TRADING BAY STATE GAME REFUGE
AND
REDOUBT BAY CRITICAL HABITAT AREA
MANAGEMENT PLAN

JULY 1994

Prepared by the Divisions of
Habitat and Restoration
and
Wildlife Conservation

Alaska Department of Fish and Game
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Anchorage, AK 99518-1599

Carl L. Rosier, Commissioner

The Alaska Department of Fish and Game has published this document in accordance with AS 44.62 to assist in the management of the Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area at a cost of $14.24 per copy. This document was printed in Anchorage, Alaska.

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The Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area Management Plan has been prepared by Alaska Department of Fish and Game (ADF&G) biologists Debra Clausen (Habitat and Restoration Division) and Rick Sinnott (Wildlife Conservation Division), with special assistance from clerical staff Susan Peyer and cartographic support from Frances Inoue.

This plan has been developed with the aid of an interagency planning team composed of representatives from state, federal, and local agencies with jurisdiction over the refuge and critical habitat area. Planning team members who participated in development of the plan are as follows: Katie Farley, Alaska Department of Natural Resources; Priscilla Wohl, Alaska Department of Environmental Conservation; Dennis Haanpaa, Division of Commercial Fisheries Management and Development, ADF&G; Craig Whitmore, Division of Sport Fish, ADF&G; Rita Miraglia, Division of Subsistence, ADF&G; Deborah Gilcrest, Kenai Peninsula Borough; and Laurie Fairchild, U.S. Fish and Wildlife Service. Phil North, Environmental Protection Agency, was also named to the planning team.

The Redoubt Bay Critical Habitat Area Citizens' Advisory Committee has provided guidance in the development of the management plan for the Redoubt Bay Critical Habitat Area throughout the planning process. Members of the advisory committee are as follows: Greg Bell, Greg Caille, Patrick Cowan, Bud Crawford, Bradley Penn, Jim Doyle, Henry Knackstedt, Keith Hursh, and Mark Mahan.

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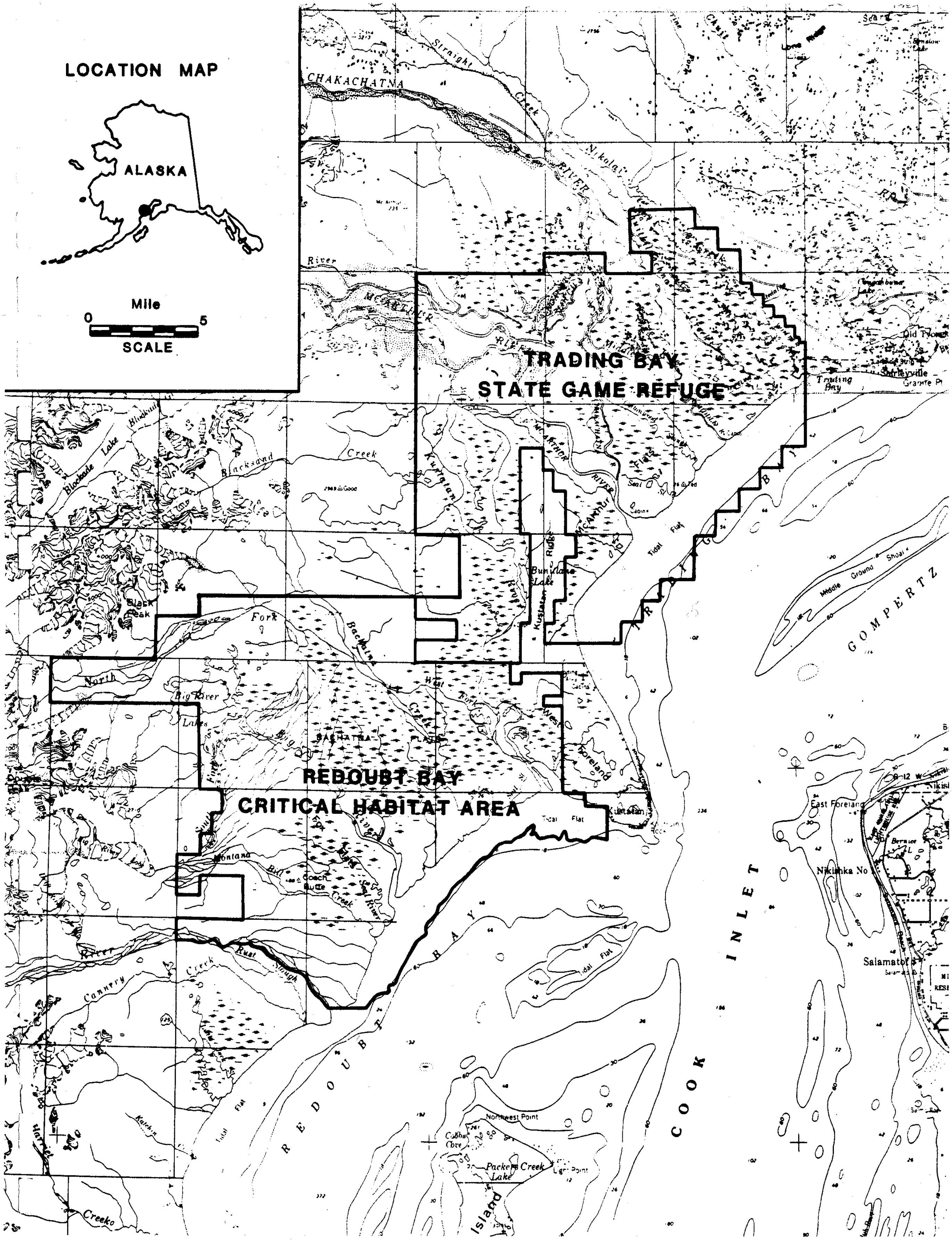
LOCATION MAP
ALASKA
Mile
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SCALE
TRADING BAY
STATE GAME REFUGE
REDOUBT BAY
CRITICAL HABITAT AREA
CHAKACHATNA
Straight
Creek
Nikolai
RIVER
McARTHUR
RIVER
Blacksand
Creek
Black Peak
Fork
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Lakes
BASHATNA
FLATS
West
Foreland
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Kustatan
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Middle Ground Shoal
GOMPERTZ
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Nikishka No
Salamatof
COOK INLET
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Montana
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Butte
Creek
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INTRODUCTION

The Trading Bay State Game Refuge was established in 1976 to protect fish and wildlife populations; waterfowl nesting, feeding, and migration; moose calving areas; spring and fall bear feeding areas; salmon spawning and rearing habitats; public use of fish and wildlife (waterfowl, moose, and bear hunting); viewing; photography; and general recreation in a high quality environment.

The Redoubt Bay Critical Habitat Area was established in 1989 to ensure the protection and enhancement of fish and wildlife habitat and populations, especially Tule geese; the continuation of fish and wildlife harvest; and public use and enjoyment of the area in a high quality environment.

The purpose of the Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area Management Plan is to provide consistent long-range guidance to the Alaska Department of Fish and Game and other agencies involved in managing the refuge and critical habitat area.

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

This plan is the result of a public planning process led by the Alaska Department of Fish and Game. The plan has been developed by a planning team representing state, federal, and municipal agencies including: the Alaska Departments of Fish and Game (ADF&G), Natural Resources (DNR), and Environmental Conservation (DEC); the U.S. Fish and Wildlife Service (USFWS); and the Kenai Peninsula Borough (KPB). The Redoubt Bay Critical Habitat Area Citizens' Advisory Committee was instrumental in providing guidance in the development of goals and policies for the Redoubt Bay Critical Habitat Area.

At the beginning of the public planning process, public meetings were held in Soldotna, Anchorage, and Tyonek to explain the planning process and solicit citizens' opinions regarding the issues, interests, and concerns pertinent to refuge and critical habitat area management. The meetings' results and written comments received 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 fish and wildlife populations, 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 presented in the Appendix.

Management goals and policies for the refuge and critical habitat area were developed by the planning team to address the identified issues. All policies were developed with consideration of their ability to meet the plan's management goals. In addition, other applicable laws and the Public Trust Doctrine were considered.

The draft plan was distributed for public review. Based on comments received during the review, appropriate changes were made, and the Commissioner of Fish and Game adopted the plan for use by the department in managing the refuge and critical habitat area.

The plan is implemented by the ADF&G in several ways. A special area permit is required for any habitat altering activity, including any construction work, in a designated state game refuge or critical habitat area (5 AAC 95). A special area permit application form can be obtained from any ADF&G office and should be submitted to the Habitat and Restoration Division regional office in Anchorage. The Habitat and Restoration Division will review all proposed activities for consistency with the goals and policies outlined in the plan. Activities will be approved, conditioned, or denied based on the direction provided in the plan as well as other applicable state laws and regulations.

Future Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area management activities of the ADF&G 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 within the refuge and critical habitat area as well. Any use, lease, or disposal of resources on state land in the refuge or critical habitat area requires DNR authorization. For example, DNR awards leases for oil and gas on the refuge and critical habitat area through procedures outlined in Title 38 of the Alaska Statutes. Activities affecting air or water quality require authorization from DEC. The U.S. Army Corps of Engineers (COE) evaluates applications for discharging dredged and fill material in waters of the United States including wetlands. Federal and state agencies, including the USFWS, National Marine Fisheries Service (NMFS), and Environmental Protection Agency (EPA), along with local governments, review proposals for COE permits, pursuant to the Fish and Wildlife Coordination Act (16 USC 661-666 et. seq.). U.S. Coast Guard approval is required for certain kinds of work in navigable waters. The KPB reviews and comments on all permit proposals within the coastal zone, including the Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area.

TRADING BAY STATE GAME REFUGE STATUTES

Alaska Statutes which pertain specifically to the establishment and management of the Trading Bay State Game Refuge are as follows:

AS 16.20.020. Purpose. *The purpose of AS 16.20.010 - 16.20.080 is to protect and preserve the natural habitat and game population in certain designated areas of the state.*

AS 16.20.038. Trading Bay State Game Refuge*. (a) The following state-owned land, including tide and submerged land, and all land, including tide and submerged land, acquired in the future by the state lying within the parcels described in this subsection is established as the Trading Bay State Game Refuge:*

(1) Township 9 North, Range 13 West, Seward Meridian
Section 6-7;
(2) Township 9 North, Range 14 West, Seward Meridian
Sections 1-4, E½ 5, 8-12, W½ 13, 14-17, E½ 19, 20-22, W½ 23, W½ 27, 28-30;
(3) Township 9 North, Range 15 West, Seward Meridian
Sections W½ 1, 2-4, 9-11, W½ 12 and 13, 14-16, 19-23, W½ 24, 26-28, 31-35;
(4) Township 10 North, Range 13 West, Seward Meridian
Sections 1-12, 14-22, 28-32;
(5) Township 10 North, Range 14 West, Seward Meridian
Sections 1-18, E½ 19, 20-29, 32-36;
(6) Township 10 North, Range 15 West, Seward Meridian
Sections 1-12, 14-23, 26-35;
(7) Township 11 North, Range 13 West, Seward Meridian
Sections SW¼ 3, 4-10, SW¼ 11; W½ SW¼ 13; 14-23; W½, SE¼, W½ NE¼, SE¼ NE¼ 24, 25-36;
(8) Township 11 North, Range 14-15 West, Seward Meridian
Sections 1-36;
(9) Township 12 North, Range 13 West, Seward Meridian
Sections 19, 29-33;
(10) Township 12 North, Range 14 West, Seward Meridian
Sections 23-26, 31-33, 36.

(b) The Trading Bay State Game Refuge is established to protect the following:

(1) fish and wildlife habitat and populations, particularly waterfowl nesting, feeding, and migration areas; moose calving areas; spring and fall bear feeding areas; salmon spawning and rearing habitats;

(2) public uses of fish and wildlife and their habitat, particularly waterfowl, moose and bear hunting; viewing; photography; and general public recreation in a high quality environment.

(c) Entry upon the Trading Bay State Game Refuge for purposes of exploration and development of oil and gas resources shall be permitted when compatible with the purposes specified in (b) of this section; however, all existing leases shall be valid and continue in full force and effect according to their terms.

(d) Land selected by a borough within the area described in (a) of this section shall be included in the Trading Bay State Game Refuge, subject to borough approval. If the borough relinquishes the selection of the land, the selected land becomes part of the Trading Bay State Game Refuge.

(e) The state may not acquire by eminent domain privately-owned land within state-owned land specified in (a) of this section for inclusion in the Trading Bay State Game Refuge. The Department of Natural Resources may adopt, in accordance with AS 44.62 (Administrative Procedure Act), zoning regulations governing privately-owned land within the Trading Bay State Game Refuge, only to the extent that these regulations are imperative to ensure compatibility with the intended use of the refuge.

(f) Egress and ingress to and from private property within the parcels described in (a) of this section shall be allowed through access corridors established through agreement between the Department of Natural Resources, Department of Fish and Game, and the private property owners involved. The establishment of a refuge under this section does not impair or alter existing rights of access to set net site leases.

(g) The establishment of a refuge under this section does not impair or alter existing rights of a municipality to state land selected under former AS 29.18.190 - 29.18.200.

(h) Land within existing and applied for highway, pipeline, and railway rights-of-way, as of September 22, 1976, are excluded from the land described in (a) of this section; however, when these interests revert to the state, the land shall be included within the Trading Bay State Game Refuge.

(i) The Department of Natural Resources shall adopt regulations governing the issuance of permits for seasonal cabins or shelters within the refuge. The department shall issue a permit to owners of cabins or shelters existing on the day this Act becomes law. Use permits shall be for a period not to exceed five years and shall be renewable.[*]

(j) Any land conveyed to Cook Inlet Region, Inc., by the state under the terms of the Cook Inlet land exchange is excluded from the refuge.

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* Note: An Attorney General's opinion found this subsection unconstitutional and it was never implemented.

TRADING BAY STATE GAME REFUGE GOALS

Activities that occur within the Trading Bay State Game Refuge will reflect the following goals in accordance with the purpose for which the area was established (AS 16.20.038). All department management decisions in the Trading Bay State Game 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. Maintain, protect, and if appropriate, enhance the quality and quantity of habitat for historically occurring resident and migrant wildlife, particularly nesting, rearing, staging, feeding, and molting habitat for waterfowl, especially swans; important moose wintering and calving areas; and spring and fall bear feeding areas.

   B. Minimize harmful disturbance to fish and wildlife.

   C. Maintain, protect, and if appropriate, enhance salmon spawning, rearing, and overwintering habitat.

   D. Maintain water quality.

II. **Public Use** - Manage the refuge to maintain and enhance public use of fish, wildlife, and refuge lands and waters consistent with the other goals of this management plan.

   A. Maintain public access to and within the refuge.

   B. Maintain and, if compatible with existing public use as described in AS 16.20.038(b)(2), improve opportunities for waterfowl, moose, and bear hunting, trapping and fishing within the refuge.

   C. Maintain and, if compatible with existing public use as described in AS 16.20.038(b)(2), improve opportunities for wildlife viewing, photography, and general recreation in a high quality environment.

   D. Make information about the refuge available to the public.

III. **Multiple Use** - Manage multiple uses, including oil and gas, in the refuge in a manner compatible with goals I and II of this management plan.

Explanation of Terms

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

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 fish or wildlife populations. Harmful disturbance does not refer to the legal harvest of fish or wildlife.

High Quality Environment: Includes a natural landscape containing native plant communities; a full complement of native fish and wildlife species in their naturally occurring diversity and abundance; pristine air and water quality; an absence or only incidental occurrence of man-made noise and structures; and dispersed, low-intensity, seasonal public use.

TRADING BAY STATE GAME REFUGE POLICIES

Access - Maintain legal public access for continued public use and enjoyment of the area. Allow development of new public access where compatible with the goals of the management plan. Monitor motorboat use, including jetboat and airboat use, and aircraft use, including helicopter use, with special emphasis on the Kustatan River and adjacent shorelands, and, if necessary, establish motorboat and aircraft use restrictions consistent with the protection of fish and wildlife habitat; the conservation of fish and wildlife populations; and maintenance of public recreation in a high quality environment.

Information and Education - Provide information to refuge users regarding resource values and rules, including courtesy information on boating and aircraft use, low impact use, and the wilderness ethic. Encourage compatible research of fish, wildlife, and habitat resources and their use.

Off-Road Use of Motorized Vehicles - To ensure the protection of important habitat, avoid harmful disturbance to fish and wildlife, and accommodate a variety of users, the department will, in its discretion, as appropriate, issue a special area permit for the off-road use of wheeled, tracked, or other ground-effect equipment in the refuge. The recreational use of off-road motorized vehicles in ice free months will not generally be permitted, unless extenuating circumstances exist which render an activity in the best interests of public use of the area and consistent with the goals and policies of the management plan. Corridors for off-road use of motorized vehicles for access to setnet sites and private inholdings may be established by special area permit. A general special area permit will not be issued for off-road use of motorized vehicle access to the refuge from non-road easements.

Fish and Wildlife Habitat and Population Enhancement - As appropriate, allow management, enhancement, and rehabilitation of indigenous fish and wildlife populations and their habitats if it furthers the management goals of the area, is not at the expense of resource values (including diversity and abundance) for which the area was established, and does not interfere with public use and enjoyment.

Land Acquisition - The department will, in its discretion, acquire private lands or conservation easements within the refuge from willing sellers as time and funding permit through purchase or trade. Donation of lands or conservation easements for addition to the refuge will also be considered.

Cabins - Permit the continuing use and maintenance of authorized existing personal use cabins under terms and conditions compatible with the purposes for which the refuge was established. To maintain public use opportunities and experiences, protect refuge resources, and preclude proprietary use of refuge land, the department will, in its discretion, allow public use cabins, administrative cabins, trapping cabins, or cabins leased to a non-profit organization for a youth encampment or similar recreational or educational purpose in a manner consistent with maintenance of fish and wildlife habitat, fish and wildlife populations and public use of the area in a high quality environment. Commercial cabins will not be allowed except for access to shore fishery leases. A cabin permit or lease will be limited to the minimum acreage necessary to accommodate the structure and essential associated activities. The construction of new private or personal use cabins

will not be allowed on refuge lands. Unauthorized cabins will not be allowed. If appropriate, permit private non-profit groups to adopt existing cabins for public use.

Facilities for Commercial Guides, Outfitters and Seasonal Camping -To maintain public use opportunities in a high quality environment, a permanent facility for commercial guides or outfitters will not be allowed on the refuge unless it meets a public need specific to the purposes for which the area was established which cannot otherwise be met (e.g., on adjacent public lands or private inholdings) and does not displace other established non-commercial use. Establishment of a camp in excess of 14 consecutive days or relocating a camp within a 14-day period within a two-mile radius of the previous 14-day camp or any use of a tent platform on the refuge requires authorization through a special area permit. Temporary tent platforms (not exceeding one season's use) that will not significantly preclude existing public use of the refuge may be allowed. Permanent tent platforms (exceeding one season's use) will not be allowed. Use of temporary structures does not convey any future or exclusive rights and may not exceed one season's use.

Forest Management - Forest management on the refuge will be generally passive. If a forest disease or insect population level in the area is likely to unacceptably alter fish or wildlife habitat, then forest management activities may be authorized on the refuge. Timber harvest for management purposes, or personal use may be allowed only if compatible with the goals of this plan and the purposes for which the refuge was established. It is the intent of this policy to allow the harvest of dead and down trees of any size for personal use, except within 100 feet of the banks of fish bearing waters and other places determined inappropriate by the department.

Oil and Gas - Oil and gas exploration, development, and production activities will be allowed on the refuge under terms and conditions consistent with the goals and policies of this plan, terms and standards of 5 AAC 95, and the purpose for which the refuge was established. Terms and conditions for oil and gas activity on the refuge will be based upon existing lease conditions in existing leases on the refuge. It is not the intent of this policy to limit development of new stipulations based upon improved information and technology.

Pipelines, Utility Lines, and Roads - A new utility or pipeline will only be allowed to cross the refuge if there is no feasible 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 mitigated. Existing corridors will be used whenever appropriate, to the maximum extent feasible. A utility or pipeline will be buried. Any easement issued within the refuge will be non-exclusive use only. Private non-exclusive or public use winter roads on the refuge may be allowed under a special area permit where compatible with the refuge goals. New permanent (year-round use, more than one year's duration) roads will not be allowed on the refuge. Oil pipeline construction and maintenance activities listed in 5 AAC 95.420 require a special area permit and must be consistent with the goals and policies of this plan, terms and standards in 5 AAC 95, and the purpose for which the area was created.

Material Extraction - Do not allow material extraction within the refuge unless for purposes of maintenance, enhancement, or restoration of the refuge, except that gravel extraction may be allowed if extenuating circumstances create a transcending public need for which there is no feasible alternative. All material extraction activities within the refuge must be consistent with refuge statutes and regulations and with the goals and policies of this management plan. Impacts will be mitigated including, if appropriate, rehabilitation and restoration.

Mining - Recommend closure of the refuge to new locatable mineral entry and mineral leasing and closure of tide and submerged lands to issuance of offshore prospecting permits under AS 38.05.185-275. Do not allow coal leasing under AS 38.05.150 in the refuge. Recreational mining using hand tools may be allowed by individual special area permit.

Hazards and Hazardous Wastes - Encourage clean-up of existing hazards and hazardous wastes by responsible parties. Hazardous materials may not be stored or deposited in the refuge. Temporary use and transport of hazardous materials may be allowed under appropriate terms and conditions where authorized by a special area permit. The accidental or intentional placement or discharge of petroleum products on land or water in the refuge is not allowed; however, transport of oil or gas in a pipeline is addressed in the policy on Pipelines, Utility Lines, and Roads.

Other Uses - To protect fish and wildlife populations and their habitats in the refuge, the department will, in its discretion, 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 the management plan. Any activity that 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.

REDOUBT BAY CRITICAL HABITAT AREA STATUTES

AS 16.20.500. Purpose. *The purpose of AS 16.20.500 - 16.20.690 is to protect and preserve habitat areas especially crucial to the perpetuation of fish and wildlife, and to restrict all other uses not compatible with that primary purpose.*

AS 16.20.625. Redoubt Bay Critical Habitat Area*. (a) The state-owned land and water above mean lower low water contained in the following described parcels is designated as the Redoubt Bay Critical Habitat Area:*

(1) Township 6 North, Range 16 West, Seward Meridian
Sections 1-12: North of the south bank of Drift River
Sections 14-18: North of the south bank of Drift River
Sections 20-22: North of the south bank of Drift River;

(2) Township 6 North, Range 17 West, Seward Meridian
Sections 1-6: North of the south bank of Drift River
Sections 10-12: North of the south bank of Drift River;

(3) Township 7 North, Range 14 West, Seward Meridian
Section 5: S½
Sections 6-8
Section 18;

(4) Township 7 North, Range 15 West, Seward Meridian
Sections 1-21
Sections 29-31;

(5) Township 7 North, Range 16 West, Seward Meridian;

(6) Township 7 North, Range 17 West, Seward Meridian
Sections 1-4
Section 8: E½
Sections 9-17
Sections 19-27
Section 30
Sections 34-36;

(7) Township 8 North, Range 15 West, Seward Meridian
Section 1: S½
Section 2: S½
Section 3: W½
Sections 4-11
Section 12: N½
Sections 13-36;

(8) Township 8 North, Range 16 West, Seward Meridian;

(9) Township 8 North, Rang 17 West, Seward Meridian
Sections 1-17
Sections 20-29
Sections 32-36;

(10) Township 8 North, Range 18 West, Seward Meridian
Sections 1-12;

(11) Township 9 North, Range 15 West, Seward Meridian Sections 29-30;
(12) Township 9 North, Range 16 West, Seward Meridian Sections 19-36;
(13) Township 9 North, Range 17 West, Seward Meridian Sections 21-36.

(b) Notwithstanding AS 16.20.500 and the establishment of the Redoubt Bay Critical Habitat Area under (a) of this section, egress and ingress to and from private property within the Redoubt Bay Critical Habitat Area shall be permitted through access corridors established through agreement between the state and the private property owners involved.

(c) The state may not acquire by eminent domain privately-owned land within the Redoubt Bay Critical Habitat Area but may acquire privately-owned land within the Redoubt Bay Critical Habitat Area by purchase, exchange, or otherwise for inclusion in the Redoubt Bay Critical Habitat Area.

(d) The department shall permit entry within the Redoubt Bay Critical Habitat Area for the exploration and development of oil and gas resources when it is compatible with the purposes for which the critical habitat area is established. An oil and gas lease of state land and existing oil and gas pipeline rights-of-way within the critical habitat area are valid and continue in full force according to their terms. The Commissioner shall permit inspection and maintenance activities necessary to ensure the integrity of oil and gas pipelines on existing leases and pipeline rights-of-way in a manner that is compatible with the purposes for which the Redoubt Bay Critical Habitat Area was established.

(e) The department shall permit uses of the Redoubt Bay Critical Habitat Area in a manner that is compatible with the purposes for the Redoubt Bay Critical Habitat Area is established. The department shall permit the following public uses to continue without further approval by the department unless the department determines that the use is not compatible with the purposes for which the Redoubt Bay Critical Habitat Area is established:

(1) hunting, including subsistence hunting, trapping, and subsistence, commercial, and sport fishing, including the continued use of cabins for the purpose of hunting, trapping, and fishing;

(2) hiking, backpacking, and camping, including the use of campfires;

(3) cross-country skiing, snowmachining, boating, and the landing of aircraft; and

(4) other related uses that are temporary in duration and have no foreseeable adverse effects on vegetation, drainage, soil stability, or fish and game and their habitat.

(f) The Kenai Peninsula Borough shall establish a citizens' advisory committee to work with the Department of Fish and Game and the Department of Natural Resources and advise on the development of policies and regulations that affect the Redoubt Bay Critical Habitat Area.

(g) Appointees to the citizens' advisory committee shall be made by the Kenai Peninsula Borough and shall include representatives from

(1) industry and commercial users including oil and gas industry, timber, mining, and commercial fishing;

(2) hunters, trappers, fishermen, cabin owners, and recreational users; and

(3) officials representing the Kenai Peninsula Borough.

Cross references. - For legislative purpose in establishing the Redoubt Bay Critical Habitat Area, see § 1 ch 111 SLA 1989 in the Temporary and Special Acts as follows:

> *The Redoubt Bay Critical Habitat Area is established to ensure the protection and enhancement of fish and wildlife habitat and populations, especially Tule geese; the continuation of fish and wildlife harvest; and public use and enjoyment of the area in a high quality environment.*

REDOUBT BAY CRITICAL HABITAT AREA GOALS

Activities that occur within the Redoubt Bay Critical Habitat Area will reflect the following goals in accordance with the purpose for which the area was established. All department management decisions in the Redoubt Bay Critical Habitat Area, 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 critical habitat area to maintain and enhance fish and wildlife populations and their habitat.

   A. Maintain, protect, and if appropriate, enhance the quality and quantity of habitat for resident and migrant wildlife, particularly nesting, rearing, staging, feeding, and molting habitat for waterfowl, especially Tule whitefronted geese and swans; and brown bear spring and fall feeding areas.

   B. Minimize harmful disturbance to fish and wildlife.

   C. Maintain, protect, and if appropriate, enhance salmon spawning, rearing, and overwintering habitat.

   D. Maintain water quality.

II. **Public Use** - Manage the critical habitat area to maintain and enhance public use of fish, wildlife, and critical habitat area lands and waters consistent with the other goals of this management plan.

   A. Maintain public access to and within the critical habitat area.

   B. Maintain and, if compatible with existing public use as described in AS 16.20.625(e), improve opportunities for hunting and trapping within the critical habitat area.

   C. Maintain and, if compatible with existing public use as described in AS 16.20.625(e), improve opportunities for fishing within the critical habitat area.

   D. Maintain and, if compatible with existing public use as described in AS 16.20.625(e), improve opportunities for wildlife viewing, photography, and general recreation in a high quality environment.

   E. Make information about the critical habitat area available to the public.

III. **Multiple Use** - Manage multiple uses, including oil and gas, in the critical habitat area in a manner compatible with goals I and II of this management plan.

Explanation of Terms

Minimize: To reduce harmful effects to a level which does not have a significant adverse impact on fish or wildlife populations or their habitats within the critical habitat area or significantly reduce public opportunity for successful harvest or non-consumptive use of fish and wildlife.

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 fish or wildlife populations. Harmful disturbance does not refer to the legal harvest of fish or wildlife.

High Quality Environment: Includes a natural landscape containing native plant communities; a full complement of native fish and wildlife species in their naturally occurring diversity and abundance; pristine air and water quality; an absence or only incidental occurrence of man-made noise and structures; and dispersed, low-intensity, seasonal public use.

REDOUBT BAY CRITICAL HABITAT AREA POLICIES

Access - Maintain legal public access for continued public use and enjoyment of the area. Allow development of new public access where compatible with the goals of the management plan. To ensure use is compatible with the purposes for which the Redoubt Bay Critical Habitat Area was established, monitor motorboat use, including jetboat and airboat use, and aircraft use, including helicopter use, with special emphasis on the Kustatan River, Big River Lakes, and adjacent shorelands, and, if necessary, establish motorboat and aircraft use restrictions consistent with the protection of fish and wildlife habitat; the conservation of fish and wildlife populations; and maintenance of public recreation in a high quality environment. To ensure use is compatible with the purposes for which the Redoubt Bay Critical Habitat Area was established, including the prevention of disturbance to fish or wildlife populations and the maintenance of general recreation in a high quality environment, the department may in its discretion establish an aircraft parking area or a no-taxi area on Big River Lakes.

Information and Education - Provide information to critical habitat area users regarding resource values and rules, including courtesy information on boating and aircraft use, low impact use, and the wilderness ethic. Encourage compatible research of fish, wildlife, and habitat resources and their use.

Off-Road Use of Motorized Vehicles - To ensure the protection of important habitat, avoid harmful disturbance to fish and wildlife, accommodate a variety of users, and ensure use is compatible with the purposes for which the Redoubt Bay Critical Habitat Area was established, the department may, as appropriate, issue a special area permit for the off-road use of wheeled, tracked, or other ground-effect equipment in the critical habitat area including a general permit for use of snowmachines in appropriate places during appropriate seasons. The recreational use of off-road motorized vehicles in ice free months will not generally be permitted, unless extenuating circumstances exist which render an activity in the best interests of public use of the area and consistent with the goals and policies of the management plan. The off-road use of motorized vehicles for collection of firewood and retrieval of game may be allowed where compatible with the goals and polices of this management plan. Corridors for off-road use of motorized vehicles for access to setnet sites and private inholdings may be established by special area permit. A general special area permit will not be issued for off-road use of motorized vehicle access to the critical habitat area from non-road easements.

Fish and Wildlife Habitat and Population Enhancement - As appropriate, allow management, enhancement, and rehabilitation of indigenous fish and wildlife populations and their habitats if it furthers the management goals of the area, is not at the expense of resource values (including diversity and abundance) for which the area was established, and does not interfere with public use and enjoyment.

Land Acquisition - The department may acquire private or municipal lands or conservation easements within the critical habitat area from willing sellers as time and funding permit through purchase or trade. Donation of lands or conservation easements for addition to the critical habitat area will also be considered. To provide uniform management of land within the Redoubt Bay Critical Habitat Area and ensure protection of its fish and wildlife habitat and resources, work with the Kenai Peninsula Borough to identify opportunities for relinquishment of municipal selections (Township 18 West, Range 8 North, Sections 1 and 12, Seward Meridian; and Township 17 West, Range 8 North, Sections 6, 7, and 8, Seward Meridian) within the critical habitat area.

Cabins - Allow the continued use and maintenance of cabins in existence at the time Redoubt Bay Critical Habitat Area was established as provided in AS 16.20.625(e). To maintain public use opportunities and experiences, protect critical habitat area resources, and preclude proprietary use of critical habitat area land, the department will, in its discretion, allow public use cabins, administrative cabins, trapping cabins, or cabins leased to a non-profit organization for a youth encampment or similar recreational or educational purpose in a manner consistent with maintenance of fish and wildlife habitat, fish and wildlife populations and public use of the area in a high quality environment. Commercial cabins will not be allowed except for access to shore fishery leases. A cabin permit or lease will be limited to the minimum acreage necessary to accommodate the structure and essential associated activities. The construction of new private or personal use cabins will not be allowed on critical habitat area lands. Unauthorized cabins will not be allowed. If appropriate, permit private non-profit groups to adopt existing cabins for public use.

Facilities for Commercial Guides, Outfitters and Seasonal Camping -To maintain public use opportunities in a high quality environment, a permanent facility for commercial guides or outfitters will not be allowed on the critical habitat area unless it meets a public need specific to the purposes for which the area was established which cannot otherwise be met (e.g., on adjacent public lands or private inholdings) and does not displace other established non-commercial use. To ensure use is compatible with the purposes for which Redoubt Bay Critical Habitat Area was established, establishment of a camp in excess of 14 consecutive days or relocating a camp within a 14-day period within a two-mile radius of the previous 14-day camp or any use of a tent platform on the critical habitat area requires authorization through a special area permit. Temporary tent platforms (not exceeding one season's use) that will not significantly preclude existing public use of the critical habitat area may be allowed. Permanent tent platforms (exceeding one season's use) will not be allowed. Use of temporary structures does not convey any future or exclusive rights and may not exceed one season's use. A bear viewing program may be authorized only where it is determined to be in the best interests of proper bear management, will be operated in a manner that does not conflict with established recreational uses at that site and does not allow bears to associate humans with food.

Forest Management - Forest management on the critical habitat area will be generally passive. If a forest disease or insect population level in the area is likely to unacceptably alter fish or wildlife habitat, then forest management activities may be authorized on the critical habitat area. Timber harvest for management purposes, or personal use may be allowed only if compatible with the goals of this plan and the purposes for which the critical habitat area was established. It is the intent of this policy to allow the harvest of dead and down trees of any size for personal use, except within 100 feet of the banks of fish bearing waters and other places determined inappropriate by the department.

Oil and Gas - Oil and gas exploration, development, and production activities will be allowed on the critical habitat area under terms and conditions consistent with the goals and policies of this plan, terms and standards of 5 AAC 95, and the purpose for which the critical habitat area were established. Terms and conditions for oil and gas activity on the critical habitat area will be based upon existing lease conditions in existing leases on the critical habitat area. It is not the intent of this policy to limit development of new stipulations based upon improved information and technology.

Pipelines, Utility Lines, and Roads - A new utility or pipeline will only be allowed to cross the critical habitat area if there is no feasible alternative. Utilities will be sited, designed, constructed, and maintained to avoid impacts to critical habitat area values to the maximum extent feasible. All unavoidable impacts will be mitigated. Existing corridors will be used whenever appropriate, to the maximum extent feasible. A utility or pipeline will be buried. Any easement issued within the critical habitat area will be non-exclusive use only. Private non-exclusive or public use winter roads on the critical habitat area may be allowed under a special area permit where compatible with the critical habitat area goals. New permanent (year-round use, more than one year's duration) roads will not be allowed on the critical habitat area. Oil pipeline construction and maintenance activities listed in 5 AAC 95.420 require a special area permit and must be consistent with the goals and policies of this plan, terms and standards in 5 AAC 95, and the purpose for which the area was created.

Material Extraction - Do not allow material extraction within the critical habitat area unless for purposes of maintenance, enhancement, or restoration of the critical habitat area, except that gravel extraction may be allowed if extenuating circumstances create a transcending public need for which there is no feasible alternative. All material extraction activities within the critical habitat area must be consistent with critical habitat area statutes and regulations and with the goals and policies of this management plan. Impacts will be mitigated including, if appropriate, rehabilitation and restoration.

Mining - Recommend closure of the critical habitat area to new locatable mineral entry and mineral leasing, and closure of tide and submerged lands to issuance of offshore prospecting permits under AS 38.05.185 - AS 38.05.275. Do not allow coal leasing under AS 38.05.150 in the critical habitat area. Recreational mining using hand tools may be allowed by individual special area permit.

Hazards and Hazardous Wastes - Encourage clean-up of existing hazards and hazardous wastes by responsible parties. Hazardous materials may not be stored or deposited in the critical habitat area. Temporary use and transport of hazardous materials may be allowed under appropriate terms and conditions where authorized by a special area permit. The accidental or intentional placement or discharge of petroleum products on land or water in the critical habitat area is not allowed; however, transport of oil or gas in a pipeline is addressed in the policy on Pipelines, Utility Lines, and Roads.

Other Uses - To protect fish and wildlife populations and their habitats in the critical habitat area, the department will, in its discretion, allow by permit only those activities compatible with the purposes for which the critical habitat area was established, terms and standards of 5 AAC 95, and the goals and policies of the management plan. Any activity that is not compatible with the purposes for which the critical habitat area was established, terms and standards of 5 AAC 95, and the goals and policies of this plan will not be allowed.

IMPLEMENTATION

The Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area Management Plan will be implemented by the ADF&G through its day-to-day, on-the-ground management activities, through its annual budgetary process, and through special area permits issued for land use activities.

Special Area Permits - A special area permit is required for any habitat-altering activity, including construction work, in the Trading Bay State Game Refuge or Redoubt Bay Critical Habitat Area. A special area permit application form can be obtained from any ADF&G office and should be submitted to the Habitat and Restoration Division regional office in Anchorage (5 AAC 95).

Fish and Wildlife Protection - State fish and wildlife protection officers and deputized department biologists patrol the Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area to provide on-the-ground enforcement of harvest regulations, refuge and critical habitat area regulations, and permit requirements.

Local Knowledge - Once the plan is completed, department staff should continue to work with users of the areas to apply local information and knowledge to management of the refuge and critical habitat area.

Kustatan River Salmon Escapement - Department staff will conduct surveys to determine salmon escapement levels on the Kustatan River for use in monitoring and managing increasing public use and fishing.

Aircraft and Motorboat Use - Department staff will monitor aircraft and motorboat use in the special areas for use in determining levels of public use and identification of areas needing more management attention.

Kenai Peninsula Borough - Work with the Kenai Peninsula Borough to identify opportunities for relinquishment of municipal selections (Township 18 West, Range 8 North, Sections 1 and 12, Seward Meridian; and Township 17 West, Range 8 North, Sections 6, 7, and 8, Seward Meridian).

Other Agencies' Activities - This plan will also be used by other state, federal, and local decision makers in making management decisions for the refuge and critical habitat area under their respective statutory authorities.

REGULATIONS

5 AAC 95.535 TRADING BAY STATE GAME REFUGE GOALS AND POLICIES. The Trading Bay State Game Refuge goals and policies located in the Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area Management Plan dated July 1994 are adopted by reference. The plan presents management goals and policies for the refuge and its resources that the department will use in determining whether proposed activities in the refuge are compatible with the protection of fish and wildlife, their habitats, and public use of the refuge. Under 5 AAC 95.420, a special area permit is required for certain activities occurring in a designated state game refuge. The department will review each special area permit application for consistency with the Trading Bay State Game Refuge goals and policies adopted by reference in this section. A special area permit for an activity in the Trading Bay State Game Refuge will be approved, conditioned, or denied based on the criteria set out in the Trading Bay State Game Refuge goals and policies located in the Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area Management Plan and on the standards contained elsewhere in 5 AAC 95. (Eff. 11/24/94, Register 132)

Authority: AS 16.05.020
AS 16.05.050
AS 16.20.020
AS 16.20.038
AS 16.20.050
AS 16.20.060

Editor's notes. A copy of the Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area Management Plan dated July 1994, is available at the Alaska Department of Fish and Game, Habitat and Restoration Division, 333 Raspberry Road, Anchorage, AK 99518-1599.

5 AAC 95.615 REDOUBT BAY CRITICAL HABITAT AREA GOALS AND POLICIES. The Redoubt Bay Critical Habitat Area goals and policies located in the Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area Management Plan dated July 1994 are adopted by reference. The plan presents management goals and policies for the critical habitat area and its resources that the department will use in determining whether proposed activities in the critical habitat area are compatible with the protection of fish and wildlife, their habitats, and public use of the critical habitat area. Under 5 AAC 95.420, a special area permit is required for certain activities occurring in a designated state critical habitat area. The department will review each special area permit application for consistency with the Redoubt Bay Critical Habitat Area goals and policies adopted by reference in this section. A special area permit for an activity in the Redoubt Bay Critical Habitat Area will be approved, conditioned, or denied based on the criteria set out in the Redoubt Bay Critical Habitat Area goals and policies located in the Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area Management Plan and on the standards contained elsewhere in 5 AAC 95. (Eff. 11/24/94, Register 132)

Authority: AS 16.05.020
AS 16.05.050
AS 16.20.500
AS 16.20.520
AS 16.20.530
AS 16.20.625

Editor's notes. A copy of the Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area Management Plan dated July 1994, is available at the Alaska Department of Fish and Game, Habitat and Restoration Division, 333 Raspberry Road, Anchorage, AK 99518-1599.

APPENDIX

TRADING BAY STATE GAME REFUGE
AND
REDOUBT BAY CRITICAL HABITAT AREA
RESOURCE INVENTORY

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LOCATION AND GEOGRAPHICAL SETTING

Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area are adjacent special areas on the west side of Cook Inlet. Trading Bay State Game Refuge is located about 50 miles WSW of Anchorage. The critical habitat area is about 20 miles WNW of Kenai. Most of the state's population lies within a 100-mile radius of the refuge and critical habitat area. The nearest communities are Tyonek and Shirleyville, located about 12 and 4 miles northeast, respectively, from the refuge. Tyonek had about 325 residents in 1985--approximately 95% were Native (EPA 1990).

Trading Bay State Game Refuge is about 160,960 acres in size. Redoubt Bay Critical Habitat Area is about 171,500 acres.

Except for Kustatan Ridge (most of which lies between the refuge and critical habitat area) and scattered mounds or buttes, the land from the coast inland is mostly wetlands less than 100 feet in elevation until it meets the abrupt slopes of the Alaska Range.

HISTORY

Upper Cook Inlet was inhabitated by the Dena'ina, members of the the Athabaskans. The Dena'ina are thought to have arrived in the upper Cook Inlet area from the western slope of the southern Alaska Range in the last 1,500 years (Kari and Fall 1987:13). A later influx, with a different dialect, settled between Kustatan and Polly Creek, possibly 500 to 700 years ago.

The Tyonek area may have been the first coastal site occupied by the Dena'ina (Kari and Kari 1982:96). House sites extended from Granite Point to Beluga. The Dena'ina maintained semipermanent villages in the Tyonek area because food resources were abundant. Coastal waters and rivers supplied salmon, eulachon, seals, and belukhas. Wetlands supplied waterfowl and furbearers. Inland areas supplied caribou, sheep, and some moose. Prior to the 1920s the Tyonek Dena'ina hunted extensively north of Tyonek (Kari and Fall 1987:52). Big game and ground squirrels were hunted primarily on Lone Ridge (Kari and Fall 1987:53).

Tyonek was a major trade center, supplying oil from seals and belukhas and dry fish in exchange for furs and meat from inland areas (Kari and Fall 1987:40). Other Dena'ina villages and camps were located in the Kustatan area (de Laguna 1975, Cook Inlet Historic Sites Project 1975). Dena'ina still lived at K'nu'ka, a possibly prehistoric site at the south end of Trading Bay, in 1891; however, most of the villages near the West Foreland were "doubtless modern" (de Laguna 1975:139). In 1910 (or 1930, according to Kari and Fall [1987:39]) the village of Kustatan was abandoned (de Laguna 1975:138).

Captain James Cook and his crew were the first Caucasians to visit the area. On May 30, 1778, they anchored near the West Foreland. Two Natives approached his vessels in canoes.

> One of them talked a great deal to no purpose for we did not understand a word he said; he kept pointing to the shore and we guessed he wanted us to go there. (Cook 1967:363)

The next day Cook anchored just south of North Foreland, near Tyonek, and was visited by one large and several small canoes.

> We got from them a few of their fur dresses, made from the skins of Sea Beaver [sea otter], Martins, Hares, etc. a few darts and a small matters of Salmon and Halibut for old Clothes, Beads pieces of iron etc. it was difficult to see what it was they most Valued. They were in possession of iron and a few sky blue glass beads... (Cook 1967:364-365)

After trading with the Natives from his vessels, Cook left the area on June 3rd, remarking:

> ...for I will be so bold to say that the Russians were never amongst these people, nor carry on any commerce with them, for if they did they would hardly be cloathed in such valuable skins as those of the Sea Beaver; the Russians would find some means or other to get them all from them. (Cook 1967:371)

After learning of Captain Cook's voyage, Russian interest was piqued and they quickly established a presence in upper Cook Inlet. In 1786, eight years after Cook's visit, Captains Portlock and Dixon led another English expedition into Cook Inlet. Both officers had accompanied Cook on the first visit. A Dena'ina elder from Kustatan told Portlock that they had recently fought the Russians and driven them out of the area (Portlock 1968). Another elder tried to enlist English aid against the Russians.

Portlock and Dixon anchored their vessels at the tip of the West Foreland and in the large bay to the north for several weeks in late July and August. Portlock named it Trading Bay. The Dena'ina traded sea otter pelts and other furs for several days, then told Portlock "their neighborhood was drained of furs, but that they would go to procure more in adjacent country." Returning in two days with additional furs, they told the English that "the adjoining country was entirely drained of skins." Earlier trade with Russians may have depleted furbearer populations, or the Dena'ina may have wanted the foreigners to leave.

Russians built a trading post at North Foreland around 1790. The Dena'ina acted as middlemen between the Russians and upper Kuskokwim Athapaskans (Zagoskin 1967:169??).

Captain George Vancouver visited Trading Bay and Old Tyonek from April 16 to May 4, 1794 (Vancouver 1798:95-122). Three Natives in small canoes (kayaks?) in Redoubt Bay hitched a ride north. They were joined by two others in a canoe who apparently spoke a few Russian words. These Natives left Vancouver's vessel for a village about nine miles north of the West Foreland on April 19. On April 30, men from Vancouver's crew found 19 Russians in the Tyonek settlement. The Russians had been there for four years. There was not evidence of cultivation.

The Russians were heavy-handed, and by 1797 the local Dena'ina had suffered as much persecution as they could endure. They destroyed the outpost, killing a number of Russians and subject natives (Tikhmenev 1978:46). After 1800 the Russians reestablished trade relations; however, they apparently did not rebuild the outpost until 1845 (Bacon 1982:43) nor establish any more major posts in the upper Cook Inlet area (Kari and Fall 1987:49). Bacon (1982:61) also cited Federova (1973:145), who reported the Russian settlement near Tyonek was reestablished in 1844 as an agricultural community.

The United States acquired the territory from Russia in 1867. In about 1875 the Alaska Commercial Company opened a store on Old Tyonek Creek. Located on the oldest Tyonek village site, this was the first permanent store in the upper Cook Inlet region (Kari and Fall 1987:45). During the late 1890s and early 1900s, Tyonek was a major staging area, supplying prospectors, miners, trappers, and explorers in the Cook Inlet region. Thousands of prospectors landed at Tyonek in the late 1890s (Bacon 1982:68). The topography of the upper Cook Inlet region contributed to Tyonek's choice: anyone heading in and out of the vast Susitna Basin was funneled by the drainages, and the Old Tyonek-Beluga area was the nearest anchorage to the Susitna River mouth and the Turnagain Arm gold field where seagoing vessels could unload (Bacon 1982:63, 65).

Old Tyonek was abandoned in about 1900 because of tidal erosion. The second main village of Tyonek is named Tobona on U.S. Geological Survey topographical maps. Tobona was abandoned in 1932 when high tides forced residents to the present location of Tyonek (Kari and Fall 1987:49). Fall et al. (1984) provide much more historical detail for the Tyonek area.

After the turn of the century, a new village across Cook Inlet that become known as Anchorage replaced Tyonek as the region's trade center. Without the decision to lay a railroad track from Seward to Fairbanks, which led to the founding of Anchorage, the marshes of Trading and Redoubt bays would be very different today.

PLACE NAMES

The names of local landmarks are often snapshots of the history of an area. Many of the rivers and others features in the refuge and critical habitat area have retained their original, usually descriptive, Dena'ina names, although their spelling on maps allows only an approximation of their Dena'ina pronounciation. Examples cited in Kari and Fall (1987) include Chakachatna River for Ch'akajatnu ("river where tail comes out"), Chuitkilnachna Creek for Ch'k'e'ula Betnu ("river where we chew something [waterfowl]"), and Noaukta Slough for Nughi'ukda ("extends down poorly").

Other features in the area acquired local names in English that were recorded mainly by the U. S. Geological Survey (USGS) in 1958. Examples cited in Orth (1971) include the Big, Middle, and

Seal rivers; Blacksand, Montana Bill, and Nikolai creeks; Coach Butte; and Fox Flats. Similarly, U. S. Coast and Geodetic Survey (USC&GS) personnel published local names for Redoubt Bay in 1869 and Drift River in 1912. Orth (1971) does not give reasons for these names, though most are obviously descriptive.

Relatively few features were named by the scientists and surveyors themselves. Examples from Orth (1971) include the McArthur River, named in 1910 by the USC&GS for the steamer McArthur, and Straight Creek, named in 1926 by USGS geologists for its straight course.

TRADING BAY STATE GAME REFUGE

Trading Bay State Game Refuge was one of three state game refuges created by the Legislature in 1976. The adjacent Susitna Flats State Game Refuge was created the same year. Two other nearby state game refuges in upper Cook Inlet--Palmer Hay Flats and Goose Bay--had been created in 1975. Within two years, all of the large saltwater marshes in Cook Inlet had been designated as state game refuges except Redoubt Bay and Chickaloon Flats.

REDOUBT BAY CRITICAL HABITAT AREA

ADF&G asked the Legislature to classify Redoubt Bay marshes as a refuge in 1978 and 1981 because of their high value for waterfowl, especially tule white-fronted geese. The area was not established as a refuge; however, consensus was achieved among cabin owners, hunters, anglers, commercial fishermen, and others for another proposal in 1987. This proposal differed from the previous ones in several significant respects. The area would be classified as a critical habitat area because of the unique status of the tule white-fronted goose. The proposal was sponsored by the public and specifically maintained existing public activities. Introduced in 1988, this bill had widespread support from the public and groups using the area. Because the bill was introduced late in the session, it did not pass; however, it was reintroduced in 1989 and passed that year.

PHYSICAL ENVIRONMENT

CLIMATE

The climate is similar to that of Anchorage and Kenai, due to the influence of the Chugach and Alaska ranges and Cook Inlet (EPA 1990). Air temperature and annual precipitation was measured at Tyonek in 1899-1908 and 1967-1970 (Darbyshire & Associates 1981). Science Applications, Inc. (1984) monitored meteorological conditions near Granite Point from April 1983 through March 1984. The Big River Lake weather station has weather records since 1979 (D. Timm, pers. commun.).

The record low air temperature at Tyonek was -27°F and the record high was 91°F. The air temperature near Cook Inlet is slightly warmer in winter and cooler in summer than areas further inland (EPA 1990). The average annual precipitation at Tyonek was 22.8 inches and average annual snowfall was 82 inches over a 9-year period. Precipitation increases at higher altitudes (EPA 1990). The growing season is short (Darbyshire & Associates 1981).

Snow melt in spring is fastest in northern Trading Bay, and snow tends to remain longer as one moves south. An exception seems to be the mouth of the Kustatan River, where tide flats and vegetation exposed in early spring are often critical for returning waterfowl.

GEOLOGY

The geology and topography of an area influence its use by fish, wildlife, and humans. Much of this influence is indirect: for example, the mountains create a rain shadow, the level terrain decreases drainage, and glacial silt increases turbidity and sedimentation in waterbodies.

The slow, grinding advance and retreat of glaciers has affected the local terrain more than any other geological process. The mountains that define the inland edge of the refuge and critical habitat area are comprised of Jurassic bedrock, mostly igneous and metamorphic rocks of volcanic origin (Riehle and Emmel 1980). The gentle slopes between Bachatna Creek and the McArthur River are undifferentiated glacial drift. The hilly country that forms the tip of West Foreland is also undifferentiated glacial drift. The valley floors of rivers in the mountains, active river channels on the flats, and the base of West Foreland are proglacial stratified drift and recently deposited outwash fans. The moderately to heavily vegetated floodplains of rivers and streams that cover large portions of the area are outwash fans comprised of well-sorted sands and gravels of glacial origin. Kustatan Ridge is thought to have a bedrock core, but the upper part of the ridge is possibly an ice-thrust moraine that marks a former interlobate ice-margin position (Riehle and Emmel 1980). Another notable landmark, Coach Butte, is Jurassic bedrock.

Most glacial events are measured in centuries. However, geological processes can directly influence human uses through catastrophic means; for example, volcanos, floods, and earthquakes.

Volcanos

Active volcanos are located south of the critical habitat area and north of the refuge.

Mt. Redoubt. Located approximately 17 miles from the southwest corner of Redoubt Bay Critical Habitat Area is Redoubt Volcano. Redoubt Volcano has erupted at least 30 times in the last 10,000 years and 4 times since 1900 (Pack 1990). The last series of eruptions began in December 1989, after 22 years of quiescence. This volcano has a history of producing earthquakes, ash falls, lava, debris flows, and floods.

All of these were generated in the 1989-90 eruptions. The eruptions deposited a considerable quantity of ash on the critical habitat area. Hot debris flows contacted Drift Glacier, scouring and melting the ice. Between December 14 and January 2 at least three and as many as six distinct pulses of meltwater flooding, which also carried sediment and ice downstream, reached the Drift River oil terminal, located near the river's mouth. The largest flood, on January 2, 1990, filled the Drift River valley wall-to-wall, flattened and abraded some adjacent forests, blocked the main channel with sediment and spilled into Rust Slough and other inactive alluvial fan channels, covered the oil terminal's landing strip, circumvented the outer protective dike, and came within four feet of overflowing the inner containment dikes surrounding individual oil storage tanks.

Mt. Spurr. Mt. Spurr has erupted three times since 1900: in 1953, 1954, and 1992. Each of these eruptions had ash falls. Additional hazards include flooding of local streams, including a possible breakout of an ice-dammed lake (Evans et al. 1972:IV-21).

Earthquakes

The Bruin Bay fault parallels the western shore of upper Cook Inlet (Riehle and Emmel 1980). In Trading Bay the fault lies just offshore of the mean high tide line. In Redoubt Bay the fault lies 3-4 miles inland; from Trading Bay to Big River the fault follows the oil and gas pipeline. It has been inactive since late Tertiary time.

Unlike most coastal wetlands in Cook Inlet, the refuge and critical habitat area were little affected by the Alaska earthquake of March 27, 1964. The line between slight subsidence and slight uplift was nearly parallel to the coast in this area (Plafker 1969). The coastline may have uplifted about 0-1 foot in the critical habitat area and subsided about 0-1 foot in the refuge. Seasonal inhabitants on nearby Susitna Flats noticed no major changes in tidal frequency and duration in vegetated areas (Vince and Snow 1984). Though long-term effects of uplift or subsidence may have been slight, the shock itself may have affected local wildlife somewhat; local residents reported that about 40% of beavers in the nearby area of Tuxedni Bay, which was uplifted about 1 1/2 feet, died when pond ice cracked, either crushing them or pushing their winter food caches into the mud (Plafker et al. 1969:G45).

OCEANOGRAPHY

Cook Inlet is a large tidal estuary. Salinities vary by location, depth, and season. A mean salinity of about 15 ppt has been estimated near Granite Point (EPA 1990).

Tides are the major influence on marine water movement in Cook Inlet. Normal tidal range is about 13-14 feet (EPA 1990), but extreme tidal range is about 28 feet (-4 to +24 feet). Tidal ebb and flow flushes water up and down the inlet. Freshwater runoff, the coriolis force, basin morphology, and probably winds result in a net outward movement of fresh, turbid water from Knik Arm and the Susitna River along the west shore (Evans et al. 1972). Other oceanographic information is summarized in EPA (1990).

The velocities and turbulence of tidal currents and shoals are hazards to commercial fishing, shipping, subsistence, and recreational boating. Ships have been damaged in Cook Inlet by striking *stamukhi*, frozen layers of ice and silt, floated by high tides (Evans et al. 1972:II-3). Ice floes, which are most common from December-February, tend to concentrate along Cook Inlet's western shore during ebb tides (EPA 1990).

Tides also exert a major influence in Cook Inlet salt marshes. Coastal marshes in Redoubt Bay are generally less brackish than those in Trading Bay because of lower high tides and greater land relief (D. Timm, pers. commun.). Marsh vegetation patterns on the flats are influenced by soil salinity and saturation (Vince and Snow 1984).

HYDROLOGY

Most of the refuge and critical habitat area are flat, water-saturated marshes and bogs. Ponds and lakes are numerous, particularly in spring during snowmelt. Most rivers and creeks are low-gradient and meandering. The low gradient terrain and high sediment loads of some systems result in a multitude of channels and sloughs; the Big River system and McArthur/Chakachatna rivers are the best examples. During high tides, rivers and creeks are backed up many miles inland. While average high tides do not flood over slough banks, extreme high tides flood marshes 3 to 5 miles inland (Smith undated).

Water quality was sampled on the McArthur River in 1970, Chakachatna River between 1955-1972, and Drift River in 1970 (Still 1976).

SOILS

Soils in both the refuge and critical habitat area are classified as typic cryaquents (Rieger et al. 1979). The principal components of this soil type (and estimated proportions) in upper Cook Inlet are nearly level, sandy, typic cryaquents (65%); nearly level, loamy, typic cryofluvents (15%); and nearly level, fluvaquentic borohemists (15%).

Cryaquents are wet soils with little or no evidence of soil formation. They occur south of the permafrost zone on nearly level, poorly drained outwash plains below the terminus of large glaciers. Flooding is frequent and, in periods between floods, the water table is near the surface. Typically, they have a thin peaty surface mat over a mottled, dark gray stratified sand. The substrate becomes very gravelly sand at depths.

Cryofluvents are well-drained soils on natural levees that border major streams. Flooding is rare. Typically, these soils have a thin mat of partially decomposed plant litter over 2-5 feet of stratified silt and fine sand that, in turn, overlies very gravelly sand. These soils support plant communities similar to those in nearby upland areas, except for a higher proportion of cottonwood and willow.

Fluvaquentic borohemists are thick, partially decomposed organic material derived, in Alaska, mostly from sedges and mosses. Most of the plant fibers can be destroyed by rubbing between the fingers. Thin lenses of volcanic ash are common. The poorly drained peat accumulated in former lake basins and abandoned stream channels. The water table is always at or near the surface.

The soils underlying Redoubt Bay and Trading Bay marshes differ from other marshes in upper Cook Inlet. The coastal wetlands in Susitna Flats are comprised of deep layers of peat (sphagnic borofibrists) and well-drained soils associated with glacial moraines (typic cryorthods). The soils of Palmer Hayflats are loamy, rather than sandy. Coastal wetlands along the east side of Cook Inlet also have well-drained soils associated with glacial moraines (typic cryorthods).

Soil types have been rated by the Soil Conservation Service for suitable land uses (Rieger et al. 1979:192). Most of the soils in the Redoubt and Trading bay areas are rated poor or unsuited for common crops, grazing livestock, and commercial forestry. Most of these soils also have severe or very severe limitations for road location, low buildings, recreational site development, and off-road trafficability.

BIOLOGICAL RESOURCES

VEGETATION

Terrestrial Vegetation

The vegetation of the Trading Bay State Game Refuge has been described in four studies [BCM 1983, ERT 1984c, wetlands maps of the National Wetlands Inventory, unpubl. vegetation maps at ADF&G]. An incomplete plant list adapted from BCM (1983) is included in Table 1. The following descriptions of habitat types are adopted from BCM (1983).

Unvegetated Mudflats. A significant portion of the refuge and critical habitat area is unvegetated or algae-covered mudflats which are inundated daily by high tides.

Coastal Marsh. The coastal marsh generally lies inland of the mudflats along most of the Cook Inlet shoreline. Coastal marsh is also extensive in the lower seven miles of the McArthur River, and smaller areas occur along the lower Chakachatna, Middle, Kustatan, Big, and other rivers. The coastal marsh is often inundated by high tides, but is better drained than the bogs lying inland, due to a network of tidal guts. Ponds and small lakes in the coastal marsh range from highly saline near the coast to slightly saline inland. Coastal marsh habitat is characterized by sedges (*Carex*), grasses (*Puccinellia*, *Poa*, *Festuca*), and other vascular plants such as *Triglochin*, *Plantago*, and *Potentilla*. Woody vegetation is scarce, but willow and sweet gale (*Myrica gale*) occur in high spots, such as stream berms. Salt marsh plants and environmental influences are described in detail for a nearby area on the Susitna Flats (Vince and Snow 1984) and in somewhat less detail for Redoubt Bay marshes (Smith undated).

lack Spruce Riparian. This is the most extensive habitat type on the refuge. Black spruce riparian areas are poorly drained and characterized by black spruce, diamondleaf willow, alders, sedges, and grasses. Black cottonwood is absent.

Resin Birch Bog. Resin birch bogs are generally inland of the black spruce riparian type and often situated along watercourses. These bogs are poorly drained, with large mats of floating vegetation. Vegetation is characterized by shrubs such as resin birch, bog blueberry, and narrowleaf Labrador tea, as well as herbaceous plants such as grasses and sedges.

Black Cottonwood Riparian. This vegetative type occurs along the banks of most of the refuge's rivers and streams. Black cottonwood riparian habitat is characterized by black cottonwood, thinleaf alder, paper birch, and willows (e.g., diamondleaf, feltleaf, Barratt, undergreen, and grayleaf).

Black Spruce Transitional. This type is limited in the refuge and surrounding areas. It is most common in the northern part of the refuge, between the McArthur River and Noaukta Slough and between the Chakachatna River and Nikolai Creek. Physically, these areas were

intermediate between bog and riparian sites. Black spruce transitional is an ecotone between open bogs and riparian areas. The vegetation is a mixture of bog and riparian species.

Upland Alder Thicket. This type is uncommon in the refuge only because the refuge is comprised primarily of lowlands. In the refuge, it occurs along Kustatan Ridge. Vegetation is characterized by black cottonwood, Sitka alder, and paper birch. Herbaceous plants are uncommon, except for grasses.

Plants found within these habitat types are listed in Table 1. ERT (1984c) compiled a much more comprehensive plant list from a study area north of Tyonek, and most, if not all, of these species can probably be found in lowland spruce-hardwood forest within the refuge and critical habitat area.

Prior to logging, upland areas were comprised of 77% white spruce, 22% paper birch, and 1% balsam poplar/black cottonwood and mountain hemlock (Baker and Kemperman 1974). The few scattered stands of mountain hemlock (*Tsuga mertensiana*) are on higher ground. Average annual timber growth rates for white spruce in the Beluga area range from 10-20 cubic feet/acre, while growth rates for black spruce are considerably lower (ERT 1984c).

In 1969 an infestation of the spruce beetle (*Dendroctonus rufipennis*) was discovered between the McArthur River delta to the Beluga River (Lockhart 1973). The exact cause of the infestation is unknown. The earliest known spruce mortalities were in 1966 (Baker 1973) from Stedatna Creek (Lockhart 1973). The outbreak was probably exacerbated by warm, dry summers in 1968 and 1969 and the high density of large white spruce trees (Baker and Kemperman 1974). By 1971 many trees had lost their foliage. By 1973 tree mortality had probably peaked on and adjacent to the refuge as the infestation moved north. However, blowdowns were increasing. At that time, the average mortality of white spruce at least 5 inches diameter-at-breast-heighth (dbh) was 65% (Baker and Kemperman 1974). A few dominant or codominant spruce survived the infestation and subsequent clearcutting, but birch became the major overstory component of most stands, with bluejoint grass and tall shrubs such as high bush-cranberry and alder.

A comprehensive survey of habitat types and plant species has not been conducted on the Redoubt Bay Critical Habitat Area. They are presumed to be similar to those of the refuge before logging. Some habitat types, such as Willow Thicket Riparian (BCM 1983), may be more widespread in the critical habitat area because its boundaries extend farther inland than those of the refuge. The U.S. Fish and Wildlife Service has mapped wetlands in the Redoubt Bay Critical Habitat Area.

Marine Vegetation

The marine waters of upper Cook Inlet are relatively unproductive. Tideflats are scoured daily by silt-laden tidal currents. Silt also limits light penetration. In winter, the currents scour intertidal areas with floating ice.

Plankton, which form the base of many marine foodchains, are not abundant in upper Cook Inlet. The most common phytoplankton are diatoms (Kinney et al. 1970, Bakus et al. 1979). Copepods, such as the calanoid *Acartia*, cyclopods, and harpacticoids, are the most common zooplankton. Macroalgae, or seaweed, is also uncommon in upper Cook Inlet. Only *Fucus*, *Cladophora*, and *Enteromorpha* are known to occur (Jackson 1970, Dames and Moore 1983), albeit so rarely that the entire shoreline was considered devoid of cover by Sears and Zimmerman (1977). A benthic algae (*Vaucheria longicaudalis*) forms a green band on mudflats along the shoreline (Bakus et al. 1979, EPA 1990).

INVERTEBRATES

Apparently, no one has sampled terrestrial or aquatic invertebrates in the refuge or critical habitat area. Big River Lakes have an extensive population of freshwater clams that are heavily used by river otters (Westlund 1992).

Pacific razor clams (*Siliqua patula*) are distributed from Granite Point south (Michel and Ballou 1985). Large razor clams apparently do not occur in the refuge or critical habitat area, judging by the distance Tyonek residents travel to dig. Tyonek residents also collect cockles (*Clinocardium*) and Alaskan surf clams (Fall et al. 1984), so these species are also likely to be found in the critical habitat area and refuge.

Marine invertebrates have been surveyed in upper and lower Cook Inlet. Invertebrate communities in the refuge and critical habitat areas are assumed to be more like those of the upper inlet. Like marine flora, marine invertebrates are limited by low primary productivity, silt, ice, and fluctuating water temperatures and salinities (Bakus et al. 1979). Small clams in upper Cook Inlet include *Macoma balthica*, *Mya arenaria*, and *Clinocardium nuttalli*. Periwinkles (*Littorina* spp.) are found in Turnagain Arm (ADF&G 1977). Other marine invertebrates observed in upper Cook Inlet include gammarid amphipods, minute hydroids, harpacticoid copepods, polychaetes, and crangonid shrimp (*Crangon*) (Bakus et al. 1979).

AMPHIBIANS

A wood frog (*Rana sylvatica*) was collected at Tyonek[1] by Osgood (1901:57). ERT (1984b) found wood frogs from near sea level to approximately the 1,750-foot level on Lone Ridge. They were most abundant from late June through late August. Wood frogs were common in moist tundra along streams, but they are also likely to inhabit grassland, open forest, and muskeg (Hodge 1976). They probably occur in these habitats throughout the refuge and critical habitat area. Several frogs were observed crossing the road near Nikolai Creek in late June 1993 (D. Clausen, pers. commun.). Wood frogs are abundant in the Big River Lakes area (D. Timm, pers. commun.)

The only other amphibian that is likely to be found in this area is the rough-skinned newt which may be found in and about small, permanent waterbodies with abundant vegetation in the spruce-hemlock coastal forest (*Taricha granulosa*) (Hodge 1976). None were found by ERT (1984b).

FISH

Freshwater and Anadromous Fish

Species of freshwater and anadromous fish are listed in Table 2.

The Kustatan River is the single largest producer of coho (silver) salmon on the west side of Cook Inlet. The Kustatan also supports populations of king salmon, sockeye salmon, pink salmon, and Dolly Varden. In addition to the Kustatan River, there are four anadromous fish streams in the refuge and seven anadromous fish streams in the critical habitat area. The McArthur-Chakachatna River system is probably the most productive system in Trading Bay State Game Refuge, supporting populations of all five species of salmon--coho, sockeye, chinook, pink and chum--as well as Dolly Varden. Combined escapement counts in 1982 for the Chakachatna and McArthur rivers exceeded 78,500 sockeye salmon, 28,000 pink salmon, 1,900 chum salmon, and 7,300 coho salmon. The Middle River supports sockeye and coho salmon and Dolly Varden. Approximately 500 king, 500 coho and 10,000 pink salmon and Dolly Varden are found in Nikolai Creek, according to a Cook Inlet Aquaculture Association survey.

Most notable in Redoubt Bay Critical Habitat Area is the Big River sockeye salmon run, which extends from mid-June through July. Department stream surveys in 1980-82 and weir counts at Wolverine Creek showed escapement ranging between 17,522 and 32,980. The number of sockeyes may be declining. Impromptu counts in 1991 and 1992 found only about one-half and one-third of the highest count, respectively (Westlund 1992).

Populations of king, coho and pink salmon, Dolly Varden, and rainbow trout are also found in the Big River system. Bachatna Creek and Johnson Slough support sockeye and coho salmon. Montana Bill Creek, Seal River and an Unnamed Creek located between Bachatna Creek and Big

[1] When Osgood visited Tyonek it was located about 2 miles south of its present location. The site is named "Tobona" on USGS topographical maps.

River support coho salmon and Dolly Varden. Coho salmon also are found in Drift River. Aerial surveys by Cook Inlet Aquaculture Association in 1983 counted 822 coho salmon in Drift River.

Eulachon pass through this area enroute to spawning in the Susitna River during late April and early May (Fall et al. 1984).

Rainbow trout are the most abundant freshwater game fish, inhabiting most local streams and lakes (Fall et al. 1984). Sticklebacks are abundant in lakes and ponds in both areas.

Marine Fish

ERT (1984a) sampled fish with a beach seine in the North Foreland area in late fall. A more intensive sample was collected by Dames & Moore (1983) in Knik Arm during spring. The species they found are included in Table 2. Little else is known of marine fishes in upper Cook Inlet (EPA 1990).

BIRDS

One hundred twenty-nine species have been documented in the vicinity of the refuge and critical habitat area (Table 3). Bird species are similar to a list compiled by Kessel et al. (1982) for the lower Susitna River floodplain, and most, if not all, of the species from that list may eventually be found to inhabit the refuge and critical habitat area.

The Coastal Marsh Riparian habitat has the highest bird diversity (BCM 1983). Lowest diversity is in Upland Alder Thicket, Resin Birch Bog, and Willow Thicket Riparian habitats.

There have been some changes in bird abundance since Osgood (1901) visited Cook Inlet in late August-September 1900. Osgood saw no bald eagles, although others told him they had seen them. Large gulls (*Larus spp.*) were "noticeably uncommon" because they had been systematically shot during the last two years for the millinery trade.

Waterfowl

Both the refuge and critical habitat area were established primarily because of their value as waterfowl habitat. ADF&G (1985b) describes a general progression of habitat types from the tidal flats to inland areas and their importance to waterfowl.

Tidal flats. Tidal flats are used most intensively in spring and fall. Large numbers of dabbling ducks, primarily northern pintails, green-winged teal, mallards, and American wigeon, are found resting from the tide line to one-half mile offshore, and they feed on Macoma and other invertebrates in the intertidal area. The tidal flats appear to provide a preferred food source during the fall (Bill Eldridge, pers. commun.). Migrant ducks and geese roost on exposed mud during the spring.

Puccinellia-Triglochin community. The near-coastal *Puccinellia-Triglochin* community is most valuable for snow and cackling Canada geese that stop to feed during spring migration. Waterfowl nesting is uncommon in this habitat and the Ramenski sedge-shallow pond community because they are frequently flooded by tides, although a few duck and tule goose nests have been found in Redoubt Bay very near the inlet on berms along tide guts and streams.

Ramenski sedge-shallow pond community. The Ramenski sedge-shallow pond community is also used primarily for feeding and roosting. Nesting is minimal in this habitat because periodic tides flatten vegetative cover and can inundate nests. The numerous semi-permanent ponds attract migrant ducks and are used by resident dabbling ducks for brood rearing.

Marsh community. The marsh community is the most valuable habitat type for most waterfowl. During spring and fall, numerous permanent ponds and cover are the primary staging area for tundra swans, loons, grebes, and diving ducks. Marsh habitat is also the most productive nesting habitat for tule white-fronted geese, ducks, loons, grebes, and gulls. The marsh community is flooded only on the highest tides.

Shrub-bog community. The shrub-bog community contains numerous, deep, permanent ponds; however, they are acidic and unproductive. During fall, Canada and tule geese use this habitat type for roosting at night. The interface between the marsh and shrub-bog communities has the greatest concentration of nesting ducks, geese, and cranes.

Waterfowl surveys have been conducted sporadically in Trading Bay and Redoubt Bay (Tables 4-7). These observations should be considered "snapshots" of bird populations, with the following assumptions: the limited number of surveys always miss the period when peak numbers are in the area, surveys always miss some individuals (small, dark birds such as ducks are more difficult to count than large, white birds such as swans), and counts separated by days or weeks do not account for turnover as individual birds and flocks move through an area. Thus, the actual number of birds using these areas is probably much higher than the counts indicated, particularly during migration. Additional aerial surveys were conducted by Timm (1982b) and Rosenberg (1990).

Trumpeter Swans. One of the most significant wildlife populations in the refuge and critical habitat area is that of the trumpeter swan.

Trumpeter swans are one of the few species brought back from the verge of extinction. In 1933 only 66 trumpeters were found in the contiguous United States, with another remnant population in Alberta, Canada. Conservationists of that era were unaware that trumpeters bred in Alaska (Trumpeter Swan Subcommittee 1984).

Hanson et al. (1971) suggested that few, if any, swans nested in Southcentral Alaska in the late nineteenth and early twentieth centuries, basing this supposition on the lack of documented observations by prospectors, trappers, government surveyors, and naturalists. Osgood (1901) noted that miners in the Cook Inlet region often saw tundra swans and had shot several, but tundra swans do not nest in Southcentral Alaska. Tundra swans are more numerous in Cook Inlet marshes than trumpeters during spring and fall migration; however, Osgood may have assumed these were tundra swans--a case of mistaken identity that probably occurred repeatedly (Trumpeter Swan Subcommittee 1984). Wildlife biologists "discovered" breeding trumpeters in Southcentral Alaska in 1954, and subsequent aerial surveys found they were widespread. These were assumed to be the source of the large numbers of trumpeters that had been recently reported wintering along the coast of British Columbia. The discovery of the Alaskan breeding grounds, in conjunction with protection and slow recovery in wintering areas, resulted in removing trumpeters from the endangered species list in 1968 (Trumpeter Swan Subcommittee 1984). The trumpeter swan population is increasing in Alaska (Trumpeter Swan Subcommittee 1984, Conant et al. 1991).

The U.S. Fish and Wildlife Service conducted aerial surveys of swans in upper Cook Inlet in 1968, 1975, 1980, 1985, and 1990. The trumpeter swan management plan recommends that these surveys continue to be conducted every 5 years.

Swans begin arriving in upper Cook Inlet in early April. The peak of migration occurs in early May, depending largely on snow melt. The largest count in recent years was 2,115 in the Trading and Redoubt Bay areas on May 3, 1985 (Table 8). Most of these swans are tundra swans and trumpeter swans onroute to more northern nesting areas; however, many trumpeters remain to nest.

Trumpeter swan nesting and brood-rearing is widespread in the refuge and critical habitat area. The most concentrated use occurs in the drainages of the Kustatan River, Bachatna Creek, North Fork Big River, and the lower Big and Chakachatna rivers (see Trumpeter Swan and Bald Eagle Map).

The Kustatan-Drift River area was the last major breeding grounds found in Southcentral Alaska. The first aerial census in this area, in May 1958, counted 112 swans, including 34 adult pairs. A subsequent aerial survey in August 1958 counted 9 broods totaling 43 cygnets (Hansen et al. 1971). The number of swans has increased substantially since 1958 (Table 8). In August 1990, the Kustatan-Drift River area had 153 adult swans comprising 67 adult pairs and 42 broods with 92 cygnets inside the refuge and critical habitat area.[2]

[2] The exact area censused in 1958 is unknown so comparison with 1990 data is inexact. Swans observed outside the refuge and critical habitat area in 1990 bring the total count for the drainages

Most pairs and broods are observed in or near ponds, lakes, streams, and sloughs. Trumpeters are seldom found on coastal sedge flats. Each pair defends a shallow, stable waterbody ranging in size from 6 to 128 acres (Hansen et al. 1971). Only large lakes are occupied by more than 1 pair. Nests are usually built directly on the bottom in emergent vegetation (e.g., *Carex* or *Equisetum*) in water 1 to 3 feet deep. The nests are often reused in subsequent years. From nest building to the time cygnets can fly requires 145-150 days; therefore, trumpeters begin nesting while snow and ice cover most of the vicinity. Cygnets typically remain in the vicinity of their nest after they hatch. Their first flight normally occurs between September 10 and October 5, depending on time of hatch.

By mid-October most swans have left upper Cook Inlet for wintering areas along the Pacific Coast (Bellrose 1978). Some may fly as far south as the lower Columbia River. In some years, poor weather conditions in Cook Inlet during peak fall migration force some swans to stay in the area longer than they would if they could see well enough to negotiate mountain passes. In such years, the marshes of Cook Inlet serve as important staging areas, and swan numbers build up. While the number of trumpeters versus tundra swans is unknown, Cook Inlet important to both.

The refuge and critical habitat area encompass most of the trumpeter swan nesting and brood-rearing habitat in this area. Notable exceptions include both sides of the McArthur River valley below Blockade Glacier and the Cannery Creek and Jack Slough area south of Drift River (see Trumpeter Swan and Bald Eagle Map). The FWS surveys have documented a substantial increase in swans in both areas since 1975.

The continuing loss of winter habitat may eventually reduce the number of swans summering in Alaska. Trumpeters once bred and wintered throughout the contiguous states. In recent decades, despite substantial population growth, they appear reluctant to recolonize previous habitats, such as the midwestern states.

Trumpeter swans are sensitive to human activity, particularly in the vicinity of their nests and broods. Potential impacts of human population growth and industrial development on trumpeter swans were recognized by Hansen et al. (1971). Trumpeters tend to avoid lakes with cabins; the more cabins, with associated human activity, the less likely swans are to return (Timm 1981).

The trumpeter swan management plan (Trumpeter Swan Subcommittee 1984) recommends that the FWS and ADF&G identify, catalog, and make known the important habitats of swans for better maintenance and protection. Review project impact statements and land-use permit applications to ensure recognition and protection of swan habitats. Enter into cooperative agreements with other federal/state land-managing agencies and Native corporations to minimize impacts of development on swan habitats.

Geese. During spring migration, thousands of Canada [three subspecies: lesser (*parvipes*), Taverner's (*taverneri*), and cackling (*minima*)], snow, and white-fronted geese use the refuge (Table

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from the Kustatan River to Jack Slough to 203 adult swans, 91 adult pairs, 45 broods, and 103 cygnets.

4). and critical habitat area (Table 6). All of the snow geese and Pacific white-fronted geese and most Canada geese nest further to the north and west. Upper Cook Inlet, including Trading Bay and Redoubt Bay, is considered critical migration habitat for cackling Canada geese (Pacific Flyway Council 1986) and Pacific white-fronted geese. These coastal wetlands are the last feeding areas that cackling Canada geese are known to use before they arrive on nesting areas of the Yukon-Kuskokwim Delta. The Pacific white-fronted, snow, and probably Taverner's Canada geese take a different route south. Canada geese are not known to nest in the refuge, although some nesting is likely, and few nest in the critical habitat area (D. Timm, pers. commun.). The first successful nesting in the Redoubt Bay Critical Habitat Area (of a pair of lesser Canada geese) was observed in 1992 (Westlund 1992).

Some geese are sensitive to human disturbance. In Redoubt Bay, aircraft flying at or below an altitude of 500 feet and passing within 500 feet cause flocks of geese to take flight (Loranger and Eldridge 1986). This may significantly decrease feeding opportunity at times, particularly during spring migration, when foods are most limited but needed to replenish energy. Tule geese are sensitive to disturbance during nesting and brood-rearing. Feeding flocks are easily spooked by air traffic and hunters (Campbell 1981). Snow geese during spring migration may be more sensitive to air traffic on Redoubt Bay and Trading Bay marshes than on nearby Susitna Flats. On Susitna Flats, aircraft over 600 feet did not usually flush snow geese, and aircraft passing by at distances greater than one-third mile from a flock caused minimal alert behavior (Hupp 1990).

Tule White-fronted Goose.--The west side of Upper Cook Inlet has the world's only known nesting, brood rearing, and molting areas for tule white-fronted geese (*Anser albifrons gambelli*). Almost all evidence of breeding has been located in the critical habitat area.

Tule geese, a subspecies of the greater white-fronted goose, have long been an ornithological enigma. They were first described overwintering in Texas in 1852. In 1917 another tule goose population was described overwintering in California. Yet, for more than a century the nesting grounds of these birds, presumed to be in the arctic, remained unknown. After at least 8 attempts to locate nesting areas in remote portions of Canada and Alaska, Dan Timm, a waterfowl biologist with the ADF&G captured a few white-fronted geese in Redoubt Bay marshes that appeared to be tules. During the winters of 1979-80 and 1980-81, 200 tule geese and about 1,000 of the more common subspecies, the Pacific white-fronted goose (*A. a. frontalis*), were captured in California and marked with numbered, plastic collars. Subtracting known mortalities, 25% of the collared tules were sighted in Cook Inlet in 1980 and 1981. In 1980 and 1981, 344 white-fronted geese from Redoubt were marked with plastic collars and leg bands, and 11 tule goose nests were found in the Big River drainage of Redoubt Bay. Standard measurements of bill and leg lengths also confirmed that the white-fronted geese breeding on Redoubt Bay were the elusive tule geese (Timm et al. 1982, Subcommittee 1991).

This research verified tules were a distinct subspecies. Their nesting grounds in Cook Inlet are geographically isolated from Pacific white-fronted goose nesting areas further west by the peaks and glaciers of the Alaska Range. They are also larger and darker than Pacific white-fronted geese and tend to be segregated in migration and wintering areas (Timm et al. 1982).

Our understanding of tule nesting distribution is still fragmentary (Timm et al. 1982). Besides the 11 nests found near the lower Big River, only 2 other nests have been located. Both were used by

collared tules in the Susitna Flats State Game Refuge--one near Seeley Lake (B. Campbell, pers. commun.) and the other in the Chedatna Lakes close to the Theodore River (C. Brauch, pers. commun. in Timm et al. 1982). Goslings have been seen on Seeley Lake, near the now-drained Stump Lake, and near the lower Little Susitna River in Susitna Flats refuge (B. Campbell, pers. commun.). There is a report of tules nesting in the upper McArthur River drainage as well. Tules are only rarely seen in Cook Inlet outside of Redoubt Bay, Trading Bay, and Susitna Flats. Tules have also been seen in Tuxedni and Chinitna bays and Innoko National Wildlife Refuge (Subcommittee 1991), but it is not known if they nest or molt in these areas.

Their choice of nesting and brood-rearing habitat is one reason for the paucity of nesting information. The few nests that have been found were in brackish and freshwater marsh habitat. This is typical nesting habitat for Pacific white-fronted geese. However, tules appear to be brush-loving geese. Over 100 goslings and hundreds of adults were seen in flooded brush along the upper Big River. Their affinity for brushy areas and secretive nature during nesting and molting makes them very difficult to find.

Most frequently grazed plants in salt marshes are among the most common available, including *Puccinellia phryganoides*, *Triglochin maritima*, *Carex ramenskii*, and *Carex lyngbyaei*. In upriver habitats, tules grazed on *Eriophorum scheuchzeri*, *Arctagrostis latifolia*, *Carex aquatilis*, *Carex saxatilis*, *Eleocharis palustris*, *Juncus drummondii*, and *Equisetum fluviatile* (Smith undated).

Tules arrive in upper Cook Inlet in late April. Their migration up the coast from wintering areas is swift. Three marked birds traveled about 1,900 miles from northern California to Redoubt Bay in a maximum of 4 days (Timm et al. 1982). After nesting, brood-rearing, and molting, the tules begin to leave Redoubt Bay by mid-August. Some remain in upper Cook Inlet until early September. Major migratory stopovers are in eastern Oregon and the Klamath Basin in northern California. Their primary wintering area is the Central Valley, Suisun Marsh, and Sacramento River Delta in California (Pacific Flyway Council 1981).

The world population of tule geese is best estimated on wintering areas in California. Winter population estimates have increased steadily from 2,100 in 1978-79 to 6,900 in 1989-90 (Subcommittee 1991). In spring 1980, 1,652 tules were counted in Redoubt Bay (Timm et al. 1982) of an estimated total population of 2,500 (Subcommittee 1991). There have been no systematic counts of tules in Alaska since the early 1980s.

Because tule geese closely resemble the more abundant Pacific white-fronted geese, wildlife managers have been concerned that tules were vulnerable to overhunting, particularly in California, where most tules are shot (Subcommittee 1991). Beginning in 1979, a series of restrictive regulations and site-specific closures allowed both populations to increase.

In 1981 the International Council for Bird Preservation proposed listing the tule goose as a threatened subspecies in accordance with the Endangered Species Act (Timm et al. 1982). The Pacific Flyway Council and ADF&G recommended against listing because other actions, including establishing Redoubt Bay Critical Habitat Area, would provide adequate protection. Some concerns were expressed that if tules were listed, hunting for all white-fronted geese would be curtailed. This could have serious ramifications for wetland preservation in California, which is driven largely by

the sale of duck stamps and hunting licenses, Pittman-Robertson funding, and private hunting clubs. The U.S. Fish and Wildlife Service decided not to add tule geese to the list of threatened species.

Since 1987 hunting regulations have been liberalized and the harvest has been allowed to increase, although the estimated annual hunting mortality appears to be less than 5% of the known total population.

Snow Goose.--Up to 34,000 snow geese have been counted in upper Cook Inlet marshes enroute from their wintering area near the Skagit and Fraser rivers in Washington and British Columbia to their nesting area on Wrangel Island, Siberia. Typically, about 11,000-15,000 snow geese use Trading and Redoubt bay marshes, although in some years only a few thousand geese may be observed due to rapid turnover of individuals (Hupp 1990).

The distribution of snow geese and their length of stay in upper Cook Inlet depends on the pattern of snow melt during a 1 to 3 week period in late April-early May (Hupp 1990). In spring migration, snow geese feed in areas where snow has recently melted, areas with saturated soils and shallow pools of meltwater. Snow melt is usually slower in Trading and Redoubt bay marshes; therefore, snow geese usually use these areas later than the Kenai and Kasilof rivers. Peak numbers of snow geese have been observed in years of delayed snowmelt when birds apparently remain in Cook Inlet for longer periods while waiting for feeding habitat to become available. Smaller numbers of snow geese are more likely to be observed in years when snowmelt is early and movement through Cook Inlet is more rapid. Timing of migration and duration of use in Cook Inlet may also be affected by habitat conditions on wintering and migration areas at lower altitudes.

Ducks. Twenty-three species of ducks have been found on the refuge and critical habitat area (Table 3). Dabbling ducks are more abundant than diving ducks (Table 9). The refuge appears to have a greater density of breeding ducks than the critical habitat area (Table 9). The most abundant ducks are northern pintails. Green-winged teal, American wigeon, mallards, northern shovelers, and scaup are also numerous (Tables 4-7). Ducks have not been counted as frequently as swans and geese in this area (Tables 4-7). Trading Bay holds more ducks later than other marshes in Cook Inlet in the fall. The area between McArthur and Middle rivers is particularly important, but the area adjacent to the Shirleyville strip can be important also. Both Trading Bay and Redoubt Bay are important staging areas for ducks in the spring and fall.

Shorebirds and Other Waterbirds

At least 33 species of shorebirds and other waterbirds such as sandhill cranes, loons, and gulls occur seasonally. Shorebirds are very abundant during spring and fall migration when they probably number in the hundreds of thousands. The tidal flats and *Puccinellia-Triglochin* communities are used most intensively by shorebirds (ADF&G 1985b). Relatively few nest in the area. Loons are probably not common breeding birds in the refuge and critical habitat area because few lakes and ponds are deep enough to support prey species of fish. Sandhill cranes are common in the coastal marsh riparian habitat type (BCM 1981) and many were observed on the tide flats in late June 1993 (D. Clausen, pers. commun.). In 1976 and 1977 an estimated summer population of 400 cranes were in the Trading Bay area and 345 cranes were in the Redoubt Bay area (Timm 1077). Based on aerial surveys in 1980-82, D. Timm (pers. commun.) estimated at least one crane nest per lineal mile of shrub-bog/marsh interface, in addition to nests in much of the coastal marshes. Over 10,000 cranes funnel into the Cook Inlet region in fall, bound for wintering areas in California (Subcommittee 1983). Mew and glaucous-winged gulls are among the most conspicuous birds in the area.

Hudsonian godwits are a large shorebird once considered to be a rare breeder in Alaska and several Canadian provinces (Williamson and Smith 1964). A recent aerial spring survey of shorebirds reported 277 Hudsonian godwits in the Trading Bay area (Gill and Tibbitts 1993).

Raptors

Bald eagles and northern harriers are the most ubiquitous raptors in the area (Table 3).

Bald Eagle.--There have been no comprehensive nest site surveys; however, a few nests have been documented (see Trumpeter Swan and Bald Eagle Map). Aerial surveys of bald eagle nest sites in the Susitna Valley (Parker 1988) are probably indicative of nest sites in the refuge and critical habitat area. Nest trees are primarily mature cottonwoods near rivers and lakes. White spruce trees are occasionally used for nesting (ERT 1984b, Parker 1988). Nest trees were usually located in a stand of cottonwoods (i.e., not solitary trees). They were usually the largest tree in the stand and located within 20 yards of water. Bald eagles probably begin nesting by early April and lay one to three eggs in mid- to late April. Young eagles fledge in mid- to late August.

Bald eagles nesting on the Kenai Peninsula appear to be sensitive to human disturbance (Bangs et al. 1982). Eagles did not reproduce as successfully in areas frequented by recreationists as they did in less disturbed areas. Most of the refuge and critical habitat area are seldom visited during the nesting season; however, there are areas such as the Kustatan River and Big River Lake that attract numerous visitors in summer where human use could affect nesting eagles.

Other Birds

Common ravens and black-billed magpies are the only birds common to all terrestrial habitat types. The most abundant passerines may be savannah sparrows, because their preferred feeding habitats are the open grass and sedge flats that comprise the bulk of the refuge and critical habitat area. Swallows are also abundant, feeding on mosquitos and other small flying insects in open areas. Three of the four swallow species use radically different nesting strategies. Tree and violet-green swallows nest in tree cavities, bank swallows nest in colonies excavated in exposed dirt banks, and cliff swallows plaster their mud nests on vertical walls. Thousands of cliff swallow nests have been built under the eaves of Trading Bay and Redoubt Bay duck shacks. They can constitute a minor nuisance to humans when feather mites leave the nests and move indoors; however, the nests cannot be removed without a federal permit.

MAMMALS

Terrestrial and Aquatic Mammals

Twenty-five species of terrestrial and aquatic mammals have been documented in the vicinity (Table 10). The Black Cottonwood Riparian habitat type has the highest mammalian diversity (15 species; BCM 1983). Resin birch bog has the lowest diversity (5 species).

Moose. According to oral history, moose only recently appeared in Cook Inlet region. In 1900, older Indians said that moose were not there when they were boys (Osgood 1901:61), and Tyonek elders report moose remained rare into the 1940s (Fall et al. 1984). This local scarcity or absence may have been temporary (de Laguna 1975:13) and caused by natural succession of habitat types (Lutz 1960). The Dena'ina themselves were relatively recent immigrants to the Cook Inlet region, apparently arriving not long before the first Europeans (de Laguna 1975). Moose may have been scarce or absent when the Dena'ina arrived, but fires or other man-caused changes in habitat would have resulted in more browse, which would have hastened the recolonization of moose. Tyonek elders attribute the arrival of moose to a large burn in the vicinity of Chakachamna Lake in the 1930s (Fall et al. 1984:138). The Dena'ina used to find caribou on the Susitna Flats in the "distant past" (Kari and Fall 1987:56) where none have been found in historic times, which also points to possible habitat differences.

Moose are year-round residents of the refuge and critical habitat area. Most moose move to higher elevations out of the refuge and critical habitat area in spring (Faro 1985). In summer and fall, moose are most often found in open-canopy spruce-hardwood forest. Rutting concentration areas are outside of the refuge. In November-December, snowfall starts moose moving back to lower riparian areas. By January, moose have moved into winter habitat, where they spend most of their time in the closed-canopy spruce-hardwood forest. Winter concentration areas occur along the lower McArthur River, upper Middle River, Noautka Slough, lower Chakachatna River, and Nikolai Creek (see Mammals maps, Faro 1985).

In winter, moose need food and cover in close proximity. Riparian areas are strips of concentrated browse species (primarily willows, but also birch, aspen, and cottonwood) where moose feed for brief periods in winter before moving back into cover. The logged area in the refuge also provides abundant, high quality moose browse that is eaten in early winter by some moose, before the snow gets too deep. However, it is seldom used during the remainder of the year (Faro 1985). The snow is deeper than in the closed-canopy forest, making movement more difficult; most of the clearcut areas are too far from the thermal protection of the forest; and human activities along the road system may discourage wary animals.

Although moose have been counted often in the vicinity of Redoubt and Trading bays (Tables 11 and 12), our knowledge is incomplete and it is difficult to discern patterns from the aerial surveys. Boundaries of the aerial census areas approximate drainages and do not conform to the boundaries of the refuge and critical habitat area.

Moose prefer riparian areas and hillsides with abundant browse. They are less frequently encountered on the sedge flats that comprise much of the refuge and critical habitat area, although these open areas may be important in late spring and early summer, after calves are born.

Moose numbers are low to moderate in the area. From 1972-1988 the density of moose in the three Redoubt Bay census areas has ranged from 0.2 to 1.0 moose/mi^2, but there is no trend. In fact, moose density was remarkably stable at 0.9 moose/mi^2 from 1986 to 1988 in the Big River census area. From 1982 to 1989 the density of moose in the McArthur River census area of Trading Bay has ranged from 0.9 to 1.7 moose/mi^2, with no trend. These data are comparable to moose populations in the remainder of Game Management Unit 16 (Faro 1985).

Productivity is low to moderate. In Redoubt Bay, calf recruitment declined severely in 1984; the number of calves/100 cows in the mid- to late 1980s was about half of what it was in the 1970s and early 1980s. Calf recruitment is very low in the Big River census area of Redoubt Bay; in 1987 only 7 calves were counted per 100 cows. Brown bear predation is believed to limit calf recruitment in the Redoubt Bay area (D. Timm, pers. commun.). In the McArthur River census area of Trading Bay, calf recruitment declined in the mid-1980s, but appears to have returned to previous levels.

The bull:cow ratio is adequate. However, the number of bulls with antler spreads of 30 inches or greater (i.e., bulls typically older than a yearling) appears to have declined in the mid- to late 1980s to about one-half of what they were in the early 1980s in both the refuge and critical habitat area.

Predators. Mammalian predators include several canids, bears, lynx, and several species of the weasel family. Coyotes are an abundant large predator. They are common in all habitat types and are most abundant in the coastal marsh riparian habitat that comprises much of the refuge and critical habitat area (BCM 1983). Wolves are only occasionally seen. Smith (undated) observed wolf tracks once on the North Fork of Big River. Red foxes inhabit the refuge and critical habitat area. They were not observed in Trading Bay State Game Refuge by BCM (1983), although red foxes are common in the Tyonek area (Fall et al. 1984:164). Red foxes seem to be more numerous than coyotes around Big River Lakes (Westlund 1992).

Bears are found in all habitat types. Most of the critical habitat area is intensively used by brown bears from spring to fall (see Mammals maps). In coastal areas, sedges and beach lovage (*Ligusticum scoticum*) are important components of brown bear diets in spring. Brown bears are also commonly found on the beach, searching for dead eulachon (Fall et al. 1984) and other carrion. Black bears are more abundant in wooded areas, seldom venturing farther than 350 yards from mature trees or tall shrubs (EPA 1990). They are commonly seen along the shoreline of the inlet, along streams, around bogs, and in clearings. Spring concentration areas are located on the shore between Kustatan and the Kustatan River, the upper McArthur River, and the slopes bordering the critical habitat area between Drift River and the South Fork Big River (see Mammals maps). An aerial survey conducted on July 1, 1989, found 24 brown bears (7 sows, 15 cubs, 2 subadults) on the coastal flats between the Kustatan River and Montana Bill Creek - an area of about 18 mi^2 (B. Quirk, 1989). Both species are concentrated along salmon streams in the late summer and fall, particularly the Kustatan River. Berries are also an important food, beginning in late July. Both species spend the winter in dens, but den sites are not well known. Bears are the main predators of moose in this area (Faro 1985).

Both brown and black bears are frequently observed on Wolverine Creek, a tributary of Big River Lake that is heavily used by anglers. More bears seem to use the creek when anglers are not present (Westlund 1992).

Lynx are uncommon in the Tyonek area (Fall et al. 1984:164), and their habitat is limited on the refuge and critical habitat area.

In 1900, Osgood (1901) observed mink were moderately common in the Cook Inlet region and river otters were uncommon. Mink are still common in black cottonwood riparian areas and are occasionally encountered in other freshwater riparian areas (BCM 1983). River otters are occasionally found in freshwater riparian areas. Osgood (1901) captured one least weasel in the Tyonek area, and ermine are also present in the Tyonek (Fall et al. 1984) and Big River Lakes areas (D. Timm, pers. commun.). Marten inhabit forested habitat in the Tyonek (Fall et al. 1984, ERT 1984b) and Big River Lakes areas (D. Timm, pers. commun.), and probably occur in suitable habitat, which is limited, in the refuge and critical habitat area. Wolverines also inhabit the Tyonek (Fall et al. 1984) and Big River Lakes areas (D. Timm, pers. commun.), but are not common.

Beaver. Evidence that they had been substantially reduced in number in the vicinity of Knik Arm. Osgood (1901:63) noted that a "limited number" were taken every year along mountain streams about 60 miles inland of Tyonek and a "small quota" were brought to a trading station on the lower Susitna River. "Compared with former receipts, however, the number now obtained is lamentably small" (Osgood 1901:64).

Beaver are now abundant in the area, and their dams have impounded many streams and sloughs. These are the most heavily used and productive areas in northern Trading Bay refuge (Rosenberg 1990) and probably other parts of the refuge and critical habitat area. Beaver ponds are used by other waterbirds, rearing salmon fry, moose, mink, and other animals.

Other Mammals. Four small mammal surveys have been conducted in the Trading Bay or Redoubt Bay area. Osgood (1901) set traps and talked to locals in the Tyonek area in autumn 1900. BCM 1981, 1983) conducted 22 low-elevation aerial surveys and on-the-ground surveys on 23 study plots (averaging 2 mi^2 each) in association with Alaska Power Authority's environmental assessment of the Chakachamna hydroelectric project. In addition, they trapped small rodents in several representative vegetation zones, including the edge of the floodplain near the confluence of the Chakachatna River and Straight Creek, in heavily wooded area west of the Chakachatna River, and on McArthur Flats near Seal Slough. Environmental Research & Technology, Inc. (1984b) conducted surveys in an area bordering Trading Bay State Game Refuge about 5-10 miles northwest of Tyonek in association with the Diamond Shamrock - Chuitna Coal Joint Venture. Smith (undated) and R. Sinnott (pers. observ.) collected small mammal information in the critical habitat area. There is probably little difference in mammal distribution or abundance, within suitable habitats, between the refuge and critical habitat area.

Osgood (1901) found masked and dusky shrews were very common near Tyonek. He captured one pigmy shrew. Pigmy shrews are comparatively rare in Alaska in relatively dry, open spruce forest with a moss and lichen ground cover (Rausch 1967). Northern red-backed voles were abundant in mossy places and about decayed logs in the woods. Tundra voles were very abundant in beach rye grass on low, sandy stretches near tide level. Muskrats were common about small ponds in peat bogs. A meadow jumping mouse was found drowned in a water barrel, but they seemed to be rare. Porcupines were very rare. Snowshoe hares were present, but numbers were low in 1900. Norway rats (*Rattus norvegicus*) had occasionally escaped from vessels at Tyonek, but reportedly did not increase in numbers.

Recent surveys have found some of the same species (Table 10). Dusky shrews are common in alder thickets and some riparian areas. Masked and pigmy shrews inhabit the Big River Lakes area (D. Timm, pers. commun.). Northern red-backed voles are the most ubiquitous small mammal, having been found in 6 of 8 terrestrial habitat types on Trading Bay (BCM 1983). Tundra voles are common in black cottonwood riparian areas (BCM 1983) and beach rye grass (R. Sinnott, pers. observ.). Meadow voles (*Microtus pennsylvanicus*) and meadow jumping mice (*Zapus hudsonius*) occur in the Big River Lakes area (D. Timm, pers. commun.). Northern red squirrels are occasionally found in a variety of habitat types. Muskrats are common in freshwater riparian areas. Porcupines are common in black cottonwood riparian areas.

Several additional species have been found in the Tyonek vicinity and are likely to inhabit suitable habitat in the refuge and critical habitat area. Environmental Research & Technology, Inc. (1984b) found arctic shrew (*Sorex arcticus*); little brown bat (*Myotis lucifugus*); arctic ground squirrel (*Spermophilus parryii*); and singing vole (*M. gregalis*) in lowland spruce-hardwood forest north of Trading Bay. Northern flying squirrels (*Glaucomys sabrinus*) occur at the head of Knik Arm (Osgood 1901:63) and are likely to inhabit suitable habitat near Trading and Redoubt bays. Collared pikas (*Ochotona collaris*) have been found at the west end of Chakachamna Lake (Rausch 1961), and similar alpine habitat occurs in the critical habitat area, in the North Fork Big River valley.

Other species listed by ERT (1984b) as potential inhabitants of the Beluga area are the water shrew (*Sorex palustris*), silver-haired bat (*Lasionycteris noctivagans*), hoary marmot (*Marmota caligata*),

brown lemming (*Lemmus sibiricus*), northern bog lemming (*Synaptomys borealis*), Norway rat (*Rattus norvegicus*), and house mouse (*Mus musculus*).

With the exception of relative abundance estimates by BCM (1983), abundance levels are not known for any mammals except moose.

Marine Mammals

Only three species of marine mammals have been documented in the area: belukha (or white whales), harbor seal, and Pacific walrus (*Odobenus rosmarus*). Walrus are undoubtedly accidental visitors; four or five hauled out on a sand bar near Kalgin Island in 1979 (Anonymous 1979) and a small bull spent several weeks near the mouth of the Drift River in 1987 or 1988 (J. Warniers, pers. commun.). A few other species, such as orca [or killer whales (*Orcinus orca*)], are likely to have passed through offshore waters in rare visits to upper Cook Inlet.

Belukha. Belukhas have been seen in offshore portions of the critical habitat area and refuge. Cook Inlet had an estimated population of at least 1,293 belukhas in 1979; this population may be geographically isolated from belukhas in the Bering Sea and Arctic Ocean (Calkins 1989). Belukhas are year-round residents. In general, they seem to be absent from the upper inlet in winter. A few appear in the upper inlet in May, they concentrate at river mouths from late May through June, groups disperse throughout the upper and central inlet in July and August, and they move back to the lower inlet by November (Calkins 1984).

The exact abundance and distribution of belukhas in Trading and Redoubt bays is not well-known. Belukhas are most abundant in Trading and Redoubt bays from June to August. Calkins (1984) counted 62 in the McArthur River area on an aerial survey in August 1982. They gather near the mouths of some local streams to feed on migrating salmon, eulachon, and "tomcod" (*Microgadus proximus*?) (Fall et al. 1984), as they do in other parts of Cook Inlet.

Harbor Seal. A few harbor seals use two haul-outs in the area (see Redoubt Bay Critical Habitat Area Mammals Map). Seals are seen in nearshore marine waters and sometimes swim far upriver. Seals were occasionally seen in Big River below the lakes from early July through August in 1991 and 1992 (D. Timm, pers. commun.). Two harbor seals were observed feeding on coho salmon in Big River Lake from August 31-September 18, 1992 (Westlund 1992). Other than these sightings, their abundance and seasonal distribution is essentially unknown.

LAND OWNERSHIP

Most of the land within the Trading Bay State Game Refuge, including 3,840 acres of original Mental Health land in the northeast portion of the refuge, and the Redoubt Bay Critical Habitat Area is state owned. The tide and submerged lands within these areas are also state owned. There are three small private inholdings in the Trading Bay State Game Refuge and two small private inholdings in the Redoubt Bay Critical Habitat Area (see Land Status Maps). Private lands within the refuge and critical habitat area are not subject to refuge or critical habitat area authorities; but would, if acquired, become part of the special area as provided in statute. The Kenai Peninsula Borough has a municipal selection on five sections of state land in the vicinity of Big River Lakes.

PUBLIC ACCESS

Recreational access is primarily by small airplanes, with wheels or floats, and less commonly by boat. Subsistence users access the area by boat and motorized vehicles, including snowmachines. Government and industry personnel often use small airplanes or helicopters.

AIRCRAFT

Airstrips and floatplane-accessible lakes are shown on the Land Status Maps. Airstrips are located along the McArthur River, Drift River, North Fork of Big River, Kustatan River, and Bachatna Creek; however, none are state-maintained. Small planes can also land on many parts of the sedge flats.

Some landing areas are very popular. In recent summers, approximately 350-400 airplanes have landed in the southwest corner of Big River Lake near the mouth of Wolverine Creek (Westlund 1992).

BOATS

Boats are used by setnetters, anglers, hunters, and other recreationists.

Tyonek residents travel along the shoreline in dories to beaches south of the Drift River to dig clams during minus tides from mid-April to June and in September (Fall et al. 1984). They also use marine waters in travelling between Tyonek and navigable rivers.

The MacArthur, Chakachatna, Kustatan, Middle, and Big rivers and Montana Bill Creek are navigable (see Land Status Maps). Moose hunters from Tyonek travel south by boat to hunt up the McArthur and Middle rivers (Fall et al. 1984). Tyonek residents used to navigate a circuit up the Middle River, into the Chakachatna River, and down the McArthur River before changes in the river channels made this route impassable to propeller-driven boats (Fall et al. 1984). Boats can still go up the Middle River to its confluence with the Chakachatna and up the McArthur River to the western boundary of the refuge.

Some sport anglers and hunters from the Kenai/Soldotna area travel by boat across Cook Inlet, particularly to the Kustatan River. An estimated 2-5 boats per year cross the inlet to hunt up the Big River and Montana Bill Creek (D. Timm, pers. commun.). Some waterfowl hunters keep small boats in both the refuge and critical habitat area to better access hunting areas. The use of river boats equipped with jet units has increased in recent years, and complaints about noise and crowding on the Kustatan River during the fall coho fishing season have been voiced in public meetings.

Boats are used in Big River Lake. In recent summers, about 100-150 boat-use days were estimated to occur on the lake for fishing (Westlund 1992). Air taxis and other commercial operators kept up to eight boats on Big River Lake in 1991 and 1992 (D. Timm, pers. commun.).

ROAD VEHICLES

During the early 1960s, roads were constructed in the area for oil and gas exploration. Timber companies built additional roads in the 1970s. Tyonek residents use these roads extensively (Fall et al. 1984). Moose hunters from Tyonek drive trucks along old logging and oil and gas roads south towards the Chakachatna River (Fall et al. 1984). Some trappers use trucks near the road system; others use snowmachines when snowcover is adequate (Fall et al. 1984).

Sport hunters and anglers also use the road system, primarily by landing at the Tyonek airstrip (EPA 1990). Several wilderness fishing guides meet clients in Tyonek and drive them to streams north of the refuge. Most moose hunting also occurs north of the refuge. The refuge is also road-accessible from the Shirleyville airstrip. The Shirleyville Lodge rents trucks to occasional anglers to drive to Nikolai Creek.

A road system extends from the Trading Bay Production Facility north into the Trading Bay State Game Refuge a short distance (along the pipeline right-of-way) and south into the Redoubt Bay Critical Habitat Area as far as the Kustatan River.

EXISTING HUMAN USES

CABINS

Private cabins were built on remote federal lands on the west side of Cook Inlet since before the turn of the century. By statehood, there were probably 1-2 cabins on Trading Bay. In 1977, 17 cabins were found on Trading Bay (ADF&G 1985b). Two of the Trading Bay cabins were on private land, two appeared to be used for commercial fishing, and the rest were used for recreation or other purposes.

In the late 1970's and early 1980's, the state Attorney General's office, ADF&G, Department of Natural Resources, and Governor's office tried to reconcile the constitutional and management problems raised by legitimizing the existing trespass cabins.

Meanwhile, more cabins were being built or discovered. A partial survey found 20 cabins in Trading Bay in 1984, an increase of five since 1977 because two cabins had deteriorated (ADF&G 1985b).

ADF&G (1985b) assessed the potential for cabin use to affect waterfowl. Cabins used for commercial fishing were clustered near the best setnetting sites and where access was possible with a moderate-sized boat. These cabins were located either upriver in shrub-bog habitat or in the *Puccinellia-Triglochin* zone near river mouths. The shrub-bog community is marginal waterfowl habitat and the *Puccinellia-Triglochin* community is used by waterfowl primarily in spring and fall, before and after the commercial fishing season. Hence, traditional use patterns at these cabins probably has little impact on waterfowl. About 70% of the cabins surveyed in Trading Bay and Susitna Flats refuges were used for waterfowl hunting. These cabins were located near good hunting areas where access was convenient. Overall, 44% of the "duck shacks" were located in the marsh habitat type that is most attractive to ducks. Another 48% of the "duck shacks" were in Ramenski sedge and *Puccinellia-Triglochin* communities that are also important to waterfowl in fall, when waterfowl hunters are present. Human activity during the waterfowl hunting season, particularly floatplane traffic near lakes, disturbed waterfowl. The report concluded that the number and density of cabins on Trading Bay refuge had not caused measurable long-term impacts to waterfowl or their habitats. However, it also noted that the number of waterfowl hunters and hunter use-days were both increasing in upper Cook Inlet marshes more rapidly than statewide.

The refuge and critical habitat area were last surveyed for cabins in 1991 and 1992, respectively. There were 29 cabins still present in the refuge and 52 cabins still present in the critical habitat area (see Land Status Maps and Tables 13 and 14). Most cabins are located near waterbodies in the coastal marsh and are either personal use cabins or set net cabins. Several of the cabins are on private land. Some of the cabin permits have expired, and some cabins were never permitted or their status is in question. Some of these cabins are in such poor condition that they should be removed. Several of the cabins are owned by the state (generally because permittees failed to renew their permit). Of the cabin owners with valid permits in the Trading Bay State Game Refuge, most are residents of the Anchorage area and the rest are from the Kenai Peninsula. Of the 34 cabin owners with valid permits in the Redoubt Bay Critical Habitat Area, 26 are residents of the Kenai Peninsula

(primarily from Soldotna and Kenai) and eight from Anchorage. Two of the cabins are used by setnetters, but most are personal use cabins used in the fall by waterfowl hunters.

ADF&G staff have removed dilapidated trespass cabins in other refuges in upper Cook Inlet in recent years. Dilapidated trespass cabins in the Trading Bay State Game Refuge and the Redoubt Bay Critical Habitat Area may also be removed. The department may determine that trespass cabins that are in good condition should be used by permit by nonprofit groups or as public use cabins.

SUBSISTENCE HUNTING

Since the 1920s, partly in response to increased hunting pressure by non-Natives north of the Beluga River, Tyonek hunters have concentrated their main hunting effort west and south of Tyonek (Kari and Fall 1987:52). The main hunting areas for waterfowl are the mouths of Nikolai Creek, Middle River, and McArthur River (Fall et al. 1984).

Since 1990, Trading Bay refuge has had a Tier II subsistence moose hunting season. Moose harvested from this hunt are included in Table 19. Tier II permits are issued only to Alaskan residents and are awarded based on factors such as the number of years the applicant hunted moose in this area, the proportion of fish and wildlife in their diet, availability of alternative food sources, and how close they live to the hunt area. Many permit winners are not from the Tyonek area. For example, of the 57 permit winners for the 1993-94 moose hunt in TM 569, which includes the area south of the Beluga River and all Trading Bay drainages, 40% were from Tyonek and Beluga, 35% were from Anchorage and Eagle River, 21% were from the Matanuska-Susitna Valley, and 4% were from the Kenai Peninsula.

Tyonek residents occasionally hunt black bears, but no longer hunt brown bears (Fall et al. 1984). Both black and brown bears are sometimes shot in defense of life or property by Tyonek residents (Fall et al. 1984).

The Dena'ina of Cook Inlet are the only Athapaskans who have regularly hunted whales. Prior to 1940, belukhas supplied a major part of the Tyonek diet (Kari 1987a). Before the Tyonek Dena'ina obtained rifles, they hunted belukhas in stream mouths by upending and burying a spruce log with a large root bole at low tide and placing a hunter with harpoons attached to inflated sealskin floats in the bole. When a foraging belukha swam by at high tide it would be harpooned and hunters in bidarkas would pursue and dispatch it. An estimated six or seven belukhas were harvested each year in the 1930s and 1040s. Then, for several decades, they were not hunted regularly. In 1979, the belukha hunt was reinstituted, using rifles from shore and from boats instead of spears. Harbor seals have traditionally been harvested along the shores of Trading Bay and Redoubt Bay (Fall et al. 1984).

SPORT HUNTING

The refuge and critical habitat area are used by waterfowl and moose hunters from Anchorage, Matanuska-Susitna Valley, and Kenai Peninsula.

Waterfowl

Relatively few ducks are shot by sport hunters in Trading and Redoubt Bay marshes. From 1981-1990, the average annual reported waterfowl harvest in the Trading Bay area was 980 dabbling ducks, 15 diving ducks, and 86 geese; in the Redoubt Bay area, 450 dabbling ducks and 26 diving ducks were reported harvested per year (Bartonek 1991). The total for both areas was only about 8% of the dabblers, 2% of the divers, and 11% of the geese reported harvested in Cook Inlet each year.

In most years, four species--northern pintails, mallards, American wigeons, and green-winged teal--comprise over 85% of the ducks harvested in Redoubt and Trading Bay marshes (Tables 15 and 16). Few diving ducks are shot. From 1972-1991 the estimated duck harvest has ranged from 508 to 5,570 (median = 1,512) in Trading Bay and from 370 to 3,605 (median = 1,309) in Redoubt Bay. A few Canada and white-fronted geese are shot in Trading Bay marshes but very few geese are shot in Redoubt Bay marshes.

Unlike nearby Susitna Flats State Game Refuge and road-accessible Palmer Hay Flats State Game Refuge, these areas are not heavily hunted (Tables 17 and 18). From 1972-1991 the estimated number of waterfowl hunter-days ranged from 333 to 1,475 (median = 601) in Trading Bay and from 161 to 1,470 (median = 596) in Redoubt Bay. In most years, less than 3% of the estimated statewide duck harvest, less than 1% of the estimated goose harvest, and less than 2% of the estimated hunter-days occurs in Redoubt or Trading Bay marshes (Tables 17 and 18). Hunting success is relatively high, ranging in most years from 2-3 waterfowl/hunter/day.

Samples of mallard and pintail gizzards and livers were collected from hunters in Redoubt Bay Critical Habitat Area in 1985 and 1986 to assess ingestion and absorption rates of lead shot (Campbell et al. 1988). About 13% of both species (22% of mallards and 8% of pintails) had ingested one or more lead pellets. This was comparable to ingestion rates of ducks from Susitna Flats (15%) and half the rate of Palmer Hay Flats (33%). Similarly, about 17% of both species had lead concentrations greater than or equal to 2.00 ppm (wet weight) in their livers, compared to 13% of those collected in Susitna Flats and 29% in Palmer Hay Flats.

Thus, mallards and pintails collected in Redoubt Bay marshes had high rates of ingestion and absorption relative to other areas in the United States (Campbell et al. 1988). The mean ingestion rates from 25 studies conducted throughout the continguous states from 1973 to 1984 were about 8% for mallards and 12% for pintails. About 15% of dabbling ducks collected in 1983-84 in the Pacific flyway had liver lead concentrations greater than or equal to 2 ppm. The U. S. Fish and Wildlife Service established two criteria for identifying areas with lead-poisoning problems: (1) one or more ingested lead pellets in 5% or more of gizzards sampled, and (2) 2 ppm or higher lead levels in 5% or more of livers sampled. Ingestion and absorption rates for both mallards and pintails exceeded these criteria in all three areas sampled in upper Cook Inlet. This problem was rectified in fall 1991, when Alaska joined the other states in prohibiting lead shot for waterfowl hunting.

Moose

Hunting pressure is light in the critical habitat area and refuge because they are not connected by roads to the large population centers in Southcentral Alaska and moose are not numerous enough to attract many fly-in hunters.

Between 1988 and 1992, the annual number of moose hunters that reported hunting in this area ranged from 27 to 56 (Table 19). About half of the hunters were from the Kenai Peninsula and about one-third from the Anchorage area. Success rates are relatively high, compared to other areas in the state. Hunters from the Kenai Peninsula and guided nonresidents have a much higher success rate than hunters from other parts of Alaska in this area. Moose hunts in the critical habitat area and refuge average 5-7 days. Airplanes are the primary means of access, followed by boats. Some moose hunters use all-terrain vehicles. These are either left at cabin sites, carried into the area via aircraft or boat, or driven along the road out of Tyonek and Shirleyville. Several hunters have used highway vehicles, presumably from Tyonek. Most Tyonek residents hunt moose north of the Trading Bay State Game Refuge.

Bulls are not large compared with other areas in Alaska. In most recent years, the average antler spread has been 40-50 inches. The largest antler spread on a bull taken between 1988-1992 measured 69 inches, but few bulls have antler spreads greater than 50 inches. Nevertheless, dispersed hunters and spectacular scenery contribute to a high-quality hunt.

Tyonek residents formed a fish and game advisory committee in 1983. Their active participation in the state's Board of Fisheries and Game process resulted in amendments to moose hunting regulations to better approximate the traditional hunting season (Fall et al. 1984). Until 1974, hunting regulations allowed an early hunt in August and September and a late hunt in November. In 1976, moose hunting in GMU 16B was restricted to September due to growing pressure from urban hunters from southcentral Alaska. Since 1983, the Board of Game has provided a winter moose hunt, initially for local residents, but recently for anyone qualifying for the Tier II hunt.

Bears

Few bears are shot in the critical habitat area or refuge. For example, from 1961-1982 only 5 brown bears were shot in the Trading Bay area, based on sealing records and harvest tickets. Since then, brown bear harvests have increased; however they are still low. In the spring and fall hunting seasons of 1992, only 7 brown bears were reported shot by sport hunters in the drainages of Trading and Redoubt bays, and some of these may have been outside of the refuge and critical habitat area.

Black bears are probably shot incidentally by moose hunters. Like brown bears and moose, the majority are shot in accessible areas.

Other Species

Small game is seldom taken by sport hunters in this area, although hunters of waterfowl and moose may incidentally take grouse or other species.

TRAPPING

A few trappers from the Kenai Peninsula use airplanes to access the critical habitat area for trapping beavers, otters, and wolverines (J. Faro, pers. commun.). Some aerial coyote hunting has also occurred in the past. Year-round residents at Big River Lake occasionally trap. Very little trapping is done by Tyonek residents.

WILDLIFE OBSERVATION AND OTHER RECREATION

Few visitors are attracted to the refuge and critical habitat area solely to watch or photograph wildlife. Aavian Outdoors, a lodge and guide service located on Big River Lake, caters to birders and other nonconsumptive users, as well as anglers. Its brochures emphasize the tule goose, brown bears, and belukhas and seals at the mouth of Big River.

The lodge owners applied for a lease in 1992 to operate a bear viewing camp at the outlet of Big River Lake. The request was denied. Another operator subsequently established a camp on the site without a permit and was asked to leave. Westlund (1992) provides a list of points to consider when reviewing proposals for a bear viewing program in this area.

Wildlife observation is undoubtedly an important component of some hunters and anglers, while it may only be incidental to others. The area probably has the potential to attract nonconsumptive users, particularly in spring when waterfowl, shorebirds, and brown bears are abundant on the flats. The rapids of the upper Chakachamna River are thought to be navigable by kayaks, albeit with difficulty (BCM 1983:6-102). Use of nearby Chakachamna Lake was increasing in the 1970s and early 1980s. Floatplanes land on the lake, wheeled planes land on gravel bars, and visitors kayak the lake and hike up the drainages.

SPORT FISHING

Most sport fishing occurs on the Kustatan and Big River Lakes system. Both systems are growing in popularity (Nelson 1993).

The turbid Kustatan River supports a run of coho salmon that arrives earlier than Kenai Peninsula cohos. Kustatan cohos are present from as early as mid-July through August. Recreational anglers reach the Kustatan primarily by wheel or float planes. Small planes can land in the lower river, on small lakes adjacent to the river, on unimproved landing strips, and on gravel bars. A few anglers take boats across Cook Inlet from the Kenai Peninsula. Most fishing occurs near the landing areas. The most popular fishing site is the confluence of the Kustatan with a clearwater slough about three miles upstream from Cook Inlet (Nelson 1993). Several commercial operators establish temporary camps here each year and provide small river boats for clients. Most of the fish harvested at this site are thought to originate in the slough. However, it is not known whether the slough is a spawning or holding area.

In 1991, over 4,500 anglers fished an estimated 6,674 days on the Kustatan River, catching an estimated 5,768 cohos, 200 sockeyes, 30 kings, 850 Dolly Varden and 90 rainbow trout. Records indicate two explosive increases in annual harvest and participation during the last nine years. The harvest of cohos increased 80%/yr from 1983 to 1987. Harvests dropped from the peak in 1988 to 1990, but were up again in 1991. The participation rate increased 145%/yr from 1983 to 1985. After a relatively stable period from 1986 to 1990, the number of angler/days jumped 179% between 1990 and 1991. The catch per unit effort increased from 1984 to 1988, but has declined every year since (Table 20).

An annual sport harvest of less than 7,000 fish is probably not exceeding the productive capacity of the Kustatan River (Nelson 1993). However, if the heavily fished slough is a spawning area, a growing number of recreational anglers may be capable of decreasing the reproductive potential of salmon in the Kustatan drainage.

Sport fishing effort is also increasing on Big River Lake and Wolverine Creek for sockeyes and, to a lesser extent, cohos. Wolverine Creek flows into Big River Lake. Both are clear water systems, although the lake is somewhat turbid due to glacial water from North and South forks of Big River and periods of organic stain. Access is by float plane. Sockeye salmon are caught in Big Lake at the mouth of Wolverine Creek from mid-June through July. Several guides and air charters offer unguided and guided sport fishing at Big River Lake.

The limited data on the number of fish caught and participation rates indicates a rapidly growing sport fishery at Wolverine Creek. Cook Inlet Aquaculture Association staff, onsite throughout most of the fishing season, observed about one plane full of sport anglers each day for 43 days in 1981. Assuming four anglers/plane and a catch of three sockeyes/day (the latter being "the only condition the crew observed"), an estimated 500 sockeyes were caught (Mears 1981). In 1982, weir staff observed 123 planes, one helicopter, and three boats bringing 396 anglers to Wolverine Creek. Assuming a harvest of three sockeyes/angler, about 1,188 sockeyes were caught (Mears and Marcuson 1982). In 1983 the weir staff observed 196 planes, 2 canoes, and five other boats transporting 624 anglers to the mouth of Wolverine Creek. Assuming a harvest of three sockeyes/angler ("easily achievable and noted as the common take"), an estimated 1,872 sockeyes

were caught in 64 days (Marcuson 1984). A decade after these observations, in 1991 and 1992, Dan and Karen Timm observed an average of 8 planes/day arriving at and departing from the lake from June 20 to July 25 each year. In August, the daily average declined to 1.25 planes/day.

Assuming about three anglers/plane, the Timms estimated 1,070-1,140 anglers arrived by floatplane in both 1991 and 1992. Assuming five salmon were kept by each angler (daily bag limit was 3, possession limit was 6), they estimated an annual harvest of 5,350-5,700 salmon, of which 585-625 were cohos and the remainder sockeyes (Nelson 1993).

Bachatna Creek is also regularly fished; however, statistics on effort and catch are not available. The McArthur River and Nikolai Creek attract some anglers. Nikolai Creek offers good fishing opportunities for chinook and red salmon, but guides are not known to visit there (EPA 1990).

COMMERCIAL FISHING

The only commercial fishing that occurs in the refuge and critical habitat area is setnetting. Setnet fishermen intercept salmon moving north along the coast. In the refuge, setnet sites are grouped just south of the McArthur River and south of Nikolai Creek. This area is in the Northern District of upper Cook Inlet. There are approximately two dozen setnet sites authorized under shore fishery leases in the refuge. An unknown number of setnetters have not obtained shore fishery leases, which are not required by law. Target species are king, sockeye, and coho salmon (Table 21).

In the critical habitat area, setnet sites are clustered north of Drift River. This area is in the Kustatan Subdistrict of Upper Cook Inlet. Approximately two dozen setnet sites are authorized under shore fishery leases in the Kustatan Subdistrict. An unknown number of setnetters have not obtained shore fishery leases. Target species are sockeye and coho salmon; up to 1,000 king salmon may be kept (Table 22).

FISHERY ENHANCEMENT

Cook Inlet Aquaculture Association operated a fish weir on Wolverine Creek from 1981-1983 and has investigated the potential for enhancing sockeye salmon runs in the Big River Lake system (CIAA 1981, Mears and Marcuson 1982, Marcuson 1984). No sockeye or coho salmon were found in the large lake south of Wolverine Lake. They speculated that this lake could serve as a water source for a hatchery or be used as a nursery area if supplied with annual fry releases. However, the best option for developing a salmon run appears to be by transporting local broodstock and providing fish ladders (Mears and Marcuson 1982). Although it appears feasible, there are no immediate plans for enhancing this system.

OIL AND GAS EXPLORATION AND DEVELOPMENT

Potential oil and gas fields were identified in the area in the late 1950s. The state has leased onshore and offshore tracts since the mid-1960s. Seismic testing and test drilling have occurred onshore since at least the mid-1960s. Oil fields have been discovered offshore and gas fields have been discovered on and offshore. Marathon Oil Company operates an oil and gas treatment plant 20 miles southwest of Tyonek near the south end of Kustatan Ridge, between the refuge and critical habitat area. The Drift River Petroleum Terminal is located just south of Redoubt Bay critical habitat area. Oil platforms are scattered offshore, outside of the refuge and critical habitat area. Oil and gas pipelines are buried onshore in the refuge and critical habitat area (see Land Status Maps).

There have been several oil spills in marine waters of the refuge and critical habitat area. A tanker leaving the Drift River terminal in December 1967 was pierced by an underwater object, spilling 1,500 to 1,700 barrels of oil into Cook Inlet (Shepherd et al. 1968:12-13). Within 6 hours, the slick stretched along the entire shoreline of Redoubt Bay, and it eventually spread from Nikiski to below Chisik Island (Evans et al. 1972). However, five days after the spill, an aerial survey found no significant traces. In October 1968 a rupture in the Shell Oil Company Nikiski Middleground Shoal pipeline released an estimated 1,000 barrels of crude oil into Cook Inlet (Weeden et al. 1969). On the first day, the slick extended from Old Tyonek to 12 miles south of the Forelands, covering an area of about 240 square miles. Two days after the spill, the slick covered most of the area between the Forelands and Kalgin Island, although the leading edge had dispersed. Oil was never observed in Redoubt Bay, but six out of seven ducks collected in Redoubt Bay three days after the spill had traces of oil in their plumage.

There are no producing wells within the refuge or critical habitat area. There have been no documented spills in recent years and industry has worked closely with ADF&G since the creation of the refuge and critical habitat area.

PIPELINES, UTILITY LINES, AND ROADS

Two major pipelines, one oil and one gas, cross the Trading Bay State Game Refuge and the Redoubt Bay Critical Habitat Area on private non-exclusive use easements. In addition, Chugach Electric Association has a reserved easement for an unconstructed electric line across the Trading Bay State Game Refuge. The easement was reserved at the time of construction of the Beluga Power Station. A road system in the northeastern portion of the Trading Bay State Game Refuge was constructed in part to support oil and gas development and in part to access timber lands adjacent to the refuge. A road constructed at the southern end of the refuge was also built to provide access for oil and gas development and extends south into the Redoubt Bay Critical Habitat Area as far as the Kustatan River. Oil and water pipelines from offshore oil platforms come onshore at Granite Point, just to the north of the Trading Bay State Game Refuge and also to an onshore collection facility at the south end of Trading Bay. All easements existing in the Trading Bay State Game Refuge at the time it was established were excluded from the refuge.

LOGGING

Logging has had the largest long-term impact of any land use in the refuge to date. Because of this and because another timber sale has been proposed in the area, a detailed assessment of the sale and logging practices is warranted in this resource inventory.

The Westside Salvage sale was first proposed by state foresters in November 1972 to salvage beetle-killed timber before it became unmerchantable (Becia 1972). Three bids were received, but one of these was rejected (Dutton 1973b).

In June 1973, the state sold timber rights on 223,000 acres to Kodiak Lumber Mills, Inc. (KLM), a new company (Dutton 1973b). Mitsui Trading Company of Japan was a stockholder and furnished the initial capital outlays (Anonymous 1974a). The total volume sold was 285 million board-feet (MBF) of white spruce, 116 MBF of aspen and birch, and 24 MBF of cottonwood (DNR 1973). The winning bid was for $1 per thousand board-feet of spruce (about 5 cents/tree [Imhoff 1977a]), $2 per thousand board-feet of aspen and birch, and $4 per thousand board-feet of cottonwood, and primary manufacture of 35 MBF/yr. Because utilization of the hardwoods was optional, the estimated total price was $285,000 for the spruce only. Almost one-half of the sale area (Peacock 1980), but probably less than one-third of the volume, was on state land that would become part of the Trading Bay State Game Refuge three years later. Much of the forested land within the refuge contains insignificant volumes of merchantable spruce, is located on extremely wet ground, and is considered economically unsuitable for logging under any conditions (Imhoff 1977b).

The Westside Salvage Sale was plagued with problems from the start. Problems first arose with the conditions of the sale. Several potential bidders protested the large size of the sale, claiming that it excluded small operators (Dutton 1973b). Within a month, the estimated volume of available spruce in the sale area was being challenged by KLM (Arnold 1973a, b). At the time of the sale, KLM had proposed to process the timber in Homer (Woodrow 1973). By October 1973 they had begun negotiations with the Tyonek Village Corporation for a land lease for facilities near Tyonek (Daly 1973). In May 1974 preliminary work on the dock, lumber mill, and roads leading to Tyonek were

begun (March 1974). Unfortunately, the Bureau of Land Management was not expecting to deed these lands to Tyonek until later in the year. KLM's spokesperson admitted knowing they were in trespass, but wanted to build the facility as soon as possible before the timber deteriorated (Anonymous 1974b). KLM was issued a citation for trespassing and, when construction work did not slacken, they were fined. Later, they were fined $500 after pleading no contest to a charge by the Alaska Department of Environmental Conservation that their sewage facilities were built without state approval and did not meet state standards (Anonymous 1975a).

In 1974 a new company, Tyonek Timber, Inc., was formed to conduct the actual logging (Anonymous 1975b). Tyonek Natives were promised preference in hiring. Logging began in 1974, and the mill and dock were finished in 1975.

A network of logging roads was constructed, connecting Tyonek with northern portions of the refuge. Most of the roads and clearcuts in the refuge lie between Noaukta Slough and Chuitkilnachna Creek.

Additional problems first arose with logging and road-building activities in 1975. Stipulations in the logging plan prohibited harvesting or damaging hemlock. Attempts to harvest spruce from predominantly hemlock stands were damaging a considerable amount of hemlock, and damaged hemlock of commercial size and quality were being removed (LaTocha 1975b). Required buffer zones of 150 feet along lakes and "any" streams were cut (LaTocha 1975a, Barrett 1976). Tyonek Timber believed the restriction applied only to "main" streams (Imhoff 1975) and this stipulation was changed to "major" streams in 1976 (in 1977 the state forester allowed Tyonek Timber to log up to the banks of the Chakachatna River and islands on the floodplain and ADF&G concurred). Rubber-tired skidders were getting stuck in some areas and causing considerable damage to the ground (LaTocha 1975b). Some culverts were installed improperly, blocking fish passage (Barrett 1975).

A shipment of round logs sent to Japan in 1975 for analysis was found to be smaller, knottier, and have less strength than comparable Siberian logs (Mitsui & Co. Ltd. 1976). Therefore, there was little or no market for round logs from the Westside Salvage sale.

In 1976, 2,645 high stumps were counted by foresters as a result of cutting trees at the snow line, and Tyonek Timber was fined $5,290 for damages (Wibbenmeyer 1976, LaTocha 1976b). Debris along the road system was not promptly cleaned up and secondary roads were not "put to bed," or protected from erosion (LaTocha 1976a).

In 1976, concerns were raised by the Forest Service's Institute of Northern Forestry about regeneration (Zazada 1976). They made the following recommendations: (1) Leave 10-20 live trees/acre, if possible, to provide a minimum seed source from beetle-resistant trees; (2) Reserve several sites within the sale area to study stand development and regeneration; (3) Cutting the spruce and leaving the hardwoods to be cut later was not a good practice to ensure adequate regeneration of spruce; (4) Severe soil disturbance in areas where sphagnum moss was present indicated that these areas would be best logged in winter; (5) Disturbance associated with roads and landings was excessive; and (6) Grasses (mainly *Calamagrostis*) were responding so well to the clearcutting that

they would be a problem for regenerating trees. Several years later, state foresters estimated that leaving 10 seed trees/acre would make many stands economically inoperable (Korhonen 1981a).

A state forester established several experimental plots in clearcut areas to determine regeneration rates of various seedlings (white spruce from Palmer and Kenai, Sitka spruce from Haines, and lodgepole pine from Oregon) (Wibbenmeyer 1976). A year later, in 1977, foresters returned to check seedling survival rates. For all experimental plots combined, survival rate was less than 15%. Most seedlings had been pushed out of the ground by frost heaving and many of the survivors were deficient in nutrients. Conclusions were that wetter areas were more prone to frost heaving, planting should be in spring rather than fall, and some form of fertilization was needed (Harding 1977).

The state had recommended several regeneration methods in 1972 and had the contractual authority to reserve up to 10 seed trees/acre and exclude up to 5% of the total volume. However, with the exception of the aforementioned experimental plots, no reforestation had been initiated by the end of 1977 (Smith 1977). The state foresters had concluded that it was unlikely that the timber in the Westside Salvage Sale area would regenerate successfully on its own (Smith 1977). They esimated that artificially regenerating only 50% of the sale area would cost close to $10 million (at an estimated $200/acre). No funds were available from timber sale receipts for regeneration and, if they were, it would amount to no more than about $10/acre (Smith 1977).

By the end of 1977, logging was still concentrated north of Nikolai Creek, just outside the northeast side of the refuge. During 1977, state foresters inspected the sale area only once every six to eight weeks, on average. Sound management would have required daily inspections by a forester; however, the state did not have the funds nor manpower (Smith 1977).

In 1978, KLM again raised the issue of a short-fall in estimated timber volume (Daly 1978). KLM estimated about 80 MBF of recoverable spruce, compared to the state's estimate of 285 MBF, and slightly over half had already been harvested. KLM asked for an additional eight townships, all lying north of the refuge, to be added to the contract. The state ultimately admitted it had misestimated the volume by 49% in spruce and 46% in birch, but refused to enlarge the sale area because KLM had agreed to the estimate of 285 MBF as a condition of accepting the contract (Dutton 1981). From 1976-1978, KLM paid penalties of $71,030 for not harvesting spruce at the rate initially agreed upon (Daly 1979). After 1978, the state charged no more penalty payments, although KLM was never able to meet the minimum annual harvest specified in the contract (Orr 1981b).

In 1978 a magazine article characterized the Tyonek Timber work force as totalling about 150 men, with at least 75-80% nonresidents. Hiring inexperienced workers was considered "one of the biggest headaches for the logger" (Mason 1978). By 1979 few villagers worked for KLM. In the mid-1980s, Tyonek residents were still expressing dissatisfaction with KLM's performance (EPA 1990). They felt that agreements between KLM and Tyonek regarding, preferential local hiring, worker conduct, and a no guns/no hunting policy were violated, ignored, and subverted. They mentioned instances of KLM employees hunting moose in the area.

Several new problems surfaced in 1978. Tyonek Timber was clearing road right-of-ways of 100-150 feet, instead of acceptable widths of 66 feet (Wallingford 1978). By reducing the widths to 66

feet, an additional seven acres of forest for every road mile would be conserved. Excessive soil disturbance from skidding in wet areas and slash disposal continued to be problems (Harding 1978).

In 1979 Tyonek Timber bridged the Chakachatna River north of the refuge to better access timber on the other side.

Another visit by staff from the Institute of Northern Forestry renewed their previous concerns with reforestation (Alden 1979). The sale, although characterized as a salvage operation for beetle-killed spruce, was removing all live spruce trees of seed-bearing size. Thus, vast areas were unstocked and lacked a suitable seed source of preferred species for natural regeneration. In fact, the report concluded, the remaining spruce would require several generations (200-500 years) without interference to reach former stocking levels and several more generations to reverse the unfavorable genetic drift caused by losing the variability inherent in the native stock.

State foresters planted 15,400 trees in a variety of sites in 1979 and revisited the 1976 and 1977 plantings. Of the surviving plants, only the lodgepole pine seemed to be growing exceptionally well. Alden (1979) recommended lodgepole pine for restocking the sale area. Reforestation costs were estimated in excess of $250/acre (Sturgeon 1979).

A large portion of the sale area, about 88,941 acres, including most of the lands north of the refuge, was transferred to Cook Inlet Region, Inc., a Native corporation, in December 1978. At the same time, the state enacted the Forest Practices Act. Ultimately, both of these actions changed the whole complexion of the Westside Salvage Sale. The foresters had higher standards to uphold, and they wanted to enforce them to set a good example to CIRI, but staff and funding were limited (Peacock 1979).

The state had to pay CIRI for payments received from the sale after 1978.

In 1980, foresters sampled a representative uncut site within the sale area about three miles north of the refuge to determine the number of live trees that had survived the beetle infestation (Kerr 1980). They found 22 live green spruce/acre and 15 dead spruce/acre greater than 6.5 inches diameter-at-breast-heighth (dbh). Later that year, 194 acres logged in 1975 near Stedatna Creek were surveyed for regeneration (Ellis and Munson 1980). Some birch and very few spruce, generally of poor form and vigor, were left standing. Grasses dominated where ferns and shrubs and been the predominant ground cover. Grasses were very tall (up to five feet) and were competing with seedlings. They also found many log landing areas, numerous deep skid ruts, and two large gravel pits where little or no revegetation was occurring.

Approximately 20,000 acres were logged between 1973 and 1980 (Faro 1985). Most of this area lies outside of the refuge. A few scattered areas were logged in 1981. At this point most the state timber, particularly the higher volume stands, had been cut (Korhonen 1981a).

Another survey of natural regeneration was conducted by state foresters in 1981 on plots cut in 1975-1977 (Korhonen 1981b). They found an average regeneration rate of 155 spruce, 1,355 birch, and 115 poplar/cottonwood per acre. They believed the spruce regeneration was adequate, but that the number of birch trees was too high. Much of the birch had been browsed by moose.

In July 1981 the state assigned the administration of the timber sale contract to CIRI, and CIRI required KLM to renegotiate the terms of the contract (Sagerser 1981). CIRI required the following terms: an increase in stumpage rate to $80/MBF, retroactive to at least August 1978, a provision to purchase sand and gravel from CIRI, and a performance bond of $250,000. These terms were probably a factor in KLM's decision to terminate logging in 1981, one year before the contract expired (Daly 1981). The chip mill continued to operate in 1982, processing the accumulation of logs, and cleanup work was conducted on logged areas.

Many of the problems with slash disposal and rutting continued into 1981 (Harding 1980, Peterson 1981). New problems included the discovery of a large area that had been cut on BLM land north of the refuge (Orr 1981a, 1982a). The state was required to pay the BLM about $9,700 that it had collected as stumpage fees from KLM (Tindall 1982). BLM also asked the state to pay for rehabilitating the clearcut areas, because it was negligent in allowing KLM to cut the timber. The state estimated rehabilitation costs to be $100,000-300,000 (Orr 1982b), but it is not known whether this was ever payed. The state paid CIRI $18,191 for stumpage payments received since the time of conveyance (Orr 1982c).

CIRI contended that, due to the state's administration of the sale, they had been damaged to the extent of $1,040,340 (Hillard 1983). Based on advice from the Attorney General's office, the Division of Forestry recommended that none of CIRI's claims be honored (Levy 1983, Sturgeon 1983). CIRI then sued the state for $940,360 (Anonymous 1984). An out-of-court settlement of $657,000 ($605,000 plus $52,600 interest) was funded by the Legislature in 1987 (N. Cliff, pers. commun.).

The Westside Salvage Sale cost the state many times more than it raised in stumpage fees. Although there were extenuating circumstances that probably would not be encountered in a future sale of this type, there are many lessons to be learned from this sale.

MATERIAL EXTRACTION

In 1985, a permit application for removal of material (sand and gravel) was received from Diamond Shamrock Chuitna Coal Company for road construction and port development. Four hundred acres of the requested area was located along the road system within Trading Bay State Game Refuge. No other material is documented to have been removed from either Trading Bay State Game Refuge or Redoubt Bay Critical Habitat Area, however, construction of the logging road system in Trading Bay State Game Refuge probably utilized on-site material.

HAZARDS AND HAZARDOUS MATERIALS

From 1941 to 1960, the future critical habitat area and refuge were designated as a bombing, gunnery, and rocketry range (C. Denfeld, pers. commun.). The Air Force obtained the first tract in 1941. At its maximum, the range extended from Beluga to Harriet Point and inland as far as Mt. Spurr and Redoubt Volcano. The Moquawkie Reservation and a two-mile safety zone next to Cook Inlet were excluded. The Air Force constructed two buildings, a fuel storage tank, and an access road at an unknown location that was probably near the coast.

The range was returned to the public domain in two tracts in 1951 and 1960. The range was used, but the frequency and amount of ordnance is unknown (C. Denfeld, pers. commun.). Possible craters may still be discerned in some areas (B. Campbell, pers. commun.).
In the early 1960's, Don and Frank Standifer (pers. commun.) remember finding shell casings, unshot shells, portions of missiles, and bomb craters near their family's fish camp on the north bank of the lower McArthur River.

The U.S. Army Corps of Engineers will be researching the question of explosives still present in the areas and has recommended that, in the interim, site access be restricted until more complete information regarding safety is available. In addition, both of these areas have inactive reserve pits left over from old oil and gas exploratory wells. There are five old well sites in the Trading Bay State Game Refuge and eight old well sites in the Redoubt Bay Critical Habitat Area.

OTHER USES

There are three private inholdings in Trading Bay State Game Refuge and two in Redoubt Bay Critical Habitat Area. These inholdings are not subject to refuge or critical habitat area statutes or regulations unless they are acquired by purchase, exchange, or other method. Inholdings may not be acquired by eminent domain, however.

INFORMATION NEEDS

Ongoing waterfowl surveys coordinated with the U.S. Fish and Wildlife Service should continue. This data provides valuable information on population trends and use patterns for application in land use decisions.

With increasing interest in bears, both for hunting and viewing, more information is needed on bear use of the Redoubt Bay sedge flats and Big River Lakes area.

Data on salmon escapement and sport harvest levels, at least for the Kustatan and Big River systems is needed.

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PERSONAL COMMUNICATIONS

Campbell, B. Waterfowl Biologist, Div. Wildlife Conservation, Alaska Dept. of Fish and Game, Anchorage. 1993.

Clausen, D. Habitat Biologist, Habitat & Restoration Division, Alaska Dept. of Fish and Game, Anchorage. July 1993.

Cliff, N. Alaska Dept. of Law. January 1994.

Denfeld, C. Historian, U.S. Army Corps of Engineers, Anchorage, Alaska. March 22, 1993.

Faro, J. Wildlife Biologist, Div. Wildlife Conservation, Alaska Dept. of Fish and Game, Soldotna. 1993.

Standifer, Don and Frank. Tyonek residents. November 1993.

Timm, D. Former Regional Supervisor and Waterfowl Biologist, Div. Wildlife Conservation, Alaska Dept. of Fish and Game, Anchorage. Also resident at Big River Lake in 1991 and 1992. August 1993.

Warniers, J. Helicopter pilot for Alaska Helicopter. Information based on conversations with D. Timm.

Tables

Table 1. Species composition and relative abundance of plants identified in the Trading Bay area.[1]

Common Name[2]	Scientific Name[2]	Habitat Type[3]							
		UAT	HAR[4]	BCR	CMR	BST	RBB	WTR[4]	BSR
Black cottonwood	*Populus balsamifera trichocarpa*	D	O	A	R	O		D	
Quaking aspen	*Populus tremuloides*	O	R						
Sitka alder	*Alnus crispa sinuata*	D	D	O				O	C
Thinleaf alder*	*A. incana tenuifolia*		O	D	C	C		A	C
Paper birch	*Betula papyrifera*	A	D	A	R	C	C	O	O
Shrub (or resin) birch	*B. glandulosa*					O	D		
Dwarf birch	*B. nana*					O	C		C
Black spruce	*Picea mariana*				O	O	D		D
White spruce	*P. glauca*	O	C	C		R		C	
Diamondleaf willow*	*Salix phylicifolia planifolia*	A	A	R	R	R	C	D	D
Alaska willow	*S. alaxensis*	A	A	A	O			A	A
Barratt willow*	*S. barrattiana*			O					C
Undergreen willow*	*S. commutata*			O				O	
Grayleaf willow*	*S. glauca*			O				O	C
Alaska bog willow*	*S. fuscescens*					R	C		O
Barren-ground willow*	*S. brachycarpa*							R	
Richardson willow*	*S. lanata*			R				R	O
Sitka willow	*S. sitchensis*							R	O

Table 1. Continued.[1]

Common Name[2]	Scientific Name[2]	Habitat Type[3]							
		UAT	HAR[4]	BCR	CMR	BST	RBB	WTR[4]	BSR
Skunk currant	*Ribes glandulosum*	O							
Northern red currant	*R. triste*	O		C	R	O	O		
Trailing black currant	*R. laxiflorum*			C		R			
Raspberry	*Rubus idaeus*	O		O	R	R			
Pacific red elder*	*Sambucus racemosa arborescens*	O	R	O		R			
High bush cranberry	*Viburnum edule*			O					
Lingonberry	*Vaccinium vitis-idaea*					O	O		O
Early blueberry*	*V. ovalifolium*					O			
Bog blueberry*	*V. uliginosum*					O	A		C
Bunchberry	*Cornus canadensis*					R			
Crowberry	*Empetrum nigrum*					O	C	O	O
Saskatoon serviceberry*	*Amelanchier alnifolia*					O	O		C
Pacific serviceberry	*A. florida*							R	
Labrador tea	*Ledum palustre groenlandicum*					O	C		O
Narrow-leaf Labrador tea	*L. p. decumbens*					R	A		
Prickly rose	*Rosa acicularis*			O		O			

Table 1. Continued.[1]

Common Name[2]	Scientific Name[2]	Habitat Type[3]							
		UAT	HAR[4]	BCR	CMR	BST	RBB	WTR[4]	BSR
Sweet gale	*Myrica gale*			R		O	C		C
Rusty menziesia	*Menziesia ferruginea*					C	R		
Bog-rosemary*	*Andromeda polifolia*					O	C		
Shrubby cinquefoil	*Potentilla fruticosa*					O	A		
Cassandra	*Chamaedaphne calyculata*					R	O		
Devil's club	*Echinopanax horridum*	R		R	R				
Fireweed	*Epilobium spp.*	C	C	O	R			O	
Sedges	*Carex spp.*			R	A	R	C		C
Beach rye grass	*Elymus mollis*								
Grasses	*Gramineae*	C	C	C	D	C	A	C	A
Fern	*Polystichum spp.*		R	R		O			
Cotton grass[5]	*Eriophorum spp.*					R	O		R
Horsetails	*Equisetum spp.*		O	O	C	R	O	R	O
Parsley	*Angelica genuflexa*				O				
Wormwood	*Artemesia tilesii*	R	R	R					
Lupines	*Lupinus spp.*							R	

[1] From Bechtel Civil & Minerals Inc. (1981). D = Dominant, A = Abundant, C = Common, O = Occasional, R = Rare.

[2] Common and scientific names follow Hulten (1968), except where noted (* = Vierick and Little 1972).

[3] Habitat types include UAT (Upland Alder Thicket), HAR (High Altitude Riparian), BCR (Black Cottonwood Riparian), CMR (Coastal Marsh Riparian), BST (Black Spruce Transitional), RBB (Resin Birch Bog), WTR (Willow Thicket Riparian), BSR (Black Spruce Riparian).

[4] Not found in Trading Bay State Game Refuge; however, they may occur in Redoubt Bay Critical Habitat Area in the upper reaches of the North Fork or South Fork Big River, Montana Bill Creek, or the Drift River.

[5] Observed by Osgood (1901) in the Tyonek area.

Table 2. Fish species known to occur in upper Cook Inlet (EPA 1990).

Common Name	Scientific Name	Spawning Period
SALMON/TROUT/WHITEFISH	*Salmonidae*	
Pink salmon	*Onchorhynchus gorbuscha*	mid-Jul to early Sep
Chum salmon	*O. keta*	early Aug to early Oct
Coho salmon	*O. kisutch*	early Aug to Feb
Sockeye salmon	*O. nerka*	early Aug to Nov
Chinook salmon	*O. tshawytscha*	mid-Jun to mid-Aug
Steelhead trout	*Salmo gairdneri*	fall to spring
Dolly varden	*Salvelinus malma*	fall
Bering cisco	*Coregonus laurettae*	fall(?)
SMELTS	*Osmeridae*	
Surf smelt	*Hypomesus pretiosus*	Mar to May
Longfin smelt	*Sperinchus thaleichthys*	Oct to Dec
Eulachon	*Thaleichthys pacificus*	mid to late May
HERRING	*Clupeidae*	
Pacific herring	*Clupea harengus pallasi*	spring
CODFISHES	*Gadidae*	
Pacific cod	*Gadus macrocephalus*	usually Jan and Feb
Walleye pollock	*Theragra chalcogramma*	winter
Saffron cod	*Elginus gracilis*	
STICKLEBACKS	*Gasterosteidae*	
Threespine stickleback	*Gasterosteus aculeatus*	Jun to Jul
Ninespine stickleback	*Pungitius pungitius*	May to Jul
SNAILFISH	*Liparidae*	
Ringtail snailfish	*Liparis rutteri*	
SCULPINS	*Cottidae*	
Pacific staghorn sculpin	*Leptocottus armatus*	Oct to Mar
FLOUNDERS	*Pleuronectidae*	
Starry flounder	*Platichthys stellatus*	Mar to Apr
Flathead sole	*Hippoglossoides elessodon*	Mar to late Apr
Pacific halibut	*Hippoglossus stenolepis*	winter
Yellowfin sole	*Limanda aspera*	

Table 3. Species composition and relative abundance of birds identified in the Trading Bay area.[1]

Common Name	Scientific Name	Habitat Type[2]							
		UAT	HAR[3]	BCR	CMR	BST	RBB	WTR[3]	BSR
Red-throated loon[4,6]	*Gavia stellata*								
Arctic loon (Pacific loon?)[4]	*G. pacifica*								
Common loon[4,6]	*G. immer*								
Horned grebe[4,6]	*Podiceps auritus*								
Red-necked grebe[4,6]	*P. grisegena*								
Double-crested cormorant[4]	*Phalacrocorax auritus*								
Pelagic cormorant[5]	*P. pelagicus*								
Tundra swan[4,5,6]	*Cygnus columbianus*								
Trumpeter swan[6]	*Cygnus buccinator*		O	C	C				C
Greater white-fronted goose[6]	*Anser albifrons*	O	O						
Snow goose[4,6]	*Chen caerulescens*								
Canada goose[6]	*Branta canadensis*			O	C				
Black brant[6]	*B. bernicla*								
Green-winged teal[6]	*Anas crecca*				A				
Mallard[6]	*A. platyrhynchos*				A				
Northern pintail[6]	*A. acuta*	O	O	O	A				O
Northern shoveler[4,6]	*A. clypeata*								
Gadwall[4,6]	*A. strepera*								
American wigeon	*A. americana*				A				O
Eurasian wigeon[6]	*A. penelope*								

Table 3. Continued.[1]

Common Name	Scientific Name	Habitat Type[2]							
		UAT	HAR[3]	BCR	CMR	BST	RBB	WTR[3]	BSR
Canvasback[6]	*Aythya valisineria*								
Redhead[4,6]	*A. americana*								
Ring-necked duck[4]	*A. collaris*								
Greater scaup[6]	*A. marila*								O
Lesser scaup[4]	*A. affinis*								
Common eider[4,6]	*Somateria mollissima*								
Harlequin duck[4]	*Histrionicus histrionicus*								
Oldsquaw[6]	*Clangula hyemalis*				O				
Black scoter[4,6]	*Melanitta nigra*								
Surf scoter[6]	*M. perspicillata*								
White-winged scoter[4,6]	*M. fusca*								
Common goldeneye[6]	*Bucephala clangula*				O				
Barrow's goldeneye[4,6]	*B. islandica*								
Bufflehead[4,6]	*B. albeola*								
Common merganser[6]	*Mergus merganser*			O					C
Red-breasted merganser[6]	*M. serrator*				O				

Table 3. Continued.[1]

Common Name	Scientific Name	Habitat Type[2]							
		UAT	HAR[3]	BCR	CMR	BST	RBB	WTR[3]	BSR
Osprey[6]	*Pandion haliaetus*								
Bald eagle[6]	*Haliaeetus leucocephalus*	C	C	C	C	O	O	O	C
Northern harrier[6]	*Circus cyaneus*	O	C	C	C		C	O	C
Sharp-shinned hawk	*Accipiter striatus*				C				
Northern goshawk[5,6]	*A. gentilis*								
Swainson's hawk	*Buteo swainsoni*				O				
Red-tailed hawk[6]	*B. jamaicensis*			O	O	O	O		
Rough-legged hawk[6]	*B. lagopus*								
Golden eagle[4]	*Aquila chrysaetos*								
American kestrel[6]	*Falco sparverius*								
Merlin[4,5,6]	*F. columbarius*								
Spruce grouse[6]	*Dendragopus canadensis*			C		O	O		
Willow ptarmigan[6]	*Lagopus lagopus*				O	O			
Sandhill crane	*Grus canadensis*				C		O		
Black-bellied plover	*Pluvialis squatarola*				O				
Semipalmated plover[4,6]	*Charadrius semipalmatus*								
Greater yellowlegs	*Tringa melanoleuca*				O				

Table 3. Continued.[1]

Common Name	Scientific Name	Habitat Type[2]							
		UAT	HAR[3]	BCR	CMR	BST	RBB	WTR[3]	BSR
Lesser yellowlegs[4,6]	*T. flavipes*								
Solitary sandpiper[4]	*T. solitaria*								
Spotted sandpiper[6]	*Actitis macularia*			O	O				
Upland sandpiper[4]	*Bartramia longicauda*								
Whimbrel[4,6]	*Numenius phaeopus*								
Hudsonian godwit[4]	*Limosa haemastica*								
Ruddy turnstone[4]	*Arenaria interpres*								
Western sandpiper[4]	*Calidris mauri*								
Least sandpiper[6]	*C. minutilla*				O				
Baird's sandpiper[4]	*C. bairdii*								
Pectoral sandpiper	*C. melanotos*				A				C
Dunlin[4]	*C. alpina*								
Short-billed dowitcher	*Limnodromus griseus*				C				
Common snipe[6]	*Gallinago gallinago*				O			O	C
Red-necked phalarope[6]	*Phalaropus lobatus*				O			O	O
Pomarine jaeger[4]	*Stercorarius pomarinus*								
Parasitic jaeger[4,6]	*S. parasiticus*								
Bonaparte's gull[4,6]	*Larus philadelphia*								
Mew gull[6]	*L. canus*	O	C	C	C	O			

Table 3. Continued.[1]

Common Name	Scientific Name	Habitat Type[2]							
		UAT	HAR[3]	BCR	CMR	BST	RBB	WTR[3]	BSR
Herring gull[6]	*L. argentatus*			O					
Glaucous-winged gull[6]	*L. glaucescens*	O	C	C	C				
Arctic tern[6]	*Sterna paradisaea*				C				
Great horned owl[4],[5,6]	*Bubo virginianus*								
Snowy owl[4]	*Nyctea scandiaca*								
Northern hawk owl	*Surnia ulula*			O					
Short-eared owl[6]	*Asio flammeus*			O	O	O			
Rufous hummingbird[5]	*Selasphorus rufus*								
Belted kingfisher[6]	*Ceryle alcyon*			O					
Hairy woodpecker[6]	*Picoides villosus*		O						
Three-toed woodpecker[4],[5]	*P. tridactylus*								
Northern flicker[4]	*Colaptes auratus*								
Olive-sided flycatcher[4]	*Contopus borealis*								
Western wood-pewee[4]	*C. sordidulus*								
Say's phoebe[6]	*Sayornis saya*								
Tree swallow[4,6]	*Tachycineta bicolor*								
Violet-green swallow[4,6]	*T. thalassina*								
Bank swallow	*Riparia riparia*			C	C				
Cliff swallow	*Hirundo pyrrhonota*								
Gray jay[6]	*Perisoreus canadensis*			O	O	C	O	O	O

Table 3. Continued.[1]

Common Name	Scientific Name	Habitat Type[2]							
		UAT	HAR[3]	BCR	CMR	BST	RBB	WTR[3]	BSR
Black-billed magpie[6]	*Pica pica*	C	C	C	C	C	C	C	C
Common raven[6]	*Corvus corax*	C	C	C	C	C	C	C	C
Black-capped chickadee[6]	*Parus atricapillus*	A	A	C	O	O	O	A	O
Boreal chickadee	*P. hudsonicus*		O						
Brown creeper	*Certhia americana*					O			
American dipper[4,6]	*Cinclus mexicanus*								
Golden-crowned kinglet[4]	*Regulus satrapa*								
Ruby-crowned kinglet[6]	*Regulus calendula*			O		O	O		
Gray-cheeked thrush[6]	*Catharus minimus*								
Swainson's thrush[4,6]	*C. ustulatus*								
Hermit thrush	*C. guttatus*		O						
American robin[4,6]	*Turdus migratorius*								
Varied thrush[4,6]	*Ixoreus naevius*								
American pipit	*Anthus rubescens*			C	C	O			
Bohemian waxwing[4]	*Bombycilla garrulus*								
Northern shrike[6]	*Lanius excubitor*								
Orange-crowned warbler[4]	*Vermivora celata*								
Yellow warbler[6]	*Dendroica petechia*					O			
Yellow-rumped warbler[4,6]	*D. coronata*								
Blackpoll warbler[4,6]	*D. striata*								
Northern waterthrush[4]	*Seiurus noveboracensis*								

Table 3. Continued.[1]

Common Name	Scientific Name	Habitat Type[2]							
		UAT	HAR[3]	BCR	CMR	BST	RBB	WTR[3]	BSR
Wilson's warbler[4,6]	*Wilsonia pusilla*								
American tree sparrow	*Spizella arborea*		C	O	C			C	
Chipping sparrow	*S. passerina*			C			O		
Savannah sparrow[6]	*Passerculus sandwichensis*			O	C				
Fox sparrow[6]	*Passerella iliaca*	O							
Song sparrow[4,6]	*Melospiza melodia*								
Lincoln's sparrow[4]	*M. lincolnii*								
Golden-crowned sparrow[4,6]	*Zonotrichia atricapilla*								
White-crowned sparrow[4,6]	*Z. leucophrys*								
Dark-eyed junco[6]	*Junco hyemalis*		C	C		C		C	
Lapland longspur	*Calcarius lapponicus*				C			C	
Snow bunting[6]	*Plectrophenax hyperboreus*			C					
Rusty blackbird[4,5,6]	*Euphagus carolinus*								
Pine grosbeak[4]	*Pinicola enucleator*								
Common redpoll[6]	*Carduelis flammea*				C	O		C	
Pine siskin[6]	*C. pinus*		C	O		O			

[1] From Bechtel Civil & Minerals Inc. (1981). A = Abundant, C = Common, O = Occasional.

[2] Habitat types include UAT (Upland Alder Thicket), HAR (High Altitude Riparian), BCR (Black Cottonwood Riparian), CMR (Coastal Marsh Riparian), BST (Black Spruce Transitional), RBB (Resin Birch Bog), WTR (Willow Thicket Riparian), BSR (Black Spruce Riparian).

[3] These habitat types were not found in Trading Bay State Game Refuge. However, they may occur in Redoubt Bay Critical Habitat Area in the upper reaches of the North Fork or South Fork Big River, Montana Bill Creek, or the Drift River.

[4] Observed in the Tyonek area by ERT (1984a); probably occur in suitable habitat in the CHA and refuge.

[5] Observed in the Tyonek area by Osgood (1901); probably occur in suitable habitat in the CHA and refuge.

[6] Observed in the Big River Lakes area by Dan and Karen Timm in 1991 and 1992 (Westlund 1992).

Table 4. Spring and summer aerial surveys of waterfowl and other waterbirds at Trading Bay (Havens 1970, 1971; Timm 1977, 1978, 1982; Campbell and Timm 1983; Campbell 1984; Butler and Gill 1985a,b,c, 1986a,b,c,d, 1987a,b,c,d; Gill and Butler 1985a,b; Faro 1989; Roberston and Hupp 1992).[1]

	1969			1970			1974
Species	Apr	May 6	Aug 25	Apr 16	Jun 25	Aug 12	Jul 30
Northern pintail	--[2]	--	1,696	636	74	1,240	--
Mallard	--	--	115	402	91	271	--
American wigeon	--	--	130	0	27	334	--
Green-winged teal	--	--	130	0	6	180	--
Northern shoveler	--	--	0	0	0	0	--
Gadwall	--	--	0	0	0	0	--
Unident. dabblers	--	--	0	1	6	325	--
Scaup spp.	--	--	0	0	0	0	--
Goldeneye spp.	--	--	0	0	0	0	--
Merganser spp.	--	--	0	0	0	0	--
Scoters spp.	--	--	30	0	0	0	--
Unident. divers	--	--	0	7	60	0	--
Unidentified ducks	1,490	190	415	0	0	0	--
TOTAL DUCKS	1,490	190	2,516	1,046	264	2,350	--
Canada goose	3,100	5,716	208	20	0	100	1
White-fronted goose	0	1	82	0	0	110	110
Snow goose	1,250	5,155	0	0	0	0	0
TOTAL GEESE	4,350	10,872	290	20	0	210	111
Swan spp.	0	0	4	0	0	0	2
Sandhill crane	0	9	0	0	1	0	--
Red-throated loon	--	--	--	--	--	--	--
Common loon	--	--	--	--	--	--	--

[1] Unknown area surveyed. Table does not include one wigeon and three pintail broods observed on June 25, 1970.
[2] Species not counted.
[3] Beginning in 1980, these were reported as tule geese (Campbell and Timm 1983).

Table 4. Continued.[1]

Species	1976 May 24-25	1977 Jun 7	1978 May 26	1980 Jul 19-24	1981 late Jul	1982 late Jul	1983 Jul 18-23
Northern pintail	4,890	5,805	829	--[2]	--	--	--
Mallard	471	1,996	1,083	--	--	--	--
American wigeon	1,209	578	231	--	--	--	--
Green-winged teal	2,750	2,243	1,835	--	--	--	--
Northern shoveler	578	164	739	--	--	--	--
Gadwall	107	204	103	--	--	--	--
Unident. dabblers	0	0	0	--	--	--	--
Scaup spp.	374	114	373	--	--	--	--
Goldeneye spp.	235	0	530	--	--	--	--
Merganser spp.	214	449	0	--	--	--	--
Scoter spp.	0	0	0	--	--	--	--
Unident. divers	0	0	0	--	--	--	--
Unidentified ducks	0	0	0	--	--	--	--
TOTAL DUCKS	10,828	11,553	5,723	--	--	--	--
Canada goose	0	43	0	0	0	--	0
White-fronted goose	289	0	0	0	0	0	130
Snow goose	0	0	0	0	0	--	0
TOTAL GEESE	289	43	0	0	0	0	130
Swan spp.	21	86	86	--	--	--	--
Sandhill crane	642	171	0	--	--	--	--
Red-throated loon	385	86	0	--	--	--	--
Common loon	86	0	0	--	--	--	--

Table 4. Continued.[1]

Species	1985					1986	
	Apr 18	Apr 26	May 3	May 9	May 22	Apr 17	Apr 25
Northern pintail	--	--	--	--	--	150	--
Mallard	--	--	--	--	--	200	--
American wigeon	--	--	--	--	--	--	--
Green-winged teal	--	--	--	--	--	--	--
Northern shoveler	--	--	--	--	--	--	--
Gadwall	--	--	--	--	--	--	--
Unident. dabblers	--	--	--	--	--	--	--
Scaup spp.	--	--	--	--	--	--	--
Redhead	--	--	--	--	--	--	--
Goldeneye spp.	5	--	--	--	--	--	--
Merganser spp.	--	--	--	--	--	--	--
Scoter spp.	--	--	--	--	--	--	--
Unidentified divers	--	--	--	--	--	--	--
Unidentified ducks	200+	--	--	--	--	--	--
TOTAL DUCKS	205+	--	--	--	--	350	--
Canada goose	329	7,812	5,247	5,627	300	0	3,154
White-fronted goose[3]	28	48	772	127	14	--	415
Snow goose	--	75	2,372	6,467	135	--	290
Unident. geese	--	--	70	--	--	--	200
TOTAL GEESE	368	7,935	8,461	12,221	449	0	4,059
Swan spp.	23	485	1,535	--	78	9	437
Sandhill crane	--	--	4	3	4	--	--

Table 4. Continued.[1]

Species	1986		1987				1989
	May 3	May 6	Apr 18	Apr 28	May 5	May 12	Apr 28
Northern pintail	--	--	--	--	--	--	--
Mallard	--	--	--	--	--	--	--
American wigeon	--	--	--	--	--	--	--
Green-winged teal	--	--	--	--	--	--	--
Northern shoveler	--	--	--	--	--	--	--
Gadwall	--	--	--	--	--	--	--
Unident. dabblers	--	--	--	--	--	--	--
Scaup spp.	--	--	--	--	--	--	--
Redhead	--	--	--	--	--	--	--
Goldeneye spp.	--	--	--	--	--	--	--
Merganser spp.	--	--	--	--	--	--	--
Scoter spp.	--	--	--	--	--	--	--
Unidentified divers	--	--	--	--	--	--	--
Unidentified ducks	--	--	--	--	--	--	--
TOTAL DUCKS	--	--	--	--	--	--	--
Canada goose	3,000	1,130	1,025	1,977	4,705	356	695
White-fronted goose[3]	286	--	--	225	262	41	30
Snow goose	4,899	175	--	981	2,424	75	2,350
Unident. geese	--	--	--	--	--	--	--
TOTAL GEESE	8,185	1,305	1,025	3,185	7,391	472	3,075
Swan spp.	487	152	--	184	223	120	80
Sandhill crane	66	4	--	80	47	33	--

Table 4. Continued.[1]

Species	1992		
	May 1	May 5	May 7
Northern pintail	--	--	--
Mallard	--	--	--
American wigeon	--	--	--
Green-winged teal	--	--	--
Northern shoveler	--	--	--
Gadwall	--	--	--
Unident. dabblers	--	--	--
Scaup spp.	--	--	--
Redhead	--	--	--
Goldeneye spp.	--	--	--
Merganser spp.	--	--	--
Scoter spp.	--	--	--
Steller's eider	--	--	--
Unidentified divers	--	--	--
Unidentified ducks	--	--	--
TOTAL DUCKS	--	--	--
Canada goose	686	2,185	1,504
White-fronted goose[3]	110	75	633
Snow goose	762	311	481
Black brant	--	--	--
Unident. goose	0	0	0
TOTAL GEESE	1,558	2,571	2,618
Swan spp.	130	108	198
Sandhill crane	2	6	19

Table 5. Fall aerial surveys of waterfowl and other waterbirds at Trading Bay (Havens 1970, 1971, 1972).[1]

Species	1969			1970	1971
	Sep 9	Oct 2	Oct 22	Sep 28	Oct 5
Northern pintail	--	705	450	--	--
Mallard	--	710	985	--	--
Pintail/mallard	--	0	1,110	--	--
Pintail/mallard/wigeon	--	2,550	0	--	--
Green-winged teal	--	40	0	--	--
Unidentified dabblers	--	--	--	1,785	1,585
Scaup spp.	--	100	0	--	--
Unidentified ducks	4,000	0	0	0	0
TOTAL DUCKS	4,000	4,105	2,535	1,785	1,585
Canada goose	0	525	0	480	1,250
White-fronted goose	18	0	0	0	0
TOTAL GEESE	18	525	0	480	1,250
Swan spp.	0	0	0	0	0
Sandhill crane	7	0	0	0	0

[1] Unknown areas surveyed.

Table 6. Spring and summer aerial surveys of waterfowl and other waterbirds at Redoubt Bay (Havens 1970, 1971; Timm 1975, 1976, 1977, 1978, 1982; Campbell and Timm 1983; Campbell 1984; Butler and Gill 1985a,b,c, 1986a,b,c,d, 1987a,b,c,d; Gill and Butler 1985a,b; Faro 1989; Robertson and Hupp 1992).[1]

	1969	1970		1974
Species	Aug 25	Apr 16	Aug 12	Jul 30
Northern pintail	520	334	573	--[2]
Mallard	36	784	263	--
American wigeon	150	2	90	--
Green-winged teal	69	0	35	--
Northern shoveler	0	0	0	--
Gadwall	0	0	0	--
Unidentified dabblers	0	0	382	--
Scaup spp.	0	0	0	--
Redhead	0	0	0	--
Goldeneye spp.	0	0	0	--
Merganser spp.	0	0	0	--
Scoter spp.	0	0	500	--
Unidentified divers	0	52	0	--
Unidentified ducks	352	0	0	--
TOTAL DUCKS	1,127	1,170	1,843	--
Canada goose	0	0	20	0
White-fronted goose	472	0	30	693
TOTAL GEESE	472	0	50	693
Swan spp.	24	0	2	9
Sandhill crane	3	0	22	--
Red-throated loon	--	--	--	--

[1] Unknown areas surveyed.
[2] Species not counted.
[3] Beginning in 1980, these were reported as tule geese (Campbell and Timm 1983).

Table 6. Continued.[1]

Species	1976 May 24-25	1977 Jun 6	1978 May 26	1980 Jul 19-24	1981 late Jul	1982 late Jul	1983 Jul 18-23
Northern pintail	6,015	6,307	1,504	--[2]	--	--	--
Mallard	2,458	3,205	886	--	--	--	--
American wigeon	1,110	2,968	349	--	--	--	--
Green-winged teal	6,468	2,670	1,027	--	--	--	--
Northern shoveler	0	1,655	662	--	--	--	--
Gadwall	205	0	103	--	--	--	--
Unident. dabblers	0	0	0	--	--	--	--
Scaup spp.	1,100	1,797	522	--	--	--	--
Redhead	0	232	232	--	--	--	--
Goldeneye spp.	711	119	237	--	--	--	--
Merganser spp.	474	0	0	--	--	--	--
Scoter spp.	0	0	0	--	--	--	--
Unidentified divers	0	0	0	--	--	--	--
Unidentified ducks	0	0	0	--	--	--	--
TOTAL DUCKS	18,541	19,215	5,522	--	--	--	--
Canada goose	0	0	0	4	0	--	0
White-fronted goose[3]	172	86	0	1,419	1,058	881	820
TOTAL GEESE	172	86	0	1,423	1,058	881	820
Swan spp.	356	151	75	--	--	--	--
Sandhill crane	86	517	0	--	--	--	--
Red-throated loon	43	0	0	--	--	--	--

Table 6. Continued.[1]

Species	1985					1986	
	Apr 18	Apr 26	May 3	May 9	May 22	Apr 17	Apr 25
Northern pintail	--	--	--	--	--	400	--
Mallard	--	--	--	--	--	--	--
American wigeon	--	--	--	--	--	--	--
Green-winged teal	--	--	--	--	--	--	--
Northern shoveler	--	--	--	--	--	--	--
Gadwall	--	--	--	--	--	--	--
Unident. dabblers	--	--	--	--	--	--	--
Scaup spp.	--	--	--	--	--	--	--
Redhead	--	--	--	--	--	--	--
Goldeneye spp.	--	--	--	--	--	--	--
Merganser spp.	3	--	--	--	--	--	--
Scoter spp.	--	--	--	--	--	--	--
Steller's eider	--	--	--	--	--	50	--
Unidentified divers	--	--	--	--	--	--	--
Unidentified ducks	200+	--	--	--	--	--	--
TOTAL DUCKS	203+	--	--	--	--	--	--
Canada goose	1,045	6,276	11,708	5,922	22	232	3,443
White-fronted goose[3]	54	5	659	218	65	--	121
Snow goose	--	2,640	11,842	4,041	30	4	366
Black brant	--	--	--	--	--	--	--
Unident. goose	--	--	3	--	--	--	15
TOTAL GEESE	1,110	8,921	24,212	10,181	117	236	3,945
Swan spp.	6	494	580	--	7	--	11
Sandhill crane	--	--	13	212	22	--	

Table 6. Continued.[1]

Species	1986		1987			
	May 3	May 6	Apr 18	Apr 28	May 5	May 12
Northern pintail	--	--	--	--	--	--
Mallard	--	--	--	--	--	--
American wigeon	--	--	--	--	--	--
Green-winged teal	--	--	--	--	--	--
Northern shoveler	--	--	--	--	--	--
Gadwall	--	--	--	--	--	--
Unident. dabblers	--	--	--	--	--	--
Scaup spp.	--	--	--	--	--	--
Redhead	--	--	--	--	--	--
Goldeneye spp.	--	--	--	--	--	--
Merganser spp.	--	--	--	--	--	--
Scoter spp.	--	--	--	--	--	--
Unidentified divers	--	--	--	--	--	--
Unidentified ducks	--	--	--	--	--	--
TOTAL DUCKS	--	--	--	--	--	--
Canada goose	1,478	128	326	3,166	4,602	548
White-fronted goose[3]	160	6	5	52	344	53
Snow goose	6,456	1,250	--	7,304	12,520	690
Black brant	2	--	--	--	--	1
Unident. geese	150	6	0	0	0	0
TOTAL GEESE	8,246	1,390	331	10,522	17,466	1,292
Swan spp.	--	--	--	180	119	63
Sandhill crane	3	--	--	5	9	22

Table 6. Continued.[1]

Species	1989 Apr 28	1989 May 8	1989 Apr 28	1989 May 8
Northern pintail	--	--	--	--
Mallard	--	--	--	--
American wigeon	--	--	--	--
Green-winged teal	--	--	--	--
Northern shoveler	--	--	--	--
Gadwall	--	--	--	--
Unident. dabblers	--	--	--	--
Scaup spp.	--	--	--	--
Redhead	--	--	--	--
Goldeneye spp.	--	--	--	--
Merganser spp.	--	--	--	--
Scoter spp.	--	--	--	--
Steller's eider	--	--	--	--
Unidentified divers	--	--	--	--
Unidentified ducks	--	--	--	--
TOTAL DUCKS	--	--	--	--
Canada goose	720	2,045	966	527
White-fronted goose[3]	200	262	137	15
Snow goose	1,680	1,660	6,570	4,413
Black brant	--	--	--	--
Unident. goose	--	--	--	--
TOTAL GEESE	2,600	3,987	7,673	4,955
Swan spp.	--	19	--	--
Sandhill crane	--	--	--	3

Table 7. Fall aerial surveys of waterfowl and other waterbirds at Redoubt Bay (Havens 1970, 1971, 1972).[1]

Species	1969		1970	1971
	Sep 9	Oct 2	Sep 28	Oct 5
Northern pintail	--	408	--	--
Mallard	--	390	--	--
Pintail/mallard/wigeon	--	1,045	--	--
Green-winged teal	--	40	--	--
Unidentified dabblers	--	--	1,400	1,375
Unidentified divers	--	--	15	0
Unidentified ducks	2,280	0	0	0
TOTAL DUCKS	2,280	1,885	1,415	1,375
Canada goose	345	740	1,155	2,150
Snow goose	0	0	15	0
TOTAL GEESE	345	740	1,170	2,150
Swan spp.	7	7	2	6

[1] Areas surveyed not known.

Table 8. Aerial surveys of trumpeter swans in Redoubt Bay Critical Habitat Area and Trading Bay State Game Sanctuary.[1]

REDOUBT BAY					
	1968	1975	1980	1985	1990
No. adult swans	35	49	83	145	98
No. adult pairs	12	16	30	44	41
No. broods	5	5	15	12	19
No. cygnets	22	14	57	34	48

TRADING BAY					
	1968	1975	1980	1985	1990
No. adult swans	52	65	137	184	154
No. adult pairs	23	23	37	50	59
No. broods	10	10	18	13	23
No. cygnets	37	30	63	31	94

[1] Data collected by U. S. Fish and Wildlife Service (Conant et al. 1991) and mapped on 1:63,360-scale overlays. Typically, about 90% of adult swans are seen in aerial surveys; cygnets are missed more often.

Table 9. Densities of breeding ducks on marshes in Redoubt and Trading bays (Timm 1978).

Area	Size (mi^2)	% of area sampled	Ducks/mi^2								
			Dabblers			Divers			Total		
			1976	1977	1978	1976	1977	1978	1976	1977	1978
Redoubt Bay	248	9.3	65.5	67.8	18.3	9.2	9.7	4.0	74.7	78.5	22.3
Trading Bay	107	9.3	93.5	102.7	45.0	7.7	5.4	8.4	101.2	108.0	53.4

Table 10. Species composition and relative abundance of mammals observed in the Trading Bay area.[1]

Common Name[2]	Scientific Name[2]	Habitat Type[3]								
		UAT	HAR[4]	BCR	CMR	BST	RBB	WTR[4]	BSR	Offshore
Masked shrew[6]	*Sorex cinereus*									
Dusky shrew	*S. monticolus*	C	C	C						
Pigmy shrew[6]	*S. hoyi*									
Snowshoe hare[5,6]	*Lepus americanus*									
Red squirrel	*Tamiasciurus hudsonicus*	O	O	O	O	O			O	
Beaver	*Castor canadensis*			C				C	C	
N. red-backed vole	*Clethrionomys rutilus*	A	C	C	C	C	C			
Tundra vole	*Microtus oeconomus*			C						
Muskrat	*Ondatra zibethicus*		O	C				C	C	
Meadow jumping mouse[6]	*Zapus hudsonius*									
Porcupine	*Erithizon dorsatum*		C	C	O					
Coyote	*Canis latrans*	C	C	C	A	C	C	C	C	
Wolf	*C. lupus*	O	C	O	O	O		O		
Red fox[5]	*Vulpes vulpes*									

Table 10. Continued.[1]

Common Name[2]	Scientific Name[2]	Habitat Type[3]								
		UAT	HAR[4]	BCR	CMR	BST	RBB	WTR[4]	BSR	Offshore
Black bear	*U. americanus*	A	A	C	C	O	C	C	C	
Brown bear	*Ursus arctos*	C	A	C	C	O	O	C	C	
Marten[5]	*Martes americana*									
Least weasel[6]	*Mustela nivalis*									
Ermine	*Mustela erminea*									
Mink	*M. vison*	O	O	C				O	C	
Wolverine	*Gulo gulo*	O	O	O				O	O	
River otter	*Lutra canadensis*			O				O	O	
Lynx[5]	*Felis lynx*									
Harbor seal	*Phoca vitulina*									O
Moose	*Alces alces*	O	A	A	C	C	C	C	C	
Caribou	*Rangifer tarandus*		O							
Belukha	*Delphinapterus leucas*									O

[1] From Bechtel Civil & Minerals Inc. (1983). A = Abundant, C = Common, O = Occasional.
[2] Common and scientific names follow Jarrell and MacDonald (1989).
[3] Habitat types include UAT (Upland Alder Thicket), HAR (High Altitude Riparian), BCR (Black Cottonwood Riparian), CMR (Coastal Marsh Riparian), BST (Black Spruce Transitional), RBB (Resin Birch Bog), WTR (Willow Thicket Riparian), BSR (Black Spruce Riparian).
[4] Not found in Trading Bay State Game Refuge; however, these habitats may occur in Redoubt Bay Critical Habitat Area in the upper reaches of the North Fork or South Fork Big River, Montana Bill Creek, or the Drift River.
[5] Observed in the Tyonek area by ERT (1984a); probably occur in suitable habitat in the CHA and refuge.
[6] Observed in the Tyonek area by Osgood (1901); probably occur in suitable habitat in the CHA and refuge.

Table 11. Fall aerial surveys of moose abundance and sex and calf ratios in the Redoubt Bay area.

Census area[1]	Year[2]	Large bulls[3]	Total bulls	Cows w/0	Cows w/1	Cows w/2	Total cows	Total calves	Unk	Total moose	Bulls /100 cows	Calves /100 cows	Time (min)	Moose /hr	Area (mi^2)	Moose /mi^2
Drift River	1986	0	4	22	2	1	25	4	0	33	16	16	134	15	64	0.5
	1987	0	8	34	3	0	37	3	0	48	22	8	90	32	64	0.8
Big River	1986	19	26	77	8	2	87	12	0	125	30	14	142	53	136	0.9
	1987	16	18	93	7	0	100	7	0	125	18	7	105	71	136	0.9
	1988	--	--	--	--	--	--	--	120	120	--	--	142	51	136	0.9
Kustatan R.	1986	8	9	26	8	0	34	8	0	51	27	24	64	48	48	1.1
	1988	--	--	--	--	--	--	--	39	39	--	--	85	28	80	0.5
TOTAL[4]	1972	24	26	183	54	4	241	63	0	330	11	26	438	45	766	0.4
	1973	26	41	124	53	11	188	78	0	307	22	42	510	36	766	0.4
	1977	64	112	179	49	10	238	69	0	419	47	29	840	30	766	0.5
	1980	43	56	156	17	7	180	32	1	269	31	18	444	36	766	0.4
	1981	50	63	203	67	7	277	81	0	421	23	29	798	32	766	0.5
	1983	39	35	123	41	13	177	67	0	279	20	38	450	37	766	0.4
	1984	16	19	106	11	2	119	15	0	153	16	13	312	29	766	0.2
	1985	19	33	128	19	5	152	29	0	214	22	19	432	30	766	0.3
	1986	30	39	125	18	3	146	24	0	209	27	16	340	37	248	0.8
	1987	24	26	127	20	0	147	20	0	193	18	14	195	59	200	1.0
	1988	--	--	--	--	--	--	--	159	159	--	--	227	42	216	0.7

[1] Census areas conform to stream drainages (Figure 1) rather than the boundaries of the critical habitat area.

[2] Aerial censuses were conducted in late November and early December.

[3] Large bulls are those with antler spreads of 30 inches or greater (typically older than a yearling).

[4] The Redoubt Bay census area is comprised of three census areas (Drift River, Big River, and Kustatan River). The Big River census area encompasses about two-thirds of the critical habitat area. Totals for 1987 and 1988 do not include all three areas.

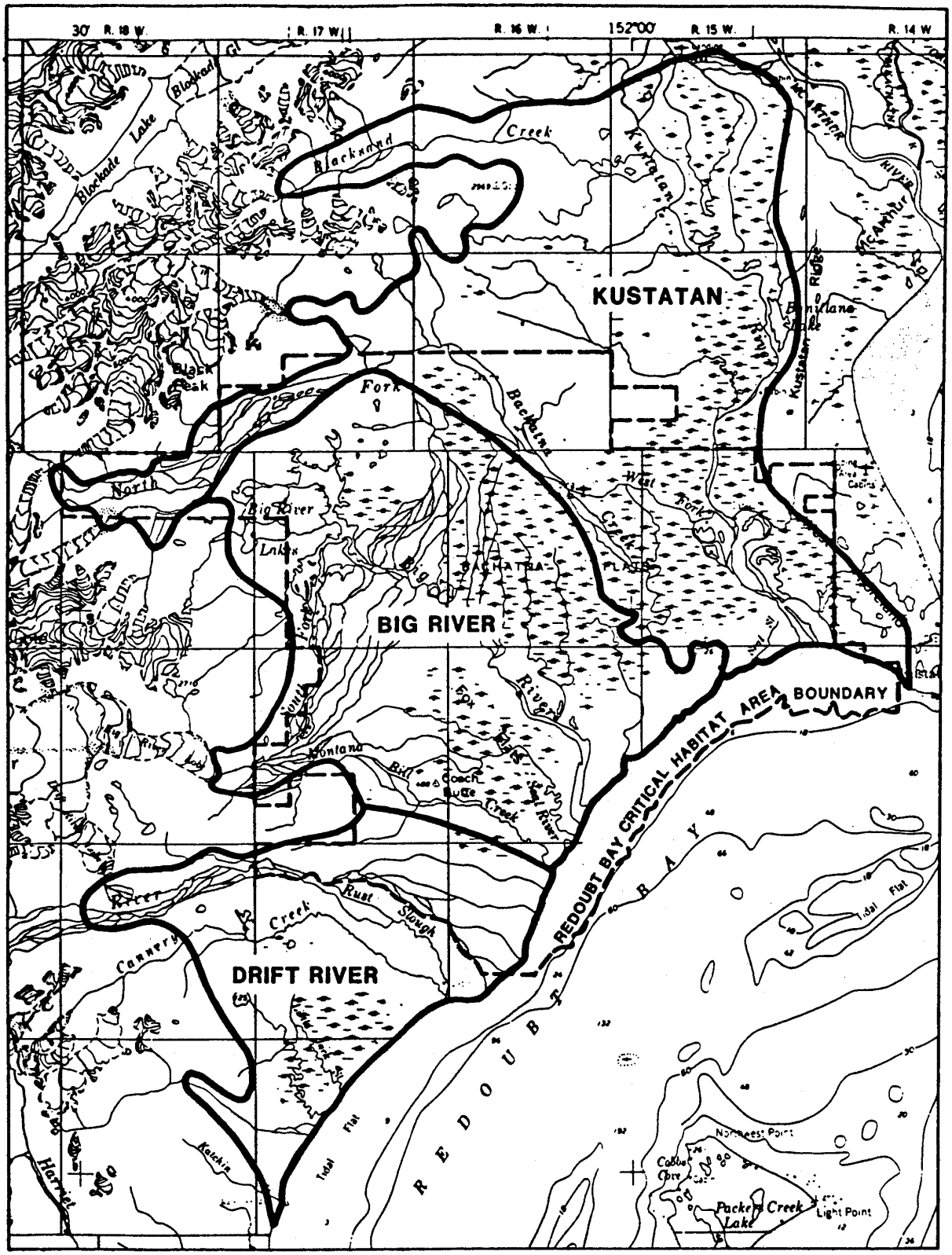

Figure 1. Uniform Coding Units for the Portion of Game Management Unit 16B That Overlaps With Redoubt Bay Critical Habitat Area.

Table 12. Fall aerial surveys of moose abundance and sex and calf ratios in the Trading Bay area.

Census area[1]	Year[2]	Large bulls[3]	Total bulls	Cows w/0	Cows w/1	Cows w/2	Total cows	Total calves	Unk.	Total moose	Bulls /100 cows	Calves /100 cows	Time (min)	Moose /hr	Area (mi^2)	Moose /mi^2
McArthur R.	1982	16	27	43	17	2	62	21	0	110	44	34	162	41	102	1.1
	1983	16	24	52	31	1	84	33	0	141	29	39	198	43	102	1.4
	1985	15	21	52	9	1	62	11	0	94	34	18	78	72	102	0.9
	1987	6	23	102	15	0	117	15	1	156	20	13	185	51	102	1.5
	1989	7	19	51	18	2	71	22	0	112	27	31	73	92	67	1.7
Lone Ridge M2	1981	10	11	22	16	2	40	23	0	74	28	58	300	15	152	0.5
	1983	8	11	34	10	1	45	12	0	68	24	27	288	14	152	0.4
Lone Ridge N3	1981	20	23	67	29	3	99	35	0	157	23	35	285	33	117	1.3
	1989	12	19	50	14	3	67	20	0	106	28	30	156	41	50	2.1

[1] Census areas conform to stream drainages (Figure 2), rather than the boundaries of the refuge. The refuge includes portions of four census areas. The Kustatan census area lies in both the refuge and critical habitat area. The McArthur River census area is the only aerial survey that lies completely in the refuge. The two census areas that include northern portions of the refuge--Lone Ridge M2 and N3--also include large forested areas north of the refuge.

[2] Aerial censuses were conducted in late November and early December.

[3] Large bulls are those with antler spreads of 30 inches or greater (typically older than a yearling). Beginning in 1989, this category includes bulls classified as "medium" during aerial surveys.

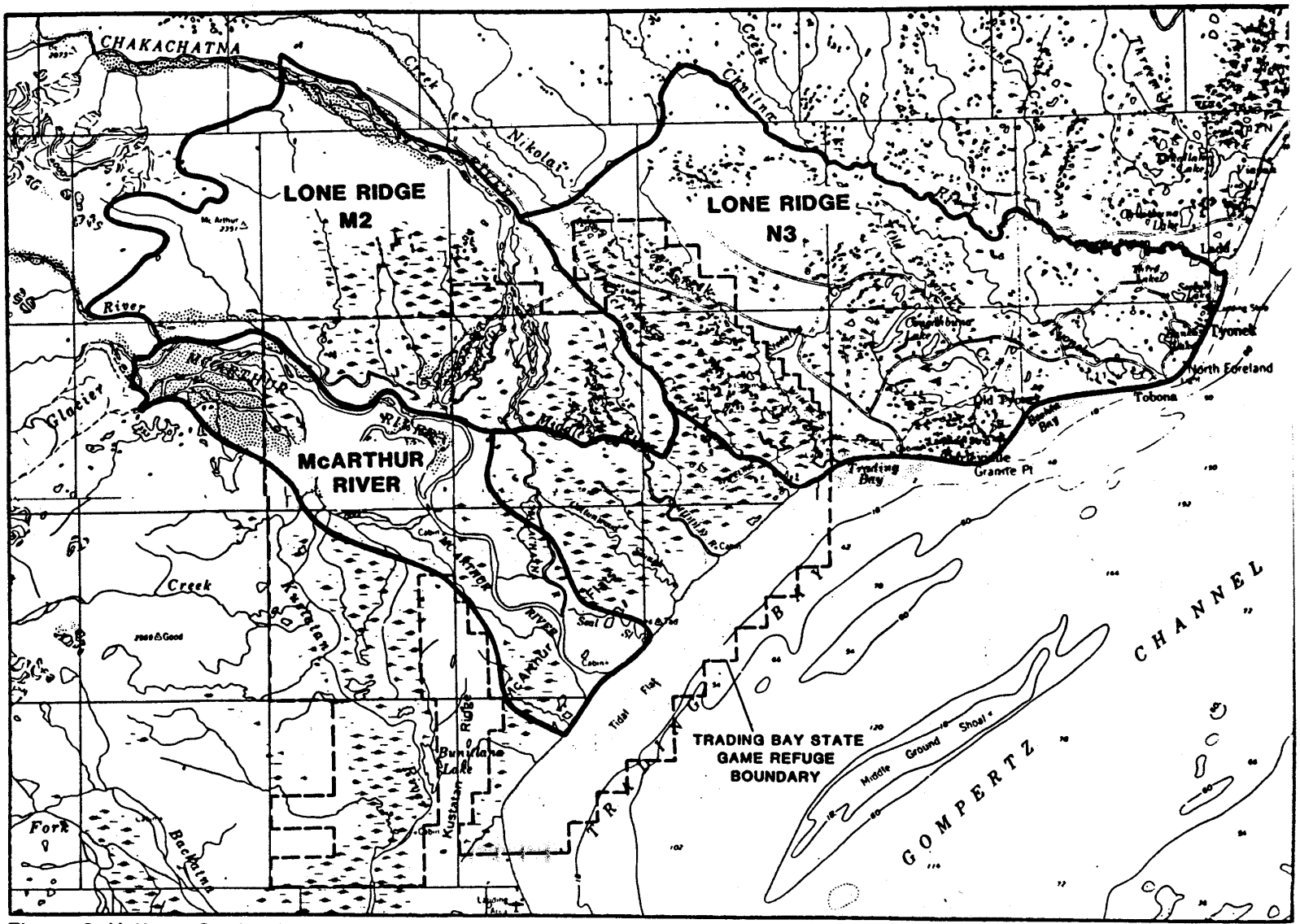

Figure 2. Uniform Coding Units for the Portion of Game Management Unit 16B That Overlaps With Trading Bay State Game Refuge.

Table 13. Trading Bay State Game Refuge Cabin Owners.

TBY 1	Betty Cuddy
TBY 2	Clyde Smith
TBY 3	Charles Urann
TBY 4	William Prosser
TBY 5	Donald Hickel
TBY 6	John Hendrickson
TBY 7	Charles Pohland
TBY 8	Edward Rasmuson
TBY 9	Gregory Svendsen
TBY 10	Henry Pratt
TBY 11	William Erwin
TBY 12	Jay Mueller
TBY 13	L. Luce
TBY 14	Michael Wirschen
TBY 15	Trespass
TBY 16	Not Found
TBY 17	Theodore Chickalusion
TBY 18	John Anderson
TBY 19	Gary Spidahl
TBY 20	Gerald Sibley
TBY 21	Jan Hursch
TBY 22	Allen Sawyer
TBY 23	Dwight Wood
TBY 24	James Carr
TBY 25	Patrick Carty
TBY 26	DNR
TBY 27	Trespass
TBY 28	Not Found
TBY 29	Trespass
TBY 30	Betty Cuddy
TBY 31	Trespass

Table 14. Redoubt Bay Critical Habitat Area Cabin Owners

RBY 1	Dennis Downs	RBY 33	Not Found
RBY 2	Not Found	RBY 34	Timothy Downs
RBY 3	Clifford Haas	RBY 35	ADF&G
RBY 4	James Doyle	RBY 36	Shelby Johnson
RBY 5	C. Henderson	RBY 37	Eugene Kissee
RBY 6	Spencer Devito	RBY 38	Brian Alexander
RBY 7	David Lawer	RBY 39	FWP
RBY 8	Alex Russell, Jr.	RBY 40	Ronald Jacob
RBY 9	Sidney Logan	RBY 41	James Geeslin
RBY 10	Doug Brewer	RBY 42	T. Hinkle
RBY 11	Dan France	RBY 43	Trespass
RBY 12	David Barnett	RBY 44	Trespass
RBY 13	Maxwell Best	RBY 45	Trespass
RBY 14	John Wood	RBY 46	Victor Tyler
RBY 15	Randy Russell	RBY 47	David Schmitt
RBY 16	Sherron Perry	RBY 48	Trespass
RBY 17	Timothy Sandahl	RBY 49	Trespass
RBY 18	Glen McCollum	RBY 50	Not Found
RBY 19	Michael Hamrick	RBY 51	Not Found
RBY 20	Lawrence Craft	RBY 52	Not Found
RBY 21	Not Found	RBY 53	Not Found
RBY 22	William Eldridge	RBY 54	Randy Wild
RBY 23	Janet Stenga	RBY 55	Ronald Wild
RBY 24	Herman Stenga	RBY 56	Not Found
RBY 25	Not Found	RBY 57	Trespass
RBY 26	Gregory Bell	RBY 58	Trespass
RBY 27	Clark Whitney, Jr.	RBY 59	Trespass
RBY 28	Fred Braun	RBY 60	Max Pate
RBY 29	Trespass	RBY 61	Max Pate
RBY 30	Patrick Cowan	RBY 62	Max Pate
RBY 31	Rahn Kerkvliet	RBY 63	Dennis Branham
RBY 32	Harry Hefler		

Table 15. Waterfowl species harvested by sport hunters at Trading Bay (Havens 1971, 1972).[1]

Species	1970		1971		1981-1990[2]	
	No.	% of harvest	No.	% of harvest	No.	% of harvest
Northern pintail	65	42.8	21	31.8	225	22.6
Mallard	27	17.8	2	3.0	228	22.9
American wigeon	39	25.6	19	28.8	197	19.8
Green-winged teal	10	6.6	12	18.2	252	25.3
Blue-winged teal	0	0	0	0	0	0
Gadwall	5	3.3	4	6.1	0	0
Northern shoveler	6	3.9	4	6.1	78	7.8
Greater scaup	0	0	0	0	0	0
Lesser scaup	0	0	3	4.5	0	0
Common goldeneye	0	0	0	0	15	1.5
Bufflehead	0	0	0	0	0	0
Oldsquaw	0	0	0	0	0	0
White-winged scoter	0	0	1	1.5	0	0
Unidentified ducks	1	--	2	--	0	0
TOTAL DUCKS	153	100.0	68	100.0	995	100.0
White-fronted goose	6	100.0	0	0	26	30.2
Canada goose	0	0	0	0	60	69.8
TOTAL GEESE	6	100.0	0	0	86	100.0

[1] Based on bag checks. No dates or locations specified, but may have been conducted on September 28, 1970, and October 5, 1971, during waterfowl surveys.

[2] Mean annual harvest based on federal waterfowl harvest surveys (Bartonek 1991).

Table 16. Waterfowl species harvested by sport hunters at Redoubt Bay (Havens 1971, 1972).[1]

Species	1970[1]		1981-1990[2]	
	No.	% of harvest	No.	% of harvest
Northern pintail	7	16.3	173	36.3
Mallard	10	23.2	70	14.7
American wigeon	15	34.9	103	21.6
Green-winged teal	3	7.0	57	12.0
Blue-winged teal	0	0	10	2.1
Gadwall	0	0	13	2.7
Northern shoveler	5	11.6	24	5.0
Greater scaup	2	4.6	4	0.8
Lesser scaup	0	0	0	0
Common goldeneye	0	0	11	2.3
Bufflehead	0	0	7	1.5
Oldsquaw	1	2.3	4	0.8
White-winged scoter	0	0	0	0
Unidentified ducks	1	--	0	0
TOTAL DUCKS	44	100.0	476	100.0
White-fronted goose	1	100.0	0	0
TOTAL GEESE	1	100.0	0	0

[1] Based on bag checks. No dates or locations specified, but may have been conducted on September 28, 1970, during waterfowl surveys.

[2] Mean annual harvest based on federal waterfowl harvest surveys (Bartonek 1991).

Table 17. Waterfowl harvests on Redoubt Bay compared to the rest of Alaska (Timm and Havens 1973, 1974, 1975; Timm 1976, 1977, 1978, 1980, 1981, 1982; Timm and Sellers 1979; Campbell and Timm 1983; Campbell 1984, 1991; Campbell and Rothe 1985, 1986, 1989, 1990; Campbell et al. 1988, 1992).[1]

Hunting season[2]	Estimated duck harvest		Estimated goose harvest		Estimated hunter-days	
	No.	% of state	No.	% of state	No.	% of state
1972-73	--[3]	<0.1	--	<0.1	--	<0.1
1973-74	627	0.7	--	<0.1	289	0.5
1974-75	575	0.8	--	<0.1	161	0.3
1975-76	2,898	3.3	373	2.0	912	1.6
1976-77	3,367	3.3	202	1.4	1,470	2.2
1977-78 NS		1.0		--[4]		
1978-79 NS		4.7		0.0		
1979-80 NS		2.2		0.0		
1980-81 NS		0.0		0.0		
1981-82 NS						
1982-83	3,605	3.2	30	0.2	1,350	2.2
1983-84	370	0.3	30	0.2	608	0.8
1984-85	915	0.9	--	<0.1	532	0.7
1985-86 NR						
1986-87 NS						
1987-88	1,703	2.2	15	0.3	666	1.2
1988-89	2,869	3.4	--	<0.1	584	1.3
1989-90 NR						
1990-91	846	1.1	--	<0.1	286	0.6
1991-92 NR						

[1] Based on Alaska waterfowl-hunter surveys (fall hunting seasons of 1972-1976, 1982-1985, 1987-1992) and U. S. Fish and Wildlife Service parts collection survey (1977-1980). Site-specific estimates should be used with caution because they may be biased by a relatively small sample size, nonresponse error, recall error, or "trophy" bias.

[2] NS = No state survey conducted; NR = State survey was not reported.

[3] Waterfowl harvests were not tabulated when they comprised less than 0.1% of the statewide harvest of ducks or geese.

[4] Not reported.

Table 18. Waterfowl harvests on Trading Bay compared to the rest of Alaska (Timm and Havens 1973, 1974, 1975; Timm 1976, 1977, 1978, 1980, 1981, 1982; Timm and Sellers 1979; Campbell and Timm 1983; Campbell 1984, 1991; Campbell and Rothe 1985, 1986, 1989, 1990; Campbell et al. 1988, 1992).[1]

Hunting season[2]	Estimated duck harvest		Estimated goose harvest		Estimated hunter-days	
	No.	% of state	No.	% of state	No.	% of state
1972-73	1,376	1.5	--[3]	<0.1	594	1.0
1973-74	--	<0.1	37	0.2	--	<0.1
1974-75	1,867	2.6	333	2.5	697	1.3
1975-76	1,054	1.2	37	0.2	342	0.6
1976-77	2,551	2.5	29	0.2	735	1.1
1977-78 NS		2.5		--[4]		
1978-79 NS		0.9		5.5		
1979-80 NS		3.1		0.0		
1980-81 NS		1.2		0.0		
1981-82 NS						
1982-83	5,570	5.0	55	0.4	1,475	2.4
1983-84	2,101	1.7	147	1.0	608	0.8
1984-85	508	0.5	76	0.5	760	1.0
1985-86 NR						
1986-87 NS						
1987-88	656	0.9	34	0.6	333	0.6
1988-89	1,490	1.8	83	0.9	386	0.9
1989-90 NR						
1990-91	1,533	1.9	--	<0.1	453	1.0
1991-92 NR						

[1] Based on Alaska waterfowl-hunter surveys (fall hunting seasons of 1972-1976, 1982-1985, 1987-1992) and U. S. Fish and Wildlife Service parts collection survey (1977-1980). Site-specific estimates should be used with caution because they may be biased by a relatively small sample size, nonresponse error, recall error, or "trophy" bias.

[2] NS = No state survey conducted; NR = State survey was not reported.

[3] Waterfowl harvests were not tabulated when they comprised less than 0.1% of the statewide harvest of ducks or geese.

[4] Not reported.

Table 19. Moose harvests in Redoubt Bay Critical Habitat Area and Trading Bay State Game Refuge: 1988-89 to 1992-93 hunting seasons.[1]

		Residency						
	No.	GMU	Kenai	Anch.	Other	Non-	%	Ave.	
1988-89 UCU 0601									
Successful	6		4	2				3.5	P4,U2
Unsuccessful	8		3	4		1		3.8	P6,B2
Total	14		7	6		1	43	3.6	P10,B2,U2
1988-89 UCU 0701									
Successful	2		2					5.0	P1,B1
Unsuccessful	14		8	5		1		5.6	P10,B2,A2
Total	16		10	5		1	13	5.6	P11,B3,A2
1988-89 UCU 0702									
Successful	10		5	1	2	2		5.5	P7,B2,A1
Unsuccessful	16		6	5	4	1		7.7	P8,B3,A4,H1
Total	26		11	6	6	3	39	6.8	P15,B5,A5,H1
1988-89 TOTAL									
Successful	18		11	3	2	2		4.8	P12,B3,A1,U2
Unsuccessful	38		17	14	4	3		6.1	P24,B7,A6,H1
Total	56		28	17	6	5	32	5.6	P36,B10,A7,H1,U2
1989-90 UCU 0601									
Successful	9		4	4		1		5.7	P8,B1
Unsuccessful	17[3]	3	3	9	1			7.4	P13,B3,H1
Total	26	3	7	13	1	1	35	6.8	P21,B4,H1
1989-90 UCU 0701									
Successful	1		1					14.0	P1
Unsuccessful	7		4	2	1			6.3	P6,U1
Total	8		5	2	1		13	7.3	P7,U1
1989-90 UCU 0702									
Successful	7		6	1				7.7	P5,A1,U1
Unsuccessful	8		6	2				6.9	P5,B3
Total	15		12	3			47	7.3	P10,B3,A1,U1
1989-90 TOTAL									
Successful	17		11	5		1		7.0	P14,B1,A1,U1
Unsuccessful	32	3	13	13	2			7.0	P24,B6,H1,U1
Total	49	3	24	18	2	1	35	7.0	P38,B7,A1,H1,U1

Table 19. Continued.

1990-91 UCU 0601									
Successful	1		1					1.0	P1
Unsuccessful	8		2	5	1			7.1	P8
Total	9		3	5	1		11	6.4	P9
1990-91 UCU 0701									
Successful	1		1					10.0	P1
Unsuccessful	7		7					7.0	P5,U2
Total	8		8				13	7.4	P6,U2
1990-91 UCU 0702									
Successful	3		3					7.0	P1,B1,A1
Unsuccessful	7		1	6				4.4	P5,B2
Total	10		4	6			30	5.2	P6,B3,A1
1990-91 TOTAL									
Successful	5		5					6.4	P3,B1,A1
Unsuccessful	22		10	11	1			6.2	P18,B2,U2
Total	27		15	11	1		19	6.3	P21,B3,A1,U2
1991-92 UCU 0601									
Successful	4		4					5.0	P2,B1,H1
Unsuccessful	13		4	8		1		6.5	P12,B1
Total	17		8	8		1	24	6.2	P14,B2,H1
1991-92 UCU 0701									
Successful	6		3	1		2		4.3	P4,B2
Unsuccessful	8	1	6	1				7.5	P7,B1
Total	14	1	9	2		2	43	6.1	P11,B3
1991-92 UCU 0702									
Successful	3			1		2		5.7	P2,B1
Unsuccessful	9		5	3	1			6.7	P6,B2,A1
Total	12		5	4	1	2	25	6.4	P8,B3,A1
1991-92 TOTAL									
Successful	13		7	2		4		4.8	P8,B4,H1
Unsuccessful	30	1	15	12	1	1		6.8	P25,B4,A1
Total	43	1	22	14	1	5	30	6.2	P33,B8,A1,H1

Table 19. Continued.

1992-93 UCU 0601									
Successful	1			1				1.0	P1
Unsuccessful	8			8				5.5	P6,B1,H1
Total	9			9			11	5.0	P7,B1,H1
1992-93 UCU 0701									
Successful	7		6			1		5.0	P6,B1
Unsuccessful	9[3]		6	2				5.1	P6,B3
Total	16		12	2		1	44	5.1	P12,B4
1992-93 UCU 0702									
Successful	4		3		1			6.8	P4
Unsuccessful	3		2		1			5.7	P2,B1
Total	7		5		2		57	6.3	P6,B1
1992-93 UCU TOTAL									
Successful	12		9	1	1	1		5.3	P11,B1
Unsuccessful	20		8	10	1			5.4	P14,B5,H1
Total	32		17	11	2	1	38	5.3	P25,B6,H1

[1] Uniform Coding Units 1601, 1701, and 1702 are subunits of Game Management Unit 16B that best approximate the boundaries of the CHA and refuge (see Figures 1 and 2). Although the inland boundaries of the UCUs extend well beyond the CHA and refuge boundaries, few if any moose are harvested outside of the CHA and refuge because moose habitat is limited and access is difficult. Harvest data includes general season and permit hunts. The actual number of harvested moose is probably slightly higher because some hunters fail to return harvest reports and some of the reports do not indicate a specific hunting location.

[2] Transporation codes (P = plane, B = boat, A = all-terrain vehicle, H = highway vehicle, U = unknown.

[3] One of these hunters failed to indicate residency.

Table 20. Estimated total angler-days, coho salmon harvests, and catch per unit effort in the Kustatan River, Alaska.

Year	Total Angler-days	No. of Coho Salmon Harvested	Harvest per Unit Effort (Cohos/Angler-day)
1983	1,499	1,800	1.2
1984	1,673	1,646	1.0
1985	4,335	4,889	1.1
1986	2,737	3,239	1.2
1987	3,622	5,723	1.6
1988	3,674	6,221	1.7
1989	3,522	5,413	1.5
1990	3,724	4,584	1.2
1991	6,674	5,768	.9

Table 21. Number of salmon harvested by commercial set gillnets in the Northern District of upper Cook Inlet, Alaska.

Year	Chinook	Sockeye	Coho	Even-year Pink	Odd-year Pink	Chum	Total
1966	76	10,166	22,546	100,570		6,018	139,376
1967	39	10,757	14,678		1,771	10,336	37,581
1968	120	19,320	38,701	135,755		7,172	201,068
1969	573	3,844	5,116		1,956	995	12,484
1970	436	12,091	30,461	52,200		3,641	98,829
1971	3,009	5,177	5,057		2,067	4,600	19,910
1972	1,530	12,955	5,003	23,595		2,151	45,234
1973	56	8,261	6,521		39,100	5,462	59,400
1974	57	9,765	14,649	11,973		3,976	40,420
1975	49	7,477	7,805		23,081	5,038	43,450
1976	107	6,080	7,393	28,591		2,259	44,430
1977	107	17,107	4,301		19,676	3,409	44,600
1978	160	9,214	9,156	86,592		5,676	110,798
1979	171	5,700	6,942		5,517	703	19,033
1980	242	8,819	15,288	97,571		1,302	123,222
1981	156	30,974	34,988		7,955	4,350	78,423
1982	648	8,966	16,164	18,633		2,742	47,153
1983	302	11,418	8,016		1,964	3,002	24,702
1984	353	23,899	17,285	14,661		8,839	65,037
1985	379	11,188	8,638		2,518	1,321	24,044
1986	3,194	16,437	13,458	15,193		2,625	50,907
1987	2,426	19,701	9,919		2,073	2,553	36,672
1988	1,779	11,922	20,793	7,134		3,642	45,270
1989	3,257	33,755	16,420		2,725	1,852	58,009
1990	2,816	7,624	17,397	3,790		2,211	33,838
1991	1,867	9,111	14,813		717	1,426	27,934
1992	1,670	6,037	7,702	932		1,217	17,558
MEAN	947	12,510	14,045	42,656	8,548	3,649	57,385

Table 22. Number of salmon harvested by commercial set gillnets in the Kustatan Subdistrict of upper Cook Inlet, Alaska.

Year	Chinook	Sockeye	Coho	Even-year Pink	Odd-year Pink	Chum	Total
1986	74	3,087	7,810	266		54	11,291
1987	7	2,141	6,579		51	27	8,805
1988	17	1,289	7,918	35		250	9,509
1989	1,012	8,059	6,145		139	81	15,436
1990	945	6,853	849	18		34	8,699
1991	864	13,432	7,713		18	55	22,082
1992	938	4,598	5,718	18		11	11,283
MEAN	551	5,637	6,105	84	69	73	12,444

SPECIAL AREA PERMIT REGULATIONS

Title 5 Alaska Administrative Code

ARTICLE 4.
SPECIAL AREAS

Section
400. Implementation of authority
410. Notice requirements
420. Activities requiring a Special Area Permit
430. Conditioning, approval, or denial of special area permits
440. Limitations on special area permits

5 AAC 95.400. IMPLEMENTATION OF AUTHORITY. The commissioner will implement the authorities vested in AS 16.20.050, AS 16.20.060, AS 16.20.120, AS 16.20.170, AS 16.20.250, and AS 16.20.260, excluding hunting, trapping, and fishing, in accordance with procedures established in this chapter. (Eff. 6/5/86, Reg. 98)

Authority:	AS 16.05.020	AS 16.20.060
	AS 16.05.050	AS 16.20.120
	AS 16.05.251	AS 16.20.170
	AS 16.05.255	AS 16.20.250
	AS 16.05.270	AS 16.20.260
	AS 16.20.050	

5 AAC 95.410. NOTICE REQUIREMENTS. (a) Before a lease or other disposal of land under state jurisdiction and control in a special area, or private land in a critical habitat area, the responsible state department or agency or private landowner shall notify the commissioner.

(b) No person or governmental agency may undertake an activity listed in 5 AAC 95.420(a) within a special area unless the commissioner has been notified and a permit for the activity has been issued by the commissioner under 5 AAC 95.700 - 5 AAC 96.760. (Eff. 6/5/86. Reg. 98).

Authority:	AS 16.05.020	AS 16.20.120
	AS 16.05.050	AS 16.20.130
	AS 16.05.251	AS 16.20.170
	AS 16.05.255	AS 16.20.250
	AS 16.20.050	

5 AAC 95.420. ACTIVITIES REQUIRING A SPECIAL AREA PERMIT. (a) No person or governmental agency may engage in the following uses or activities within a special area without first obtaining a special area permit following the procedures of 5 AAC 95.700-5 AAC 95.760:

(1) construction, placement, or continuing use of any improvement, structure, or real property within a special area;

(2) destruction of vegetation;

(3) detonation of an explosive other than a firearm;

(4) excavation, surface or shoreline altering activity, dredging, filling, draining, or flooding;

(5) natural resource or energy exploration, development, production, or associated activities;

(6) water diversion or withdrawal;

(7) off-road use of wheeled or tracked equipment unless the commissioner has issued a general permit under 5 AAC 95.770;

(8) waste disposal, placement, or use of a toxic substance;

(9) grazing or animal husbandry; and

(10) any other activity that is likely to have a significant effect on vegetation, drainage, water quality, soil stability, fish, wildlife, or their habitat, or which disturbs fish or wildlife other than lawful hunting, trapping, fishing, viewing, and photography.

(b) The commissioner makes the final determination as to whether a specific activity is subject to the provisions of this chapter. (Eff. 6/5/86, Reg. 98)

Authority: AS 16.05.020 AS 16.20.120
AS 16.05.050 AS 16.20.130
AS 16.05.251 AS 16.20.170
AS 16.05.255 AS 16.20.260
AS 16.20.060

5 AAC 95.430. CONDITIONING, APPROVAL, OR DENIAL OR SPECIAL AREA PERMITS. If the procedural requirements of 5 AAC 95.700 - 5 AAC 95.760 are met, the commissioner will permit a use or activity listed in 5 AAC 95.420 that meets or can be conditioned to meet the following standards:

(1) the use or activity is consistent with the protection of fish and wildlife and their use, protection of fish and wildlife habitat, and the purpose for which the special area was established; and

(2) the use or activity does not unduly restrict or interfere with the public use and enjoyment of the resource values for which the special area was established; and

(3) any adverse effect upon fish and wildlife, and their habitats, and any restriction or interference with public use, is mitigated in accordance with 5 AAC 95.900. (Eff. 6/5/86, Reg.98)

Authority: AS 16.05.020 AS 16.20.120
AS 16.05.050 AS 16.20.130
AS 16.05.251 AS 16.20.170
AS 16.05.255 AS 16.20.260
AS 16.20.060

5 AAC 95.440. LIMITATIONS ON SPECIAL AREA PERMITS. A permit issued under 5 AAC 95.700 - 5 AAC 95.760

(1) does not convey an interest in state land or grant any preference right for the lease or purchase of state land; and

(2) does not allow the permittee to restrict or interfere with public access across or public use of a special area unless specified in the permit. (Eff. 6/5/86, Reg. 98)

Authority: AS 16.05.020 AS 16.20.120
AS 16.05.050 AS 16.20.130
AS 16.05.251 AS 16.20.170
AS 16.05.255 AS 16.20.260
AS 16.20.060

ARTICLE 7.
PERMIT PROCEDURES

Section
700. Application procedures
710. Permit decision
720. Permit conditions and assignment
730. Permit term
740. Amendments to the permit
750. Retention of permit: inspection of permit sites
760. Renewal of permit
770. General permits

5 AAC 95.700. APPLICATION PROCEDURES. (a) An applicant for a permit shall submit a completed application on a form or in a manner approved by the commissioner. The application must be correct and complete to the best of the applicant's knowledge and be signed and dated by the applicant or the applicant's designee. The submission of a completed application satisfies any related notification required by AS 16 and this chapter. An application form is available from the department's offices.

(b) The completed application must include the anticipated commencement date, duration, and area of proposed activity including a scaled map, identification of waterbodies at the site, description of

type of activity, description of any proposed facility, description of proposed access route and means and time of travel, and other information necessary for the commissioner to determine whether the activity will comply with the applicable provisions of this chapter.

(c) A completed application must be submitted to the department's habitat division office representing the region or area in which the proposed activity will occur. (Eff. 6/5/86, Reg 98)

Authority:	AS 16.05.020	AS 16.20.120
	AS 16.05.050	AS 16.20.130
	AS 16.05.251	AS 16.20.170
	AS 16.05.255	AS 16.20.250
	AS 16.20.050	AS 16.20.260
	AS 16.20.060	

5 AAC 95.710. PERMIT DECISION. (a) The commissioner will issue a permit if he or she determines that the requirements of this chapter are met.

(b) The commissioner will notify an applicant in writing of any denial. The notice will include:

(1) the reason for the denial; and

(2) a statement that the applicant may appeal under 5 AAC 95.920 or submit new or additional information and ask for reconsideration under (c) of this section.

(c) The commissioner will, in his or her discretion, reconsider a denial of an application if the applicant submits, to the appropriate habitat division office, factual information which is new or additional to that supplied with the original application. An applicant may submit the new or additional information as an amendment to the original application, or the applicant may submit a new application. The procedures of 5 AAC 95.700 - 5 AAC 95.760 apply to reconsideration. (Eff. 6/5/86, Reg 98)

Authority:	AS 16.05.020	AS 16.20.120
	AS 16.05.050	AS 16.20.130
	AS 16.05.251	AS 16.20.170
	AS 16.05.255	AS 16.20.250
	AS 16.20.050	AS 16.20.260
	AS 16.20.060	

5 AAC 95.720. PERMIT CONDITIONS AND ASSIGNMENT. (a) To provide for the proper protection and management of fish and wildlife, and their habitats, the commissioner will consider and will, in his or her discretion, include as conditions of the permit:

(1) the duration of the proposed activity, including any provision for changing the time period during which the permit is valid and any provision for changing the effective time period of the permit;

(2) any other seasonal use restrictions on a specific activity;

(3) limitation of the areal extent of the activity;

(4) any provision for the mitigation of damage to fish or wildlife, or their habitats;

(5) any provision to facilitate periodic monitoring of the proposed land or water use or activity by an authorized representative of the state, including inspection and sampling;

(6) reporting requirements;

(7) any provision for the posting of a performance bond or other surety as authorized in 5 AAC 95.950, necessary to insure compliance with the provisions of this chapter or conditions of the permit; and

(8) any other necessary condition.

(b) A permit may not be transferred but may be assigned upon written consent by the commissioner.

(c) The commissioner will, in his or her discretion, require a permit applicant to sign and date the permit before its validation as acknowledgement of the permittee's agreement to, and full understanding of, all conditions of the permit. (Eff. 6/5/86. Reg. 98)

Authority: AS 16.05.020 AS 16.20.120
AS 16.05.050 AS 16.20.130
AS 16.05.251 AS 16.20.170
AS 16.05.255 AS 16.20.260
AS 16.20.060

5 AAC 95.730. PERMIT TERM. (a) Except as provided in (b) and (c) of this section, a permit will, in the commissioner's discretion, be issued for a fixed term not to exceed two years, subject to the provisions of this chapter.

(b) A permit for a personal use cabin issued concurrent with 11 AAC 65 will, in the commissioner's discretion, be issued for up to six years.

(c) A permit will, in the commissioner's discretion, be issued for a fixed term exceeding two years if the commissioner determines that the activity meets the purposes and requirements of this chapter and the activity is permanent in nature. (Eff. 6/5/86, Reg. 98)

Authority: AS 16.05.020 AS 16.20.120
AS 16.05.050 AS 16.20.130
AS 16.05.251 AS 16.20.170
AS 16.05.255 AS 16.20.260
AS 16.20.060

5 AAC 95.740. AMENDMENTS TO THE PERMIT. (a) The commissioner will, in his or her discretion, initiate action to amend a permit to correct any condition or change any method authorized by the permit which was reasonably unforeseeable at the time of permit approval and which threatens to cause a substantially adverse effect upon:

(1) fish or wildlife, or their habitat; or

(2) if the permit is a special area permit, the purpose for which the special area was established.

(b) Any action a permittee desires to take which increases the overall scope of the project or which negates, alters, or minimizes the intent or effectiveness of any condition contained in a permit, is a deviation from the approved plan and requires an amendment before initiation of the action.

(c) A permittee may request amendment of a permit by submitting, to the department's habitat division office where the permit was issued, a written statement explaining why the amendment is necessary, including the amended plan, the location, commencement time, duration, and type of activity requiring amendment.

(d) The commissioner will issue an amendment to the permit if he or she determines that the requirements of this chapter will be met. Review of a request for amendment after receipt of the written statement in the appropriate habitat division office will not exceed 30 days. The procedures of 5 AAC 95.700 - 5 AAC 95.760 apply to a request for amendment.

(e) An amendment approved by the commissioner becomes effective upon receipt by the permittee, or at a later date specified by the amendment. An amendment is valid for the duration of the permit or for a shorter specified period. (Eff. 6/5/86, Reg. 98)

Authority: AS 16.05.020 AS 16.20.120
AS 16.05.050 AS 16.20.130
AS 16.05.251 AS 16.20.170
AS 16.05.255 AS 16.20.260
AS 16.20.060

5 AAC 95.750. RETENTION OF PERMIT: INSPECTION OF PERMIT SITES. (a) A permittee shall keep a copy of the permit, including any amendments, at the work site until completion of the project, and shall make it available for inspection upon request by an authorized representative of the state.

(b) For the purpose of inspecting or monitoring compliance with any condition of the permit or the requirements of this chapter, a permittee shall give an authorized representative of the state free and unobstructed access, at safe and reasonable times, to the permit site. A permittee shall furnish whatever assistance and information as the authorized representative reasonably requires for monitoring and inspection purposes. (Eff. 6/5/86, Reg. 98)

Authority: AS 16.05.020 AS 16.20.120
AS 16.05.050 AS 16.20.130
AS 16.05.251 AS 16.20.170
AS 16.05.255 AS 16.20.260
AS 16.20.060

5 AAC 95.760. RENEWAL OF PERMIT. (a) A permittee may request renewal of an existing permit before the expiration of the current term of the permit. Procedures in this chapter apply to renewal, except that the filing of a new application under 5 AAC 95.700 is not required.

(b) If an existing permit expires or is revoked, a permittee may obtain a new permit only by filing a new completed application in accordance with 5 AAC 95.700. (Eff. 6/5/86, Reg. 98)

Authority: AS 16.05.020 AS 16.20.120
AS 16.05.050 AS 16.20.130
AS 16.05.251 AS 16.20.170
AS 16.05.255 AS 16.20.260
AS 16.20.060

5 AAC 95.770. GENERAL PERMITS. Notwithstanding 5 AAC 95.700 and 5 AAC 95.750 - 5 AAC 95.760, the commissioner will, in his or her discretion, issue a permit to the public at large for a specific activity in a specified area. (Eff. 6/5/86, Reg. 98)

Authority: AS 16.05.020 AS 16.20.120
AS 16.05.050 AS 16.20.130
AS 16.05.251 AS 16.20.170
AS 16.05.255 AS 16.20.260
AS 16.20.060

ARTICLE 8.
GENERAL PROVISIONS

Section
900. Mitigation of damages
910. Failure to adhere to standards
920. Appeals
930. Exclusion periods
940. Exemption for emergency and police power activities
950. Bonding or security
990. Definitions

5 AAC 95.900. MITIGATION OF DAMAGES. (a) Each permittee shall mitigate any adverse effect upon fish or wildlife, or their habitat, which the commissioner determines may be expected to result from, or which actually result from, the permittee's activity, or which was a direct result of the permittee's failure to:

(1) comply with a permit condition or a provision of this chapter; or

(2) correct a condition or change a method foreseeably detrimental to fish or wildlife, or their habitat.

(b) Mitigation techniques must be employed in the following order of priority:

(1) avoid an impact altogether by not taking a certain action or parts of an action;

(2) minimize an impact by limiting the degree of magnitude of the action;

(3) rectify the impact by repairing, rehabilitating, or restoring the affected environment;

(4) reduce or eliminate the impact over time by preservation and maintenance operations during the life of the action;

(5) compensate for the impact by replacing or providing substitute resources or environments.

(c) The duty to mitigate in (a) of this section does not apply to unavoidable adverse effects upon fish or wildlife populations, or their habitat, arising from an overwhelming force of nature with consequences not preventable by due and reasonable precautions.

(d) The commissioner will, in his or her discretion, specify, by permit amendment, additional provisions for mitigating damage to fish and wildlife populations, and their habitat.

(e) Notwithstanding the expiration or revocation of a permit, a permittee is responsible for the obligations arising under the terms and conditions of the permit, and under the provisions of this chapter. (Eff. 6/5/86, Reg. 98)

Authority: AS 16.05.020 AS 16.20.120
AS 16.05.050 AS 16.20.130
AS 16.05.251 AS 16.20.170
AS 16.05.255 AS 16.20.260
AS 16.20.060

5 AAC 95.910. FAILURE TO ADHERE TO STANDARDS. The commissioner will, in his or her discretion, require in writing that a permittee correct a condition or remove a structure or installation constructed under permit by the permittee, which is not in accordance with a provision of the permit. (Eff. 6/5/96, Reg. 98)

Authority: AS 16.05.020 AS 16.20.120
AS 16.05.050 AS 16.20.130
AS 16.05.251 AS 16.20.170
AS 16.05.255 AS 16.20.260

AS 16.20.060

5 AAC 95.020. APPEALS. An interested person may initiate an appeal of a decision made under this chapter in accordance with the provisions of AS 44.62.330 - 44.62.630 by requesting a hearing under AS 44.62.370. (Eff. 6/5/86, Reg. 98)

Authority: AS 16.05.020 AS 16.20.120
AS 16.05.050 AS 16.20.130
AS 16.05.251 AS 16.20.170
AS 16.05.255 AS 16.20.260
AS 16.20.060

5 AAC 95.930. EXCLUSION PERIODS. (a) The commissioner will notify a permittee that the term of the permit is or will be interrupted for a period of time of the commissioner determines that:

(1) a temporary environmental condition exists which was reasonably unforeseeable at the time of permit approval and the permitted activity, if allowed to continue, threatens to cause a substantial adverse impact;

(2) the permittee has failed to implement a required mitigating or preventative measure; or

(3) the permittee has failed to comply with a provision of this chapter, or a condition of the permit.

(b) The exclusion period established under (a) of this section will be as long as necessary for abatement of the temporary condition, completion of the required mitigating or preventative measure, or compliance with the permit condition or the provisions of this chapter, and will not exceed a total of 30 days in any calendar year, without the consent of the permittee.

(c) The commissioner will, by notice to the permittee, terminate an exclusion period after the permittee demonstrates abatement, compliance, or implementation of the required mitigating measures.

(d) If the commissioner finds, before or during an exclusion period, that corrective action is unlikely to be completed within any available exclusion period, the commissioner will, in his or her discretion, initiate a revocation proceeding under AS 44.62.330 - 44.62.630. (Eff. 6/5/86. 98)

Authority: AS 16.05.020 AS 16.20.120
AS 16.05.050 AS 16.20.130
AS 16.05.251 AS 16.20.170
AS 16.05.255 AS 16.20.260
AS 16.20.060

5 AAC 95.940. EXEMPTION FOR EMERGENCY AND POLICE POWER ACTIVITIES. In an emergency, the commissioner will, in his or her discretion, issue an oral permit for emergency or policy power activities before receiving the completed application required in 5 AAC 95.800. A

completed application must be submitted within the time specified by the commissioner, whether before or after the emergency or police power activity takes place. (Eff. 6/5/86, Reg. 98)

Authority: AS 16.05.020 AS 16.20.120
AS 16.05.050 AS 16.20.130
AS 16.05.251 AS 16.20.170
AS 16.05.255 AS 16.20.260
AS 16.20.060

5 AAC 95.950. BONDING OR SECURITY. (a) The commissioner will, in his or her discretion, require a performance bond with a surety company authorized to transact business in Alaska, or other specified security to secure the performance of the terms and conditions of a permit issued under this chapter.

(b) A performance bond or security required when (a) of this section is limited to an amount reasonably necessary to ensure compliance with the provisions of this chapter or the terms and conditions of a permit issued under this chapter.

(c) The commissioner will inspect or review actions taken under each applicable term or condition of a permit issued under this chapter, and will make a written finding that each applicable term and condition of the permit has been completed, before the permittee's performance bond or security is released.

(d) The posing of a performance bond or the taking or other security under (a) of this section does not limit the department's right, under applicable law, to seek further compensation from the permittee for actual damages to fish or wildlife, or their habitats, or for a violation of the permit. (Eff. 6/5/86, Reg. 98)

Authority: AS 16.05.020 AS 16.20.120
AS 16.05.050 AS 16.20.130
AS 16.05.251 AS 16.20.170
AS 16.05.255 AS 16.20.250
AS 16.20.050 AS 16.20.260
AS 16.20.060

5 AAC 95.990. DEFINITIONS. In addition to the definitions set out in AS 16.05.940, as used in this chapter:

(1) "authorized representative of the state" means one who is legally empowered to enforce a statute under which regulations in this chapter are promulgated;

(2) "completed application" means the submission of full plans, specifications, and notifications required by AS 16.20, and includes a form, series of forms, letter, or other documents that provide all of the information necessary for the commissioner to issue, condition, or deny a permit;

(3) "emergency" means an unforeseeable situation that presents an imminent threat to life or property;

(4) "mitigate" means to compensate fully for damage to fish and wildlife populations and their habitat by employing the most appropriate techniques;

(5) "permittee" means the holder of a permit and includes anyone employed, contracted, or assigned by the person or the organization to whom the permit was issued to conduct a land or water use operation;

(6) "permit" means the approval of plans and specifications required by AS 16.20.060 or AS 16.20.260, and any authorization made under AS 16.20.120, 16.20.130, or 16.20.170;

(7) "special area" means a state game refuge, a state game sanctuary, or a state fish and game critical habitat area, established under AS 16.20;

(8) "wildlife" means any species of bird or mammal as described in AS 16.05.940(14). (Eff. 6/5/86, Reg. 98)

Authority:	AS 16.05.020	AS 16.20.120
	AS 16.05.050	AS 16.20.130
	AS 16.05.251	AS 16.20.170
	AS 16.05.255	AS 16.20.260
	AS 16.20.060	