

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



A Comprehensive Wildlife Conservation Strategy
Emphasizing Alaska's Nongame Species

April 2006



Development of this Comprehensive Wildlife Conservation Strategy was funded by the State Wildlife Grants (SWG) Program. This program consists of funds from the U.S. Department of Interior offshore oil and gas leasing receipts. A portion of the receipts are designated annually by Congress and apportioned among the states and territories through a formula based on each state's geographic area and population. Alaska receives a maximum 5% of the funds available each year. The funds are administered by the U.S. Fish and Wildlife Service. One of the primary purposes of SWG is to focus on conservation actions that benefit species of greatest conservation need while taking into consideration the relative level of other funding available for the conservation of those species.

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

This document should be cited as:

Alaska Department of Fish and Game. 2006. Our Wealth Maintained: A Strategy for Conserving Alaska's Diverse Wildlife and Fish Resources. Alaska Department of Fish and Game, Juneau, Alaska. xviii+824 p.

**Comprehensive Wildlife Conservation Planning Team,
Alaska Department of Fish and Game**

Task Force: Ellen Fritts, CWCS Project Coordinator, Division of Wildlife Conservation (DWC); Mark Burch, Statewide Planner, Sport Fish Division (SF); Mary Rabe, Nongame Program Coordinator, DWC; James Schwarber, Statewide Planner, SF; Betsy McCracken, Fisheries Biologist, SF

Key Technical Support: Cathy Brown, Publications Specialist, DWC; Erica Sigurdsson, Student Intern, SF

Acknowledgements

As with any large, complex, multiyear project, preparation of this Strategy involved a variety of state agency staff and other partners who collectively made the impossible possible. Their efforts have contributed greatly to our understanding of the needs of wildlife resources in Alaska.

Many agencies and organizations provided hours of in-kind support. We would like to especially thank Doug Alcorn and Al Havens, U.S. Fish and Wildlife Service; John Schoen, Audubon Alaska; Randy Hagenstein and Amalie Couvillion, The Nature Conservancy; and Keith Boggs and Tracey Gotthardt, Alaska Natural Heritage Program, for leveraging their resources and lending their staff to this project.

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

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

The Alaska Department of Fish and Game administers all programs and activities free from discrimination based on race, color, national origin, age, sex, religion, marital status, pregnancy, parenthood, or disability. The department administers all programs and activities in compliance with Title VI of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973, Title II of the Americans with Disabilities Act of 1990, the Age Discrimination Act of 1975, and Title IX of the Education Amendments of 1972.

If you believe you have been discriminated against in any program, activity, or facility, or if you desire further information please write to ADF&G, P.O. Box 115526, Juneau, AK 99811-5526; U.S. Fish and Wildlife Service, 4040 N. Fairfax Drive, Suite 300 Webb, Arlington, VA 22203 or O.E.O., U.S. Department of the Interior, Washington DC 20240.

For information on alternative formats for this and other department publications, please contact the department ADA Coordinator at (voice) 907-465-6077, (TDD) 907-465-3646, or (FAX) 907-465-6078.

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

Executive Summary

Introduction

The state of Alaska covers a vast area, 656,425 square miles. The name is derived from an Aleut word meaning “great land,” and a land of superlatives it is: Alaska has over 3 million lakes and 44,000 miles of coastline, more coastline than the rest of the nation combined. A population of 630,000 is spread across the state, with 78% of those people living in metropolitan areas. The state’s natural beauty and outstanding wildlife¹ populations are important factors in sustaining residents and attracting tourists. Residents of Alaska depend greatly on natural resources in their daily life.-

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

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

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

¹ In the Strategy, use of the word “wildlife” includes fish unless specified otherwise.

Purpose and Scope

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

With initial annual receipt of nearly three million dollars³ in federal SWG funding, Alaska can begin collecting and organizing information about species that are little known and poorly understood, underrepresented in the mix of species receiving traditional funding, or which experts believe have specific conservation needs that cannot be adequately met with existing funding sources. Congress specified eight elements that each CWCS must address (see Section I, page 3) and these have guided Alaska’s planning effort.

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

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

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

² Memo dated October 25, 2002 from Brent Manning, President, International Association of Fish and Wildlife Agencies (IAFWA), to State Fish and Wildlife Directors, titled “State Wildlife Grants.”

³ For 2005, the figure is almost \$4 million once mandatory nonfederal matching funds are included.

Developing the Strategy

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

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

With time and resources for Strategy development limited, the department prepared a list of CWCS nominee species, i.e., Alaska's species of greatest conservation need. We then asked experts to apply specific criteria and select a subset of species to feature in the CWCS. Seventy-four featured species or species groups were chosen after applying criteria on vulnerability of a species, subspecies, or distinct population⁴ and addressing such factors as abundance, incidence of deformity or disease, rarity, isolation, endemism, sensitivity to environmental disturbance, representation, international importance, and formal "at-risk" designation (e.g., T&E). The featured species and groups range from relative unknowns, such as a cave-dwelling invertebrate, to familiar groups, such as loons and whales.

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

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

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

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

Value of Conserving All Wildlife—Nongame as Well as Game

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

The state's nongame species, including its many endemics⁵, provide opportunities for scientific study in such fields as habitat adaptation, the effects of climate change, and evolution. Some Alaska species enjoy wide acclaim by specialists. For example, the threespine stickleback is a model species internationally for discoveries in the fields of evolutionary biology, developmental genetics, animal behavior, ecology, environmental toxicology, and medicine.

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

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

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

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

Common Themes

Information Needs

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

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

Data Gaps and Strategy Limitations

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

We were also unable to incorporate certain themes in as much depth as we would have liked, but these will be incorporated more fully in future versions of the Strategy. These themes include species migration patterns, a systematic analysis of

data gaps in species' distribution information, cultural and subsistence information, and traditional knowledge. Future iterations of the Strategy could also compile information from other states and countries that manage habitats used by wide-ranging and migratory Alaskan species.

Lack of Long-Term Monitoring

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

A key recommendation from our process is to promote and facilitate meaningful participation by communities in monitoring and sharing information about the species and ecosystems they use. Indeed, community monitoring programs may prove to be cost-effective tools for assessing species that are not commercially or recreationally harvested. Traditional and other local user knowledge⁶ can be very helpful to conservation efforts, e.g., by describing climate-related changes in northern species and habitats. Use of other creative ideas, such as tapping university science students for a term's work on part of a long-term monitoring project, should also be explored.

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

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

Primary Recommendations: Alaska's Greatest Wildlife Conservation Needs

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

Information and Data Gathering

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

Data and Classification Systems

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

Monitoring

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

Species and Habitat-related Planning

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

Funding and Collaboration

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

Education and Outreach

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

Enforcement

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

Investing Today for a Legacy of Diversity and Abundance

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

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

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

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

Literature Cited

Millsap, B.A., J.A. Gore, D. E. Runde, and S.I. Cerulean. 1990. Setting Priorities for the Conservation of Fish and Wildlife Species in Florida. Wildlife Monographs. 111:1–57.

Table of Contents

Acknowledgements	iii
Executive Summary	iv
Introduction	iv
Purpose and Scope	v
Developing the Strategy	vi
Value of Conserving All Wildlife—Nongame as Well as Game	vii
Common Themes	viii
Primary Recommendations: Alaska’s Greatest Wildlife Conservation Needs	x
Investing Today for a Legacy of Diversity and Abundance	xii
I. Introduction	1
Impetus for Improved Wildlife Conservation	1
Comprehensive Wildlife Conservation Strategies	2
Alaska’s Strategy: Comprehensive and Collaborative	3
Partnering to Implement the Strategy	4
Species of Greatest Conservation Need: The “Featured Species” and “Key Habitats”	
Approach	5
II. Methodology and Approach	7
A. Project Management Structure and Planning Focus	7
B. Public and Agency Involvement	7
C. Strategy Development	9
Review of Existing Plans and Efforts	9
Nominee Species List	9
Species Selection Criteria	10
Draft "Featured Species" List	10
Expert Group Meetings and Products	11
Peer and Technical Review	12
Habitats Review	12
D. Development of Summary Products	13
Species of Greatest Conservation Need	13
List of Primary Recommendations	14
E. Participants	14
III. Overview of Alaska	15
A. Sociological Framework: Demography and Use of Fish and Wildlife	16
People of the Land	16
Land Status	16
Use of Fish and Wildlife	17
Legal Basis for Conservation	22
B. Ecological Framework: The Lands and Waters that Produce Our Fish and Wildlife	26
Introduction: Alaska’s 32 Ecoregions	26
Polar Arctic Tundra	28
Beaufort Coastal Plain	28
Brooks Foothills	30
Brooks Range	31
Bering Taiga	33

Nulato Hills	33
Yukon-Kuskokwim Delta	34
Ahklun Mountains	36
Bristol Bay Lowlands	38
Bering Tundra	39
Kotzebue Sound Lowlands	39
Seward Peninsula	41
Bering Sea Islands	43
Intermontane Boreal	45
Kuskokwim Mountains	45
Yukon River Lowlands	46
Kobuk Ridges and Valleys	48
Ray Mountains	50
Tanana-Kuskokwim Lowlands	51
Yukon-Tanana Uplands	52
Yukon-Old Crow Basin	54
Davidson Mountains	55
North Ogilvie Mountains	57
Alaska Range Transition	58
Lime Hills	58
Cook Inlet Basin	59
Alaska Range	61
Copper River Basin	63
Aleutian Meadows	64
Aleutian Islands	64
Alaska Peninsula	66
Coastal Mountains Transition	68
Wrangell Mountains	68
Kluane Range	70
Coastal Rain Forests	71
Kodiak Island	71
Gulf of Alaska Coast	72
Chugach-St. Elias Mountains	75
Northern Coast Mountains	77
Alexander Archipelago	79
IV. Challenges for Wildlife and Fish Conservation	83
A. The Changing Natural World	83
Climate Change	83
Tectonic and Isostatic Uplift	88
Wildfire	90
Vulnerability of Species with Restricted or Limited Distributions	91
B. Lack of Shared Information and Understanding	92
Lack of Information about Species or Habitats	92
Lack of Spatial Data, Data Systems, and Compatible Terms	93
Insufficient Public Understanding About Fish and Wildlife Needs	100
C. Humans as Elements in the Ecosystem	102

Industrial and Community Development	103
Increased Access and Disturbance	117
Introduced, Nonindigenous, and Invasive Species	124
Bycatch	127
Overharvest	128
Unknown/Unrecorded Level of Human Use	128
D. Maintaining Existing Conservation Areas	130
State Special Areas	130
Needs and Opportunities	135
V. Conservation Action Plans	140
VI. Some Key Habitats of Featured Species	145
VII. Primary Recommendations: Alaska’s Greatest Wildlife Conservation Needs	148
VIII. Monitoring of Species and Habitats	152
Ecosystem Monitoring	156
Collaboration	156
Summary	158
IX. Strategy Monitoring	160
Evaluation and Reporting	163
Adaptive Management	163
X. Implementation	164
XI. Strategy Review and Revision	165
XII. Glossary	166
XIII. Acronyms	178
XIV. Appendices	
Appendix 1. Vertebrate Species of Alaska	183
Appendix 2. Road Map to the Eight Required CWCS Elements	206
Appendix 3. List of Featured Species and Groups	211
Appendix 4. Conservation Action Plans	217
Appendix 5. Key Habitats of Featured Species	653
Appendix 5.1. Forest Habitats	653
Appendix 5.2. Tundra Habitats	673
Appendix 5.3 Wetland Habitats	683
Appendix 5.4. Marine and Coastline Habitats	696
Appendix 5.5. Sea Ice Habitats	721
Appendix 5.6. Karst Cave Habitats	728
Appendix 5.7. Aquatic Habitats	740
Appendix 6. Public Comment Summary – 2003 and 2005	761
Appendix 7. Nominee Species List	765
Appendix 8. List of Planning Participants and Contributing Authors	797
Appendix 9. Alaska’s Population by Community and Ecoregion	805
Appendix 10. Alaska’s Special Areas: Management Planning Status	824

LIST OF TABLES

Table	Page
1. Beaufort Coastal Plain land status	29
2. Brooks Foothills land status.....	31
3. Brooks Range land status.....	33
4. Nulato Hills land status.....	34
5. Yukon-Kuskokwim Delta land status	36
6. Akhlun Mountains land status	37
7. Bristol Bay Lowlands land status	39
8. Kotzebue Sound Lowlands land status	41
9. Seward Peninsula land status.....	43
10. Bering Sea Islands land status	44
11. Kuskokwim Mountains land status.....	46
12. Yukon River Lowlands land status	47
13. Kobuk Ridges and Valleys land status.....	49
14. Ray Mountains land status.....	51
15. Tanana-Kuskokwim Lowlands land status	52
16. Yukon-Tanana Uplands land status	54
17. Yukon-Old Crow Basin land status	55
18. Davidson Mountains land use status.....	57
19. North Ogilvie Mountains land status	58
20. Lime Hills land status	59
21. Cook Inlet Basis land status.....	61
22. Alaska Range land status	63
23. Copper River Basin land status.....	64
24. Aleutian Islands land status	66
25. Alaska Peninsula land status.....	68
26. Wrangell Mountains land status	69
27. Kluane Range land status.....	71
28. Kodiak Island land status.....	72
29. Gulf of Alaska Coast land status.....	75
30. Chugach St. Elias Mountains land status	77
31. Northern Coast Mountains land status	78
32. Alexander Archipelago land status	81
33. Sources of Human-Caused Disturbance to Wildlife Resources.....	121
34. Key Habitats of Featured Species.....	145
35. Synopsis of Fish and Wildlife Habitat-Related Concerns.....	146
36. Sample Framework for Monitoring Overall Performance under the CWCS.....	161
37. Sample Framework for Monitoring Success in Maintaining a Single Species, Red-throated Loon	162

LIST OF FIGURES

Figure	Page
Figure 1. Unified Ecoregions of Alaska	27
Figure 2. Beaufort Coastal Plain ecoregion	28
Figure 3. Brooks Foothills ecoregion	30
Figure 4. Brooks Range ecoregion	32
Figure 5. Nulato Hills ecoregion	33
Figure 6. Yukon-Kuskokwim Delta ecoregion	35
Figure 7. Ahklun Mountains ecoregion	36
Figure 8. Bristol Bay Lowlands ecoregion	38
Figure 9. Kotzebue Sound Lowlands ecoregion	40
Figure 10. Seward Peninsula ecoregion	41
Figure 11. Bering Sea Islands ecoregion	44
Figure 12. Kuskokwim Mountains	45
Figure 13. Yukon River Lowlands ecoregion	46
Figure 14. Kobuk Ridges and Valleys ecoregion	48
Figure 15. Ray Mountains ecoregion	50
Figure 16. Tanana-Kuskokwim Lowlands ecoregion	52
Figure 17. Yukon-Tanana Uplands ecoregion	53
Figure 18. Yukon-Old Crow Basin ecoregion	55
Figure 19. Davidson Mountains ecoregion	56
Figure 20. North Ogilvie Mountains ecoregion	57
Figure 21. Lime Hills ecoregion	58
Figure 22. Cook Inlet Basin ecoregion	60
Figure 23. Alaska Range ecoregion	61
Figure 24. Copper River Basin ecoregion	63
Figure 25. Aleutian Islands ecoregion	64
Figure 26. Alaska Peninsula ecoregion	67
Figure 27. Wrangell Mountains ecoregion	68
Figure 28. Kluane Range Ecoregion	70
Figure 29. Kodiak Island ecoregion	72
Figure 30. Gulf of Alaska Coast ecoregion	73
Figure 31. Chugach-St. Elias Mountains ecoregion	76
Figure 32. Northern Coast Mountains ecoregion	77
Figure 33. Alexander Archipelago ecoregion	79
Figure 34. Current and Proposed Oil & Gas Leases on Alaska's North Slope	104
Figure 35. Lands Designated as State Refuges, Critical Habitat Areas and Sanctuaries	131

I. Introduction

Impetus for Improved Wildlife Conservation

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

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

ADF&G has conducted limited nongame and marine mammal programs for a number of years. Information about these programs is available at:

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

Although basic biological information on life history, population levels, and other parameters is lacking for many species, the majority of Alaska's wildlife resources are considered healthy. Only 17 of Alaska's 1,073 vertebrate species⁸ are listed as Threatened or Endangered. In contrast, more than 1,200 species are listed nationally, with the number expected to increase over the next decade. For specific information on the USFWS and State of Alaska endangered species programs, see

<http://www.fws.gov/fisheries/endangered/listing.htm> and <http://www.wildlife.alaska.gov/index.cfm?adfg=endangered.main>, respectively.

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



Northern Hawk Owl banding near Fairbanks.

J. Whitman, ADF&G

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

Between 2001 and 2004, Congress passed a series of bills designed to encourage and facilitate a greater level of coordination and joint funding among and within fish and wildlife programs and funding sources. One of these appropriations bills laid out the requirements by which states, territories, and tribes could begin receiving millions of dollars in federal funding under a new program administered by USFWS called the State Wildlife Grants (SWG) program. The intent is that SWG funds be used to address conservation needs of

species in the United States that are: a) little known and poorly understood; b) underrepresented in the mix of species receiving more traditional funding; or c) believed by experts to be in need of specific conservation actions.

Comprehensive Wildlife Conservation Strategies

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

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

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

The Eight Required Elements of a CWCS

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

Alaska's Strategy: Comprehensive and Collaborative

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

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

Alaska's Strategy has numerous benefits and potential uses. It informs citizens about what's unique and valuable in the natural world around them. It improves public understanding and support by fostering greater agency efficiency and collaboration in programs. The Strategy establishes new partnerships and enhances old ones. It also highlights exciting opportunities for scientific study in various specialties of biology,

toxicology, and medicine. Further, Alaska's CWCS aims to improve the sharing of wildlife conservation information with others.

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

Partnering to Implement the Strategy

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

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

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

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

The Strategy is meant to provide guidance and information to all partners, not just ADF&G. Similarly, it cannot be implemented by the department alone. Successful implementation through time will require the commitment and support of many

parties, including Alaska's Native corporations, military installations, state and federal land managers, conservation groups, industries, landowners, resource users, and neighboring jurisdictions. Continuing to build broad support for CWCS implementation will be a key activity for the department and its partners in coming years.

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

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

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

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

Literature Cited

- Crother, B.I., editor. 2000. Scientific and standard English names of amphibians and reptiles of North America north of Mexico, with comments regarding confidence in our understanding. SSAR Herpetological Circular 29. iii + 82 pp.
- Gibson, D.D., S.C. Heinl, and T.G. Tobish, Jr. 2003. Checklist of Alaska Birds, 10th ed. University of Alaska Museum. Fairbanks, AK.

Jarrell, G.H., A.O. MacDonald, and J.A. Cook. 2004. Checklist to the Mammals of Alaska. University of Alaska Museum. Fairbanks, AK.

Nelson, J.S., E.J. Crossman, H. Espinosa-Perez, L.T. Findley, C.R. Gilbert, R.N. Lea, and J.D. Williams. 2004. Common and scientific names of fishes from the United States, Canada, and Mexico. American Fisheries Society, Special Publication 29. Bethesda, MD.

II. Methodology and Approach

A. Project Management Structure and Planning Focus

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

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

B. Public and Agency Involvement

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

The most active early partners in the CWCS planning process were the AKNHP/University of Alaska, TNC, Audubon Alaska, and the USFWS Federal Assistance Office. Drawing on their previous experiences with conservation planning efforts in Alaska, individuals from these organizations provided suggestions about process and draft products. The Task Force held several group meetings with these parties to review progress and seek their recommendations for completing the next steps of the process. The AKNHP was asked to assemble and summarize species information. TNC staff provided descriptions, maps, and photos for the 32 ecoregions in Alaska. The USFWS provided substantial support in the form of travel costs and

staff participation at the expert team meetings described elsewhere in this section. Staff from many agencies and organizations helped write sections of the CWCS. Biologists within ADF&G contributed to the CWCS effort by identifying species of concern, serving on expert groups, writing habitat descriptions and various other sections, and reviewing portions of the draft Strategy.

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

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

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

During the planning process, various state and national organizations indicated their interest in assisting with preparation, review and/or implementation of Alaska's CWCS. These include NatureServe, the International Association of Fish and Wildlife Agencies (IAFWA), Partners in Amphibian and Reptile Conservation (PARC), the Natural Areas Association, the Ornithological Council, and local or

regional land trusts in Alaska, such as the Kachemak Heritage Land Trust. Relationships with these and other parties will continue to evolve as we learn more about mutual interests and opportunities for collaboration.

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

C. Strategy Development

Review of Existing Plans and Efforts

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

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

Nominee Species List

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

comment. The sources of other agencies' "at-risk" species and detailed rationales for their designations were posted on our website throughout the planning process.

Species Selection Criteria

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

Species Selection Criteria

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

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

Draft "Featured Species" List

The Task Force applied the species selection criteria above against the Nominee Species List and, from that, prepared an initial *draft* "featured species" list for each taxonomic group. In this early phase of the planning process, the team excluded from consideration: a) all species whose occurrence in Alaska is believed to be only accidental or incidental (e.g., several marine turtle, fish, and migratory bird species); and b) most of the state's species that are commercially or recreationally hunted,

trapped, or fished—i.e., species whose conservation actions are directed through an existing management mechanism or process, such as the Alaska Boards of Fisheries or Game, or a species management plan. We later learned from taxa experts about a few game species or populations warranting inclusion in the Strategy.

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

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

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



Spectacled eider

C.Dau, USFWS

Expert Group Meetings and Products

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

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

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

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

Peer and Technical Review

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

Habitats Review

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

To meet this Strategy requirement, the planning team did an initial habitat assessment by asking species experts and peers to describe the location and relative condition of key habitats associated with featured species or species groups, and to note threats associated with those habitats. In addition, the species experts sometimes proposed conservation actions relating to the habitats used by featured species. This

information is captured in the conservation action plans for each species, located in Appendix 4. During CWCS development, experts regularly noted habitats that fell into the following categories:

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

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

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

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

D. Development of Summary Products

Species of Greatest Conservation Need

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

List of Primary Recommendations

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

E. Participants

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

Literature Cited

Groves, C.R. 2003. Drafting a Conservation Blueprint: A Practitioner's Guide to Planning for Biodiversity. Island Press, Washington.

Nowacki, G., P. Spencer, M. Fleming, T. Brock, and T. Jorgenson. Ecoregions of Alaska: 2001. USGS Open-File Report 02-297 (map).

III. Overview of Alaska

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



Brant at Izembek Lagoon

USFWS

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

Approximately 53% of the state has been designated in federal or state conservation units. These units effect differing levels of protection, ranging from national parks, sanctuaries, and refuges with a heavy emphasis on landscape and species conservation to recreation areas, marine parks, state forests, and other lands often

designated for multiple uses, including resource extraction activities. Permanent ice and snow and alpine tundra and barrens cover about 15.7% of the state (Duffy et al. 1999), but make up 20% of the conservation units.

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

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

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

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

People of the Land

Alaska's population of about 627,000 (2000 Census) is one of the lowest in the nation, and about 42% of its people live in Anchorage, the largest city. Alaska's population is not uniformly distributed: In 2002, 78% of the state's human population was concentrated in the Municipality of Anchorage (269,070), Fairbanks North Star Borough (84,791), Matanuska-Susitna Borough (65,241), Kenai Peninsula Borough (51,187), and City and Borough of Juneau (30,981) (Williams 2004). These five boroughs comprise 9.2% of Alaska's area. The highest population density is in the Municipality of Anchorage (411.3/km²), and the lowest density is in the Yukon-Koyukuk Census area (0.10 persons/km²). Appendix 9 provides Year 2000 Census numbers, together with 2004 Census-based estimates of Alaska's population by community name and within each ecoregion of the state. Sixty-nine percent of the 347 Alaska communities listed in Appendix 9 have fewer than 500 residents, many of whom are Alaska Natives.

Land Status

Land ownership in the state is divided as follows: national parks and refuges, 40%; other federal lands, 19%; state and municipal lands, 28%; and private lands, the bulk of it owned by Native corporations, 12%. Multiple modes of travel are used across Alaska, with boat, snowmachine, off-road vehicle, and air travel being the primary

means of access outside of the relatively few heavily roaded regions of the state. Not surprising given Alaska's size, per capita ownership of small airplanes (private aircraft) is 14 times greater than anywhere else in the United States. Although airplane use is critical for commerce and enjoyed for recreation and tourism, air travel and the growing number of "backcountry" users increase some of our long-term conservation challenges, such as preventing introductions of invasive animal and plant species.

Use of Fish and Wildlife

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

Commercial Fishing

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



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

only to the construction industry and greater than employment figures for the oil and gas industry (Alaska Department of Labor and Workforce Development 2004).

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

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

Sport and Personal Use Hunting, Trapping, and Fishing

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

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

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



Fall caribou hunt, Interior Alaska

R. Lowell, ADF&G

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

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

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

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

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



A popular fishing spot during salmon season
USFWS

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

Not surprisingly, whether small or large in scale, these additional fishing opportunities are popular and highly valued by Alaskans. As an example, approximately 35,000 permits are issued annually to dipnet for sockeye salmon in summer fisheries located in Upper Cook Inlet and on the Copper River; a few pink, coho and chum salmon are also taken in these fisheries. In 2004, over 450,000

sockeye salmon were harvested in Upper Cook Inlet and Copper River personal use fisheries. The 2004 sockeye harvest on the Kenai and Kasilof Rivers represents approximately 6 percent of the overall Cook Inlet sockeye harvest. The harvest of king salmon is allowed in several personal use fisheries, but on a very limited basis. Smelt and herring are also important personal use species in selected locales.

Subsistence Harvest

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

State and federal law define subsistence as the “customary and traditional uses” of wild resources for food, clothing, fuel, transportation, construction, art, crafts, sharing, and trade. At present, these federal and state laws differ in who qualifies for participation in subsistence hunting and fishing. Under federal law, only rural residents qualify for subsistence preference on federal lands—about 20% of Alaska’s



Beluga muktuk at Elephant Point, Kotzebue Sound

G. Seaman, ADF&G

population (about 125,000 people) lived in rural Alaska in 2000. Federal laws apply to federal lands and decisions on subsistence management on federal lands (national parks, national wildlife refuges, national forests, and BLM lands) are made by the Federal Subsistence Board. Under state law, all state residents are eligible to participate in subsistence hunts and fisheries as established by the Alaska Board of Game and Alaska Board of Fisheries, with preference being based on an individual’s customary use of and dependence on a particular wildlife or fish population.

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

Families harvest wild foods with fish wheels, nets, motorized skiffs, rifles, all-terrain vehicles (ATVs), and snowmachines. Successful families in rural Alaska’s “mixed economy” combine wage-paying jobs (e.g., tourism, guided hunting, or the service sector) with subsistence hunting, fishing, and gathering. They share their harvests with households having members who cannot hunt or fish, including elders, small

children, and the disabled. The social bonds created by exchanges of subsistence foods are central to the survival of rural communities and traditional cultures.

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

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

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

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

The Division of Subsistence maintains a Community Profile Database that includes the results of systematic household harvest surveys conducted periodically in communities throughout the state (Scott et al. 2001). A list of the animal and plant

resources that are currently used for subsistence purposes in Alaska communities and additional readings about subsistence can be found at:

<http://www.subsistence.adfg.state.ak.us/>.

Finding and Viewing Wildlife

Opportunities to view and photograph wildlife in their natural habitats are important to both Alaska residents and visitors. Wildlife viewing enhances quality of life and economies across Alaska. In a survey of Alaska voters, 96 percent agreed that wildlife adds a great deal to their enjoyment of living in Alaska (80 percent strongly



Photographing wildlife

ADF&G

agreed), and 78 percent wanted to know more about how to find and watch wildlife. Visitor studies show that wildlife viewing is second only to scenery as the most important reason that tourists come to Alaska.

Many Alaskans and most visitors travel to view wildlife. Using a strict “primary purpose” definition, the USFWS estimates that 420,000 U.S. residents aged 16 and

older participated in wildlife viewing in Alaska in 2001, spending \$499 million, including \$358 million in expenditures by nonresidents. The economic impact of wildlife as a draw for international tourists has not been measured. However, Alaska’s unique and abundant wildlife makes it a world class viewing destination. The Alaska Travel Industry Association estimates annual in-state visitor expenditures at \$1.8 billion, with a significant portion attributed to Alaska’s wildlife viewing opportunities.

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

Legal Basis for Conservation of Fish and Wildlife

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

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

The department, the Alaska Board of Fisheries, and the Alaska Board of Game work within a legal framework formed by the Alaska Constitution, statutes enacted by the state legislature, and administrative rules, or regulations. Alaska Statute Title 16 is the primary statute governing management of Alaska’s fish and wildlife resources. This statute directs the commissioner of ADF&G to “manage, protect, maintain, improve, and extend the fish, game, and aquatic plant resources of the state⁹ in the interest of the economy and general well-being of the state.” In addition, it assigns primary responsibility for allocation of resources by user group or gear type to the Alaska Board of Fisheries and the Board of Game. One statute, AS 16.20.185, directs the commissioners of ADF&G and DNR to “take measures to preserve the natural habitat of species or subspecies of fish and wildlife that are recognized as threatened with extinction.” Other sections of AS 16.20 codify the purposes for state wildlife refuges, sanctuaries, and critical habitat areas, and designate particular places for these purposes.

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

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

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

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

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

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

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

Enforcement

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

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

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

Literature Cited

- ADF&G. 2004. Calendar Year License Sale Statistics.
<http://www.admin.adfg.state.ak.us/admin/license/>. Accessed June, 2005.
- ADF&G (Alaska Department of Fish and Game). 2003. Alaska Wildlife Harvest Summary 2001-2002. Division of Wildlife Conservation Technical Publication. Juneau, Alaska. 7pp.

Literature Cited (continued)

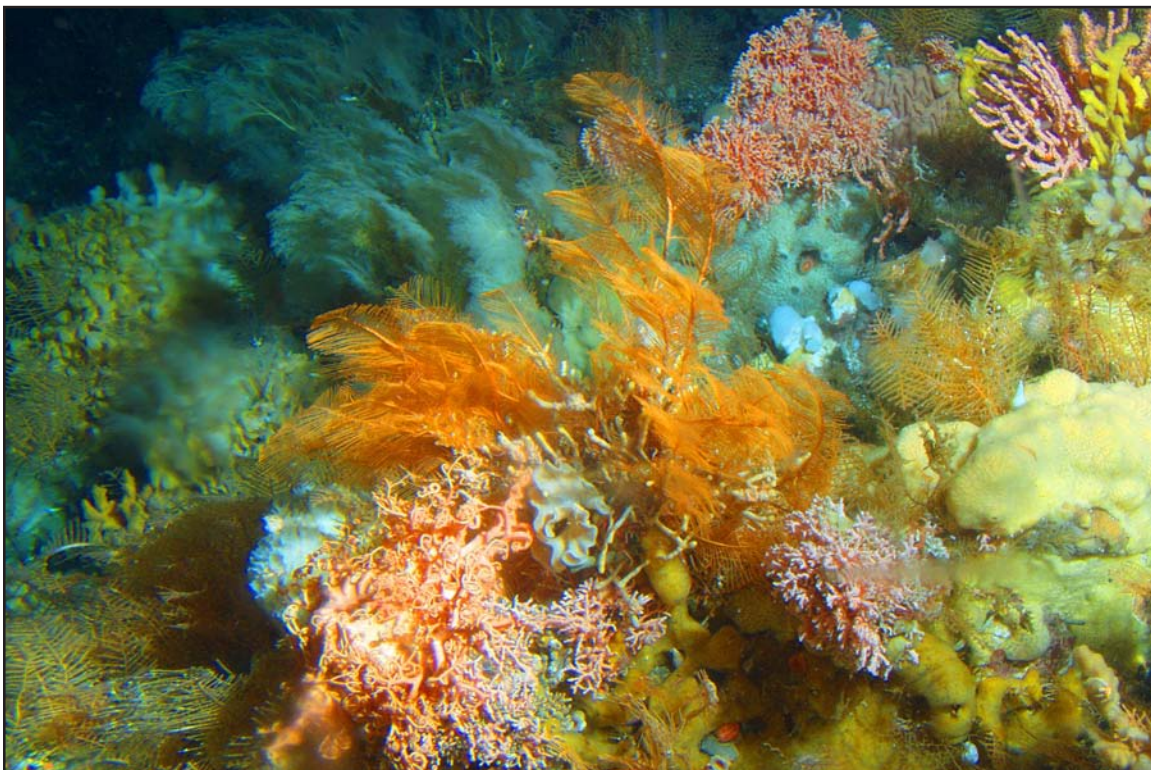
- Alaska Department of Labor and Workforce Development. 2004. Employment in the Alaska Fisheries. *Alaska Economic Trends* 24(12):15–20.
<http://www.labor.state.ak.us/trends/dec04.pdf> . Accessed June, 2005.
- American Sportfishing Association. 2003. Economic Impact of Sportfishing.
http://www.asafishing.org/asa/statistics/economic_impact/state_allfish_2003.html (accessed June 8, 2005).
- Brooks, D. J. and R.W. Haynes. 2001. Recreation and Tourism in South-central Alaska: synthesis of recent trends and prospects. Gen. Tech. Rep. NW-GTR-511. USFS, Pacific Northwest Research Station, Portland, OR.
- Duffy, D.C., K. Boggs, R.H. Hagenstein, R. Lipkin, and J.A. Michaelson. 1999. Landscape Assessment of the Degree of Protection of Alaska's Terrestrial Biodiversity. *Conservation Biology* 13(6):1332–1343.
- Eagles, P.F.J., S.F. McCool, and C.D. Haynes. 2002. Sustainable Tourism in Protected Areas: Guidelines for Planning and Management. World Commission on Protected Areas, The World Conservation Union.
<http://www.uneptie.org/pc/tourism/library/st%20in%20prot.areas/Best-Practice-8.pdf> (accessed June 6, 2005).
- Fay, Ginny (Alaska Division of Tourism). Speech given to the Alaska Wilderness Recreation and Tourism Association annual conference Feb. 4, 2000.
<http://www.dced.state.ak.us/oed/toubus/pub/wildlifespeech.pdf> (accessed June 6, 2005).
- Peltier, T. and R. Scott. 2003. Trapper Questionnaire Statewide Annual Report, 1 July 2001–30 June 2002. ADF&G Division of Wildlife Conservation. Juneau, AK. 64 p.
- Scott, C., L. Brown, G.B. Jennings, and C.J. Utermohle. 2001. Community Profile Database for Access 2000. Version 3.12. ADF&G Division of Subsistence. Juneau, AK.
- USFWS (U. S. Department of Interior, Fish and Wildlife Service) and U. S. Department of Commerce, U. S. Census Bureau. 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Alaska .
<http://www.census.gov/prod/2002pubs/fhw01-ak.pdf> (accessed June, 2005).
- Williams, J.G. 2004. Alaska population overview: 2001–2002 Estimates and Census 2000. Alaska Department of Labor and Workforce Development, Research and Analysis Section. Juneau, AK.
- Wolfe, R.J. 2000. Subsistence in Alaska: A Year 2000 Update. ADF&G Division of Subsistence. Juneau, AK.

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

Introduction: Alaska's 32 Ecoregions

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

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

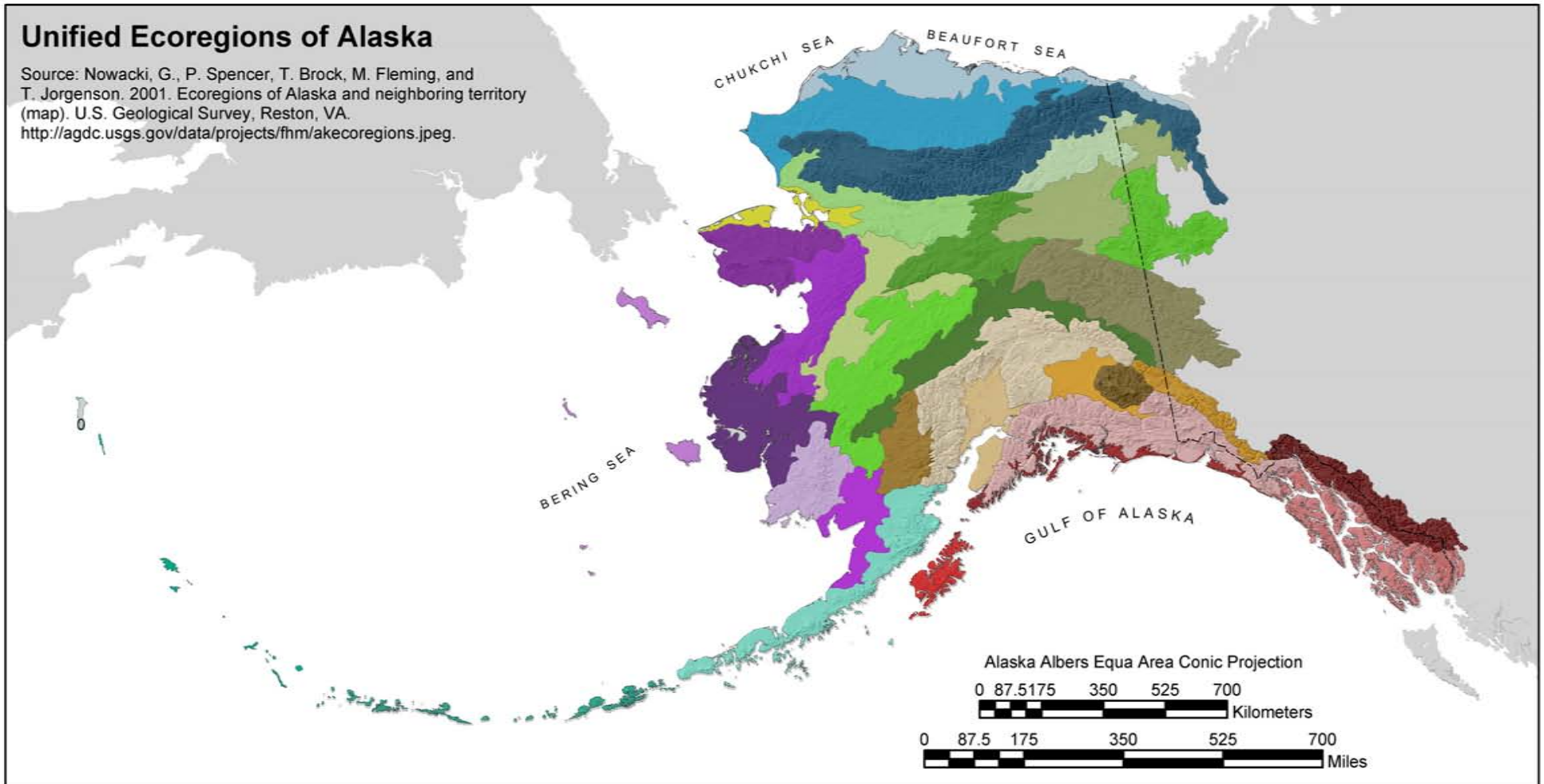


Newly discovered coral and sponge gardens off the Aleutian Islands

A. Lindner, NOAA Fisheries

Unified Ecoregions of Alaska

Source: Nowacki, G., P. Spencer, T. Brock, M. Fleming, and T. Jorgenson. 2001. Ecoregions of Alaska and neighboring territory (map). U.S. Geological Survey, Reston, VA.
<http://agdc.usgs.gov/data/projects/fhm/akecoregions.jpeg>



Polar		Temperate Continental		Temperate Coastal	
Arctic Tundra	Subarctic Tundra	Beringia Boreal	Coast Mountains Boreal	Hypermaritime Forests	Hypermaritime Meadows
Beaufort Coastal Plain	Ahklun Mountains	Davidson Mountains	Alaska Range	Chugach-St. Elias Mountains	Alaska Peninsula
Brooks Foothills	Bering Sea Islands	Kobuk Ridges and Valleys	Cook Inlet Basin	Alexander Archipelago	Aleutian Islands
Brooks Range	Bristol Bay Lowlands	Kuskokwim Mountains	Copper River Basin	Kodiak Island	
Bering Tundra	Nulato Hills	North Ogilvie Mountains	Kluane Range	Gulf of Alaska Coast	
Kotzebue Sound Lowlands	Seward Peninsula	Ray Mountains	Lime Hills	Boundary Ranges	
	Yukon-Kuskokwim Delta	Tanana-Kuskokwim Lowlands	Wrangell Mountains		
		Yukon River Lowlands			
		Yukon-Old Crow Basin			
		Yukon-Tanana Uplands			

Map created by Shane T. Feirer, The Nature Conservancy in Alaska, August 2004

Figure 1. Statewide ecoregions map

Polar Arctic Tundra

Beaufort Coastal Plain

Area: 15,862,580 acres (6,419,385 hectares)

Alaska 92%, Canada 8%

Landscape:

The Beaufort Coastal Plain is a treeless, windswept landscape stretching across the Alaska coast of the Arctic Ocean and into Canada. The ecoregion is characterized by an abundance of lakes, wetlands, and permafrost-related features such as pingos, ice-wedge polygon networks, peat ridges, and frost boils. Permafrost is almost continuous across the



Beaufort Coastal Plain in winter

USFWS

region, so soils typically are saturated and have thick organic horizons. The plain gradually ascends from the coast southward to the foothills of the Brooks Range. Numerous large, braided rivers, originating in the Brooks Range, drain northward across the coastal plain. Small streams dry up or freeze completely in the winter. Thousands of shallow rectangular lakes cover the coastal plain in a north-northwest orientation due to winds on the shorelines. These thaw lakes cover up to 50% of the Arctic coastal plain. Small sand dunes irregularly occur along the coast.

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

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

Wildlife and Fish:

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

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

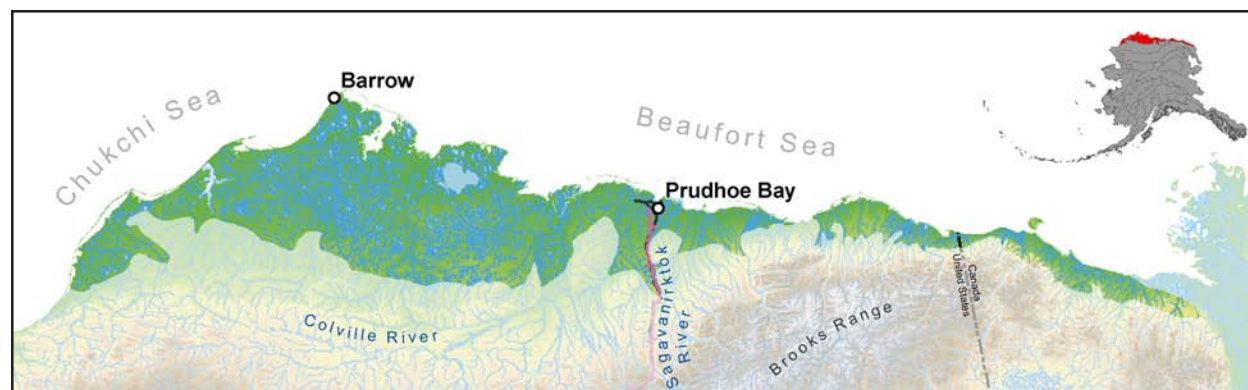


Figure 2. Beaufort Coastal Plain ecoregion

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



Arctic cisco

R. West, USFWS

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

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

People:

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

Land Use:

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

Land Management:

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

Table 1. Beaufort Coastal Plain land status

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

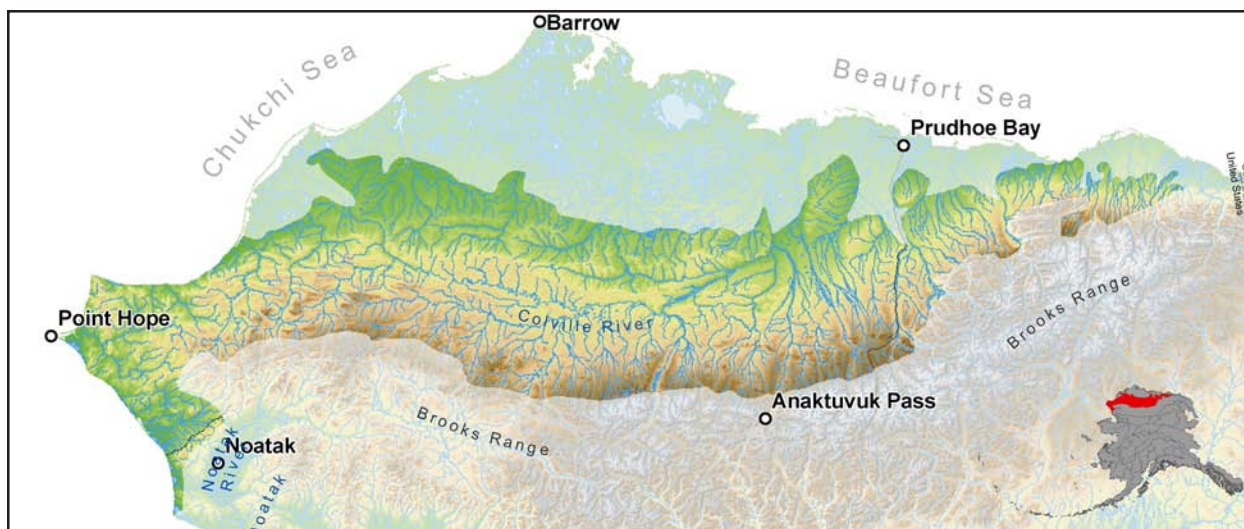


Figure 3. Brooks Foothills ecoregion

Brooks Foothills

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

Landscape:

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

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



Peregrine Falcon

USFWS

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

Wildlife and Fish:

The Brooks Foothills provide habitat for wide-ranging mammals. The Western Arctic, Porcupine and Central Arctic caribou herds migrate through the foothills to reach their calving grounds in the Utukok Uplands (Western Arctic herd) and Beaufort Coastal Plain (Porcupine and Central Arctic herds). The foothills contain denning sites for brown bears and wolves. Additionally, the area is important to muskoxen, arctic ground squirrels, Smith's Longspurs, and Peregrine Falcons. The moist tundra provides nesting habitat for Baird's, Stilt and Buff-breasted Sandpipers and small mammals such as the insular vole. The Colville River bluffs contain nesting and feeding habitat for the Peregrine Falcon and other raptors. Arctic

char, lake trout, and whitefish are found in many foothill lakes. Dolly Varden spawn and overwinter in larger rivers. Arctic grayling are year-round residents in both lakes and streams. Dolly Varden and five species of Pacific salmon spawn in some west coast rivers.

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

People:

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

Land Use:

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

Land Management:

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

Table 2. Brooks Foothills land status

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

Brooks Range

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

Alaska 82.4%, Canada 17.6%

Landscape:

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

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

The Brooks Range is the main divide between the Arctic and Interior Alaska, and vegetation on either side of the range reflects this. Valleys and lower mountain slopes on the north side of the range are

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

Wildlife and Fish:

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

People:

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



Brooks Range in summer

USFWS

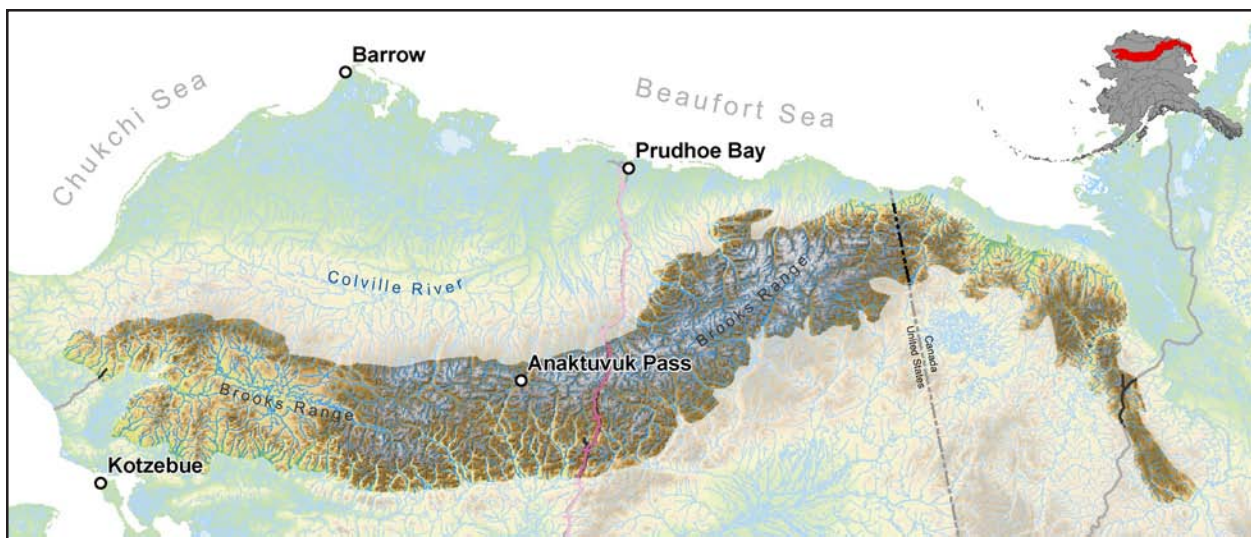


Figure 4. Brooks Range ecoregion

Land Use:

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

Land Management:

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

Table 3. Brooks Range land status

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

Bering Taiga

Nulato Hills

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

Landscape:

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

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

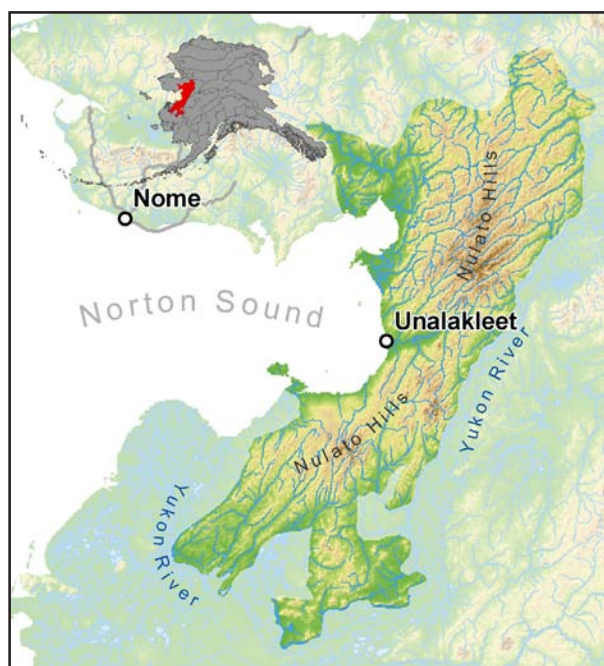


Figure 5. Nulato Hills ecoregion

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

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

Wildlife and Fish:

As part of the ice-free Beringia corridor linking North America and Asia in the past, this ecoregion still possesses species more common in Eurasia than the rest of Alaska. Yellow and White Wagtails, Bluethroats, and Red-throated Pipits are found here.

Species more common to Alaska also live here—moose, brown bears, caribou, arctic foxes, and Alaska hares. River otters occur in the major river valleys. Polar bears; spotted, bearded, and ringed seals; beluga and minke whales; and walruses are seen near the coast and on adjacent ice floes. Five species of Pacific salmon ascend area rivers to spawn. Dolly Varden spawn and overwinter in most rivers, and Arctic grayling are resident in larger streams. Bering cisco and Alaska blackfish are common residents of the fresh waters.



Nulato Hills in winter

S. Steinacher, ADF&G

People:

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

Land Uses:

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

Land Management:

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

Table 4. Nulato Hills land status

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

Yukon-Kuskokwim Delta

Area: 18,965,040 acres

(7,675,047 hectares)

Landscape:

The Yukon-Kuskokwim Delta in southwest Alaska results from the deposition of heavy sediment loads from the glacial Yukon and Kuskokwim Rivers. Abundant thermokarst lakes, meandering streams, and highly productive brackish marshes and wet meadows characterize the flat coastal plain. Isolated basalt hills and volcanic cinder cones less than 400 feet (120 meters) punctuate the landscape. Discontinuous permafrost

impedes drainage and contributes to shallow organic soils. Large tidal fluctuations near the coast, along with occasional storm tide surges, flood coastal areas with salt water, creating invertebrate-rich coastal marshes.

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



Fall tundra

USFWS

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

Wildlife and Fish:

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

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

People:

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

Land Use:

This ecoregion is almost entirely intact, with

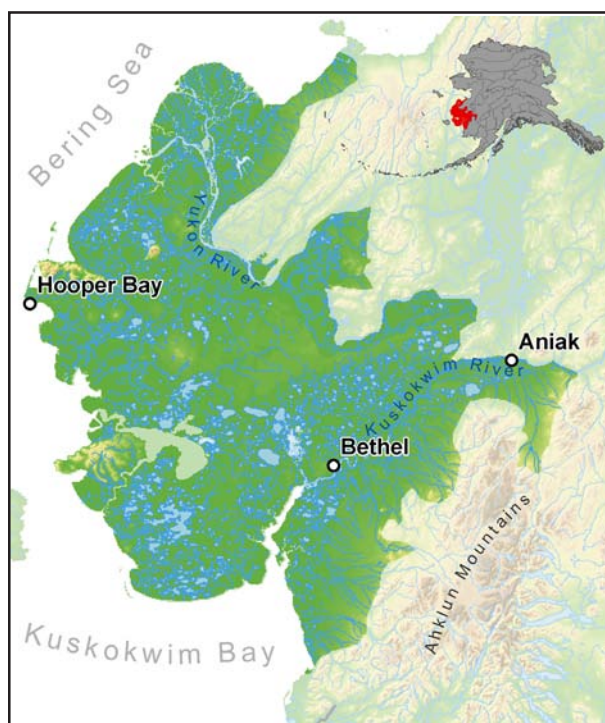


Figure 6. Yukon-Kuskokwim Delta ecoregion

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

Land Management:

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

Table 5. Yukon-Kuskokwim Delta land status

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

Ahklun Mountains

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

Landscape:

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

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

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

Wildlife and Fish:

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



Figure 7. Ahklun Mountains ecoregion

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



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

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

People:

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

Land Use:

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

Land Management:

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

Table 6. Ahklun Mountains land status

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

Bristol Bay Lowlands

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

Landscape:

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

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

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

Wildlife and Fish:

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

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

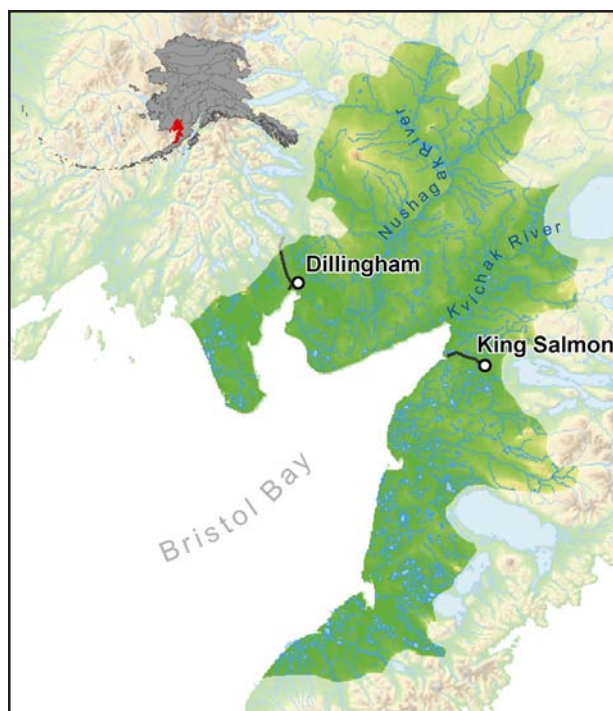


Figure 8. Bristol Bay Lowlands ecoregion



Marbled Godwit at shoreline

G. Thomson, USFWS

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

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

People:

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

Land Use:

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

Land Management:

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

Table 7. Bristol Bay Lowlands land status

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

Bering Tundra

Kotzebue Sound Lowlands

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

Landscape:

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

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

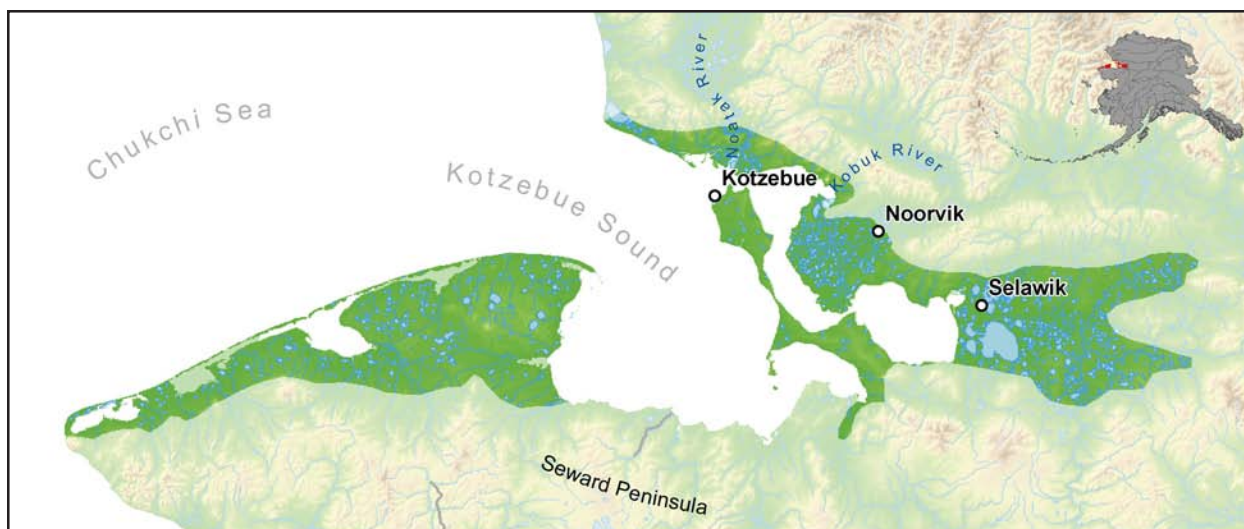


Figure 9. Kotzebue Sound Lowlands ecoregion

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

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

Wildlife and Fish:

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



Arctic Loon and brood

W. Troyer, USFWS

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

People:

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

Land Use:

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



Wetlands near Cape Espenberg

USFWS

Land Management:

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

Table 8. Kotzebue Sound Lowlands land status

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

Seward Peninsula

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

Landscape:

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



Figure 10. Seward Peninsula ecoregion

A continuous permafrost layer of varying thickness keeps most soils wet, shallow, and organic. Ice-related features, such as pingos and patterned ground, occur across the landscape. Vegetation is principally tundra, with alpine *Dryas*-lichen tundra and barrens at high elevations and moist sedge-tussock tundra at lower elevations. This region is the transition between Arctic and sub-Arctic tundra, and diversity of tundra plants is high due to this location, the past connection to Asia, and the presence of both acidic

volcanic rock and limestone. Better-drained areas support low-growing ericaceous and willow-birch shrubs, and willow, birch, and spruce-hardwood forests occur in river valleys. Wildfires are a common occurrence, spreading across the tundra in the summer after the grasses dry.

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



Solomon River

S. Steinacher, ADF&G

Wildlife and Fish:

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

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

People:

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

Land Use:

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

Land Management:

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

Table 9. Seward Peninsula land status

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

Bering Sea Islands

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

Landscape:

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

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

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

Wildlife and Fish:

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



Red-legged Kittiwake colony

USFWS

passerine endemic to Alaska, breeds only on St. Matthew and Hall Islands.

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



Figure 11. Bering Sea Islands ecoregion

The ice-associated seals—ringed, bearded, spotted, and ribbon—can be found at the northern islands. The Pribilof Islands provide critical breeding grounds for Steller sea lions and approximately 80% of the world’s northern fur seals. An important gray whale feeding area is located just north of St. Lawrence Island in the Chirikov Basin. Blue, bowhead, minke, beluga, killer, sei, northern right, humpback, and gray whales swim through the waters of the Bering Sea shelf. Dolly Varden, chum, coho and pink salmon spawn on St. Lawrence and Nunivak Islands. Resident populations of Arctic grayling, whitefish, and northern pike live in the area’s lakes and streams.

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

People:

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

Land Use:

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

Land Management:

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

Table 10. Bering Sea Islands land status

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

Intermontane Boreal

Kuskokwim Mountains

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

Landscape:

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

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

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

Wildlife and Fish:

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

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



Sunshine Mountains

J. Whitman, ADF&G

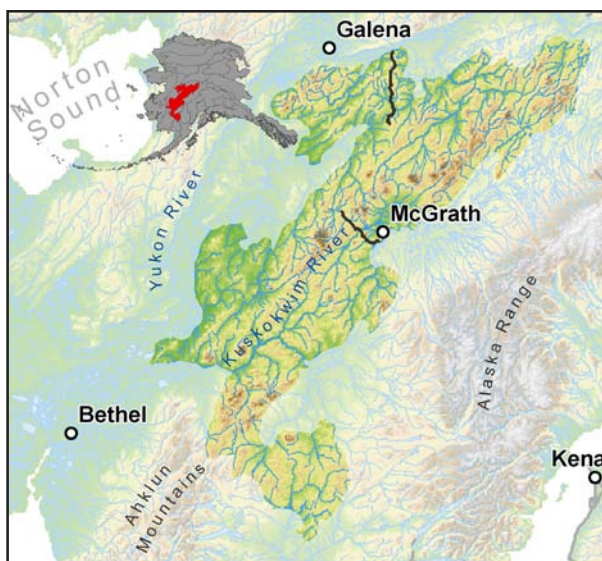


Figure 12. Kuskokwim Mountains

People:

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

Land Use:

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

Land Management:

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

Table 11. Kuskowkim Mountains land status

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

Yukon River Lowlands

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

Landscape:

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

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

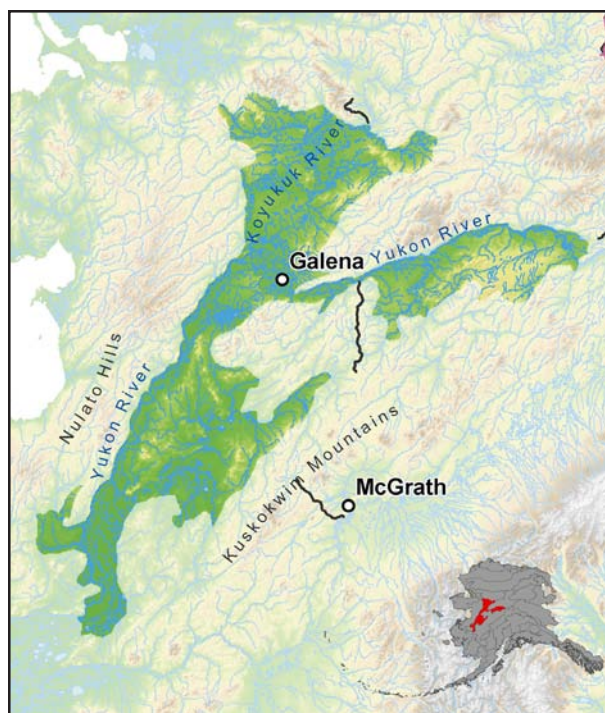


Figure 13. Yukon River Lowlands ecoregion

Along the major rivers, highly productive stands of white spruce and balsam poplar prevail. Where the meandering streams have left oxbows or cut-off sloughs, wet sedge meadows and aquatic vegetation

occur. Tall alders and willows dominate active floodplains and river bars. Seasonal changes in water levels affect these lowlands, with water levels dropping in the fall during freeze-up and then flooding during spring breakup due to ice jams.

Wildlife and Fish:

The wet habitats of these lowlands support many birds, mammals, and fish. Common Loons, Horned and Red-necked Grebes, Trumpeter Swans, and Common Goldeneyes breed near the lakes and wetlands. The forests along the river valleys attract



Wetlands, Innoko National Wildlife Refuge

USFWS

Ruffed Grouse, Belted Kingfishers, Alder Flycatchers, and Hammond's Flycatchers. Landbirds inhabiting this ecoregion include Olive-sided Flycatchers, Blackpoll Warblers, Boreal Owls, Great Gray Owls, and Rusty Blackbirds.

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

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

People:

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

Land Use:

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

Land Management:

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

Table 12. Yukon River Lowlands land status

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

Kobuk Ridges and Valleys

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

Landscape:

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

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

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

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

Wildlife and Fish:

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

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

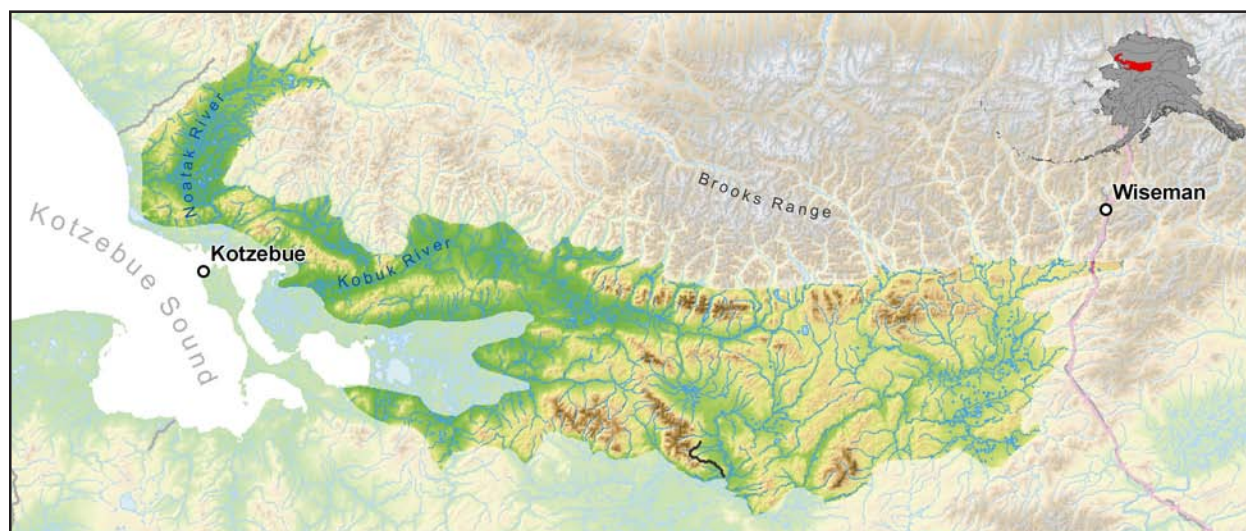


Figure 14. Kobuk Ridges and Valleys ecoregion

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



Kobuk River

John Hyde, ADF&G

People:

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

Land Use:

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

Land Management:

The federal government manages 71% of this ecoregion, with the BLM, USFWS, and NPS as the major managers. The BLM has designated several Research Natural Areas¹³ and Areas of Critical Environmental Concern. The ecoregion contains portions of several national parks and wildlife refuges. The most significant in size are Selawik and Kanuti National Wildlife Refuges and Noatak and Kobuk Valley National Parks and Preserves. The Northwest Arctic Borough has jurisdiction over part of this ecoregion.

Table 13. Kobuk Ridges and Valleys land status

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

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

Ray Mountains

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

Landscape:

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



Figure 15. Ray Mountains ecoregion

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

Wildlife and Fish:

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

People:

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

Land Use:

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

Land Management:

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



Bog and scattered spruce

USFWS

Table 14. Ray Mountains land status

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

Tanana-Kuskokwim Lowlands

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

Landscape:

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



Tetlin National Wildlife Refuge

USFWS

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

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

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

Wildlife and Fish:

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

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

People:

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

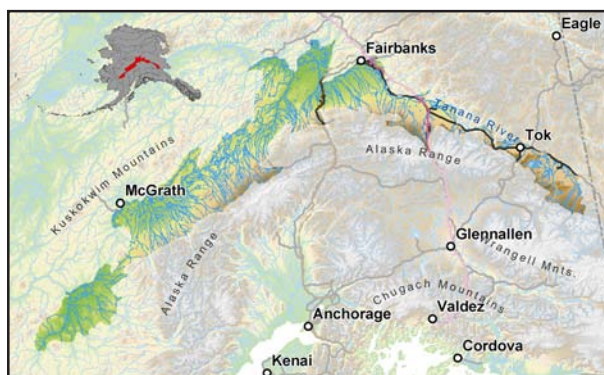


Figure 16. Tanana-Kuskokwim Lowlands ecoregion

Land use:

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

Land Management:

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

Table 15. Tanana-Kuskokwim Lowlands land status

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

Yukon-Tanana Uplands

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

Alaska 62.2%, Canada 37.8%

Landscape:

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

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

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

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

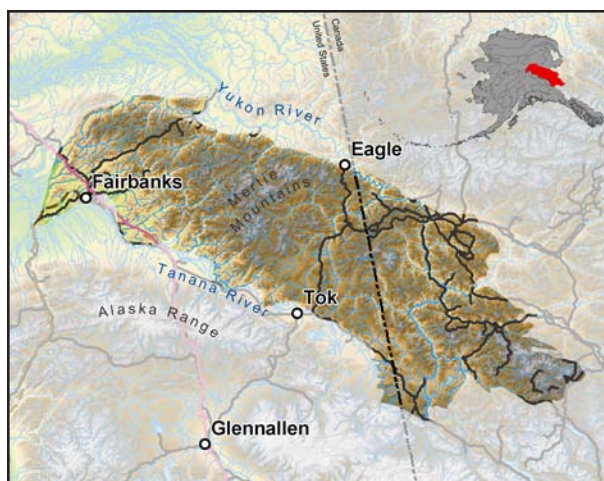


Figure 17. Yukon-Tanana Uplands ecoregion

Wildlife and Fish:

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



Northern Flicker

USFWS

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

People:

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

Land Use:

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

Land Management:

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

Table 16. Yukon-Tanana Uplands land status

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

Yukon-Old Crow Basin

Area: 17,934,802 acre (7,258,115 hectares)

Alaska 77.8%, Canada 22.2%

Landscape:

The Yukon-Old Crow Basin is characterized by meandering rivers and sloughs, sandbars, oxbow and thaw lakes, and marshy flats that occur along the Yukon, Porcupine, Chandalar, Christian, Sheenjek, and Old Crow Rivers. The rolling uplands surrounding the flats have fewer water bodies. The Old Crow Basin in the Yukon Territory, at elevations below 990 feet (300 meters), with surrounding uplands between 990 and 1,980 feet



Beaver Creek

D. Spencer, USFWS

(300 and 600 meters), has numerous squarish lakes oriented southeast to northwest. The Alaska portion of the ecoregion, often called the Yukon Flats, ranges in elevation from 300 to 820 feet (90 to 250 meters).

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

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

Wildlife and Fish:

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

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

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

People:

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

Land Use:

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

Land Management:

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

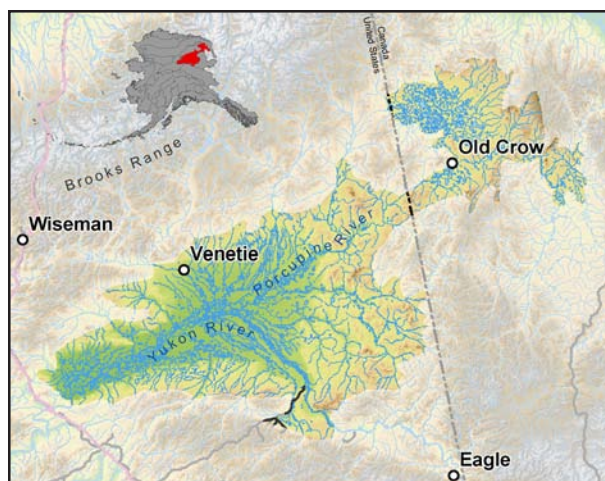


Figure 18. Yukon-Old Crow Basin ecoregion

Table 17. Yukon-Old Crow Basin land status

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

Davidson Mountains

Area: 8,335,732 acres (3,373,425 hectares)

Alaska 86%, Canada 14%

Landscape:

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

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

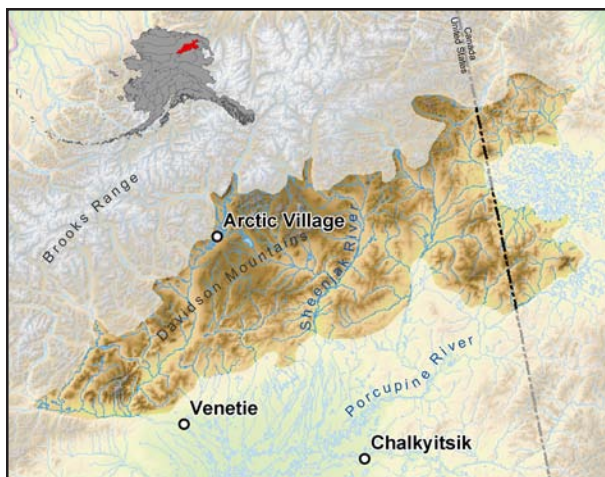


Figure 19. Davidson Mountains ecoregion

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

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



Mancha Creek near Mancha Pinnacles

D. Cline, USFWS

Wildlife and Fish:

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

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

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

People:

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

Land Use:

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

Land Management:

Fourteen percent of this ecoregion is in Canada, and part of that has been designated as Ivvavik National Park. The U.S. federal government manages almost two-thirds of the Alaska portion of this ecoregion. Of

that total, the USFWS manages more than 70% as the Arctic or Yukon Delta National Wildlife Refuges. The other major landowners on the U.S. side of the border are private individuals and Native corporations.

Table 18. Davidson Mountains land use status

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

North Ogilvie Mountains

Area: 12,896,610 acres (5,219,187 hectares)

Alaska 24.4%, Canada 75.6%

Landscape:

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

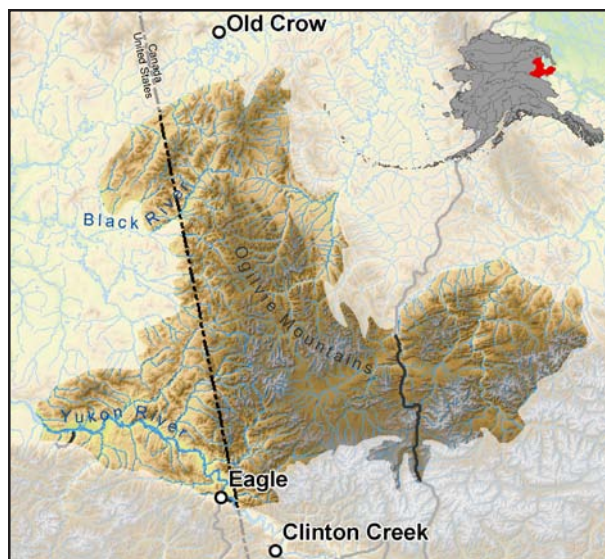


Figure 20. North Ogilvie Mountains ecoregion

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

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

Wildlife and Fish:

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

People:

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

Land Use:

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

Land Management:

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



Rusty Blackbird

USFWS

Table 19. North Ogilvie Mountains land status

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

Alaska Range Transition

Lime Hills

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

Landscape:

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

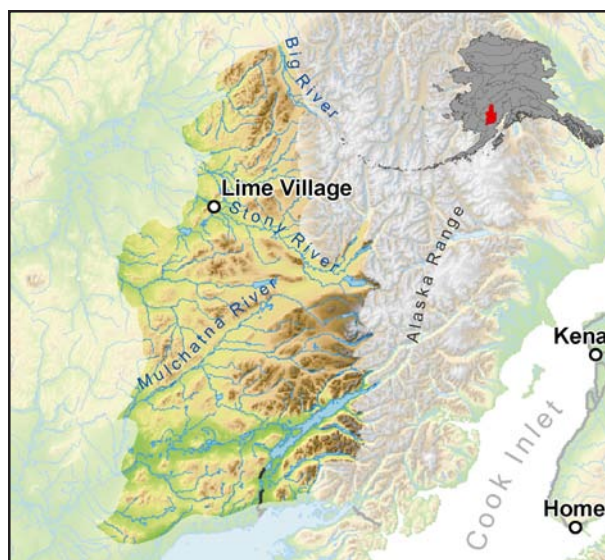


Figure 21. Lime Hills ecoregion

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

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

Wildlife and Fish:

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

People:

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



Golden Eagle

G. Atwell, USFWS

Land Use:

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

Land Management:

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

Table 20. Lime Hills land status

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

Cook Inlet Basin

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

Landscape:

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

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

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

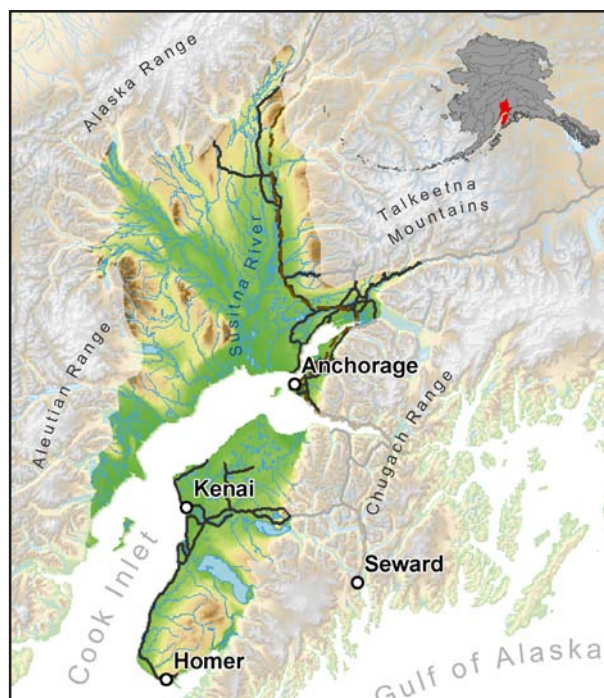


Figure 22. Cook Inlet Basin ecoregion

Wildlife and Fish:

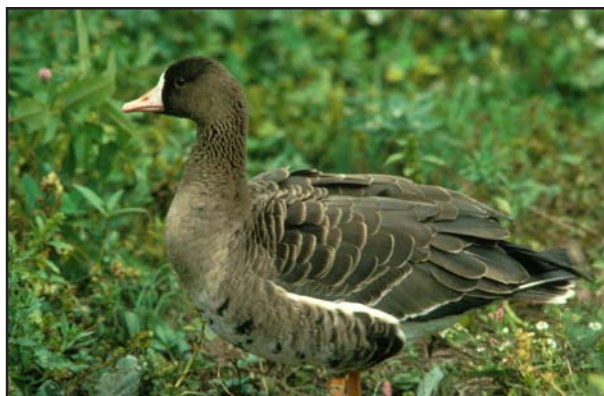
The diversity of habitats results in a diversity of species. The numerous lakes, ponds, and wetlands attract large numbers of shorebirds and waterfowl, including tundra and Trumpeter Swans. Significant numbers of Western Sandpipers, Dunlins, Rock Sandpipers, long- and Short-billed Dowitchers, and Hudsonian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

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

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

People:

The Cook Inlet Basin is the most populated region in the state. Anchorage is by far the largest community, but neighboring towns in the Matanuska-Susitna valleys and the north side of the Kenai Peninsula also host populations that are large by Alaska standards. Traditionally, Tanaina Athabascans subsisted on abundant salmon, moose, caribou, beavers, small game and birds, migratory



Tule White-fronted Goose

G. Smart, USFWS

waterfowl, freshwater fish, and plants. The diverse population today still makes widespread use of wildlife for hunting and fishing.

Land Use:

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



Kenai National Wildlife Refuge lakes

USFWS

Land Management:

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

Table 21. Cook Inlet Basin land status

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

Alaska Range

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

Landscape:

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

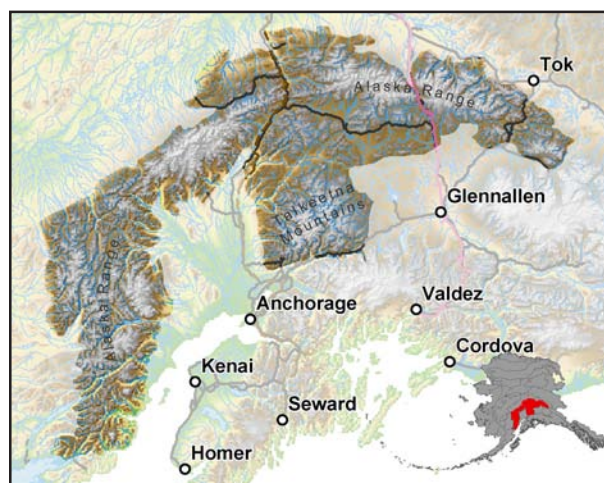


Figure 23. Alaska Range ecoregion

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



Aerial view of Alaska Range in winter

USFWS

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

Wildlife and Fish:

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

People:

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

Land Use:

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

Land Management:

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

Table 22. Alaska Range land status

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

Copper River Basin

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

Landscape:

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

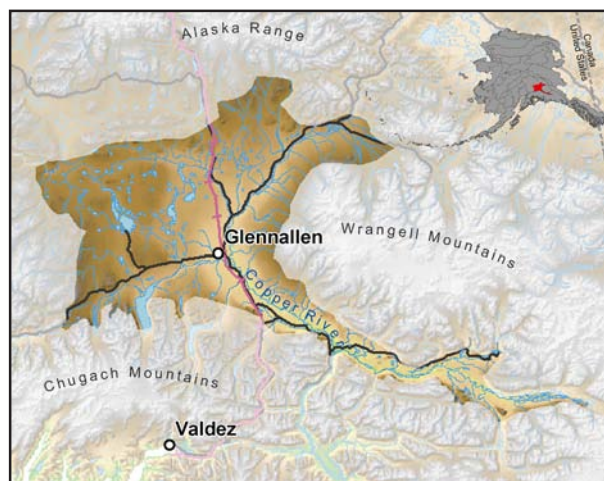


Figure 24. Copper River Basin ecoregion

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

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

Wildlife and Fish:

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

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

People:

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

Land Use:

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

Land Management:

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



Copper River Basin

T. Paul, ADF&G

Table 23. Copper River Basin land status

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

Aleutian Meadows

Aleutian Islands

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

Landscape:

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

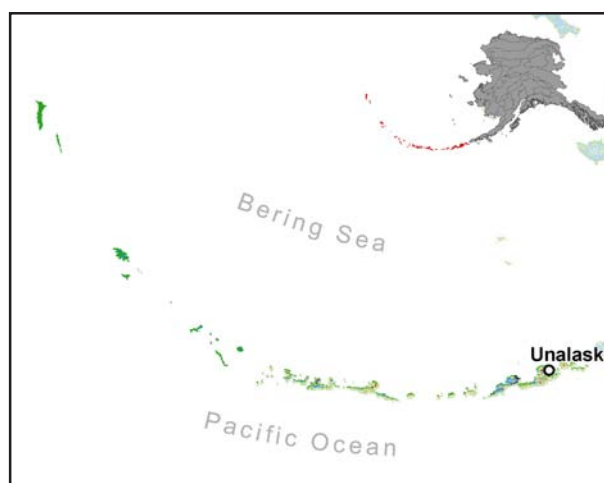


Figure 25. Aleutian Islands ecoregion

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

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



Amagat Island

USFWS

Wildlife and Fish:

The Aleutian Islands are important breeding grounds for birds and marine mammals. Large, globally important colonies of seabirds are found throughout the chain; these rugged cliffs provide habitat for Red-faced Cormorants, Leach's and Fork-tailed Storm Petrels, Red-legged and Black-legged Kittiwakes,



Crested Auklet

A. Sowls, USFWS

Common and Thick-billed Murres, and Least and Crested Auklets. The Aleutian Canada Goose breeds only in the Aleutians and on islands nearby off the Alaska Peninsula. The archipelago provides wintering habitat for Steller's Eiders and Emperor Geese and nesting grounds for Peale's Peregrine Falcon and Bald Eagles. The majority of the western population of endangered Steller sea lions give birth at rookeries on the chain, and northern sea otters live in the more protected waters among the islands. Fin, humpback, killer, and minke whales feed in the nearshore and offshore waters in the summer. Passes between the islands, especially Unimak Pass, focus migrating marine and avian species into biologically important and sensitive areas.

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

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

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

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

Intentional and accidental introductions of cattle, reindeer, foxes, rabbits, and rats to various islands have altered the habitat and seabird colonies of the islands through overgrazing and predation. Declines in

population levels of seabirds, some fish and shellfish, and marine mammals are likely a result of trophic changes in the Bering Sea ecosystem due to commercial harvest of fish and whales over the last 40 years, as well as climate change.

People:

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

Land Use:

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

Land Management:

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

Table 24. Aleutian Islands land status

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

Alaska Peninsula

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

Landscape:

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



Alaska Peninsula volcano

K. Bollinger, USFWS

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

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

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

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

Wildlife and Fish:

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

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

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

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

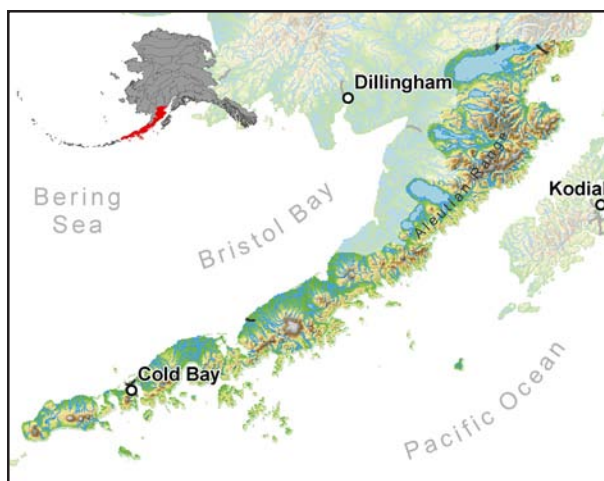


Figure 26. Alaska Peninsula ecoregion



Red-faced Cormorant
USFWS

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

People:

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

Land Use:

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

Land Management:

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

Table 25. Alaska Peninsula land status

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

Coastal Mountains Transition

Wrangell Mountains

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

Landscape:

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

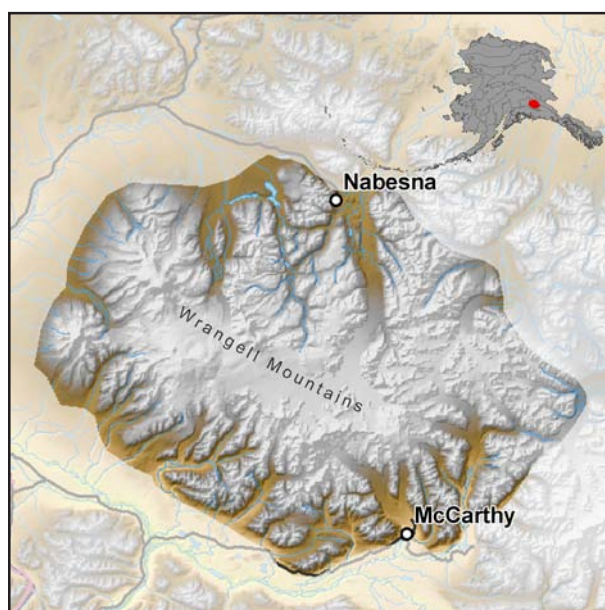


Figure 27. Wrangell Mountains ecoregion

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

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

Wildlife and Fish:

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

People:

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

Land Use:

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

Land Management:

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



Chitistone Canyon

T. Paul, ADF&G

Table 26. Wrangell Mountains land status

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

Kluane Range

Area: 5,170,434 acres (2,092,446 hectares)

Alaska 24%, Canada 76%

Landscape:

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



Kluane Range

T. Paul, ADF&G

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

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

Wildlife and Fish:

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

People:

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

Land Use:

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

Land Management:

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

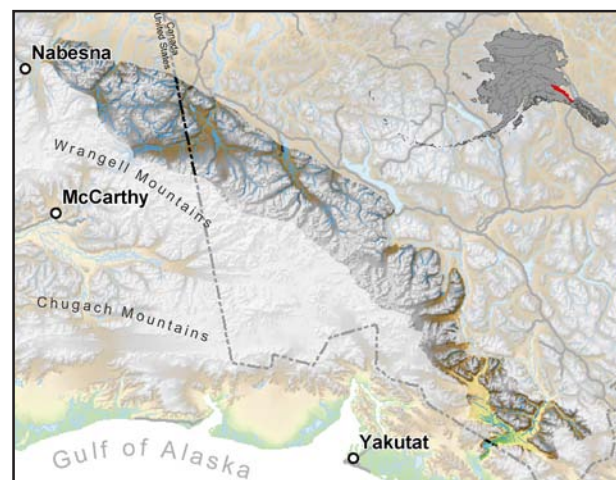


Figure 28. Kluane Range ecoregion

Table 27. Kluane Range land status

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

Coastal Rain Forests

Kodiak Island

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

Landscape:

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

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



Fireweed on Kodiak hillside

L. Van Daele, ADF&G

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



Sea otter riding an ocean swell

D. Menke, USFWS

Wildlife and Fish:

These islands have highly productive marine and freshwater ecosystems that support a diverse group of species. Offshore waters contain halibut, cod, sea otters, Steller sea lions, and whales. Tugidak Island supports one of the largest harbor seal haulouts in the state. Puffins, auklets, Black-legged Kittiwakes, and other seabirds nest in cliff colonies

along the rocky shorelines. Aleutian Terns and Harlequin Ducks live at the saltwater bays. A high concentration of Black Oystercatchers nests along the shoreline.

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

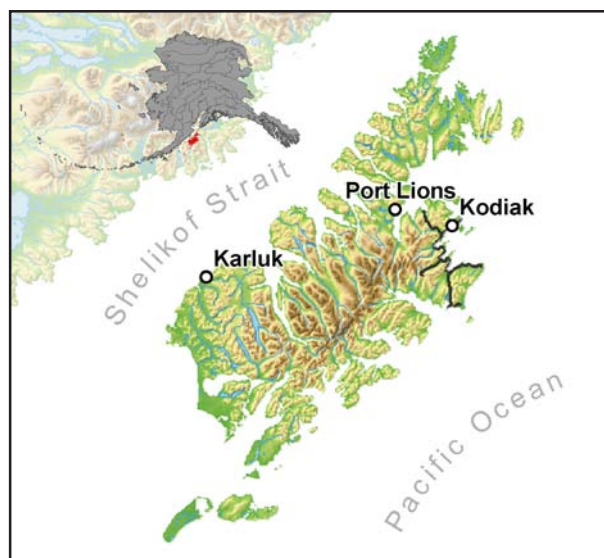


Figure 29. Kodiak Island ecoregion

People:

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

Land Use:

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

Land Management:

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

Table 28. Kodiak Island land status

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

Gulf of Alaska Coast

Area: 4,346,191 acres (1,758,879 hectares)

Landscape:

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

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



Orca in winter, Prince William Sound

USFWS

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

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

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



Figure 30. Gulf of Alaska Coast ecoregion

Wildlife and Fish:

Migratory birds find important stopover, nesting and feeding areas in this ecoregion. One of the most important shorebird stopover sites in North America is the Copper River Delta. Along with nearby Controllor Bay (Bering River Delta), the area supports the largest spring concentration of shorebirds in the Western Hemisphere (Bishop et al. 2000). Thirty-six species of migrating shorebirds have been counted in the Copper River Delta alone, with the two most abundant species being Dunlins and Western Sandpipers. Waterfowl, passerine, and shorebird species of importance include an extremely dense



Black Oystercatcher

ADF&G

population of Trumpeter Swans; the entire breeding population of Dusky Canada Geese; a sizable population of Aleutian Terns, Red-throated Loons, Harlequin Ducks, and Black Oystercatchers; a large concentration of Surfbirds each spring; and high nesting concentrations of Bald Eagles and Marbled Murrelets. Yellow-billed Loons and many species of sea ducks winter along the coast in Prince William Sound. Parasitic Jaegers are known to breed in the area, and Long-tailed Jaegers migrate through seasonally. Sensitive landbirds in the ecoregion include Olive-sided Flycatchers and Blackpoll Warblers.

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

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

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

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

People:

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

Land Use:

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

Land Management:

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

Table 29. Gulf of Alaska Coast land status

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

Chugach-St. Elias Mountains

Area: 23,013,682 acres (9,313,510 hectares)

Alaska 85.2%, Canada 14.8%

Landscape:

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



Scott Glacier

USFWS

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

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

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

Wildlife and Fish:

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

People:

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

Land Use:

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

Land Management:

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



Figure 31. Chugach-St. Elias Mountains ecoregion

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

Table 30. Chugach St. Elias Mountains land status

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

Northern Coast Mountains

Area: 10,448,214 acres (4,228,334 hectares)

Alaska 48.4%, Canada 51.6%

Landscape:

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

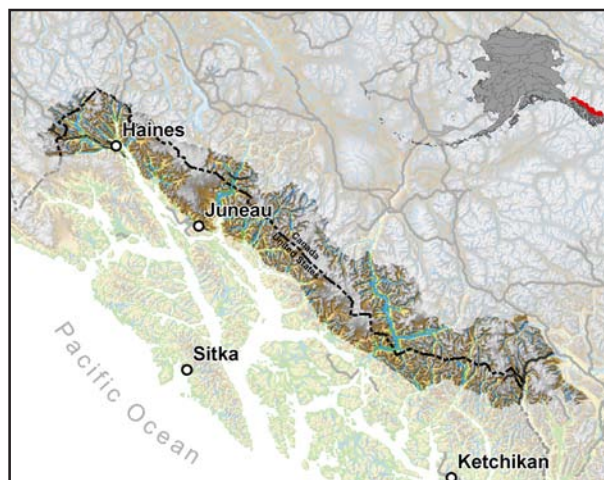


Figure 32. Northern Coast Mountains ecoregion

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

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

Wildlife and Fish:

This ecoregion provides habitat for a limited number of species. Mountain goats, hoary marmots, and ptarmigan live in the alpine areas. Moose, brown and black bears, coyote, lynx, wolverine, otters, beaver,

and gray wolves inhabit the ecoregion, as do birds, including Vancouver Canada Geese, Trumpeter Swans, and Golden Eagles. The streams, headwater lakes, and rivers support large runs of five Pacific salmon species, which transport important, marine-derived nutrients back to the freshwater and terrestrial ecosystems and draw brown bears and other scavengers. Other resident and anadromous fish species in these watersheds include Dolly Varden, and bull, cutthroat, rainbow, and steelhead trout. Other anadromous fish include lampreys and eulachon. Large spawning concentrations of eulachon can occur during spring near the mouths of rivers, attracting large concentrations of Bald Eagles, gulls, and Steller sea lions.



Taku Inlet in winter

J. Hyde, ADF&G

People:

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

Land Use:

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

Land Management:

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

Table 31. Northern Coast Mountains land status

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

Alexander Archipelago

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

Landscape:

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



Figure 33. Alexander Archipelago ecoregion

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

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

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

Wildlife and Fish:

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

This ecoregion is also rich—in comparison to the rest of the state—for the presence of amphibians, including Rough-skinned Newts, Northwestern Salamanders, Long-toed Salamanders, Wood Frogs,

Spotted Frogs, and Boreal Toads. When leather-back or green turtles follow the Japan or North Pacific currents north, there are also occasionally reptiles in this ecoregion. Additionally, there are five species of bats (little brown, long-legged, Keen's, silver-haired, and big brown), some of which also occur elsewhere along the Gulf of Alaska coast.

The forests, estuaries, wetlands, and rivers provide rich habitat for birds and fish. Dolly Varden and cutthroat, rainbow, and steelhead trout occur here.

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



Chichagof Island

T. Paul, ADF&G



Wood Frog

USFWS

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

People:

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

Land Use:

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

Land Management:

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

the ecoregion. The ecoregion falls in the jurisdictions of the Haines Borough, Ketchikan Gateway Borough, the City and Borough of Sitka, and the City and Borough of Juneau.

Table 32. Alexander Archipelago land status

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

Literature Cited

- Abell, R. A., D. M. Olson, E. Dinerstein, P. T. Hurley, et al. 2000. Freshwater ecoregions of North America, a conservation assessment. Island Press. Washington. 319 p.
- Aderman, A., M. Hinkes, and J. Woolington. 2000. Population identity and movements of moose in the Togiak, Kulukak, and Goodnews River drainages, southwest Alaska. Progress Report 00-01. USFWS and ADF&G. Dillingham, AK. 26 p.
- Alaska Department of Environmental Conservation. 1976. Coastal ecosystems of Alaska: a preliminary review of the distribution and abundance of primary producers and consumers in the marine environment / DEC, prepared by Water Programs, Environmental Analysis Section, through a reimbursable services agreement for the Alaska Coastal Management Program. Juneau, AK. 180 p.
- ADF&G. 1994. ADF&G's wildlife notebook series. Juneau, AK. 1 vol.
- ADF&G. 1999. Yakataga State Game Refuge Management Plan. ADF&G. Douglas, AK. 86 p.
- Alaska Sea Duck Working Group. 1999. Population status and trends of sea ducks in Alaska. USFWS. Anchorage, AK. 136 p.
- Alaska Shorebird Working Group. 2000. U.S. shorebird conservation plan, a conservation plan for Alaska shorebirds, version 1.0. USFWS, USGS. Anchorage, AK. 1 vol.
- Banks, D., R. Hagenstein, J. Pearce, A. Springer and M. Williams, editors. 1999. Ecoregion-based conservation in the Bering Sea: identifying important areas for biodiversity conservation. The Nature Conservancy and World Wildlife Fund. Anchorage, AK.
- Bishop, M. A., P. Meyers, and P. F. McNeley. 2000. A method to estimate shorebird numbers on the Copper River Delta, Alaska. Journal of Field Ornithology. 71(4): 627–637.
- Boreal Partners in Flight Working Group. 1999. Landbird conservation plan for Alaska biogeographic regions, version 1.0. USFWS. Anchorage, AK. 1 vol.
- Dragoo, D. E., G. V. Byrd, and D. B. Irons. 2001. Breeding status, population trends and diets of seabirds in Alaska, 2000. USFWS. Homer, AK. 77 p.
- Gallant, A. L., E. F. Binnian, J. M. Omernik, and M. B. Shasby. 1995. Ecoregions of Alaska. USGS Professional Paper 1567. Available from U.S. Government Printing Office, Washington. 73 p.

Literature Cited (continued)

- Gibson, D. D. and B. Kessel. 1989. Geographic variation in the Marbled Godwit and description of an Alaskan subspecies. *Condor* 91:436–443.
- Kruger, L. E. and C. B. Tyler. 1995. Management needs assessment for the Copper River Delta, Alaska. Gen. Tech. Report. PNW-GTR-356. USFS, Pacific Northwest Research Station. Portland, OR. 45 p.
- Mac, M. J., P. A. Opler, C. E. Puckett Haecker, and P. D. Doran. 1998. Status and trends of the nation's biological resources. U.S. Department of the Interior, USGS. Reston, VA. 2 vols, 964 pp.
- McNab, H. and P. E. Avers. 1994. Ecological subregions of the United States: Section Descriptions. USFS. Washington. Prepared in cooperation with the Regional Compilers and the ECOMAP Team of the Forest Service. WO-WSA-5.
- Nowacki, G., P. Spencer, M. Fleming, T. Brock, and T. Jorgenson. 2001. Ecoregions of Alaska: 2001. USGS Open-File Report 02-297 (map).
- Oswald, E. T. and J. P. Senyk. 1977. Ecoregions of Yukon Territory. Fisheries and Environment Canada, Canadian Forestry Service. Victoria, British Columbia. 115 p.
- Ott, R. 1998. Alaska's Copper River Delta. Artists for Nature Foundation. The University of Washington Press. 160 p.
- Ricketts, T. H., E. Dinerstein, D. M. Olson, C. J. Loucks, et al. 1999. Terrestrial ecoregions of North America, a conservation assessment. Island Press, Washington. 485 p.
- Selkregg, L. 1976. Alaska regional profiles: southwest region. Arctic Environmental Information and Data Center, Anchorage, AK. 313 p.
- Wynne, K. 1997. Guide to marine mammals of Alaska. Alaska Sea Grant College Program, University of Alaska Fairbanks. 76 p.

IV. Challenges for Wildlife and Fish Conservation

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

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

A. The Changing Natural World

Climate Change

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

Arctic Climate Impact Assessment (ACIA) Report

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

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

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

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

Selected Key Findings: Effects on Alaska Wildlife and Users

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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



Polar bear

USFWS

depend to decline, become less accessible, or possibly go extinct in the next century (NOAA website: www.beringclimate.noaa.gov).

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

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

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

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



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

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

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

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

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

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

Tectonic and Isostatic Uplift

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

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

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

Alaska, rose by 12 feet and gained more than 1,000 acres of shoreline—a boon to ground-nesting shorebird populations, but devastating for cliff-nesting seabirds such as kittiwakes, whose chicks could no longer flutter directly into the ocean.

Uplift measurements along the coast of the Gulf of Alaska averaged 6 feet (1.8 meters), with elevation gain on the seafloor adjacent to Montague Island recorded as 38 feet (11.5 meters), but estimated to have been as much as 50 feet (15.25 meters) in places. Such large changes in seafloor elevation would have significantly altered the composition of benthic communities if it caused uplift into, or subsidence out of, the photic zone (ocean depths penetrated by light).

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

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

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

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

Ongoing climatic change, tectonic shifts, and isostatic uplift highlight three important conservation and management needs for Alaska. These are to: 1) assess species distribution, abundance, and habitat use, and the potential impacts to wildlife from

climate and tectonic change; 2) institute robust long-term monitoring programs to document baseline and changing conditions for species, species assemblages and ecosystems; and 3) build capacity in terms of data management, mapping, and GIS tools available to assist fish and wildlife managers, as well as development interests.

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

Wildfire

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

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



Mosaic pattern in vegetation after wildfire
BLM, Alaska Fire Service

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

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

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

Vulnerability of Species with Restricted or Limited Distributions

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

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

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

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

Both spatial and temporal elements must be considered when evaluating any species' range and vulnerability. Some species, such as island endemics and so-called "sky island" (i.e., mountain top-restricted) species, have a generally limited spatial distribution: The entire population is always concentrated in a limited space. For

other species, the restriction in range may only occur at specific times during their life cycle, as is the case for most migratory and colonial breeding species.

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

B. Lack of Shared Information and Understanding

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



Fish sampling using beach seine

F. DeCicco, ADF&G

While there are many good examples of existing data and information sharing, this section was developed to look at the difficulties we face from lack of information about species and habitat associations. We encourage incorporation of existing traditional and local user knowledge into Alaska's toolbox for species conservation.

This section describes our lack of spatial data and data management systems and provides suggestions for addressing some major needs. It ends with a discussion of the substantial conservation benefits to be gained through targeted education and outreach efforts to Alaskan residents and visitors.

Lack of Information about Species or Habitats

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

Information sources on these nongame species do exist, however: Alaskans engaged in subsistence activities possess a wealth of information about the life histories, preferred habitats, and changing conditions of the species they use. This knowledge, generally passed orally from generation to generation, is often referred to as

traditional knowledge. Such sources exist, especially among Native elders and leaders, in communities across the state. Other sources of valuable information on CWCS species are commercial fishermen and long-established sport and commercial guides. For example, herring fishermen are acutely aware of seabird and marine mammal activity and often use these species to help locate targeted fish species and determine imminence of spawning. They also frequently have detailed timing and behavioral observations of species such as shorebirds and sea ducks that forage on herring eggs. Residents who hunt, trap, and fish often have valuable observations to share based on many years of activity in Alaska's wild lands and waters.

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

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

Lack of Spatial Data, Data Systems, and Compatible Terms

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

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

ADF&G also was unable to incorporate certain themes in as much depth as we would have liked, but these will be incorporated into future iterations of the Strategy. These themes are species migration patterns, a systematic analysis of data gaps in species' distribution information, cultural and subsistence information, and traditional knowledge of our indigenous peoples. Future iterations of the Strategy should also compile information on collaborative efforts with other states (Washington, Oregon,

California) and countries (Canada, Mexico, Russia, Japan) that manage habitats used by wide-ranging and migratory Alaskan species.

Spatial Data

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

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

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

distribution or abundance in other areas. Expansion of this capacity is particularly important for conservation, because decisions on resource development often must be evaluated based on limited or nonexistent data, but in a timely manner.

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

Birds

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

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

Most breeding landbirds in Alaska are not adequately sampled by any of the continental monitoring programs currently used throughout the rest of North America. Basic information on the distribution of species, their habitat associations, population sizes, and trends is lacking. Several well-established and widely accepted methodologies used throughout the conterminous United States and southern Canada provide insufficient coverage and potentially biased information in Alaska. For example, the USFWS and Canadian Wildlife Service North American Breeding Bird Survey routes are restricted to the existing road system, which covers only a tiny

fraction of Alaska's area and available habitats. The Audubon Society Christmas Bird Counts are largely clustered in the small fraction of urban areas in the state and miss a large percentage of potential winter habitats. The Monitoring Avian Productivity and Survivorship (MAPS) program, developed by the Institute for Bird Populations, has been useful in documenting changes in population, productivity, and survival for large numbers of birds in most of North America, but is only able to detect a statistically significant change in these parameters for a handful of species in Alaska. In an effort to address traditional program limitations, Boreal Partners in Flight and USGS developed the Alaska Landbird Monitoring Survey (ALMS) to monitor long-term trends in breeding landbirds in all ecoregions of Alaska. ALMS is a statistically rigorous, standardized methodology based on a stratified random sampling design. Despite a 2004 Memorandum of Understanding among ADF&G, USFS, USFWS, USGS, BLM, NPS, AKNHP, Alaska Bird Observatory, and Audubon agreeing to support and execute the ALMS, greater participation and sampling will be required in order to detect significant population changes for most landbirds in Alaska.

Terrestrial Mammals



Northern flying squirrel J. Nichols, ADF&G

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

Marine Mammals

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

Fish and Aquatic Invertebrates

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

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



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

Amphibians

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

Terrestrial Invertebrates

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

Ecological Systems

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

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

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

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

Recommendations to Collaboratively Address Gaps and Needs

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

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

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

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

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

Ocean Observing System [AOOS], and North Pacific Research Board [NPRB]);

- Management of Traditional Ecological Knowledge;
 - Regional partnerships like the North Slope Science Initiative (NSSI).
- r) Assess the types of information decision-makers in Alaska currently have available; identify needs and products that would improve the decision-making process.
- s) Work with other partners to support a single, statewide database that includes a spatial component and makes species information available to managers, planners, and developers.
- t) Continue participation in the existing statewide species working groups, such as Boreal Partners in Flight, to coordinate conservation efforts; explore needs and options for formation of new groups.
- u) Continue to add species information to the AKNHP Biological Conservation Database (BCD) and update species status ranking information (i.e., how imperiled are some of Alaska's species according to national/global ranking protocols).

Insufficient Public Understanding About Fish and Wildlife Needs

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

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

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

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

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

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

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



Sampling invertebrates in the Chena River
ADF&G

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

C. Humans as Elements in the Ecosystem

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

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

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

Issues of Concern in Managing Species and Habitats in Alaska

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

Industrial and Community Development

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

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

Oil and Gas Industry

Oil and gas exploration occurs in many places across the state, with production activities currently centered in Cook Inlet and on the North Slope. Oil development in Alaska is expanding, especially on the state's Arctic coastal plain. There, exploration and development currently extend over 120 miles along the coast and inland some 30 miles, with existing state and federal leases extending



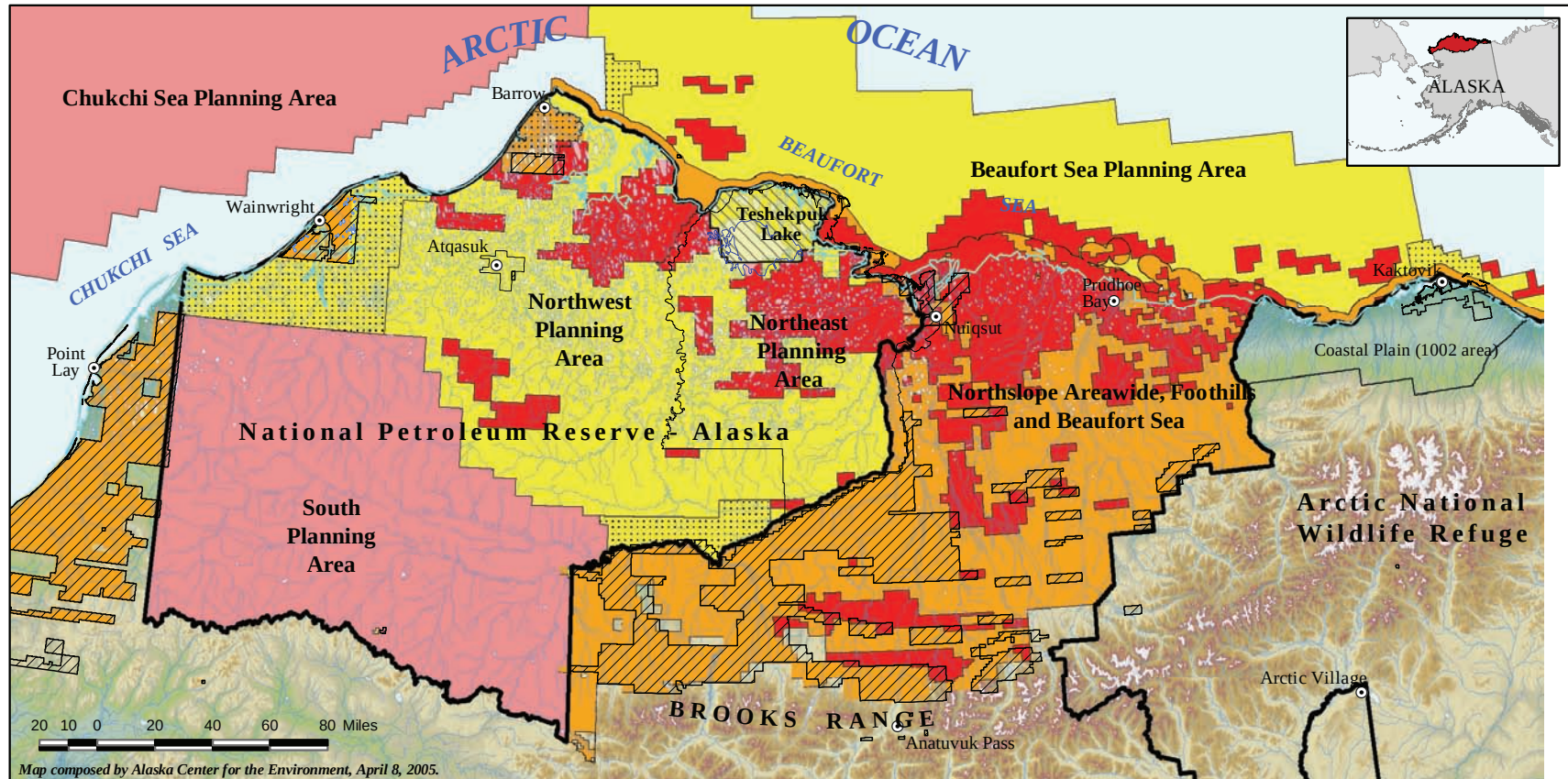
New small-footprint oil production pad on North Slope

K. Titus, ADF&G

south into the Brooks Range foothills (see Figure 34, below). Much of the visible North Slope oil field development consists of gravel fill for drill pads, roads and processing facilities, and elevated pipelines that lie on tundra habitats.

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

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



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

National Petroleum Reserve - Alaska (Federal BLM)

- * **Northeast Planning Area**
4.6 million acres - 87% opened to lease 1998
Next lease sale June 2005
- * **Northwest Planning Area**
8.8 million acres - 100% opened to lease 2004
 Open to exploration but deferred from development until 2014
Next lease sale June 2005
- * **South Planning Area**
9.2 million acres
Scoping starts January 2005

Arctic Ocean (Federal MMS)

- * **Beaufort Sea Planning Area**
9.4 million acres - 87% opened to lease 1998
Lease Sales 186 and 195 offered 97% September 2003, March 2005
Next lease sale (202) March 2007
- Barrow and Kaktovik Whaling Deferrals
- * **Chukchi Sea Planning Area**
33.8 million acres
Call for Industry Nominations April 2004
- State**
- * **Northslope Areawide, Foothills and Beaufort Sea**
14.4 million acres in active lease plan areas
4.0 million acres in existing leases
Next lease sales October 2005

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

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

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

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

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

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

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

Petroleum Product Spills

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



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

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

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

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

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

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

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

Timber harvest

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



Southeast Alaska rain forest

T. Paul, ADF&G

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

Through time, techniques have been developed to help minimize and mitigate impacts from timber harvest activities. However, clearcutting remains the most economically viable approach for timber harvest in Alaska. Clearcutting removes not only the

living trees from an area but also, for worker safety reasons, the standing dead trees. This eliminates food resources, breeding sites, roosting sites, and escape cover for many wildlife species, some of which require snags (dead, standing trees), or are adapted to unique deep-forest and understory microhabitats.

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

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

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

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

The cumulative impacts of road building need to be anticipated and monitored by land managers. Even where access is strictly controlled and/or roads are "put to bed" (culverts removed), the existence of a roadbed network increases the likelihood of human access to and disturbance of at-risk species. This includes disturbance

expected when market conditions again become favorable, precommercial thinning is needed, and/or commercial tree removal resumes.

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

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

Mining

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

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

Loss or degradation of valuable habitats from the clearing of vegetation, excavation, contaminants from spills or mobilized native bedrock materials (e.g. heavy metals), and acid drainage are additional impacts that may be associated with mining

operations and can have broad effects on fish and wildlife, including long-term persistence of the contaminant in the environment or effects far from the source.

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

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

Agriculture

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

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

Commercial Fishing

The impact of fishing gear on benthic habitats, particularly biogenic structures such as corals, has recently received increasing scrutiny. The extent of habitat damage has not been assessed, but studies have identified positive relationships between faunal density and diversity, and biogenic structures. This has led to concerns that damage to

biogenic structures will cause declines in faunal abundance and diversity. In response, the North Pacific Fisheries Management Council recently designated nearly 1 million square kilometers around the Aleutian Islands as a marine protected area. This includes 380 square kilometers in which all bottom gear contact is prohibited, in order to protect newly discovered deep-sea coral and sponge gardens. Technological advances, alternative fishing gear and methods, selective temporal



Bubble Gum Coral, Aleutian Islands

A. Lindner, NOAA Fisheries

closures, and designation of additional marine protected areas will help minimize adverse effects to sensitive seafloor species and ecosystems, and help maintain robust populations of marine fish and other species that depend on them.

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

Dams

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

No comprehensive summary exists on the effects dams have had on fish and wildlife habitat in Alaska. Because many dam locations are remote and coastal terrain is generally steep, the kinds of impacts associated with dams on long rivers in other states occur only rarely here. Still, some Alaska dams have caused a direct loss of

upland fish and wildlife habitat, alteration of aquatic thermal regimes, changes in instream flows, barriers to fish migration, and substantially reduced salmon populations; examples include Eklutna River, Cooper Creek, and Ward Creek.



Swan Lake dam, Ketchikan

ADF&G

Most attention on the effects of dams in Alaska has focused on salmon and salmon habitat; however, other anadromous and resident fish, as well as wildlife, can be affected. For example, artificial reservoir levels, including fluctuations due to seasonal variation in hydropower generation, can adversely affect shoreline habitats and the diverse species, such as lake trout and loons, known to use these

areas for breeding. Little has been done to fully assess the overall ecological changes that dams have caused in Alaska, or to evaluate how mitigation and fish passage facilities typically installed for salmon and trout can benefit other wildlife, including invertebrates, amphibians, and nongame fish.

Urbanization

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

Because of long-term population growth trends, impacts to habitat from urbanization, while local in character, are likely to be permanent. Ongoing efforts to upgrade design/construction technology and practices are needed to support human population growth, while also minimizing environmental impacts. An additional need is to develop and apply advanced land use planning tools that can track and model community growth and its effects on wildlife. Elsewhere in the United States, satellite and GIS imagery are being used to measure and model urbanization and landscape or habitat change. The National Aeronautical and Space Association (NASA) website "Urban Sprawl; the Big Picture"

(http://science.nasa.gov/headlines/y2002/11oct_sprawl.htm) describes how satellites are collecting valuable data that reveal the environmental impact of fast-growing

cities. It also contains a series of animated time-series windows showing a visualized example of urban sprawl and forest fragmentation, and a reconstruction of Baltimore, Maryland's growth over the last 200 years as an example.

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

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

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

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

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

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

¹⁴ This plan did not address fisheries or marine mammals.

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

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

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

Wastewater effluent



Stormwater runoff into Eyak Lake, Cordova

B. McCracken, ADF&G

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

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

Site-specific permitting conducted by DEC is a primary tool to ensure that discharges meet the state water quality standards that sustain fish and wildlife populations and their uses. The Alaska Water Quality Standards (AWQS; 18 AAC 70), adopted under the federal Clean Water Act, serve as the foundation for all water quality-related

permitting in the marine and freshwater environments. As required under federal law, these state standards are reviewed and updated via a public process every three years to better reflect current scientific knowledge.

Nonpoint Source Water Pollution

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

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

Pesticides

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

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

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

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

Airborne Pollution

The federal Clean Air Act provides a legal structure for controlling air pollution in the United States. Under the Clean Air Act, states are obligated to control emission-generating activities to meet air quality standards. Like other states, Alaska administers a permitting program to regulate emissions from industrial, commercial

or municipal operations; it regulates small sources, including automotive emissions, through actions outlined in a State Implementation Plan.

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

Increased Access and Disturbance

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

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

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



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

Although transport systems are essential to Alaska's economy, they are also one of the critical challenges for wildlife and land managers. By their nature, these systems

increase the risk that wildlife, primarily species that are hunted, trapped or fished, may be overexploited.

Today transportation and resource agencies work to minimize project impacts to habitats near roads, including blockages to fish passage. Alaska proactively addresses project-specific concerns by having BMPs that guide permitting of major access projects. These practices are designed to reduce impacts to fish and wildlife, and their habitats. A step-wise progression of mitigation¹⁵ is mandated for unavoidable effects, some of which are discussed below. Even with modern BMPs, however, risks to sensitive wildlife species compound as the density and scope of regional transportation systems expand.

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

Wildlife Sensitivity and Response

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

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

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

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

Habitat Fragmentation

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

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



Western toad

P. Mooney, ADF&G

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

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

Effects of Disturbance Corridors on Wildlife

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

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

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

Recreation Effects

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

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

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

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

Off-Road Vehicles

Off-road vehicles or ORVs (also called all-terrain vehicles [ATVs]) are mechanized single- or multiperson vehicles. Impacts to wildlife habitat from their use varies by type, season of use, ground conditions, intensity of use, and distribution. Most ORV trails in Alaska are not “planned” but result from repeated use by riders seeking the shortest or easiest route to their destination. For many villages, the mainline snowmachine and ORV trails to



ATV trail fanning in wetland habitat

M. Wiedmer, ADF&G

favored hunting areas are destroying habitat, especially in areas with wet soils. This is because soils typically become unstable when wet, including at spring breakup and during rainy periods. Across the state, as ORV riders encounter wet or boggy terrain, they tend to detour around the wettest spots in widening arcs; this can cause the “trail” to expand to nearly a quarter mile wide in places. Much of the worst damage caused by ORVs, including sedimentation to fish streams, could be avoided if trails had been planned to primarily traverse the driest terrain, or to incorporate appropriate crossing structures. Although improving trails in villages and recreational use areas can reduce overall habitat damage, it does not eliminate access-related effects on wildlife.

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

improve some ORV trails is important for maintaining plentiful wildlife and fish resources in Alaska.

Water Access

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

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

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



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

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

Other Recreation- and Community-related Concerns

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

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

Introduced, Nonindigenous, and Invasive Species

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

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



Northern pike, a voracious predator
ADF&G

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

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

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

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

introductions of nonindigenous prey for farmed foxes (e.g., ground squirrels, voles, mice, hares, and marmots) are unknown.

Fox and rat control programs undertaken by USFWS have shown positive effects over the past 50 years in helping protect and restore the natural diversity of islands in the Alaska Maritime National Wildlife Refuge. For example, eradication of foxes and reintroduction of Aleutian Canada geese to their former nesting islands resulted in a 100-fold increase in population; this, in turn, allowed

removal of the goose from the endangered species list in 2001.

Where monitoring has occurred, it shows that removal of alien foxes has likely increased populations of 15 to 20 bird species on the refuge by more than 200,000, and that number should continue to rise for several decades.



Introduced Arctic fox with least auklet

A. DeGange, USFWS

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

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

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

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

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

Bycatch

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



Sorting the catch

NOAA Fisheries

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

In the marine environment, some of the affected species are long-lived with very low reproductive rates. Rockfish, for example, grow slowly and can live more than 100 years. Because most suffer swim bladder damage when brought to the surface, they often remain floating and die soon after being released. Experts expressed concern

that bycatch of rockfish, especially in habitats used as nursery areas, could affect recruitment and result in serious population declines. With ongoing commercial harvests of many species, growth in tourism-related charter fishing, and increasing numbers of people living and recreating along Alaska's coast, the need to better monitor inadvertent "take" of nontargeted marine species is critical.

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

Overharvest

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

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

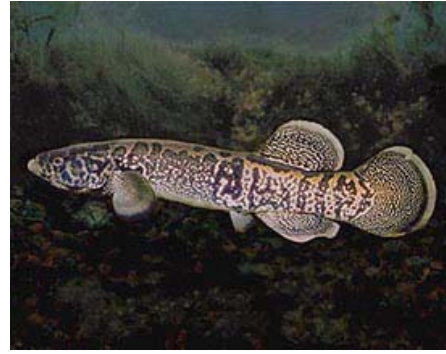
Terrestrial mammal experts raised overharvest by trapping as a potential concern for several of Alaska's small mammal species (e.g., marten, ermine). The experts felt that little attention is paid to these populations and their trophic relationships, and that there is a general lack of long-term monitoring.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

Unknown/Unrecorded Level of Human Use

A similar recommendation was made with regard to unknown or unrecorded levels of human use. Many Alaska residents harvest a wide range of species for subsistence and personal use. While noncommercial human uses of some of the Strategy's featured species is customary and traditional, in certain cases there is little or no monitoring by state or federal agencies to determine the magnitude of use. In raising

this issue, experts were quick to point out that the degree of risk this may pose to particular species is unknown; it could, in fact, be negligible.

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



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

©John Brill, Pearlfish Press

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

D. Maintaining Existing Conservation Areas

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

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

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

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

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

State Special Areas

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

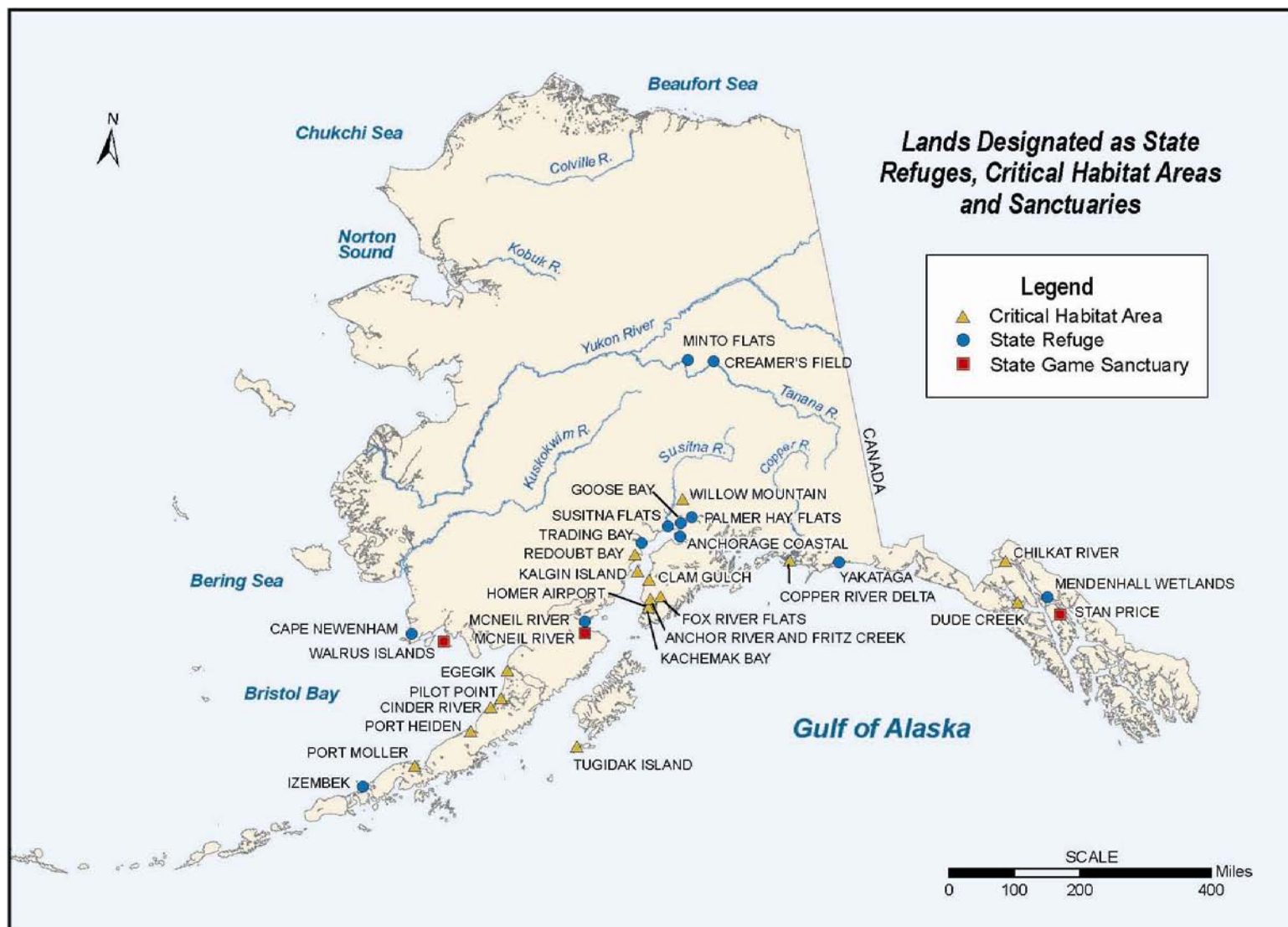


Figure 35. Lands Designated as State Refuges, Critical Habitat Areas and Sanctuaries

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

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

Background

Alaska's first special areas were established in 1960, immediately after statehood. One of the first was Walrus Islands State Game Sanctuary, created to protect a world-renowned haulout for walrus. The primary purpose of the sanctuary at the time of its creation was to protect the last remaining land haulout for walrus (*Odobenus rosmarus*) in North America. All other land haulouts had been



Walrus at Walrus Islands State Game Sanctuary

J. Hyde, ADF&G

abandoned, presumably due to harassment from commercial hunters and other disturbances. The sanctuary provides important habitat for walrus and now comprises one of four primary haulout sites used by walrus in Bristol Bay. The sanctuary also protects important habitats for many species of seabirds, Steller sea lions (*Eumetopias jubatus*), and other marine and terrestrial birds and mammals.

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

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

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

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

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



Chilkat River eagles

J. Hyde, ADF&G

Kachemak Bay and Fox River

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

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

Human Uses of Special Areas

As Alaska's population has increased, so has public use of special areas, many of which are among the most popular hunting, fishing, and wildlife viewing areas in the state. Besides the game sanctuaries and CHAs noted above, nine other special areas are within easy air or automobile access of Anchorage and Fairbanks: Anchorage Coastal Wildlife Refuge; Palmer Hay Flats, Susitna Flats, Minto Flats, and Trading Bay State Game Refuges; Kachemak Bay, Redoubt Bay, and Clam Gulch



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

CHAs; and Creamer's Field Migratory Waterfowl Refuge. The pressures on these areas to provide for the sometimes competing needs of hunters, anglers, wildlife watchers, subsistence users, mushers and retriever training enthusiasts has increased tremendously in the past two decades. Meanwhile, the state budget dollars with which to prepare, update, and implement balanced management plans have withered. As shown in Appendix 10 (Alaska's Special Areas: Management Planning Status), over a dozen special areas remain without a site-specific management plan. With greater access and human use, degradation of these areas and increasing conflicts among user groups are likely.

Land Status and Regulatory Framework

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

Needs and Opportunities

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

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

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

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

Literature Cited

ADF&G (Alaska Department of Fish and Game). 1996. Off road vehicle and snowmachine use in Alaska: a report to the Alaska Board of Game. Division of Wildlife Conservation, ADF&G. Juneau, AK.

ADF&G (Alaska Department of Fish and Game). 2002. The Alaska Aquatic Nuisance Species Management Plan. Juneau, AK.

Literature Cited (continued)

- ADF&G (Alaska Department of Fish and Game). 2000. Living with wildlife in Anchorage: a cooperative planning effort. Juneau, AK.
- Alaska Shorebird Working Group. March 2004. Alaska shorebird conservation plan. U.S. Shorebird Conservation Plan. Unpublished report. 2nd ed. Prepared by: Alaska Shorebird Working Group. Available through USFWS, Migratory Bird Management, Anchorage, AK.
- Alaskool. Alaska regional profiles, southcentral region: earthquakes
<www.alaskool.org/resources/regional/sc_reg_pro/earthquake_volcano.html>
Accessed June 28, 2005.
- Anderson, P. and G. Weller, editors. 1996. Preparing for an uncertain future: impacts of short- and long-term climate change on Alaska. Proceedings of a workshop held during the Arctic Science Conference, Sep 1995; Fairbanks, AK. 44 p.
- Anthony, R.G., A.K. Miles; J.A. Estes, and F.B. Isaacs. September 1999. Productivity, diets, and environmental contaminants in nesting bald eagles from the Aleutian Archipelago. *Environmental Toxicology and Chemistry* 18(9):2054–2062.
- Bradshaw, C.J.A., S. Boutin, and D.M. Hebert. 1998. Energetic implications of disturbance caused by petroleum exploration to woodland caribou. *Canadian Journal of Zoology* 76:1319–1324.
- Bradt, G.W. 1949. Farm cat as predator. *Michigan Conservation* 18(4):23-25.
- Burris, O. and D. McKnight. 1973. Game transplants in Alaska. ADF&G, Game Technical Bulletin #4.
- CAFF. Protected Areas of the Arctic: Conserving a Full Range of Values. Ottawa, 2002 <http://www.caff.is/sidur/uploads/Protected_Areas_of_the_Arct.pdf>
Accessed July 5, 2005.
- Carlton, J. T. 2002. Bioinvasion ecology: assessing invasion impact and scale. In: E. Leppakoski, S. Gollasch, and S. Olenin, editors. *Invasive aquatic species of Europe. Distribution, impacts and Management*, Dordrecht: Kluwer Academic Publishers. p. 7–19.
- Churcher, P.B. and J.H. Lawton. 1987. Predation by domestic cats in an English village. *Journal of Zoology, London* 212:439-455.

Literature Cited (continued)

- Coleman, J.S. and S.A. Temple. 1996. On the prowl. Wisconsin Natural Resources 20(6):4-8.
- Dellasala, D.A., J.C. Hagar, K.A. Engel, W.C. McComb, R.L. Fairbanks, and E.G. Campbell. 1996. Effects of silvicultural modifications of temperate rainforest on breeding and wintering bird communities, Prince of Wales Island, Southeast Alaska. Condor 98:706–721.
<<http://elibrary.unm.edu/sora/Condor/files/issues/v098n04/p0706-p0721.pdf>>
- Department of Natural Resources. Feb. 15, 2005. Statement of Policy on Mitigation.
- DOT& PF (Alaska Department of Fish and Game and Public Facilities). Alaska public road mileage summary report: paved/unpaved centerline road miles by Alaska DOT&PF Region (based on the 2003 Alaska Certified Public Road Mileage Report). DOT&PF Division of Statewide Planning.
- DOT&PF (Alaska Department of Fish and Game and Public Facilities). 2004. Northwest Alaska Transportation Plan, Community Transportation Analysis: An Element of the Alaska Statewide Transportation Plan.
- Eberhard, T. 1954. Food habits of Pennsylvania house cats. Journal of Wildlife Management 18:284–286.
- Findlay, C.S. and J. Bourdages. 2000. Response time of wetland biodiversity to road construction on adjacent lands. Conservation Biology 14(1):86–94.
- Fitzgerald, B.M. 1988. Diet of domestic cats and their impact on prey populations. In: D.C. Turner and P. Bateson, editors. The domestic cat: the biology of its behaviour. Cambridge University Press, Cambridge. p. 123–147.
- Goldsmith, G. 2004. Economic Projections for Alaska and the Southern Railbelt 2004–2030. Institute of Social and Economic Research, University of Alaska Anchorage. Anchorage, AK.
- Griffith, B., D.C. Douglas, N.E. Walsh, D.D. Young, T.R. McCabe, D.E. Russell, R.G. White, R.D. Cameron, and K.R. Whitten. 2002. The Porcupine Caribou herd. In: D. C. Douglas, P. Reynolds, and E. B. Rhode, editors. Arctic Refuge coastal plain terrestrial wildlife research summaries. USGS, Biological Resources Division, Biological Science Report USGS/BRD/BSR-2002-0001. p. 8–37.
- Heuer, K. 1997. Wildlife Disturbance from Backcountry Trail Use: A Literature Review. Prepared for Backcountry Division, Banff Warden Service, Banff National Park, Banff, Alberta.
- Hicks, S. and W. Shofnos. 1965. Determination of land emergence from sea level observations in Southeast Alaska. Journal of Geophysical Research. 70(14):3315–20. Cited in: Armstrong, R.H., R.L. Carstensen, and M.F. Willson. 2004. Hotspots: Bird Survey of Mendenhall Wetlands, April 2002 to May 2003. Juneau Audubon Society and Taku Conservation Society. 74 p.

Literature Cited (continued)

- Hupp, J.W., D.G. Robertson, and A.W. Brackney. 2002. Size and distribution of snow goose populations. In: D.C. Douglas, P. Reynolds, and E.B. Rhode, editors. Arctic Refuge coastal plain terrestrial wildlife research summaries. USGS, Biological Resources Division, Biological Science Report USGS/BRD/BSR-2002-0001. p. 71–74.
- Jackson, S.D. 2000. Overview of transportation impacts on wildlife movement and populations. In: Messmer, T.A. and B. West, editors. Wildlife and highways: seeking solutions to an ecological and socio-economic dilemma. The Wildlife Society. p. 7–20.
- Jalkotzy, M.G., P.I. Ross, and M.D. Nasserden. 1997. The effects of linear developments on wildlife: a review of selected scientific literature. Prepared for Canadian Association of Petroleum Producers. Arc Wildlife Services Ltd., Calgary. 115 p.
- Lochner Interests, LTD. 1997. Rural hydroelectric assessment and development study phase I report. Prepared for the Alaska Department of Community and Regional Affairs.
- Mooney, H.A. 1999. The Global Invasive Species Program (GISP). Biological Invasions 1:97–98.
- Municipality of Anchorage. State of Anchorage park system. Anchorage, AK. <http://www.muni.org/iceimages/Planning/PPChapter2.pdf>. Accessed July 8, 2005.
- National Research Council. 2003. Cumulative environmental effects of oil and gas activities on Alaska's North Slope. The National Academies Press, Washington DC.
- Nellemann, C., and R.D. Cameron. 1998. Cumulative impacts of an evolving oil-field complex on the distribution of calving caribou. Canadian Journal of Zoology 76:1425–1430.
- National Oceanic and Atmospheric Administration. <www.beringclimate.noaa.gov> Bering Climate: A current view of the Bering Sea Climate and Ecosystem. Accessed June 28, 2005.
- Onaga, L. Sept. 20, 2001. Corridors help squirrels sustain genetic diversity. USA Today. Quoting from an article by Hale et al. in the Sept. 21, 2001, issue of Science < <http://www.usatoday.com/news/science/aaas/2001-09-20-squirrels.htm> >
- Peninsula Clarion. 2000 May 27. Kenai river connects peninsula. Kenai, AK.

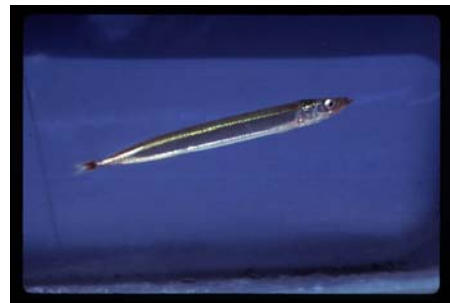
Literature Cited (continued)

- Person, D.K., M. Kirchhoff, V. Van Ballenberghe, G.C. Iverson, E. Grossman. 1996. The Alexander Archipelago wolf: a conservation assessment. General Technical Report PNW-GTR-384. USFS, Pacific Northwest Research Station, Portland, OR.
- Pimental D., L. Lach, R. Zuniga, and D. Morrison. 1999. Environmental and economic costs associated with introduced non-native species in the United States. Presented at American Association for the Advancement of Science (AAAS) proceedings; 24 Jan 1999. Anaheim, CA.
- Rocque, D.A., K. Winker. March 2004. Biomonitoring of contaminants in birds from two trophic levels in the North Pacific. *Environmental Toxicology and Chemistry* 23(3):759–766.
- Rozell, N. “Shrews beat the rule, get larger while climate warms.” Anchorage Daily News June 26, 2005: J-6. Anchorage, AK.
- Sime, C.A. 1999. Domestic dogs in wildlife habitats. In: G. Joslin and H. Youmans, coordinators. *Effects of recreation on Rocky Mountain wildlife: a review for Montana*. Committee on Effects of Recreation on Wildlife, Montana Chapter of The Wildlife Society. p. 8.1–8.7.
- Sprawlcity.org. <<http://www.sprawlcity.org/hbis/wis.html>> Accessed July 5, 2005.
- Stein, B.A. and S.R. Flack. 1996. America’s least wanted—alien species invasions of U.S. ecosystems. The Nature Conservancy, Arlington, VA.
- Truett, J.C., M.E. Miller, and K. Kertell. 1997. Effects of arctic Alaska oil development on brant and snow geese. *Arctic* 50:138-146.
- Vitousek, P.M., H.A. Mooney, J. Lubchenco and J.M. Melillo. Human domination of Earth’s ecosystems. *Science* 277(5325):494–499.
- Williams, J.G. 2004. Alaska population overview: 2001–2002 Estimates and Census 2000. Juneau (AK): Alaska Department of Labor and Workforce Development, Research and Analysis Section. Juneau, AK.

V. Conservation Action Plans

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

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



Sand lance

USFWS

Anadromous Smelts

A. Species Group description

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

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

B. Distribution and abundance

Range:

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

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

Abundance: <u>Global abundance comments:</u> Unknown <u>State abundance comments:</u> Unknown Trends: <u>Global trends:</u> Declining trends for anadromous smelt species across parts of their range <u>State trends:</u> Unknown References: McPhail and Lindsey 1970; Mecklenburg et al. 2002; Morrow 1980.
C. Problems, issues, or concerns for species (or species group) • Important forage fish for various marine predators, some of which have been identified in this Strategy as of conservation concern (e.g., Cook Inlet beluga whales) (See the Marine Fish template in Appendix 4 called “Forage Fish Occurring in Intertidal/Shallow Subtidal Areas.”) • Alaskan populations of anadromous smelt species poorly documented • Lack of information on these species, including life history, abundance, trophic ecology and instream flow needs • Taken as a human food fish throughout their range • Threats to freshwater and estuarine habitat and fish passage • High interannual variability in populations suggested by saltwater trawl surveys
D. Identify location and condition of key or important habitat areas • For all three species: lower reaches of streams and rivers and associated estuaries (e.g., Susitna River); also, eulachon are known to ascend ≥ 100 km up the Susitna (Yentna) system and rainbow smelt to enter Lower Ugashik Lake, likely spawning in tributaries to the lake (M. Weidmer, ADF&G, pers. comm.). • On the North Slope, rearing also occurs in connected lakes in river deltas. • Habitat condition overall thought to be very good to pristine • Marine habitat and ecological conditions unknown
E. Identify concerns associated with key habitats • Water diversion or impoundment could impact movements, spawning and rearing habitats, and survival. • Nearshore chronic and acute pollution (such as oil spills, wastewater effluent) • Broad-scale climate shifts affecting marine ecological conditions
F. Goal: Conserve and manage populations of Alaska anadromous smelt species throughout their natural range to ensure sustainable use of these resources
G. Conservation Objectives and Actions Objective 1: Describe and maintain species distribution and population abundance throughout their distributions in Alaska Target: Identify the distribution of anadromous smelt species in Alaska

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

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

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

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

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

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

Conservation actions:

- a) Develop sampling and indexing protocols and implement sampling schedule across geographic range
- b) Identify representative index areas
- c) Identify the habitat types or categories used by anadromous smelts (e.g., as used in ADF&G's fish community inventory database)
- d) Develop sampling techniques and document the migration and movement patterns of different species and life stages
- e) Map current distribution and other similar habitats for future investigation
- f) Develop a network of biologists/organizations to establish unified protocols, share data, leverage sampling efforts, and provide voucher specimens to museums (University of Alaska Fairbanks, etc.). AFS-Alaska Chapter might be a venue for organizing and consolidating information.

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

Conservation actions:

- a) Determine instream flow needs and habitat requirements for all life history phases of smelts
- b) Consider these smelt species when there are issues of fish passage and habitat alteration (e.g., water diversions, dams, timber harvest, mining, sedimentation)
- c) Develop a coordinated effort among governmental and nongovernmental agencies to collate and exchange information on the habitat and instream flow needs of these smelts

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

Conservation actions:

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

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

Promote coordination with state agencies, federal agencies, universities, Native entities, and nongovernmental organizations to conduct monitoring every year for 10 years to establish the target indices. Possibly involve to administer the request for proposals process for monitoring.

I. Recommended time frame for reviewing and revising species status and trends

Review at five years.

J. Bibliography

Froese, R. and D. Pauly, editors. 2004. FishBase. World Wide Web electronic publication. www.fishbase.org, version (03/2004)

McPhail, J.D. and C.C. Lindsey, 1970. Freshwater Fishes of northwestern Canada and Alaska. Fisheries Research Board of Canada Bulletin 173, Ottawa.

Mecklenburg, C.W., T.A. Mecklenburg and L.K. Thorsteinson, 2002 Fishes of Alaska. American Fisheries Society, Bethesda, MD.

Morrow, J. E. 1980. The freshwater fishes of Alaska. Alaska Northwest Publishing Company, Anchorage, AK.

In selecting species to feature in the Strategy, and in generating conservation action plans for them, the experts raised significant points about some species and species groups in Alaska. For example, they pointed out that Alaska has many species or species groups for which one or more of the following is true:

- The species or group may be widely distributed, but so little is known that the experts did not have enough information to generate an initial planning objective.
- Significant verifiable, but unexplained, population declines have occurred in recent years; these species have not been officially listed as candidate, proposed, or threatened and endangered.
- The species is believed to be on the verge of extinction or is already extinct (e.g., Montague Island marmot).
- Concerns exist regarding imminent habitat loss, and the experts have included in the conservation action plan at least one conservation action to study or address that issue.
- Unmonitored or undermonitored human use or take is occurring, but the management/scientific community knows very little about the species' population level.
- Policy changes are believed needed in the next five years, and the experts proposed a conservation action that speaks to at least one such change.
- Collaborative monitoring efforts are not yet underway, but experts thought such efforts could be successfully undertaken in the next several years if funding were provided.
- The species is in need of restoration, and research and survey efforts on that species are needed to identify what factors may assist in its restoration.
- The species is widely considered a key species in an ecosystem, it makes use of a key habitat, and little is known about the species and/or its habitat use; baseline survey information is desirable.

Given how often these same concerns arose among all the featured species and species groups, we did not feel it beneficial to Alaska's conservation efforts to prioritize between or among species in the CWCS. In Appendix 3, featured species and groups are categorized by major ecosystem type (e.g., marine, freshwater aquatic, terrestrial). Meanwhile, in Appendix 4, species are presented in approximate taxonomic order, with species assemblages or groups placed in the order that seemed most logical.

We expect that these species- and group-specific plans will be posted to the department's CWCS website and periodically updated in coming years. This will ensure their availability to a wide audience of potential users, including students, decision-makers, and potential project investigators.

VI. Some Key Habitats of Featured Species

As noted elsewhere in the CWCS, Alaska lacks spatial and quantitative data on many of its species and habitats. What we do know is that habitat diversity in Alaska, as in other places in the Arctic, can be locally very high, including over short distances. What might look to the untrained eye like broad expanses of similar terrain can contain numerous microclimates and microhabitats exploited by species with quite different life requirements (CAFF 2002).

Because the planning team did not specify a standard format or classification for habitats, the scale at which experts identified habitats of concern varied. Some experts in our process identified specific geographic locations of the state, and sometimes even particular plant associations that need conservation action to benefit CWCS species. Others were able to address location, attributes and condition of key habitats for featured species in only very general terms.

For these and other reasons, teasing out what “key habitats” should be included in the Strategy was difficult. Based on a review of the conservation action plans and other material in Appendix 4, the planning team ultimately identified seven general habitat types in Alaska: forests, tundra, freshwater aquatic, wetlands, marine aquatic and coastline, sea ice, and karst caves. Table 34 lists these types and the standard subtypes for which experts identified concrete information regarding species’ habitat requirements.

Table 34. Key Habitats of Featured Species

Forests	Marine and Coastline
Boreal	Intertidal
Coastal Temperate Rain forest	Rocky Intertidal
Tundra	Mudflats and Beaches
Alpine	Eelgrass Beds
Arctic	Marine waters
Maritime	Nearshore
Freshwater aquatic	Shelf
Glacial systems	Oceanic
Lakes and Ponds	Benthic
Rivers and Streams	Coastal Islands and Sea Cliffs
Non-glacial systems	Sea Ice
Lakes and Ponds	Fast
Rivers and Streams	Pack
Riparian Zones	Karst Caves
Wetlands	Entrance Zone
Grass	Twilight Zone
Sedge	Deep Cave Zone
Bog	
Salt marsh	

The seven habitat types are complex in form and function, and in the unique and diverse biota that they support. Appendix 5 describes each habitat type and subtype; associated species; the habitat’s ecological importance, status and threats; pertinent laws and regulations; and recommendations for conservation.

In addition to describing key habitats, participating CWCS species and habitat experts identified challenges that Alaska’s fish and wildlife managers face in conserving these habitats. The following table highlights some of the primary concerns they raised.

Table 35. Synopsis of Fish and Wildlife Habitat-Related Concerns

Forests • Decreased soil moisture and increased wildfire activity due to warming climate • Insect infestation • Fragmentation and loss	Marine Aquatic and Coastline • Coastline development • Dredging of shoreline habitat • Oil spills • Tourism pressure • Invasive species • Bycatch of coral and sponge • Deepwater disposal of dredge spoils • Tour ship increases; gray water disposal, solid waste management
Tundra • Rapid and widespread vegetation changes due to warming climate • Habitat alteration due to ATV use • Increased natural resource exploration and extraction activities	Sea Ice • Decreased quality, quantity and spatial occurrence due to warming climate • Increased marine transportation and associated probability of oil spills
Freshwater Aquatic • Increased temperatures and altered flow regimes due to warming climate • Decreased instream flow and connectivity of waterways • Nonpoint source pollution; stormwater runoff • Streambank erosion from illegal fords and inadequate crossing sites • Invasive species	Karst Caves • Silviculture practices that decrease the landscape integrity • Tourism pressure
Wetlands • Desiccation, inundation, and vegetation changes due to warming climate • Nonpoint source pollution • Dredge and fill activities • Habitat alteration due to ATV use	

The Strategy identifies Alaska’s marine, coastal, and Arctic tundra areas as being at particular risk of adverse impacts to wildlife, and various national and international initiatives have noted the importance of these habitats for subsistence purposes, their high overall biodiversity, and value to migratory species. As an example, the Arctic coastal tundra/North Slope and “Bering to Baja” coast are identified as key North American “regions of ecological significance” in *The Strategic Plan for North*

American Cooperation in the Conservation of Biodiversity (see http://www.cec.org/pubs_docs/documents/index.cfm?varlan=english&ID=1088).

This plan was produced in 2003 by the North American Commission for Environmental Cooperation (CEC) to promote conservation of migratory and transboundary species, and other species identified by the parties (Canada, United States, and Mexico). Similar to Alaska's CWCS, the CEC strategy highlights needs for integrated monitoring and assessment, improved data and information sharing, and enhanced networking and collaboration.

In the CWCS, Alaska has purposely taken a very broad and general approach to classifying and describing habitats, in part to allow for flexibility in future statewide and North Pacific habitat classification efforts. Scientists and conservation planners have identified the lack of a comprehensive habitat classification system for Alaska as a data gap in the state's efforts to better manage its natural resources. With adequate funding, a subsequent iteration of the Strategy may demonstrate results from a scientifically rigorous review of Alaska's habitats.

Meanwhile, Alaska continues to implement programs that target protection and restoration of high priority habitats. An example is ADF&G's Habitat Conservation and Protection Program (HCPP), which works with private landowners, local, state, and federal government agencies, and nongovernmental organizations (NGOs), such as Ducks Unlimited, to develop approaches that help protect key fish and wildlife habitats, including habitats for at-risk species. This nonregulatory program emphasizes development of voluntary conservation easements and fee title acquisitions as a way to achieve long-term habitat and species population goals. HCPP is funded completely with federal dollars and private nonfederal (NGO) match. Federal grant sources include the National Coastal Wetlands Conservation Act and the USFWS Landowner Incentive Program.

Alaska also needs to continue addressing other habitat and land use issues that can affect production and management of fish and wildlife resources. These include the many issues shown in Table 35 and overall effects of a growing human population, such as the expansion and infilling of urbanized areas; invasive plants, such as Japanese knotweed in Southeast Alaska and European bird cherry in Anchorage (O'Harra 2005); and wildlife deaths from wind turbines, roadways, and improper trash management.

Literature Cited

CAFF. 2002. Arctic flora and fauna: recommendations for conservation; a booklet based on CAFF. 2001. Arctic flora and fauna: status and conservation. Helsinki: Edita. 272 p.

O'Harra, D. "Plant specialists send out mayday over tree's spread." Anchorage Daily News 24 May 2005: A1.

VII. Primary Recommendations: Alaska's Greatest Wildlife Conservation Needs

In developing the CWCS, experts evaluated and discussed both the broad-scale needs relative to Alaska's wildlife and species- or group-specific needs. Many participants mentioned the value of taking an ecosystem-based approach to conservation planning and management for wildlife, one that encompasses the ecological relationships among multiple species and habitats. Potential benefits of this approach were highlighted recently when scientists announced study results showing a marked difference in plant communities between remote Aleutian Islands where introduced foxes decimated historic seabird colonies and those islands that remained fox-free. Lacking a seasonal infusion of guano, fox-infested islands transformed from lush grasslands to scrubland, affecting the habitats and populations of many wildlife species, some of them sensitive island endemics. For more information on ecosystem-based management and its elements, see:

<http://www.esa.org/pao/esaPositions/Papers/ReportOfSBEM.php>.

Experts generated hundreds of proposed conservation actions. Not surprisingly, many of the needs identified apply to all wildlife in Alaska; these include identifying and filling information and data gaps and conducting long-term monitoring of species and habitats.

Identifying and Filling Information Gaps

A serious impediment to the goal of better conserving broad arrays of species, and a central theme that quickly emerged in the CWCS development process, is the lack of information on most Alaskan species and their habitats. We've barely scratched the surface in terms of recording the diversity, abundance, distribution, and habitat relationships of most wildlife species in the state. To date, much of that effort has focused on game species that are important for commercial, recreational, and subsistence users. Little attention has been directed at the state's other wildlife resources, including invertebrates, fish, amphibians, the smaller mammals, and birds. In this first CWCS, the ability to use area- or species-specific spatial data (e.g., mapped species ranges) was hampered because information is incomplete or simply unavailable for many Alaska species.

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

process in the next 18 months. This will help us prioritize efforts to fill information gaps and direct actions toward species of greatest conservation need.

Long-Term Monitoring

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

A key recommendation from our process is to promote and facilitate meaningful participation by communities in monitoring and sharing information about the species and ecosystems they use. Traditional and other local user knowledge can also be very helpful to conservation efforts, e.g., by describing climate-related changes in northern species and habitats. Experts in our process noted possibilities for conducting basic species inventory in ways that contribute to future monitoring efforts. Monitoring to accomplish multiple purposes can help ensure that future conservation efforts are cost-effective and timely. For example, evaluating bycatch in marine and aquatic fisheries can help detect arrival of nonindigenous or invasive species.

List of CWCS Recommendations

The most significant and timely general recommendations for conserving Alaska's wildlife and fish diversity that arose during the CWCS planning effort are listed below. They fall into seven categories: Information and data gathering, data and classification systems, monitoring, species and habitat-related planning, funding and collaboration, education and outreach, and enforcement.

Information and Data Gathering

- Implement studies to collect baseline inventory and life history information on select species and their habitats; develop and implement management strategies for wildlife species of greatest conservation need.
- Implement a systematic approach such as Florida's (Millsap et al. 1990) for evaluating and quantitatively analyzing the state's wildlife and fish conservation needs.

- Conduct regional GAP analyses across Alaska as part of the National GAP; to help states maintain biodiversity, this program develops overlay maps showing land cover, stewardship, and species distribution.
- Integrate local knowledge into species and habitat data/information systems.
- Ensure that scientific data and pertinent traditional knowledge are available to decision-makers.
- Synthesize and distribute scientific information about species distribution, abundance and habitat use.

Data and Classification Systems

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

Monitoring

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

Species and Habitat-related Planning

- Support long-term land management planning that balances the needs of wildlife conservation with the need for community growth and responsible economic development.
- Develop wildlife habitat maps, including connectivity corridors, for use in designing and planning growth.
- Develop and implement effective conservation incentives for landowners and land management agencies.
- Identify and protect important habitats to help achieve long-term habitat or species population goals.
- Identify statutory and regulatory gaps that require attention to clarify responsibilities for conserving and managing species and their habitats.
- Develop protocols between agencies to better coordinate wildlife actions.
- Evaluate and establish a network of scientific control areas in representative habitats distributed across Alaska.
- Improve and maintain water quality in Alaska's estuaries and freshwaters, and water quantity in lakes, streams, and rivers.

- Support national/international efforts to reduce dumping, or loss at sea, of materials harmful to wildlife (e.g., nets, plastics, petroleum products).
- Ensure that existing conservation areas, including state special areas, are managed to maintain the wildlife values and use opportunities for which they were designated.

Funding and Collaboration

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

Education and Outreach

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

Enforcement

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

Literature Cited

Millsap, B.A., J.A. Gore, D.E. Runde, and S.I. Cerulean. 1990. Setting priorities for the conservation of fish and wildlife species in Florida. *Wildlife Monographs*. 111:1–57.

VIII. Monitoring of Species and Habitats

With its size, challenging logistics, and general lack of information on species and habitats, Alaska faces tremendous obstacles in improving the monitoring of its biodiversity. Yet nongame species can serve as important indicators of ecosystem health and resiliency (i.e., “the canary in the coal mine”). It is important and cost-effective to monitor and manage nongame species to avert the potential need for reactive, costly, and restrictive management. Some efforts have begun, and these can be strengthened and made more robust as a result of the CWCS. Implementation of additional monitoring efforts is needed, especially where anthropogenic effects are concentrated. For information about species-specific efforts and needs, please refer to Appendices 4 and 5. Once monitoring areas and control sites are established, the collection of local and traditional knowledge becomes a high priority.

Alaska has participated in various forums to rank conservation actions related to particular species (e.g., birds) and some habitats, especially the state’s aquatic and estuarine areas. For example, through its Alaska’s Clean Water Actions initiative (http://www.state.ak.us/dec/water/acwa/acwa_index.htm), DEC, DNR, and ADF&G annually set joint priorities for assessing and monitoring water quality, water quantity, and protecting aquatic habitats. ADF&G also has a long-term commitment to landbird monitoring efforts at the Creamer’s Field Migratory Waterfowl Refuge. Along with the migration station at USFWS’ Tetlin National Wildlife Refuge, the Creamer’s station has been in operation since the early 1990s. It provides information on migration timing and changes in abundance of certain migratory landbird species. It also monitors change in the fattening and molt of migratory songbirds in response to environmental changes.



Banding a Yellow Warbler
K. Sowl, USFWS

At the international level, ADF&G has collaborated with the USFWS and other U.S. agencies in the Arctic Council’s CAFF and AMAP initiatives. CAFF’s website (<http://www.caff.is/>) contains information on conserving Arctic flora and fauna, ecosystems and habitat, and monitoring Arctic biodiversity and living resources. AMAP’s website (<http://www.amap.no/>) describes efforts to monitor Arctic pollution, including airborne pollutants and contaminants carried by ocean currents.

Alaska also participates in the International Tundra Experiment (<http://www.itex-science.net/>), a circumpolar network focusing on impacts of climate change on Arctic vegetation. Some of the premier work on this topic is conducted at the University of Alaska’s Toolik Field Station, located on the North Slope.

Through the activities of scientists from USFWS, ADF&G, and other organizations, Alaska participates in sampling networks for some of the animal species and groups selected for bi- or multilateral monitoring in the Arctic: Arctic char, seabirds, shorebirds, ringed seals, and polar bear. These marine mammals, and many of the seabirds and shorebirds monitored internationally (e.g., eiders), are also featured in the CWCS. For a description of the goals for monitoring biodiversity and a list of species for which circumpolar monitoring groups have been established, see <http://www.caff.is/sidur/sidur.asp?id=9&menu=program> and click on “Monitoring Arctic Biodiversity and Living Resources.”

Monitoring is addressed through other key multidisciplinary efforts in Alaska such as the EVOS GEM program (<http://www.evostc.state.ak.us/gem/how.html>). What makes GEM unique is that it incorporates interagency cooperation and collaboration, public involvement, and accessible, informative data and information on the Gulf of Alaska ecosystem. The 1998 draft Bering Sea Ecosystem Research plan (BSER; <http://www.afsc.noaa.gov/refm/reem/doc/sciencer.pdf>) represents another excellent model for multidisciplinary efforts (Alaska Fisheries Science Center 1998). The BSER rates as its highest priority those monitoring approaches that:

- Respect the importance of traditional knowledge of Native peoples in understanding the Bering Sea.
- Provide opportunities for local involvement and communication.
- Foster cooperation among agencies and other stakeholders.
- Use and acquire information needed for adaptive management.
- Use a keystone or proxy species approach for monitoring.
- Provide opportunities for international cooperation and communication.
- Enhance technology transfer and communication among stakeholders.

Similar considerations feature prominently in the CAFF biodiversity monitoring model. The CAFF model also relies heavily on the use of standardized methods across the Arctic, so that data can be compared across regions. Using that model (as presented in the CAFF meeting report called “Monitoring Circumpolar Biodiversity Working Groups, Consolidated Results – April 29, 1999”), along with the GEM program and BSER plan as a basis for consideration, monitoring networks established to address needs of featured species and habitats in the CWCS should consider the following as objectives:

- Provide a means to share information, provide advice, and coordinate state monitoring efforts to be nationally and internationally compatible.
- Develop an ecologically based framework.
- Link to needs raised during the CWCS planning process, e.g.:
 - a) Detect past and ongoing changes in Alaska’s environment and biodiversity.
 - b) Distinguish natural and short-term fluctuations from human-induced changes.
 - c) Use monitoring as an early warning system that can trigger more specific and focused research and conservation measures.

- d) Provide independent information to test the validity of hypothesized changes.
- e) Implement and help to evaluate the effectiveness of conservation programs.
- Use monitoring results to update and prepare the next iteration of the CWCS.
- Build on existing state monitoring systems.
- Use community-based approaches to monitoring, including indigenous/traditional/local user knowledge.
- Identify indicator species as part of the monitoring framework.

Species and habitats must be monitored at appropriate scales and using appropriate indicators. For example, the draft BSER (Alaska Fisheries Science Center 1998) gives high priority to using a keystone or proxy species approach for monitoring in the Bering Sea. Meanwhile, the CAFF biodiversity monitoring plan takes a broader view as it seeks to promote monitoring across ecosystems and jurisdictions. Under that plan, useful considerations in selecting the desired scope for monitoring fish and wildlife diversity are:

- Incorporate an established ecosystem-based approach to allow for comparability between ecoregions.
- Design a monitoring process that is easily understood, sustainable, cost-effective, relevant to those involved, and paced appropriately.
- Incorporate cumulative impact assessment and an interdisciplinary approach.
- Include communications and public information as important features of a monitoring network.

To help states address USFWS guidance on CWCS monitoring requirements (see Section 1, page 3, Element No. 5), consultants under contract to Defenders of Wildlife worked with staff from several states to develop and make broadly available a “habitat monitoring framework.” The full report is available on the web at <http://www.biodiversitypartners.org/infomanage/monitoring/01.shtml>. Relevant ideas for Alaska include:

- Tracking of long-term land use changes relative to habitat priorities at a statewide and/or ecoregional scale.
- Creating a statewide, interagency and private sector monitoring group to facilitate coordinated monitoring.
- Involving citizens in some elements of monitoring programs for practical and educational purposes.

CAFF’s biodiversity monitoring plan also notes that because virtually everything can relate to biodiversity, it is important to be specific in what is to be monitored. Considerations would include such things as:

- Protocol for data collection and archiving of raw (not interpreted) data in the public domain.
- Involvement of multiple ecoregions where the phenomenon being monitored is common to each of them.

- Monitoring at intervals of a decade or longer to detect change, because Arctic floras grow slowly.
- Protection of sites being monitored for long-term change, perhaps for 100 years.

These recommendations are very similar to the findings generated by participants in Alaska's CWCS process. CWCS participants also raised several issues they felt were critical for improving monitoring efforts in Alaska. First, design programs to be integrative and coordinated with other research and monitoring efforts. For example, bycatch monitoring and monitoring of habitat changes in conservation areas could both be conducted in ways that help Alaska better detect invasive species. Experts also felt that funding recipients should be required to share results with others receiving similar funds. Successful examples included the EVOS GEM program and The Southern Oceans Convention on Antarctic Flora and Fauna. The latter monitors different ecosystem components of the Antarctic, and scientists in that effort specifically bring research together in a periodic report.

Interpreting historic data sets may provide unique and cost-effective insights into species diversity, abundance, and other characteristics. For example, ADF&G has annual furbearer sealing records dating back to 1977, and the University of

Alaska Museum of the North houses a valuable collection of skin, bones, and frozen tissue of some 86,000 mammals. A researcher accessing data through the museum's website recently made an interesting discovery: The size of masked shrews in Alaska has significantly increased in the past 50 years as the state's climate has warmed (Anchorage Daily News 2005). This finding has intrigued scientists because it runs contrary to established biological theories on the relationship between climate and animal body size.

Experts also noted that recent concerns for fish and wildlife health issues, such as West Nile virus in birds or chytrid fungus in amphibians, may have significant effects on some wildlife populations. They felt it was important, therefore, to expand species monitoring efforts to include diseases, as well as potential contaminant-related pathologies like amphibian limb or bird bill deformities. Because birds from the North American and Asian flyways mingle here, Alaska is also a prime location to test for arrival of any avian influenza strains that could potentially affect humans.



Live-trapping small mammals, Montague Island
E. Lance, USFWS

Ecosystem Monitoring

Monitoring at the ecosystem level has potential to complement efforts to monitor species and habitats. It involves the analysis and monitoring of the cross-linkages between multiple species, species groups, humans, physical and climatic systems, and both the distinct and cumulative effects and interactions among them.

Currently, Alaska is home to two of the 24 LTER sites in the United States (see <http://www.lternet.edu/>). Both are terrestrial sites located in the northern part of the state (Toolik Lake in the North Slope foothills, and Bonanza Creek in Interior Alaska). Expanding the LTER program to include terrestrial sites in other parts of the state may be beneficial. Similarly, marine experts involved in CWCS development indicated that Alaska has much to gain from establishing one or more LTERs in its marine environment. The Alaska Maritime National Wildlife Refuge provides an example of a comprehensive approach to marine monitoring (Drew et al. 1996) that has led to a better understanding of the broad mechanisms of ecosystem functions and processes (Croll et al. 2005) and might be useful elsewhere.

Besides ongoing efforts described earlier in this section, experts identified several broad new initiatives related to biological monitoring programs, from regional to national in scope, that may help further the objectives of the Strategy. During implementation, efforts will be made to formally or informally integrate the conservation actions spelled out in this Strategy with these programs. One such program is the newly formed North Slope Science Initiative (NSSI), which focuses entirely on the inventory, monitoring, and research needed to inform the resource-management decisions of member agencies on the North Slope. Another is the National Ecological Observatory Network (NEON), the first national ecological measurement and observation system designed both to answer regional- to continental-scale scientific questions and to have the interdisciplinary participation necessary to achieve credible ecological forecasting and prediction.

Collaboration

Humans are an integral part of Alaska's ecosystems. In response to the experts' collective recommendations, the Strategy contains numerous conservation actions aimed at obtaining local knowledge and involving communities in monitoring (e.g., by sampling the stomachs of species taken for subsistence purposes). Some of the pioneering work on incorporating traditional knowledge in Alaska (Miraglia 1998) was done after the Exxon Valdez oil spill, as part of the GEM program. Overall, GEM has resulted in valuable collaborative working relationships and science-based models that can be applied in studying trophic interactions and ecosystems elsewhere in the state. Extensive community involvement is central to the GEM program. Citizen volunteers assist in observations and data gathering, and Alaska Natives are consulted for traditional ecological knowledge. Strong community involvement permits the program to compile a more extensive and expansive database.

Commercial fisheries can make valuable contributions to the conservation of nontarget species with which fishermen come in contact, and models now exist on how to incorporate ecological observations by small-scale, indigenous, and commercial fishermen. Information such as onboard observers' logbook records (e.g., of seabird activity and die-offs) can augment scientific studies and enhance species and ecosystem conservation efforts, including for at-risk species such as Steller's and Spectacled Eiders. A 2001 symposium at the University of British Columbia, entitled "Putting Fishers' Knowledge to Work," included presentations on methods for obtaining and accurately representing fishermen's knowledge. The fact that over 200 people from 23 countries and many representatives of North American indigenous groups attended this meeting testifies to a growing recognition of the value of traditional knowledge for managing fish and wildlife resources.



Recording information aboard a commercial fishing vessel

M. LaCroix, Fishery Observer

Alaska's land managers can offer valuable assistance to the CWCS implementation effort in coming years. For example, some existing conservation lands are well suited as long-term control sites for evaluating the effects of habitat fragmentation outside their boundaries. Other sites are ideally positioned to monitor effects of climate change, including northward encroachment of species from more temperate regions. Land managers can bring special expertise and assistance to monitoring efforts in Alaska. In addition, private landowners may gain public relations or other benefits by making their lands available as monitoring sites. The CWCS is an opportunity to provide strategies for helping them realize those benefits, and identify other mutually advantageous relationships.

As we move to expand data gathering and improve monitoring approaches in Alaska, incentives for participation and collaboration may or may not be needed. Much will depend on how well the public understands the basic ecological issues and the long-term value of its contributions. Some people may require little added incentive besides knowing they are helping to improve conservation of the species or ecosystems upon which their livelihoods or recreational enjoyment depend. Prospective "citizen monitor" volunteers may be energized by changes that affect their day-to-day lives (e.g., reduced snow cover, altered bird breeding and plant flowering dates) or in what they see happening to habitats over long periods (e.g., elimination of amphibian breeding ponds due to coastal isostatic uplift). Alaska's growing population of senior citizens may be receptive to the idea that contributing

their time to monitoring efforts keeps them active and involved and leaves a legacy of much-needed baseline information for future generations.

Industries and nongovernmental organizations may find beneficial reasons and means to assist with Alaska's monitoring needs, including by providing matching funds, expertise, or in-kind services on multipartner projects. Where incentives to collaborate in monitoring and other CWCS efforts are needed, we can be both practical and creative. For example, with the right incentives, universities can encourage students in the sciences to devote a term's or summer's work to part of a long-term monitoring project in Alaska. In addition, the University of Alaska announced it is providing computer ownership and other incentives designed to promote greater participation in the sciences by Alaska Native high school and university students.

Cross-border collaborations have been especially effective for the management and monitoring of commercially important species. Experts noted that they also would be important for nongame species and ecosystem processes, especially collaborations with Canada, Mexico, Russia, and other countries associated with major flyways and dispersal routes.

Funding criteria related to monitoring priorities must help focus effort effectively. Experts warned of the "diluting" effects if, in the interests of being fair, decision-makers of agencies and conservation organizations spread funding across the state during each funding cycle. Instead, experts recommended that Alaska focus efforts in a way that advances priority work and then gradually revise priorities to begin focusing elsewhere.

Summary

Monitoring specifics will be developed as part of the CWCS implementation process. The descriptions of needs for each species in Appendix 4 provide substantial background and specific recommendations that should serve as a starting point. Specific steps to advance CWCS monitoring objectives include:

- Conduct an overview of existing monitoring activities in Alaska to identify gaps and deficiencies for key species, habitats and systems.



Monitoring water quality in Beaver Creek, a Kenai River tributary
D. Palmer, USFWS

- Develop strategies for identifying new partners, strengthening existing relationships, and trying new methods of collaboration.
- Evaluate the need for different types of monitoring (populations, habitats, systems) across different scales (local, regional, statewide) with respect to the major causal factors of decline.
- Develop priority system(s) for addressing gaps and deficiencies and supplementing existing efforts.
- Design appropriate monitoring activities and programs.
- Coordinate meetings with partners and stakeholders to discuss ways of meeting monitoring priorities and to identify respective roles and responsibilities.

Literature Cited

Alaska Fisheries Science Center. 1998. Draft Bering Sea ecosystem research plan. 2nd Bering Sea Ecosystem Workshop, June 2–3, 1998; Anchorage, AK. Alaska Fisheries Science Center, NMFS, Seattle; U.S. Department of the Interior, Office of the Secretary, Anchorage; and ADF&G, Commercial Fisheries Management and Development Division, Juneau, AK. 58 p.

Anchorage Daily News. June 26, 2005. Shrews beat the rule, get larger while climate warms. Anchorage, AK.

Croll, D.A., J.L. Maron, J.A. Estes, E.M. Danner and G.V. Byrd. 2005. Introduced predators transform subarctic islands from grassland to tundra. *Science* 307:1959–1961.

Drew, G.S., J.F. Piatt, G.V. Byrd and D.E. Dragoo. 1996. Seabird, fisheries, marine mammal, and oceanographic investigations around Kasatochi, Koniuiji, and Ulak Islands, August 1996. USFWS. Homer, AK. 38 p.

<http://www.absc.usgs.gov/research/seabird_foragefish/products/reports/AMNWR_7-01-03.pdf>

Miraglia, R.A. 1998. Traditional ecological knowledge handbook: a training manual and reference guide for designing, conducting, and participating in research projects using traditional ecological knowledge. EVOS Trustee Council Restoration Project 97052B. ADF&G, Division of Subsistence. Anchorage, AK.

IX. Strategy Monitoring

ADF&G has adopted the performance measurement system established by the state's Office of Management and Budget. These targets and measures provide a common understanding of purpose, direction and expected outcomes for state agency programs. They also provide for accountability through the federal and state budgeting processes. This structure will provide the basic framework for monitoring and evaluating progress under Alaska's CWCS. Interim progress (i.e., between CWCS iterations) will be reported periodically.

The department will evaluate CWCS performance at the overall strategy level and at the species or species group level. This approach will look at the performance of ADF&G and its partners in meeting identified performance indicators or "targets," as well as the effectiveness of conservation actions in attaining long-term outcomes.

The goal for the CWCS is to conserve the diversity of Alaska's fish and wildlife. Goals and objectives are also established for individual species and species groups. Efforts to document and manage habitats will also be monitored as they are implemented. All projects funded by ADF&G have specific project objectives that contribute to broader program objectives.



Red-throated Loon

D. Menke, USFWS

Two sample frameworks, one for monitoring Alaska's overall performance under the CWCS (Table 36), and one for determining success in conserving a single species (Red-throated Loon; Table 37) are shown below.

Table 36: Sample Framework for Monitoring Overall Performance under the CWCS

CWCS OUTCOMES		ACTIVITIES/OUTPUTS	INPUTS
Long-term and End Results	Short-term/ Intermediate Results	Conservation Actions	What we invest
<u>CWCS Goal:</u> Conserve the diversity of Alaska’s fish and wildlife <u>Target:</u> Decreasing trend in the ratio of species having SRANKs of S1, S2 compared to S3, S4, S5 over 5 years¹⁷ <u>Measure:</u> Trend in the ratio of species having SRANKs indicating imperiled status (S1, S2) to those with less concern or considered secure (S3, S4, S5) <u>Target:</u> No loss of genetic diversity through extirpation or extinction of populations <u>Measure:</u> Number of populations lost in the state, over which the State of Alaska has management authority and for which human activities are believed to be primarily responsible.	<u>Target:</u> Establish new quantified targets for 10 species and 5 habitats¹⁸ by 2015 <u>Measure:</u> The number of biological reference points established for CWCS featured species and key habitats <u>Target:</u> Meet the objectives (defined by targets) of 10 species by 2010 <u>Measure:</u> The number of objectives attained	Prioritize species for initial inventory and monitoring based on range-wide distribution factors such as endemism, limited, widespread, disjunct and peripheral and relative conservation concerns Define, inventory and map habitats at the ecoregional landscape level by patch communities and matrix-forming communities to identify relative vulnerability to destruction and degradation Map known populations and distributions of priority species within defined habitat communities Map expected populations and distributions based on habitat associations and predicted estimates Establish working groups, MOUs, and cooperative initiatives to facilitate collaboration among stakeholders and management agencies Explore market mechanisms that conserve the diversity of wildlife	Staff time Money Partnerships and donations of labor, equipment, and materials

¹⁷ SRANKs are codes systematically applied to a state’s species or populations by the National Heritage Network and The Nature Conservancy to indicate relative conservation status: e.g., S1 = critically imperiled, S5 = widespread, abundant, secure. For more information on SRANKs or global ranks (GRANKs), see Appendix 7, pages 4–6.

¹⁸ Numbers here were picked arbitrarily, as examples; we expect that actual numerical targets for the CWCS will be selected within the first several years of CWCS implementation, with input from multiple divisions, agencies and partners.

Table 37: Sample Framework for Monitoring Success in Maintaining a Single Species, Red-throated Loon¹⁹

CWCS OUTCOMES		ACTIVITIES/OUTPUTS	INPUTS
Long-term and End Results	Short-term/ Intermediate Results	Conservation Actions	What we invest
<u>Species Goal:</u> Ensure Red-throated Loon populations remain sustainable throughout their range within natural population-level variation and historic distribution across Alaska	<u>Species Objective:</u> Maintain viable Red-throated Loon population levels <u>Target:</u> Maintain a population of at least 10,000 to 20,000 adult breeders <u>Measure:</u> Population number as indicated by Arctic Coastal Plain Survey and the Alaska Waterfowl Breeding Survey.	Conduct studies to evaluate phenology of birds' arrival and initiation of breeding relative to survey timing and climatic variations Evaluate detectability of breeders vs. nonbreeders and detection differences among observers Implement survey to evaluate current productivity surveys Institutionalize a contaminants monitoring program of loon tissues and prey Conduct studies to estimate survival and productivity simultaneously	Staff time Money Partnerships and donations of labor, equipment, and materials

¹⁹Particulars taken from Red-throated Loon Conservation Action Plan, found in Appendix 4

Evaluation and Reporting

The Strategy's success will be evaluated at various levels: first, whether the state and its partners are meeting the intermediate result targets at the species level, and then, whether we are conserving the diversity of wildlife in Alaska as indicated by the measures experts identified.

Tracking the conservation actions of ADF&G, partners supported by State Wildlife Grants, and other state, federal and nongovernmental organizations will be a monumental task. ADF&G hopes to convene a charrette-style meeting in 2005 to engage motivated and innovative resource managers in discussing particulars of plan implementation. Monitoring will be a big part of that challenge. We expect to begin developing the more detailed approach to implementation and monitoring, and securing commitments to follow through, at this meeting.

Until a more effective, comprehensive, and collaborative system of reporting is put in place, the planning team envisions that ADF&G staff in the Wildlife Conservation and Sport Fish Divisions will be responsible for staffing the charrette and other meetings and reporting on progress towards CWCS targets. Reports will be tailored to various interests including ADF&G policymakers, Strategy partners, USFWS Federal Assistance, Alaska Office of Management and Budget, the IAFWA, and the public.

Adaptive Management

Many of the specific conservation actions and strategies within the CWCS will be implemented in a manner consistent with the principles of adaptive management. These principles include closely monitoring the conservation actions to determine if the expected results take place, learning from these results, and making changes to specific conservation actions to maximize the intended conservation intent. Conversely, if a conservation action is shown to be ineffective, the Strategy is intended to be flexible enough to allow needed changes in emphasis or approach, without waiting for scheduled milestone reviews/revisions to occur. Many experts felt that reviews should take place as conditions warrant, and an adaptive management approach is consistent with this guidance.

X. Implementation

Implementing this Strategy will depend on coordinating conservation efforts among diverse partners. Such efforts will bring together expertise and funds from various sources and apply them to needs identified in the Strategy. As an example, see discussions on collaborative monitoring found in Section VIII (Monitoring of Species and Habitats). One of the needs identified by Congress, and broadly supported by experts and partners in the Alaska process, will be to align Alaska's existing programs to better achieve multispecies and ecosystem goals and ensure protection and management of wildlife diversity.

The department's decisions about funding, timing, and cooperators will be directed according to budget cycles and federal processes associated with State Wildlife Grants and other funding sources. Since the charter establishing the CWCS



Alaska marmot

ADF&G

Oversight Committee and Task Force (see Section II, Methodology and Approach) expires with Strategy submittal and approval in fall 2005, a new decision-making structure will be needed to guide implementation efforts. Meanwhile, partners will need to follow guidance and procedures unique to their own organizations and available fiscal resources. Cooperators may find it advantageous to formalize their working arrangements in memoranda of understanding.

Many potential CWCS partners are already involved with wildlife and fish conservation in this state, and many more will become involved as funding levels and sources increase. In Alaska, collecting, compiling and reporting data on species, including monitoring of trends, will be a big challenge. Data analysis and interpretation will require staffing increases. Timely evaluation and adjustment to species and habitat conservation actions will be of primary importance in the context of plan implementation.

This Strategy provides an impetus to improve existing cooperation and involve additional partners. By compiling state fish and wildlife conservation issues in a single document for the first time, it will now be possible to develop a coordinated approach ranging from individual species' concerns up to regional or broader habitat-level concerns. The Strategy is more than an outline for specific conservation actions; it can also serve as a framework for expanding partnerships and collaboration in support of these actions. A first step will be to identify individuals, land managers, and organizations that can contribute to and use CWCS information in a timely way.

XI. Strategy Review and Revision

Alaska's CWCS will be fully reviewed every 10 years, along with an interim five-year review for certain species carried out by expert groups. Guidance received from the species expert teams was split between conducting five- or 10-year review-and-revision exercises for the species featured in the Strategy. For example, the shorebird expert team recommends that a review of the CWCS's shorebird species be done in conjunction with the Alaska Shorebird Group and its five-year revision schedule for the Alaska Shorebird Conservation Plan. Conservation action plans for these species will be updated as new information is obtained from these reviews. Public involvement is an important part of CWCS development and implementation, and ADF&G expects to involve the public in any significant modifications, especially those that include changes to goals or objectives.



Four-spotted skimmer, Alaska's State Insect

R. Armstrong

XII. Glossary

adaptive management: calls for designing the management of natural systems as replicable experiments in which participants are constantly learning and improving the management process

alluvial: of or relating to the sediment deposited by flowing water

anadromous fish: a fish or fish species that spends portions of its life cycle in both fresh and salt waters, entering fresh water from the sea to spawn; these include the anadromous forms of Pacific trouts and salmon of the genus *Onchorynchus* (rainbow and cutthroat trout and Chinook, coho, sockeye, chum, and pink salmon), Arctic char, Dolly Varden, sheefish, smelts, lamprey, whitefish, and sturgeon

anthropogenic: caused by humans

apex: the highest point; in biological terms it sometimes refers to an organism at the top of the food chain

aufeis: the ice formed when water from a stream freezes on top of previously formed ice

ballast: any heavy material placed at the bottom of a boat to stabilize it

benthic ecosystem: an ecosystem in which a collection of organisms attach, burrow, or rest on the bottom substrates

benthos: the bottom of the sea

bioaccumulate or **biomagnify:** to pass from tissues in one level of the food chain into tissues of the next higher trophic level; in this way pollutants can accumulate in the flesh of higher order organisms, including humans

biodiversity: the variety of life forms, the ecological roles they perform, and the genetic diversity they contain; often used to mean “species richness”

biogenic: produced by the actions of living organisms

biogeographic: relating to the science that deals with the location of a species on a regional or continental level

biomass: the total mass of the species in any ecological community

biome: a major regional biotic community characterized by the dominant forms of plant life and the climate

biota or **biotic:** living things; the adjective form means having to do with living things

bottomland: low-lying land near a body of water; the soil consists of sand, silt, and mud deposited by flowing water

bryophytes: a division of the plant kingdom that includes mosses and liverworts; plants with rhizoids rather than roots, and little or no vascular tissue

calcareous: containing calcium carbonate, calcium, or limestone

caldera: a large depression formed by a volcanic explosion or a volcanic collapse

canopy: the uppermost layer in a forest formed by the tops of trees

carrying capacity: number of individuals in a population that the resource of a habitat can support

charrette: an intensive brainstorming session involving any number of people and lasting anywhere from a few hours to a few days

chemosynthesis: process by which carbohydrates are made from carbon dioxide and water while using chemical nutrients as an energy source

circumpolar: surrounding or near one of the Polar Regions

cline: a gradual change in a character or feature across the distributional range of a species or population, usually associated with an environmental or geographic transition

cohort: a group of related families

colluvial: of or relating to a loose deposit of rock debris that accumulates through gravity at the bottom of a cliff or slope

colluvium: a loose deposit of rock debris at the base of a cliff or slope

colonization capacity: the capacity at which an invading species can settle in to a habitat

coniferous: of or having cones, (i.e. a coniferous tree would be a spruce)

conservation: the use of methods and procedures necessary or desirable to sustain healthy populations of wildlife, including all activities associated with scientific resources management, such as research, census, monitoring of populations; acquisition, improvement and management of habitat; live trapping and transplantation; wildlife damage management; and periodic or total protection of a species or population, as well as the taking of individuals within wildlife stock or population if permitted by applicable state and federal law

continental climate: climatic conditions under the influence of adjacent land masses

cyclic populations: animal populations that fluctuate drastically, with peak and low numbers tending to recur at regular intervals, and over large geographic areas. For example, 1960 was a “lemming year” for almost all of the Canadian Arctic. All sorts of reasons for the cycles have been suggested, from changes in the number of sunspots to snow conditions. Weather is a likely, but still unproven, trigger.

decadent: to be in a state of decline or decay

deciduous: losing foliage at the end of the growing season

decomposer: an organism, often a bacterium or fungus, that feeds on and breaks down dead plant or animal matter, thus making organic nutrients available to the ecosystem

depensatory: having a rate that increases as the size of a population decreases

detritivore: an organism that feeds on detritus, such as forest litter or leaf litter

detritus: loose matter resulting from the decay or erosion of rock or organic material

dimorphism: the existence of the same species with two different forms that can differ in size, color, or shape

ecoregion: large area of land and water that contains assemblages of vegetation communities that share species and ecological dynamics, environmental conditions, and interactions that are critical for their long-term persistence

ecotone: the transition between two adjacent ecological communities over a broad area

endemic species: a species that is restricted to, or native to, a particular area or region. Because of their limited geographic range, they are often, but not always, vulnerable to extinction.

ephemeral plant: any plant that lives only a very short time; short-lived, transitory, having a short life cycle

ephemeral stream: An ephemeral stream has flowing water only during, and for a short duration after, precipitation events in a typical year. Ephemeral stream beds are located above the water table year-round. Ground water is not a source of water for the stream. Runoff from rainfall is the primary source of water for stream flow.

epibiota: organisms living on the seafloor surface

epikarst: the upper surface of karst, consisting of a network of intersecting fissures and cavities that collect and transport surface water and nutrients underground. Epikarst depth can range from a few centimeters to tens of meters.

ericaceous: refers to the heath family, Ericaceae, e.g., blueberry; of, relating to, or being a heath or of the heath family of plants

estuaries or **estuarine:** refers to a coastal body of water that has a free connection with the open sea, where fresh water from land drainage is mixed with seawater. Estuaries are subject to tidal action.

eutrophication: the aging of a lake through the enrichment of its own water

extirpation or **extirpated:** means bringing a species to extinction within all or a part of its range; going or having gone extinct

fecundity: the state of being fertile; capacity for producing offspring

feeding guild: a group of species with similar foraging habits and similar roles in a community

fish wheels: a series of lift nets on a wheel frame that is rotated by the river current, catching migrating fish

fitness: the genetic contribution by an individual's descendants to future generations of a population

floodplain: the part of the river valley that is made up of unconsolidated, riverborne sediment and is occasionally flooded

fluvial: pertaining to rivers or streams; a product of flowing waters

food chain or **food web:** a succession of organisms in an ecological community that constitutes a continuation of food energy from one organism to another, as each consumes a lower member and in turn is preyed upon by a higher member of the chain

forbs: herbaceous ephemeral plants other than grasses, sedges or rushes

fruticose lichens: branched, shrub-like lichens that are attached to the twig by a single, sucker-like holdfast

fur sealing: process by which furbearer species are officially marked with locking tags and/or other means to record their harvest and biological information

game or game species: In common usage, this term refers to species that are commercially or recreationally hunted, trapped, or fished.

gelifluction lobes: a feature shaped by the process of soil movement over a permafrost layer in a periglacial environment

graminoid: grass or a grass-like plant

habitat: broadly defined, means all abiotic and biotic factors (temperature, humidity, precipitation, radiation, substrate, nutrient conditions, microbial communities, insect and plant communities, forage species, competitors, and predators) that describe the universe in which a given species can live and reproduce successfully over time

halophytic: of, or having to do with, a plant that grows naturally in soils having a high content of various salts

haulouts: dry land areas used by marine mammals, especially walrus and sea lions

hydrography: scientific description or analysis of the physical conditions, boundaries, flow, and related characteristics of the earth's surface waters

herbaceous: having little or no woody tissue. Most plants grown as perennials or annuals are herbaceous.

hydric: wet, excessive moisture, saturated

hydrology: scientific study of the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere

hypogean: growing or occurring underground

imperiled species: in the most general sense, typically includes species listed as Threatened or Endangered under the U.S. Endangered Species Act; species classified as critically endangered, endangered, or vulnerable by the World Conservation Union's (IUCN) Red List of Threatened Species; and those species classified as globally imperiled or critically imperiled (i.e., species global ranks of G1 – G2) by NatureServe

indigenous: existing, growing, or produced naturally in a region or country; native to an area

infauna: benthic organisms that dig into the seabed or construct tubes or burrows

infaunal: living within the sediment

instream flow: any quantity of water flowing in a natural stream channel at any time of year. The quantity may or may not be adequate to sustain natural ecological processes and may or may not be protected or administered under a permit, water right, or other legally recognized means.

interspecific interactions: interactions that occur *between* species

intraspecific interactions: interactions that occur between members of the *same* species

intertidal: the region between the high tide mark and the low tide mark

invasive species: a nonindigenous species whose introduction causes, or is likely to cause, economic or environmental harm or harm to human health. The term noxious or nuisance species is sometimes also used.

island biogeographic effects: the biological theory which says that, because of isolation, species located on islands are more subject to habitat change, the undiluted effects of natural selection and mutation, and extinction

island biogeography: the study of the distribution of living things, especially on islands

iteroparity: the condition of an organism that has more than one reproductive cycle in a lifetime

karst: a landscape topography found in any bedrock with internal drainage. The solubility of the bedrock produces fissures, underground streams, caverns, and sinkholes.

key species: important and significant species

keystone species: those species whose impact on their community or ecosystems is disproportionately large relative to their abundance. Where keystone species can be identified and used for conservation planning, they may be able to serve as surrogates for some ecological processes or ecosystems of high ecological integrity.

lentic: refers to slow-moving or standing waters typically associated with a lake or pond

life history: the life history of an organism can be described in terms of its capacity for producing offspring, growth and development, age at sexual maturity, parental care, and longevity

littoral: of or relating to the shore of a body of water

lotic: refers to fast-moving or flowing waters typically associated with a stream or river

macroalgal: of or relating to a nonvascular plant that can be seen with the naked eye

maritime climate: climatic conditions under the influence of an adjacent ocean

mesic: damp, moist, well-drained

microclimate: the climate within a small, distinct area, such as a forest or watershed, or an even more restricted space, such as a swale or cave

Native allottee: an Alaska Native who received title to a land parcel conveyed pursuant to the 1906 Alaska Native Allotment Act

necropsy: examination of an animal carcass to determine or confirm cause of death

nongame species: wildlife species that are not commonly hunted, trapped, or fished except by subsistence users

nonindigenous species: an alien species that is not native to a particular ecosystem. Alien species are also known as exotic, nonnative, or introduced, and the term noxious or nuisance species is sometimes used if the nonindigenous species can cause harm.

nonvascular plants: plants that lack the conductive tissue for the circulation of water and nutrients; moss and fungi

optimum sustainable population: population level targeted by the Marine Mammal Protection Act of 1972 as amended, which defines acceptable recovery at 60–100% of carrying capacity

overharvest: to allow harvest excessively, to the detriment of the resource

pack ice: solid sea ice; can be present only in winter, or as part of the permanent polar pack; the pack everywhere is floatable and breakable

paleoarctic: early or prehistoric Arctic

PCB: any of a family of industrial compounds produced by chlorination of biphenyl, noted primarily as an environmental pollutant that accumulates in animal tissue with resultant pathogenic or teratogenic effects

peat: partially decomposed organic matter

pelagic: of, relating to, or living in, open oceans or seas rather than waters adjacent to land or inland waters

periglacial: used to refer to geomorphic environments located at the periphery of past Pleistocene glaciers, where the landscape is dominantly influenced by frost action

phenology: the study of the impact of climate on the seasonal occurrence of flora and fauna and also the changing form of an organism and the way this affects its relationship with its environment

physiochemical: refers to the scientific analysis of the properties and behavior of chemical systems, including the earth's atmosphere and waters

physiognomy: outward appearance

physiographic: refers to natural features of the earth's surface, including land formation, climate, currents, and distribution of flora and fauna

pingo: an Arctic landform, shaped like a conical hill, that is created by the action of permafrost, contains a core of clear ice, and can be up to 75 meters high and 500 meters across

piscivorous: fish-eating

piscicide: any of a number of chemicals used to kill fish

plant community: any assemblage of plants found growing together

polynya: an area of open water surrounded by sea ice

pristine: remaining in a pure state; typical of earliest time or condition

prostrate: low growing; growing low to the ground

protist: a single-celled organism. Animal protists include naked and shelled amoebas, foraminiferans, zooflagellates, and ciliates.

proxy species: a species selected for management purposes that is intended to represent another species, group, or a habitat that will benefit from that management

radiation: species radiation refers to the diversification of a species or single ancestral type into several forms that are each adaptively specialized to a specific environmental niche; an adaptive process of species specialization

refugia: plural of “refugium,” a place that a species will go seeking safe harbor from disturbance, injury, predation, etc.

rhizomes: underground stems that often send out roots

riparian: pertaining to a river and the corridor adjoining it (i.e., its banks and floodplain)

rodenticide: any of a number of chemicals used to kill small mammals such as rats

salinity: containing salt

scrub: A straggly, stunted tree or shrub; woody vegetation predominantly of shrubs, ranging between 8 inches and 10 feet in height

sedimentation: the act or process of depositing sediment (the solid fragments of inorganic or organic material that come from the weathering of rock and are carried and deposited by wind, water, or ice)

semelparity: the condition of an organism that has only one reproductive cycle during its lifetime

senescence: the complex deteriorative processes that naturally terminate the functional life of an organ or organism

septage: liquid or solid material removed from a septic tank, cesspool, portable toilet, Type III marine sanitation device, or similar domestic wastewater treatment system

shorefast ice or **landfast ice:** the part of pack ice that is firmly frozen to the shore

shrub: a woody plant of relatively low height, having several stems arising from the base and lacking a single trunk; a bush; a woody perennial plant differing from a tree by its low stature and by generally producing several basal stems instead of a single bole, and from a perennial herb by its persistent and woody stem(s)

soil creep: the slow downhill movement of surface soil and debris due to gravity

solifluction lobes: a form shaped by the movement of soil downslope in a freeze-thaw environment

spatial segregation: the separation of individuals or species by space

species: a fundamental category of taxonomic classification consisting of related organisms capable of interbreeding. In this document, use of the word “species” includes species, subspecies and distinct populations.

species pairs: morphologically, ecologically, and genetically distinct populations of the same “species” that are sympatric during some or all of their life cycle. Examples include kokanee and anadromous sockeye; dwarf and normal Arctic char; limnetic and benthic threespine stickleback; and giant and normal pygmy whitefish. Such “populations” generally show reproductive segregation and function as independent “species,” even though by traditional taxonomic means they are not differentiated.

speleologist: a scientist who studies caves

staging: refers to areas where migratory birds congregate. The staging areas provide food that enables the birds to accumulate fat to fuel their long flights.

stygobite: aquatic cave dweller; an organism that exclusively inhabits underground habitats, such as caves and subterranean waters

subalpine: of, or pertaining to, the mountain areas between the foothills and the alpine slopes

sub-Arctic: the region just south of the Arctic Circle

sublittoral: of or pertaining to the region in a body of water between the shoreline and the edge of a steeper drop-off; the benthic zone extending from the low tide mark to the outer edge of the continental shelf (about 200 meters)

subsistence: under federal law, defined as “the customary and traditional uses by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools or transportation; for the making and selling of handicraft articles out of non-edible byproducts of fish and wildlife resources taken for personal family consumption; and for the customary trade, barter or sharing for personal or family consumption”

substrate: a surface, such as where an organism grows or is attached

subtidal: the portion of the marine environment that is below the area exposed during low tides but still within the photic zone, the area of the seabed influenced by light

surface water: all water occurring above ground. This includes wetlands, lakes, rivers, and streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, wet meadows, or ponds.

sustainable or sustainability: the ability of an ecosystem to maintain ecological processes and functions, biological diversity, and productivity over time; also, use of resources in a manner that allows the resources to be replenished by natural systems in such a manner that they will never be exhausted

taxon: a taxonomic category or group, such as phylum, order, family, genus, or species. The plural form is “taxa.”

taxonomic group: a classification of organisms in an ordered hierarchical system that indicates their natural relationships. Each species (a dog, for example) belongs to a genus (*Canis*), each genus belongs to a family (Canidae), each family belongs to an order (Carnivora), each order belongs to a class (Mammalia), each class belongs to a phylum (Chordata), and each phylum belongs to a kingdom (Animalia).

telemetry: the science and technology of automatic measurement and transmission of data by wire, radio, or other means from remote sources to receiving stations for recording and analysis

teratogenic: pertaining to substances that are suspected of causing malformations or serious deviations from the normal type, which cannot be inherited

thermokarst: a periglacial landscape that has enclosed depressions caused by the selective thawing of ground ice associated with thermal erosion by stream and lake water

traditional knowledge or traditional ecological knowledge: For the purposes of this document, traditional knowledge is broadly defined to include everything from raw notes, photographs, audiotapes and videotapes, and interviews with Native elders to formal databases organized on computer software; it also includes similar information gathered from others with long histories of observation about species and habitats, such as commercial and recreational fishermen, guides and charter operators.

troglobite: terrestrial cave dweller

troglophillic: cave-loving, dark-loving

trophic: pertaining to food or nutrition

trophic level or trophic relationship: position in the food chain determined by the number of energy-transfer steps to that level: 1 = producer; 2 = herbivore; 3, 4, 5 = carnivore

tundra scars: damage to tundra vegetation and the underlying tundra substrate

turbid or turbidity: having sediment stirred up or suspended

tussocks: a clump or tuft of growing grass

uplift: an increase in land elevation; sources of uplift include tectonic activities or isostatic changes due to glacial melting and crustal unloading

viable population: a population of sufficient numbers and reproductive potential to maintain its existence over time in spite of normal fluctuations in population levels; also, the ability of a population of a plant or animal species to persist for some specified time into the future. Viable populations are populations that are regarded as having the estimated numbers and distribution of reproductive individuals to ensure that their continued existence is well distributed in a given area.

Western science: the hypothesis-based method of scientific inquiry taught in academia

wildlife: all species in the kingdom Animalia except those considered domesticated

xeric: having very little moisture, tolerating or adapted to dry conditions

XIII. Acronyms

ACIA: Arctic Climate Impact Assessment

ACMP: Alaska Coastal Management Program

ACWA: Alaska's Clean Water Actions

ADF&G: Alaska Department of Fish and Game

AKNHP: Alaska Natural Heritage Program

ALMS: Alaska Landbird Monitoring System

AMAP: Arctic Monitoring and Assessment Program

AMBCC: Alaska Migratory Bird Co-Management Council

ANILCA: Alaska National Interest Lands Conservation Act

ANWR: Arctic National Wildlife Refuge

AOOS: Alaska Ocean Observing System

AORBBS: Alaska Off-Road Breeding Bird Survey

APOC: Arctic Peoples' Observation Center

ATVs: All-terrain vehicles

BCD: Biological Conservation Database

BLM: U.S. Department of the Interior, Bureau of Land Management

BMPs: Best management practices

BRI: Biodiversity Research Institute

BSER: Bering Sea Ecosystem Research

CAFF: Conservation of Arctic Flora and Fauna

CBC: Christmas Bird Count

CEC: Commission for Environmental Cooperation

CHAs: Critical Habitat Areas

CI: Confidence interval

CIB: Cook Inlet Beluga

CITES: Convention on International Trade in Endangered Species

COE: U.S. Army Corp of Engineers

COSEWIC: Committee on the Status of Endangered Wildlife in Canada

CPDB: Community Profile Database

CPUE: catch per unit effort

CRD: Copper River Delta

CWA: Clean Water Act

CWCS: Comprehensive Wildlife Conservation Strategy

DEC: Alaska Department of Environmental Conservation

DEMs: Digital Elevation Models

DLP: Defense of Life and Property

DNR: Alaska Department of Natural Resources

DOD: U.S. Department of Defense

DOF: Division of Forestry, DNR

DOI - MMS: Department of Interior, Minerals Management Service

DPO: Detailed plan of operations

EO: Education and outreach

EPA: U.S. Environmental Protection Agency

EPFR: Emergency Prevention, Preparedness and Response

EVOS: Exxon Valdez Oil Spill

FLUP: Forest Land Use Plan

FRPA: Alaska Forest Resources and Practices Act

GABA: gamma-aminobutyric acid

GAP: Gap Analysis Program

GEM: Gulf Ecosystem Monitoring

GIS: Geographic information system

GMU: Game management unit

GOA: Gulf of Alaska

IAFWA: International Association of Fish and Wildlife Agencies

IUCN: The International Union for the Conservation of Nature and Natural Resources

LTER: Long-term Ecological Research

LTFs: Log transfer facilities

LWD: Large woody debris

MAPS: Monitoring Avian Productivity and Survivorship

MPAs: Marine protected areas

NABBS: North American Breeding Bird Survey

NEON: National Ecological Observatory Network

NEPA: National Environmental Policy Act

NERR: National Estuarine Research Reserve

NGOs: Nongovernmental organizations

NHD: National Hydrography Dataset

NOAA: National Oceanic and Atmospheric Administration

NOAA ESI: National Oceanic and Atmospheric Administration Environmental Sensitivity Data

NPDES: National Pollution Discharge Elimination System

NPRA: National Petroleum Reserve - Alaska

NPRB: North Pacific Research Board

NRCC: National Research Committee Council

NSSI: North Slope Science Initiative

NWI: National Wetlands Inventory

OC: Oversight Committee

OHMP: Office of Habitat Management and Permitting, DNR

OPMP: Office of Project Management and Permitting, DNR

ORVs: Off-road vehicles

OSP: Optimum Sustainable Population

PAME: Protection of the Arctic Marine Environment

PARC: Partners in Amphibian and Reptile Conservation

PCB: Polychlorinated biphenyl

PIF: Partners in Flight

POPs: Persistent organic pollutants

PRISM: Program for Regional and International Shorebird Monitoring

SAR: Stock assessment report

SCALE: Shoreline Classification and Landscape Extrapolation

SDWG: Sustainable Development Working Group

SF: Sport Fish Division

SGCN: Species of Greatest Conservation Need

SWG: State Wildlife Grants

T&E: Threatened or Endangered

TEK: Traditional Ecological Knowledge

TLMP: Tongass Land Management Plan; officially the Tongass National Forest Land and Resource Management Plan 1997

TNC: The Nature Conservancy

UAF: University of Alaska Fairbanks

UAM: University of Alaska Museum

UAS: University of Alaska Southeast

UNESCO: United Nations Educational, Scientific, and Cultural Organizations

USFS: United States Forest Service

USFWS: United States Fish and Wildlife Service

USFWS - MBM: United States Fish and Wildlife Service, Migratory Bird Management

USGS: United States Geological Survey

WHSRN: Western Hemisphere Shorebird Reserve Network

Y-K: Yukon-Kuskokwim

YKD: Yukon-Kuskokwim Delta