-19-75	Anchorage	9-13-75 *
	Anchorage	7-19-75	Anchorage	9-13-75 *
	Anchorage	7-19-75	Queen Charlotte Is., BC	10-14-75 *
	Anchorage	7-19-75	Queen Charlotte Is., BC	10-..-75 *
	Anchorage	7-19-75	Willamette Valley, OR	12-20-75 *
	Anchorage	7-22-75	Willamette Valley, OR	10-12-75 *
	Anchorage	7-20-76	Anchorage	9-01-76 *
	Anchorage	7-20-76	Anchorage	9-01-76 *
	Anchorage	7-20-76	Susitna Flats, AK	9-01-76 *
	Anchorage	7-20-76	Willamette Valley, OR	10-31-76 *
	Anchorage	7-20-76	Willamette Valley, OR	11-13-76 *
	Anchorage	7-20-76	Willamette Valley, OR	11-17-76 *
	Anchorage	7-20-76	Willamette Valley, OR	11-27-76 *
	Anchorage	7-20-76	Willamette Valley, OR	11-..-76 *
	Anchorage	7-20-76	Willamette Valley, OR	12-03-76 *
	Anchorage	7-20-76	Willamette Valley, OR	12-30-76 *
	Anchorage	7-20-76	Willamette Valley, OR	1-01-77 *
	Anchorage	7-20-76	Anchorage	9-01-77 *
	Anchorage	7-20-76	Willamette Valley, OR	1-14-78 *
	Anchorage	7-20-76	Anchorage	6-04-78
	Anchorage	7-20-76	Puget Sound, WA	12-08-78 *
	Anchorage	7-20-76	Willamette Valley, OR	12-13-80 *
	Anchorage	7-20-76	Willamette Valley, OR	12-12-83 *
	Anchorage	7-21-77	Willamette Valley, OR	10-29-77 *
	Anchorage	7-21-77	Willamette Valley, OR	11-16-77 *
	Anchorage	7-21-77	Willamette Valley, OR	12-15-77 *
	Anchorage	7-21-77	Willamette Valley, OR	1-15-78 *
	Anchorage	7-21-77	Anchorage	5-24-78
	Anchorage	7-21-77	Anchorage	10-03-78 *
	Anchorage	7-21-77	Willamette Valley, OR	11-20-78 *

Species	Where Banded	Date (Mo-Da-Yr)	Where Resighted	Date (Mo-Da-Yr)
Canada goose (cont.)	Anchorage	7-21-77	Willamette Valley, OR	..-..-78 *
	Anchorage	7-21-77	Willamette Valley, OR	1-02-79 *
	Anchorage	7-21-77	Willamette Valley, OR	11-21-79 *
	Anchorage	7-21-77	Willamette Valley, OR	11-21-79 *
	Anchorage	7-22-77	Willamette Valley, OR	11-05-77 *
	Anchorage	7-22-77	Willamette Valley, OR	11-05-77 *
	Anchorage	7-22-77	Willamette Valley, OR	11-06-77 *
	Anchorage	7-22-77	Willamette Valley, OR	11-16-77 *
	Anchorage	7-22-77	Willamette Valley, OR	11-20-77 *
	Anchorage	7-22-77	Willamette Valley, OR	11-27-77 *
	Anchorage	7-22-77	Willamette Valley, OR	11-27-77 *
	Anchorage	7-22-77	Willamette Valley, OR	12-15-77 *
	Anchorage	7-22-77	Willamette Valley, OR	12-31-77 *
	Anchorage	7-22-77	Willamette Valley, OR	12-..-77 *
	Anchorage	7-22-77	Willamette Valley, OR	..-..-77 *
	Anchorage	7-22-77	Willamette Valley, OR	10-14-78 *
	Anchorage	7-22-77	Willamette Valley, OR	11-26-78 *
	Anchorage	7-22-77	Willamette Valley, OR	11-17-84 *
	Anchorage	7-18-78	Anchorage	4-29-79
	Palmer Hay Flats, AK	7-31-79	Anchorage	8-06-79
	Puget Sound, WA	6-19-81	Anchorage	..-..-84 *
	Copper River Delta, AK	7-22-85	Anchorage	2-..-89
American green-winged teal	Anchorage	7-12-74	Vancouver, BC	..-..-74 *
	Anchorage	7-12-74	SE Washington	11-08-74 *
Mallard	Colorado	2-01-65	Anchorage	9-01-68 *
	Vancouver, BC	1-21-72	Anchorage	8-26-75
	Vancouver, BC	11-25-72	Anchorage	9-01-74 *
	Anchorage	8-16-74	Willamette Valley, CA	12-28-75 *
	Anchorage	7-15-75	Anchorage	11-12-75
	Anchorage	8-26-75	Anchorage	9-01-75 *

Species	Where Banded	Date (Mo-Da-Yr)	Where Resighted	Date (Mo-Da-Yr)
Mallard (cont.)	Anchorage	8-26-75	Anchorage	9-01-75 *
	Anchorage	8-26-75	Palmer Hay Flats, AK	9-06-75 *
	Anchorage	8-26-75	Kusciusko Is., AK	10-..-75 *
	Anchorage	8-26-75	Kodiak, AK	12-18-75 *
	Anchorage	8-26-75	N. Olympic Peninsula, WA	11-25-77 *
	Anchorage	8-26-75	Anchorage	10-14-88
	Anchorage	8-28-75	Palmer Hay Flats, AK	9-06-75 *
	Anchorage	8-28-75	Matanuska Valley, AK	9-14-75 *
	Sacramento Valley, CA	2-02-76	Anchorage	10-11-76 *
	Anchorage	8-26-76	Palmer Hay Flats, AK	10-02-76 *
	Anchorage	8-31-76	Anchorage	9-18-76 *
	Anchorage	8-09-77	Palmer Hay Flats, AK	9-22-77 *
	Vancouver, BC	8-31-77	Anchorage	9-22-79 *
	Anchorage	7-18-78	Susitna Flats, AK	10-21-78 *
	Anchorage	7-18-78	Anchorage	12-29-78
	Anchorage	7-18-78	Susitna Flats, AK	9-02-79 *
	Anchorage	11-17-78	Susitna-Oshetna R., AK	9-09-80 *
	Anchorage	11-17-78	Anchorage	6-19-81
	NW Alberta	8-25-80	Anchorage	9-20-82 *
	SE Yukon	10-20-81	Anchorage	9-18-82
	Anchorage	1-06-82	Anchorage	6-14-84
	Anchorage	1-06-82	Anchorage	11-01-87 *
	Anchorage	1-07-82	Anchorage	7-..-82
	Anchorage	1-07-82	Anchorage	9-15-86
	Anchorage	1-08-82	Susitna Flats, AK	10-03-82 *
	Anchorage	1-09-82	Anchorage	9-24-84 *
	Anchorage	1-10-82	Susitna Flats, AK	9-03-82 *
	Anchorage	1-10-82	Anchorage	5-23-83
	Anchorage	1-16-82	Anchorage	12-..-82
	Anchorage	1-16-82	Anchorage	4-20-83
	Anchorage	1-19-82	Anchorage	12-03-83
	Anchorage	1-19-82	Anchorage	12-..-88
	Anchorage	1-20-82	Anchorage	3-15-83

Species	Where Banded	Date (Mo-Da-Yr)	Where Resighted	Date (Mo-Da-Yr)
Mallard (cont.)	Anchorage	1-21-82	Anchorage	3-..-86
	Anchorage	1-11-83	Anchorage	5-29-87
	Anchorage	1-12-83	Anchorage	2-..-83
	Anchorage	1-12-83	Anchorage	3-..-83
	Anchorage	1-12-83	Anchorage	..-..-84 *
	Anchorage	1-12-83	Susitna Flats, AK	9-01-85 *
	Anchorage	1-12-83	Anchorage	6-17-86
	Anchorage	1-14-83	Anchorage	9-05-83 *
	Anchorage	1-14-83	Alaska	9-15-86 *
	Anchorage	1-14-83	Anchorage	1-30-88
	Anchorage	1-19-83	Anchorage	4-17-86
	Anchorage	1-21-83	Goose Bay, AK	9-..-88 *
	Anchorage	1-11-84	Anchorage	1-02-89
	Anchorage	1-11-84	Anchorage	7-19-89
	Anchorage	1-12-84	Kake, AK	11-03-87 *
	Anchorage	1-12-84	Anchorage	5-10-90
	Anchorage	1-13-84	Anchorage	10-24-84 *
	Anchorage	1-17-84	Anchorage	1-04-86
	Anchorage	1-23-84	Anchorage	10-03-84 *
	Anchorage	1-24-84	Anchorage	4-30-89
	Anchorage	1-25-84	Anchorage	9-15-86
	Anchorage	1-25-84	Anchorage	10-12-86 *
Northern pintail	Vancouver, BC	12-18-32	Anchorage	9-01-34 *
	San Joaquin Valley, CA	3-05-33	Anchorage	9-02-34 *
	Sacramento Valley, CA	11-04-50	Anchorage	9-18-53 *
	south Saskatchewan	7-30-51	Anchorage	9-02-53 *
	San Joaquin Valley, CA	8-19-54	Anchorage	9-01-55 *
	Salton Sea, CA	1-01-57	Anchorage	9-02-57 *
	Salton Sea, CA	1-15-62	Anchorage	9-..-65 *
	SE Manitoba	8-29-69	Anchorage	9-09-72 *
	Sacramento Valley, CA	2-05-71	Anchorage	10-08-72 *
	Anchorage	7-12-74	Anchorage	9-01-74 *

Species	Where Banded	Date (Mo-Da-Yr)	Where Resighted	Date (Mo-Da-Yr)
Northern pintail (cont.)	Anchorage	7-12-74	Vancouver, BC	11-07-77 *
	Anchorage	7-23-74	Anchorage	9-01-74 *
	Anchorage	7-23-74	Lower Klamath Lake, CA	11-02-74 *
	Anchorage	7-23-74	Columbia R. mouth, WA	11-08-74 *
	Anchorage	8-16-74	Susitna Flats, AK	9-01-74 *
	Anchorage	8-16-74	Anchorage	9-01-74 *
	Anchorage	8-16-74	Anchorage	9-01-74 *
	Anchorage	8-16-74	Columbia R. mouth, WA	10-31-74 *
	San Joaquin Valley, CA	2-12-79	Anchorage	9-08-79 *
	NW Alberta	8-15-82	Anchorage	9-08-85 *
	south Alberta	8-14-84	Anchorage	9-02-89 *
American wigeon	Yukon-Innoko rivers, AK	7-24-51	Anchorage	9-30-51 *
	Sacramento Valley, CA	1-09-62	Anchorage	9-01-65 *
	Lake Mead, NV	2-03-66	Anchorage	9-01-67 *
	SE Washington	3-01-66	Anchorage	9-03-67 *
	Anchorage	8-16-74	Anchorage	9-01-74 *
	Anchorage	8-16-74	Anchorage	9-01-74 *
	Anchorage	8-16-74	Anchorage	9-11-74 *
	Anchorage	8-26-75	Anchorage	8-01-80
	Anchorage	8-26-75	Willamette Valley, OR	1-06-83 *
Greater scaup	New York	2-01-62	Anchorage	6-..-64
Northern goshawk	Anchorage	11-10-82	Matanuska Valley, AK	3-27-84
Mew gull	Anchorage	5-01-62	Willamette Valley, OR	12-15-64
	Anchorage	5-05-62	Anchorage	8-12-79
	Anchorage	5-07-62	Anchorage	5-01-72
	Anchorage	6-21-79	Sitka, AK	9-03-79
	Anchorage	6-29-79	Anchorage	7-20-79

Species	Where Banded	Date (Mo-Da-Yr)	Where Resighted	Date (Mo-Da-Yr)
Herring gull	Anchorage	5-01-62	Seattle, WA	10-17-71
	Lake Louise, AK	8-02-84	Anchorage	10-20-84
Glaucous-winged gull	Copper River Delta, AK	7-15-75	Anchorage	8-30-75
Tree swallow	Anchorage	7-19-78	Anchorage	6-27-83
Cliff swallow	Anchorage	7-10-85	Anchorage	6-01-86
American robin	Anchorage	6-13-79	Anchorage	6-18-81
White-crowned sparrow	Juneau, AK	5-10-78	Anchorage	5-11-79
Dark-eyed junco	Anchorage	8-17-80	Anchorage	5-23-81
	Anchorage	6-21-81	south Manitoba	..-..-82
	Nebraska	4-03-87	Anchorage	5-04-87
Red-winged blackbird	Delaware	1-31-63	Anchorage	6-18-81
Pine grosbeak	Anchorage	12-13-81	Anchorage	4-28-82
	Anchorage	12-15-81	Anchorage	2-08-87
Common redpoll	Anchorage	3-27-76	Ohio	5-08-78
	Anchorage	1-24-81	Anchorage	12-..-81
	Anchorage	1-24-81	Minnesota	4-03-82
	Anchorage	2-08-81	Ohio	3-25-82

[a]Same band number reported from Willamette Valley on 12-09-76.
[b]Same band number reported from Willamette Valley on 11-18-77.
* Shot by hunter.

Table 7. Waterfowl harvest and hunting effort on the Anchorage Coastal Wildlife Refuge based on estimates from the state waterfowl hunter survey.[a]

Year	Hunter Days	% State Total	Harvest	% State Total	Ducks per Hunter Day
			DUCKS		
1971	563	1.2	502	0.6	0.89
1972	415	0.7	917	1.0	2.21
1973	810	1.4	2238	2.5	2.76
1974	1770	2.2	1795	2.5	1.01
1975	684	1.0	615	0.7	0.90
1976	668	1.0	510	0.5	0.76
....					
1982	2150	3.5	2400	2.1	1.12
1983	684	0.9	247	0.2	0.36
1984	760	1.0	305	0.3	0.40
1985	2050	3.9	345	0.4	0.17
....					
1987	1704	2.9	943	1.2	0.55
1988	1025	2.3	947	1.1	0.92
1989	1210	3.7	1002	1.9	0.83
			GEESE		
1972			11	0.1	
1973			0	0.0	
1974			0	0.0	
1975			0	0.0	
1976			0	0.0	
....					
1982			70	0.5	
1983			0	0.0	
1984			0	0.0	
1985			0	0.0	
....					
1987			22	0.4	
1988			41	0.5	
1989			76	1.3	

[a] Some estimates based on small sample sizes.

Table 8. Chronology of recoveries of banded waterfowl by hunters in Anchorage, Alaska: 1934-1990.

	Date								
	September				October				Nov.
Species	1-7	8-14	15-21	22-28	29-5	6-12	13-19	20-26	27-2
Canada goose	3	3			2	1			
Mallard	5		2	2	1	2		1	1
Northern pintail	10	3	1			1			
American wigeon	5	2			1				
Total	23	8	3	2	4	4		1	1
Percent	50	17	7	4	9	9		2	2

Compiled from records of the U. S. Fish and Wildlife Service Bird Banding Laboratory, Laurel, MD 20811.

ANCHORAGE COASTAL WILDLIFE REFUGE

BIRDS AND FISH

- Duck/Canada Goose Feeding
- Duck/Canada Goose Rearing
- Duck/Canada Goose Spring and Fall Migration Stopover
- Duck/Canada Goose/ Grebe Nesting
- Concentrated Canada Goose Feeding
- Occasional Snow Goose Spring Migration Stopover
- Occasional Swans During Migration
- Shorebird Spring and Late Summer Migration Stopover
- Snipe Fall Migration Stopover
- Large Bank Swallow Colony
- Anadromous Stream

CH – Chum Salmon
CO – Coho Salmon
K – King Salmon
P – Pink Salmon
S – Sockeye Salmon
DV – Dolly Varden

r – Rearing
s – Spawning

SOURCE: R. Sinnott, June 13, 1990 (Based on meetings with Jim Hemming, Bruce Campbell, Dan Rosenberg, Dimitri Bader, and Dave Harkness)

Mile
.5 0 1
SCALE

STATE OF ALASKA
DEPARTMENT OF FISH AND GAME
FEBRUARY 1991

CH,COr,Ksr,P,Sr,DV

CH,Cos,Ksr,Ps,DV

Mew and Glaucous-Winged Gulls Nesting and Feeding Area

CO,K,P,DVr

Tree Swallows, Violet-Green Swallows, and Arctic Tern Feeding Area

COr,P

Point Woronzof

North Point

Point Campbell

POINT CAMPBELL MILITARY RESERVATION

ANCHORAGE INTERNATIONAL AIRPORT

TURNAGAIN ARM

FIRE ISLAND

ANCHORAGE

Lake Spenard

Hood Lake

Campbell Lake

Westchester Lagoon

Boardwalk

Little Survival Creek

Potter

Rabbit Creek

Chester Creek

Campbell Creek

Fish Creek

Earthquake Park

Coastal Trail

MUNICIPALITY OF ANCHORAGE
KENAI PENINSULA

ANCHORAGE COASTAL WILDLIFE REFUGE

LAND STATUS

- State Mental Health Land
- State Land Lease
- State Oil and Gas Lease
- Municipal Land
- Approved Municipal Selection
- Private Land
- Major Access Points
- Refuge Boundary

All lands and waters in the refuge unless otherwise indicated are State owned. The refuge boundary shown depicts the statutory extent of the refuge. Private lands within this boundary are not part of the refuge.

SCALE .5 0 1 Mile

STATE OF ALASKA
DEPARTMENT OF FISH AND GAME
FEBRUARY 1991

R/W Permit
Electric Transmission

Point Woronzof

ANCHORAGE INTERNATIONAL AIRPORT

POINT CAMPBELL MILITARY RESERVATION

Point Campbell

North Point

TURNAGAIN ARM

30' R/W
Sanitary Sewer

State Land Lease

R/W Permit
Oil Pipeline

Landfill

John's Park

Oceanview
Bluff Park

Rifle Range

Boardwalk

200' R/W Alaska Railroad
(excluded from the refuge)

235' R/W New Seward Highway
(excluded from the refuge)

300' R/W Old
Seward Highway
(excluded from
the refuge)

State Land Lease

30' R/W Gas Pipeline

MUNICIPALITY OF ANCHORAGE
KENAI PENINSULA

ANCHORAGE COASTAL WILDLIFE REFUGE

VEGETATION COMMUNITIES

- Tidal Flats
  - Algae
  - Mud
- Puccinellia–Triglochin Community
  Alkali Grass, Seaside Arrow-grass
- Carex Community
  Lyngbye Sedge, Silverweed, Arrow-Grass, Pondweed, Wigeon Grass
- Calamagrostis canadensis Community
  Bluejoint, Silverweed
- Scirpus–Carex Marsh Community
  Bulrush, Sedge, Pondweed
- Elymus–Forbs
- Schrub–Bog Community
  - Myrica gale Type
    Sweet Gale, Bluejoint, Drowned Paper Birch
  - Myrica gale–Sphagnum–Spruce Type
    Sweet Gale, Sphagnum Moss, Black Spruce, Labrador Tea, Bluejoint
- Black Spruce Community
  Live and Drowned Black Spruce, White Spruce, Drawf Birch, Alder, Labrador Tea, Bluejoint
- Deciduous Community
  Paper Birch, Balsam Poplar, Alder, Willow, Bluejoint
- Cobble–Gravel

Sources: Primary information from WAPORA Wetlands Report (Pichon, 1978), additional information from the National Wetlands Inventory Map, USFWS (1980) and field observations.

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SCALE

STATE OF ALASKA
DEPARTMENT OF FISH AND GAME
FEBRUARY 1991