Southwest Alaska Salmon Habitat Partnership

Strategic Conservation Action Plan for Bristol Bay Watersheds

2011

Preface

In studying the history of the decline of the salmon runs of the Pacific Coast, it is striking to notice how invariably these declines are blamed on over-fishing. These statements come most often from those least acquainted with the subject and are frequently made to cover up other causes, which may be of their own making.

While it is true that over-fishing is responsible for many declines, there is evidence to show that in numerous cases it is of minor or no consequence. The actual reasons are often found to be changes in the environment of the salmon due to natural and unnatural (man-made) conditions. This is especially true of the fresh water stages of its existence. Many examples could be cited. Some of the natural ones are cyclic climatic changes, floods, droughts, freezes, earthquakes, earth slides, beaver dams and increase in predators. On the other hand there are such man-made, or unnatural, causes as deforestation due to logging; hydro-electric, irrigation, flood control, and navigation projects; pollution, especially from pulp mills; soil conservation and reclamation schemes; gravel washing and mining operations; road construction such as stream culverts; insect control using poisonous sprays; and many others. The listing of these does not necessarily mean that all are inimical to the continuation of our salmon fisheries. It does mean, however, that if such projects are improperly and unwisely planned, the results will be disastrous to our fisheries. Alaska needs new industries, but not at the expense of her most important resource, which if properly cared for, will produce year after year.

1950 Annual Report, Alaska Fisheries Board and Alaska Department of Fisheries. The Alaska Fisheries Board was created by the 19th Territorial Legislature in 1949.

Southwest Alaska Salmon Habitat Partnership Steering Committee

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Alaska Department of Fish and Game.
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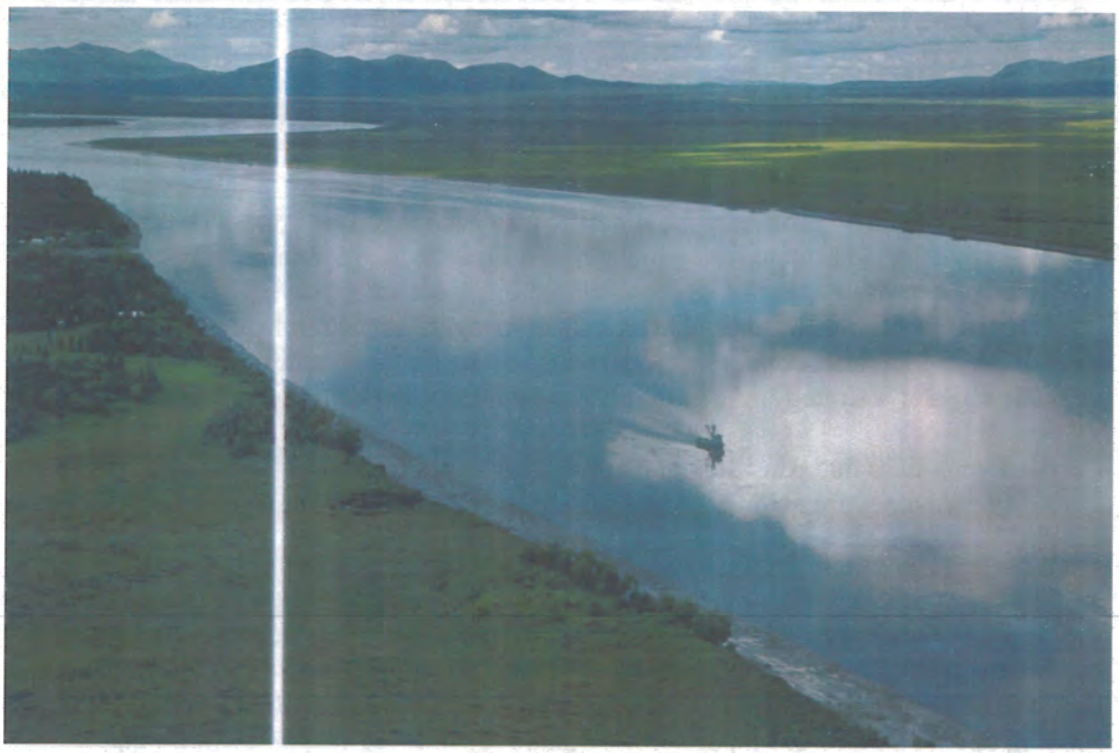


Southwest Alaska Salmon Habitat Partnership
Strategic Conservation Action Plan for Bristol Bay Watersheds

I. Executive Summary

The Southwest Alaska Salmon Habitat Partnership developed this Strategic Conservation Action Plan (Plan) to carry out its mission and help partners set priorities for collaborative actions to conserve habitat for wild salmon that spawn, rear, and overwinter in Bristol Bay watersheds. Relevant actions that could be guided by this plan include: statutory and regulatory action; project review and permitting; protection, restoration, and mitigation activities; fish or fish habitat assessment and research projects; and education and outreach activities. The Plan:

1. Identifies major watersheds in Bristol Bay and prioritizes them for protective action based upon the amount of acreage in conservation status

The Plan focuses on the bio-complexity of the large scale pristine habitat that produces the salmon resource that is the cultural and economic mainstay of the region.

2. Identifies threats to salmon habitat in each watershed.

The Plan identifies human activities that could compromise the habitat foundation for salmon production over the next fifty years. The major threats identified include: Mineral Development, Climate Change, Fragmentation of Land Ownership, Energy Development, Invasive Species, Community Development and Transportation Infrastructure

3. Identifies actions within each watershed to conserve, protect and if necessary restore salmon habitat based on identified threats.

Specific conservation strategies are identified for each of these threats. These strategies include measures to protect water quantity and flow, preserve connectivity between habitats, protect water quality, prevent habitat fragmentation, prevent invasive species, and respond to climate change. The Plan also recognizes that the lack of information and data can inhibit a complete understanding of the nature of a threat and the effectiveness of a strategy. Accordingly the Plan recommends research needs.

4. Recognizes that education and outreach activities are necessary to help maintain a constituency for salmon and the protection of habitat in Southwest Alaska.

Each of the strategies in the Plan requires collaboration among multiple partners to be successfully implemented. Some salmon conservation work has been funded directly by the National Fish Habitat Action Plan (NFHAP). Other work has been funded or carried out by partners. A major function of the Partnership will be to provide a forum to present and evaluate conservation actions, as well as to make recommendations for future funding under NFHAP. Each partner has unique capabilities, responsibilities, and

resources. Through the Partnership public agencies and private entities can coordinate funding and actions and achieve results working together that ensure healthy, abundant salmon runs in Southwest Alaska into the future.

II. Introduction

Background of the Partnership

The Southwest Alaska Salmon Partnership was originally formed in 2001 as the Southwest Alaska Conservation Coalition. The Coalition, now Partnership, is a broad based organization with a diverse membership of Native, business, Federal, State, non-profit, and private entities. The Partnership formed around a widely recognized need to conserve and protect habitat important to fish, wildlife and a variety of human uses including commercial, subsistence and recreation uses. The common thread in Southwest Alaska is salmon. Nowhere else is such a distinct group of species so vital to such a large region. Salmon are simply the keystone of Southwest Alaska's ecology, economy and culture. Accordingly, the Partnership's focus is on salmon habitat which in turn benefits a wide suite of other species and human uses.

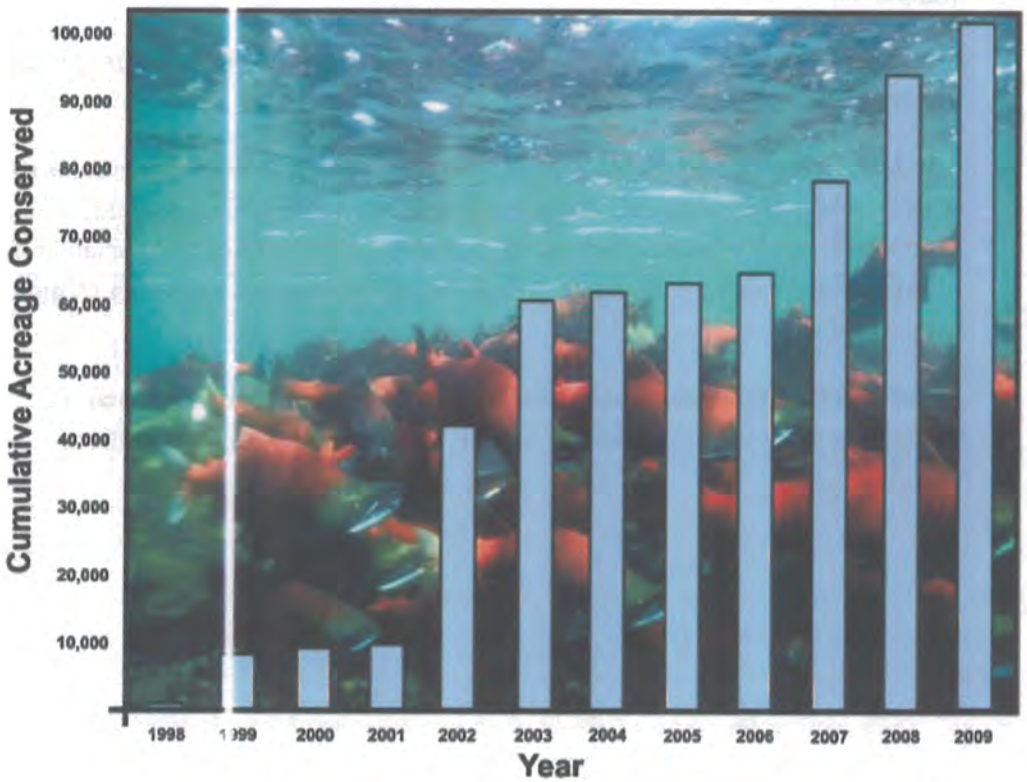
The Partnership was originally modeled after the joint ventures formed under the North American Wetlands Conservation Act. It operates with a Steering Committee and a Technical Committee. For a variety of reasons, the Partnership was originally comprised of non-governmental organizations. As the National Fish Habitat Partnership began to take shape, Federal and State agencies became much more active and visible in the Partnership.

The Partnership focuses on Southwest Alaska, an area of 39.8 million acres (62,200 square miles), and approximately the size of Washington State. The area has a high level of ecologic, economic, cultural, social, political and recreational commonality all linked by a common interest in wild salmon. The Partnership includes Native villages, Alaska Native Claims Settlement Act Corporations, State and Federal Agencies, non-profits, guides and outfitters and other businesses.

The Partnership operates with a Steering Committee representing some of the diverse interests in Southwest Alaska. The Steering Committee meets at least bi-annually and operates under Roberts Rules of Order. The Steering Committee has

adopted by-laws. The Steering Committee is supported by a Technical Committee made up of agency biologists, managers and other resource experts and other committees as needed.

Partnership members have successfully raised funds from numerous supporters; federal programs, foundations, businesses and private donors. Most of the partners have also made significant donations of money or in-kind support. Since 2001 partners have conserved through acquisition and easement approximately 94,000 acres of high value salmon habitat in 72 tracts throughout Southwest Alaska. The value of the tracts and the acquisition costs were approximately $14,900,000. Thirty-four parcels with 41,000 acres of high value salmon habitat are in various stages of negotiation. The Partnership has raised approximately $30,200,000. The money has been raised from a diverse array of Federal, foundation, business and private sources. Funding for operations, coordination, planning and day- to-day activities, however, remains the most difficult to raise.



In addition to the acquisition of fee and easements on parcels of land, members of the partnership have also been active securing protections for water under Alaska law. Since the partnership filed for recognition it has supported the filing and collection of data to perfect instream flow reservations in three river systems under Alaska law to secure minimum flows necessary to protect aquatic life. In addition, the partnership has supported projects that have added more than 100 miles of streams to Alaska's

Anadromous Waters Catalog. Streams identified as anadromous and included within the catalog receive a higher degree of protection under Alaska law and many federal and local laws than streams not included in the catalog.

Intent of the Strategic Plan

The intent of this Strategic Plan is to identify long-term goals, strategies, and voluntary actions that the Partnership and others can undertake to conserve and protect salmon habitat in each major watershed of Bristol Bay. Specific purposes of the plan are:

1. Identify and characterize habitat in each watershed used by salmon and areas which support and sustain salmon habitat, through a coordinated research program.

2. Identify threats to salmon habitat in areas that support and sustain salmon in each watershed.

3. Prioritize actions within each watershed to conserve, protect or restore salmon habitat based on identified threats.

4. Conduct education and outreach activities in southwest Alaska, other areas of Alaska, or the Nation, to inform people about: the value and importance of salmon and pristine salmon habitat in southwest Alaska; threats to sustainability of salmon and salmon habitat; and methods and approaches to sustain salmon and salmon habitat.

5. Identify potential collaborations and funding sources in each watershed for partners to address salmon habitat conservation, protection or restoration

III. Southwest Alaska Salmon Habitat Partnership

Mission Statement of Partnership

To protect, conserve, and, if necessary, restore watersheds that sustain wild salmon populations and the fisheries of Southwest Alaska.

Conservation of Southwest Alaska salmon provides a unique opportunity to apply alternative approaches that were proven inadequate elsewhere to protect salmon resources. Salmon populations proved vulnerable when economic decisions were made within political boundaries that did not adequately address the full biological requirements for salmon production, or the resulting fishery impacts. The Southwest Alaska Salmon Habitat Partnership provides a point of synergy between existing habitat conservation efforts, and a forum to develop comprehensive conservation strategies that preserve the intact and diverse ecosystems necessary to maintain the region's salmon production, and the fishery values they support. Southwest Alaska is under consideration for significant development for extraction of mineral and energy resources. Water quality, water quantity, and other fish habitat-related conditions are among some of the more important issues that will have to be addressed to maintain the fish habitat required to sustain salmon productivity.

Vision Statement of the Partnership

The Partnership envisions the continuation of the world's largest populations of salmon that perpetually sustain the culturally and ecologically important, economically valuable, and unique landscape of Southwest Alaska.

Southwest Alaska is home to the world's largest runs of wild salmon. Throughout history, salmon have provided the foundation for human habitation of this area. For thousands of years, salmon provided the most abundant food source for indigenous peoples; and subsistence fisheries for salmon continue to be a way of life for most native and rural inhabitants of Southwest Alaska. For over a century, Southwest Alaska has sustained the largest commercial fisheries for wild salmon in the world; and the commercial fishing industry continues to be the economic lifeblood of the region. For decades, Southwest Alaska has been recognized as a world-class sport fishing destination; and the region's bountiful salmon in pristine environments support thriving recreational fisheries and visitation from all over the world. Southwest Alaska is one of the few remaining areas worldwide where wild fish populations sustain the cultural foundation and economic basis for an entire region.

As a remote area, the environment of Southwest Alaska has remained virtually pristine and has not been subject to the development pressures that have devastated once abundant salmon runs in more populated areas. These naturally functioning ecosystems that provide unparalleled salmon habitat are the foundation of Southwest Alaska's salmon runs and the fisheries that they sustain.

Statement Regarding Fisheries Management

> ***The Partnership recognizes sustainable fish stocks for wild salmon as a key benefit from viable fish habitat. The Partnership supports fisheries management to provide wild salmon spawning escapements necessary for normal ecosystem functioning; but takes no position on matters of fisheries allocation or regulation.***

Sustained fisheries for wild salmon are only possible with a viable and intact habitat base. Historic levels of salmon production in southwest Alaska, and the fisheries that they support, have only been possible because the habitat has remained abundant and pristine. Of particular importance has been maintenance of the historic range of intact and largely undisturbed watersheds and near shore marine waters; that provide spawning and rearing habitats for all of the Alaska salmon species and their full genetic diversity. Maintenance of this habitat base has provided for robust salmon populations that have persisted and thrived following downturns in production, including questionable fisheries management policies such as the systematic over-exploitation by commercial fisheries before statehood.

The focus of the Partnership is conservation of fish habitat. The Partnership recognizes that the key outputs from fisheries management are protection of fish habitats, and adequate seeding of spawning salmon to these habitats. The Partnership fully supports the concepts contained in the State of Alaska's Policy for the Management of Sustainable Salmon Fisheries, which explicitly recognizes that fisheries management must: protect the full range of spawning, rearing, and migratory habitats; and provide for spawning escapements necessary to both conserve potential production and maintain normal ecosystem functioning. *See* 5 AAC 39.222

Statement Regarding Advocacy as a Strategy

> ***The Partnership will not advocate for or against legislation, regulation or policies of the Federal, State or local governments or private entities. Members of the partnership, however, are not prohibited from such advocacy or otherwise taking part in the political process.***

The members of this partnership have not come together to advocate for or against laws or policies so much as to help each other implement or take advantage of existing laws or policies available for the protection of salmon habitat. Generally, the partnership will not direct efforts to advocating for or against legislation, regulation or policies of the Federal, State or local governments or private entities. However, the partnership may provide comment or technical assistance where such comment or assistance is requested by a government or private entity or is otherwise appropriate as part of a public comment or hearing process on a matter that may directly impact salmon habitat in Southwest Alaska. Members of the partnership, however, are not prohibited from such advocacy or otherwise taking part in the political process.

Who We Work With

The conservation efforts of the Partnership represent the combined efforts of many individuals, tribes, academic institutions, organizations, and agecnies working toward the common goal of protecting the habitat that produces the greatest wild salmon runs on earth.

The Partnership is a unincorporated organization with representation from diverse communities including: Native organizations (tribal and corporate), subsistence users, anglers, hunters, commercial fishing interests, lodge owners, hunting and fishing guides, tourism interests, non-profit organizations, federal, state, and local agencies, corporations and private foundations. The partnership working cooperatively to conserve fish, wildlife and habitat and perpetuate the uses they support in Southwest Alaska. The partnership has been working together since 2001 to preserve and protect salmon habitat, watersheds and cultural and national heritage resources in Southwest Alaska.

The Partnership's record of accomplishment in preserving fish and wildlife habitat is nothing short of extraordinary. Its members have joined forces to artfully negotiate public and private land management jurisdictions, accommodate cultural diversity and multiple partner missions, and overcome the challenging logistics of working in rural remote Alaska in order to accomplish its mission.

A culture of cooperation exists among the Partnership's diverse membership. The key players in habitat conservation and management in Southwest Alaska are involved in the Partnership. The list of partner organizations is both extensive and diverse – underscoring the Partnership's ability to identify conservation projects that meet the multiple needs of its partner organizations.

For example, Alaska Native corporations and local organizations such as the Nushagak-Mulchatna /Wood Tikchik Land Trust and the Nushagak-Mulchatna Watershed Council are actively engaged in the Partnership's work. Their involvement and the success and interest generated by the Partnership's work has strengthened these organizations and has integrated *Traditional Ecological Knowledge* (TEK) and other local concerns into the Partnership's planning efforts and individual partner activities. For example, the Nushagak River Watershed Traditional Use Area Conservation Plan integrates TEK (including traditional use ecological maps) into on-going fish and wildlife management actions and land-use decisions.

The Partnership has achieved conservation outcomes that no single entity could have achieved on its own. The future of conservation in this region will increasingly rely upon this partnership to pool money, expertise and build the public and governmental support needed.

Best Available Science and Traditional Knowledge Inform Our Conservation Efforts

The conservation efforts of the Partnership are informed by the most current scientific methods and the traditional knowledge of the people of Bristol Bay about the plants, animals and fish in the region.

The conservation efforts of the partnership will be informed by the most current scientific methods as those methods are understood and applied by the technical committee.

Traditional Ecological Knowledge (TEK) is the understanding and awareness that people who are intimately connected to a particular place have of the plants, animals and environmental conditions of that place. Traditional knowledge has already been incorporated into some conservation planning efforts in the region, most notably the *Nushagak River Watershed Traditional Use Area Conservation Plan* published by the Nushagak-Mulchatna Watershed Council in 2007. Traditional Ecological Knowledge will, to the greatest extent possible, inform the conservation efforts of the partnership.

Geographic Scope of Plan

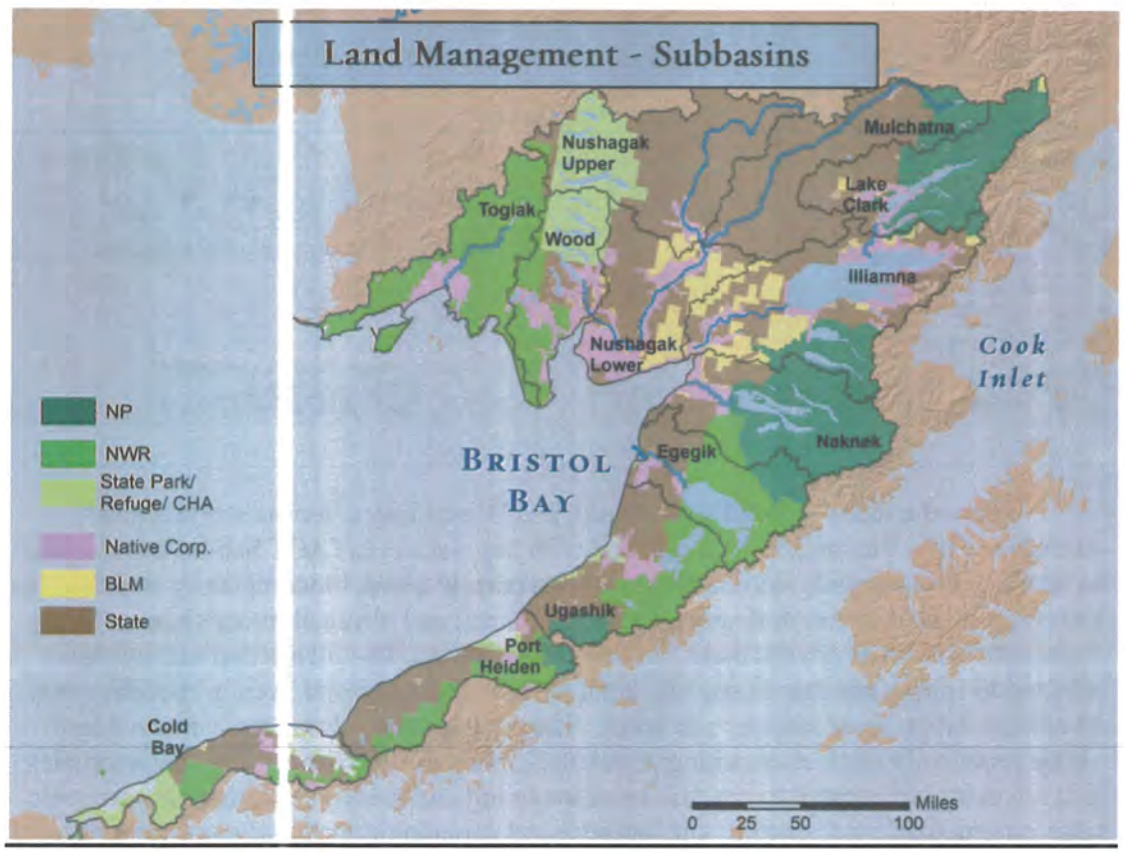
The Partnership directs its efforts to habitat protection throughout Southwest Alaska, including the Alaska Peninsula, Bristol Bay, and the watersheds flowing into the Kuskokwim Bay and River from the south and east up to and including the Aniak River; an area of 39.8 million acres

The Partnership is focused on conservation of fish habitat to maintain the abundant production of salmon in southwest Alaska. At the heart of this irreplaceable resource are the pristine waters of Bristol Bay. Bristol Bay contains an extensive complex of salmon-bearing watersheds. A striking geographic feature that defines many of the Bristol Bay watersheds is the large and productive lake basins that provide a more stable spawning and rearing environment for salmon than in many watersheds without such an abundance of lake habitat. A testament to the importance of this lake habitat is that Bristol Bay is home to the most abundant populations of sockeye salmon in the world, a species largely adapted to lake environments as rearing and overwintering habitat for the juveniles prior to their migration to marine waters. The surrounding fresh and near shore marine waters provide the essential hydromorphology to maintain these spawning, rearing, and migratory salmon habitats. Bristol Bay is defined by these large lake watersheds that are tributary to the Bering Sea, and extends from Cape Menshkof south of the Ugashik River to Cape Newenham west of the Togiak River (Map).

Salmon production in Bristol Bay is ecologically and culturally entwined with salmon-bearing waters of the Alaska Peninsula and lower Kuskokwim River. Alaska Peninsula fresh and near shore marine waters border Bristol Bay watersheds to the south

and east; and are defined by watersheds that are tributary to the Bering Sea on the Alaska mainland from Cape Menshikof to the southern end of Unimak Island at Cape Serichef, and tributary to the Gulf of Alaska along the south side of the Alaska Peninsula north to Cape Douglas. Lower Kuskokwim River and Bay fresh and near shore marine waters border Bristol Bay watersheds to the north and west; and are defined by watersheds that are tributary to the Bering Sea from Cape Newenham north to the Kuskokwim River, and watersheds flowing into the Kuskokwim River from the south and east up to and including the Aniak River.

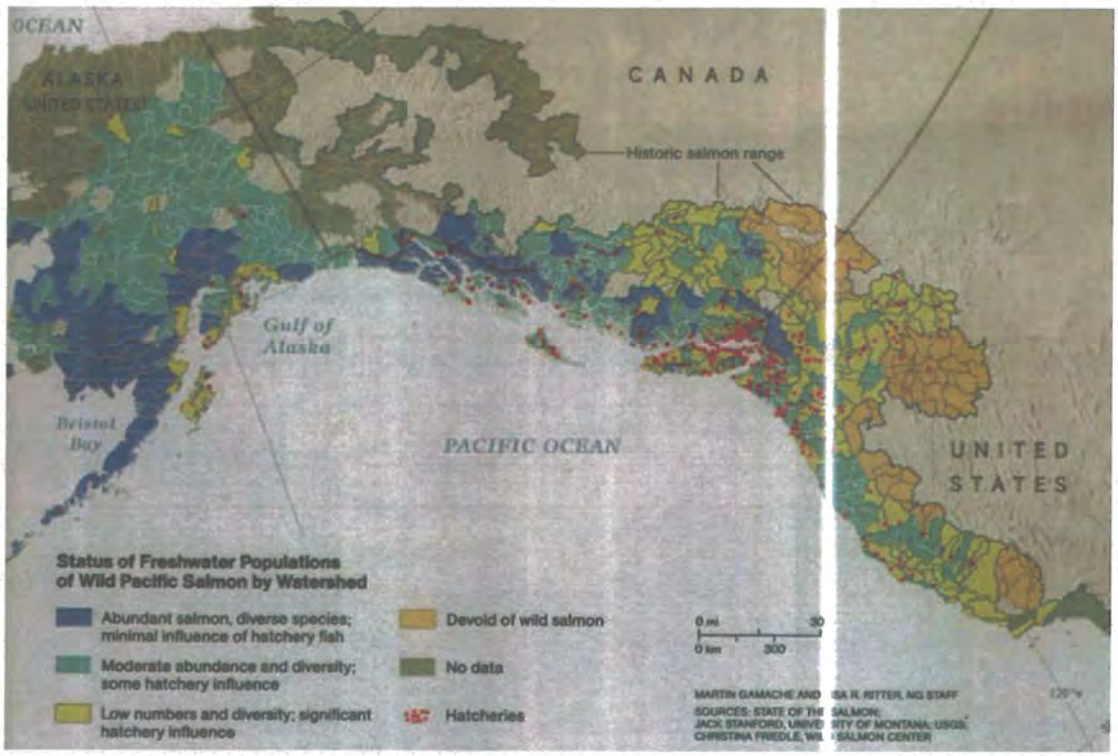
Strategic planning for the Partnership will initially focus on Bristol Bay, including the near shore marine waters north of the eastern and western bounds of this region. Within Bristol Bay, planning will be conducted by major watershed including Togiak, Wood River, Upper Nushagak, Lower Nushagak, Mulchatna River, Lake Clark, Lake Iliamna, Naknek, Egegik, Ugashik, Port Heiden, and Cold Bay; as well as the near shore marine waters and estuaries (See discussion of estuaries in Appendix A). Upon completion, strategic planning will be expanded to include the Alaska Peninsula watersheds flowing into Cook Inlet but outside the jurisdiction of the Kenai Peninsula Borough and the Kuskokwim Bay and River watersheds that border Bristol Bay up to the Aniak River.



IV. Bristol Bay Landscape

Bristol Bay – A Wild Salmon Stronghold

The key to maintaining the long-term sustainability of Southwest Alaska salmon is protection of intact fish habitat. Conservation of all existing salmon habitat contributes to the biocomplexity which sustains salmon populations over time. Southwest Alaska is one of the world's largest remaining wild salmon strongholds because habitat is still intact, water is still clean and high salmon biocomplexity tempers the effects of unpredictable environmental change.



The watersheds of Southwest Alaska and Bristol Bay offer the world's best example of how biocomplexity combined with large-scale, inTACT habitat has resulted in stable and sustainable salmon fisheries. In a narrow sense, biocomplexity is defined as the complex behavioral, biological, social, chemical, and physical interactions of living organisms with their environment. In Southwest Alaska, this means that salmon have adapted to spawn and rear in specific natal streams and lakes and even in specific types of habitat within those streams and lakes. The result is that salmon have evolved into many genetically distinct spawning populations, with diverse life history characteristics that are uniquely adapted to specific local spawning and rearing habitats. This strategic plan is particularly informed by the research and paper entitled *Population Diversity and*

the Portfolio Effect in an Exploited Species by Daniel E. Schlindler, et. al. published in the June 3, 2010 edition, Vol 466, Nature(

In Southwest Alaska, adaptation of salmon to diverse habitats (regional biocomplexity) has sustained populations over the millennia because different habitats (and ultimately productivity) respond in different ways to various environmental conditions. Salmon populations have also diversified to occupy different habitats at different life stages. During a particular climatic regime, certain geographic areas, habitat types, and salmon life histories are more productive than others. This productivity shifts within the region in response to shifts in climatic regimes. In essence, the regional biocomplexity of salmon stocks is critical for maintaining their resilience to environmental changes. Key to this regional biocomplexity and the long-term stability and sustainability of salmon is maintaining the diverse habitats still present in Southwest Alaska.

It is evident from experience in California, Oregon, Washington, Idaho and southern British Columbia, that preservation of salmon habitat is more effective in the long-term than trying to restore lost or degraded habitat and salmon populations. The rationale for adopting a preservation approach is that restoration is expensive and risky and it cannot replace what was lost. In fact, experts have concluded that current recovery efforts have a low probability of successfully restoring or even sustaining wild salmon runs through this century from southern British Columbia southward. In the past century, the entire Pacific Northwest has witnessed catastrophic declines in wild salmon populations and productivity due to a combination of degraded freshwater and estuarine habitat, poor hatchery practices, hydropower dams, natural cycles in riverine and ocean carrying capacity, and management and harvest policies. For example, numerous stocks of salmon and steelhead have been listed as endangered under the Endangered Species Act (ESA) in Washington, Oregon, Idaho, and California. These ESA listings are largely the result of habitat loss from anthropogenic changes such as dams, logging, mining, water diversions, road construction with inadequate fish passage, estuarine habitat loss, and development in riparian corridors. Millions of dollars have been spent trying to recover salmon populations but salmon have not recovered. Once habitat is lost and stocks of salmon with unique genetic diversity are gone, they cannot be replaced.

The four pillars supporting the health of wild anadromous fish populations are *abundance, life history and genetic diversity*, *productivity*, and *spatial distribution*. Each of these pillars supports the inherent *resilience* of a salmon population. Resilience, in this context, is the capacity for a salmon population to bounce back from short periods of low abundance.

What's At Stake

Healthy habitat for salmon is healthy habitat for most of the other species of fish and wildlife in Bristol Bay and is the foundation for a sustainable natural resource based economy and subsistence culture.

A. Ecological Processes

Bristol Bay and the rivers draining into it was formed during the last Pleistocene glacial advance and its retreat starting about 12,000 years ago. The modern shoreline of Bristol Bay was created in the same period that the Bering land bridge was inundated. The rising sea coupled with the melt waters of glaciers both flooded and eroded coastal areas and rivers mouths. The landscape of Bristol Bay is mostly made up of the rolling Bristol Bay-Nushagak Lowlands ecoregion, which is bounded by the Ahklun and Killbuck Mountains to the northeast and Alaska Peninsula Mountains to the south and east. The lowlands are composed of moranial, outwash, and alluvial landforms with poor to moderately drained soils. This creates a mosaic of wetland, tundra, kettle lakes, and dwarf scrub plant communities. In the northeastern regions, up to an elevation of 900 feet, tundra and wetlands are intermixed with coniferous/birch forests and willow/alder scrub communities. The extensive Wood-Tikchik finger lake system exists where the Bristol Bay-Nushagak Lowlands ecoregion meets the Ahklun Mountains. Above 900 feet, bare rock, heath tundra, and alpine meadow communities are found. Along major rivers riparian corridors of willow, cottonwood and alder are found. Where rivers meet the waters of Bristol Bay large estuaries are formed such as those of the Nushagak and Kvichak rivers. Tidal forces are large in these estuaries with amplitudes ranging over 25 feet. Tidal mudflats, sandy and/or gravelly shorelines, and bluffs of glacio-fluvial material up to 200 feet high characterize the shoreline. Bristol Bay is considered one of the richest areas in Alaska for its abundance and diversity of renewable natural resources.

Draining into Bristol Bay, the Nushagak Lowlands are recognized as a distinct eco-region. The region is characterized by rolling terrain formed of well drained glacial morainal deposits. These landforms under constant influence of seasonal rainfall and winter snow melt support complex hydro-geomorphic processes forming the foundation of dwarf scrub and wetland communities which sustain complex aquatic systems and abundant fisheries. In a natural state, permeable substrates generally remain saturated influencing surface and ground waters supporting hyporheic and riparian exchange, all of which contribute and maintain instream flows in these tributary and river systems.

Hyporheic and riparian processes maintain equilibrium supporting biological, chemical and nutrient exchange, regulate water pH, and facilitate transport of dissolved oxygen, nitrogen and other gases. The flushing of water through submerged substrates provide beneficial temperature gradients preventing freezing and icing conditions from exposing over-winter habitat and impacting salmon embryo and alevin populations. Under summer conditions, hyporheic processes further influence both spawning site selection in resident trout and anadromous salmonid species, but also influence the survival of fish embryo's within these hatching and incubating substrates.

Food chain dynamics within these watersheds are fueled by both terrestrial and aquatic organic detrital decomposition. Hydraulic exchange between riparian and hyporheic zones are essential in transferring marine derived nutrients from anadromous species migrations to terrestrial riparian vegetation. Microbial matrices and decomposers such as bacteri and fungi support populations of macro and micro fauna, aquatic invertebrates and in turn providing nutrition for larval, juvenile and adult fish populations. All of these complex and interrelated ecosystem processes support fisheries habitat and sustainable populations in this region.

Salmon essentially subsidize the freshwater and terrestrial ecosystems though several pathways and if salmon are removed, the ecosystems of Bristol Bay will likely crash.

B. Estuaries

Estuaries form where rivers meet the sea, on the eastern shore of Bristol Bay two large rivers, the Nushagak and Kvichak, shape two ecologically important estuaries. These estuaries contain an assortment of different types of habitats including freshwater and salt marshes, sandy to gravelly beaches, mud flats and sand bars. These habitats are among the most productive in Bristol Bay serving as nurseries for fish and invertebrates and staging points for large salmon runs. Cliffs of glaciofluvial material up to 200 feet high also characterize the shoreline.

The large tidal amplitudes (range 5- 8 meters) of eastern Bristol Bay form strong tidal currents in the Nushagak and Kvichak estuaries (velocities up to 4 knots) creating turbid water conditions. These tidal currents play key roles in defining the estuary's geomorphology and ecology. Strong tidal currents create the wide funnel shaped mouths observed at the Nushagak and Kvichak estuaries. Course sandy sediment is transported out of the estuary and form large sand bars at the mouth and undersea dunes at offshore areas. Barrier islands are absent as the wave action is not strong enough to build up course grained sediment onshore.

The two estuaries exhibit classic tide-dominated estuaries properties consisting of a landward-tapering funnel shaped water bodies that are bounded by various intertidal sedimentary environments including intertidal flats, sand bars and channels. The boundaries follow the irregular outline of the drowned river valley formed at periods of lower sea level.

Within the estuaries structural elements include elongate sand banks at the entrance and oriented parallel to tidal current flow. Dissecting the sand banks are deep channels containing strong tidal currents allowing more saline waters to enter estuary at flood tides. Landward the source river that feeds into tide-dominated estuaries features a meandering river channel profile. Where the meanders start represents the convergence point where tidal influences end and river process is dominate.

Four large rivers flow into Nushagak Bay: the Igushik, the Snake, the Wood-Tikchik and the Nushagak and three flow into Kvichak Bay: Naknak, Alagnak, and Kvichak. Further, due to the counter clockwise rotation current of Bristol Bay, Nushagak Bay had a lower salinity compared to the Kvichik. The highest recorded sea surface salinity measurement in the middle estuary of the Nushagak was 10 ppt compared to 20 ppt in the Kvichik. The mid to upper estuary has high turbidity averaging turbidity 200 NTU, while the river and Lower estuary zones are often less turbid.

Typical of tidally dominated estuaries, the Nushagak and Kvichak bays have large openings into Bristol Bay promotes efficient marine flushing. River flow in the summer is significantly higher then the winter due freeze up of water inputs. The estuaries have a diverse range of brackish, subtidal, intertidal and supratidal habitats. There are extensive areas where high turbidity and strong currents swept sediments, limiting macro algae, seagrasses and sessile animals from colonizing benthic areas. During the winter the strong currents and high tidal amplitude prevent the formation of shorefast ice, but ice flows scour the beach's and shallow flats limiting benthic and shore plant and animal requitment. Turbidity is high due to strong turbulence induced by tides and fine grained sediment of surrounding glacially dominated sediment

The Nushagak and Kvichak estuaries can be sub-divided into 4 habitat zones based on fauna, sediment, salinity and average current velocity. The estuaries container similar euryhaline fanua and true marine communities are encountered. In addition to the 5 species of pacific salmon commonly found summer species include rainbow smelt, starry flounder, bay shrimp (crangon), two types of amphipod, and Belgua whales. The benthic species diversity in Nushagak Bay is lower then that of Kvichak is most likely due to its low salinity and higher turbidity.

Both estuaries contain habitats such as channels, intertidal mudflats, marshes, saltflats, and sandbars. These habitats support residents freshwater and eurlyhaline species, but also can including transient marine visitors (e.g. orca). Tidal currents encourage the trapping of sediment and nutrients (e.g. nitrogen) from terrigenous sources but marine flushing results in loss of some material to the coastal ocean. Shoreline plant productivity (above the ice scour zone) may be enhanced consequent renewal of nutrients. The turbid water and redistribution of sediments limit the growth of subaquatic benthic life such as algae, seagrasses and sessile animals. The turbidity also limits light penetration reducing the amount of productivity from phytoplankton.

C. Terrestrial Mammals

Bristol Bay provides important habitat for moose, especially in lowland forests near lakes and rivers. Caribou from the Mulchatna Herd migrate and calve through the area where tundra and open boreal forest is found. Past post-calving congregations numbered 80,000 to 100,000 animals. Bristol Bay also provides habitat for brown and black bears, wolverine, wolves, porcupine and fox. Lynx and marten tend to be found in the woodlands of the area. Beaver are abundant throughout most streams and large lakes.

Sheep are found in the mountains around Lake Clark. Also common are snowshoe hare, weasels, mink, ground squirrels and microtines.

D. Marine Mammals

Bristol Bay supports many marine species a number of which have experienced significant population declines in Alaska during the last 50 years. The western population of the Steller sea lion has been listed as endangered by the US Fish and Wildlife Service, resides throughout the Aleutians and the western Gulf of Alaska,. The sea lion currently uses 7 rookeries and 61 haulouts primarily located along the Gulf of Alaska coastline. The Northern sea otter population of the Aleutians, including the Alaska Peninsula, may be listed as threatened or endangered due to population declines. Harbor seal populations appear to be stable in Bristol Bay, Beluga whales. Populations of most whales, porpoises, and walruses are difficult to assess due to their large movements and dispersed life style. There are a number of haulouts for walrus in Bristol Bay, Cape Newenham and Round Island being the largest. The are no known resident populations of Orcas in Bristol Bay, although they are occasionally observed during the summer months when salmon are returning.

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E. Birds

Bristol Bay is Alaska's most impressive migratory funnel providing staging, nesting, molting or year round habitat for some 150 species of birds. These include 32 species of waterfowl, 22 species of shore birds, 55 species of passerine, 17 species of raptors, 5 species of upland birds and 10 species of sea birds. The Audubon Society considers Bristol Bay an *Important Bird Area in the Bering Sea* for waterfowl, seabirds and shorebirds, and the Western Hemisphere Shorebird Reserve Network and the East Asian-Australasian Shorebird Reserve Network have identified Bristol Bay for its importance to migrating godwits, dunlins, golden plover, western sandpiper, and black turnstone. Essentially all emperor geese and Pacific brant stage in Bristol Bay estuaries in spring and fall and steadily increasing numbers are over-wintering due to milder climate. The Bristol Bay lowlands, of which this area makes up a significant portion, may host up to 25% of the North American population of greater scaup and roughly 10% of the breeding population of red-throated loons. Bristol Bay also supports prime breeding habitat for black scoters and tundra swans. Steller's eiders molt in estuaries and king eiders molt in nearshore waters. Huge numbers of shearwaters and other marine birds summer in Bristol Bay. The abundant freshwater fish resources support Alaska's largest concentration of osprey.

F. Fish

Bristol Bay is one of the last great strongholds for wild Pacific salmon. Bristol Bay tributaries host five species of Pacific salmon and provide the freshwater habitat for the Bristol Bay sockeye salmon run — one of the world's great migrations. In addition Bristol Bay supports at least 13 anadromous fish species, 16 resident fish species, and 4 species restricted to estuaries.

G. The Subsistence Way of Life

Although methods have changed residents of the region today, like their ancestors, still rely on the bounty of Bristol Bay's watersheds. Moose, caribou, salmon, geese, berries and plants are the principal resources that fill smoke houses, drying racks, freezers and canning jars. Hunting, fishing and gathering are a vital part of the local way of life. To lose these resources would not only jeopardize the health of people living in Bristol Bay's remote villages, but their cultures as well.

H. Commercial Fishing Economy

Bristol Bay is the world's largest wild salmon fishery and sockeye salmon is the prize. The exploitation of salmon resources of Bristol Bay did not begin until the period of American influence which coincided with the development of canning technology. The schooner Neptune prospected for salmon in Nushagak Bay in 1883 and in that same year the first cannery was built by the Arctic Packing Company at the village of Kanulik. The first salmon pack was produced in 1884, a harvest of about 4200 salmon. From this meager beginning, it was not long before the firm, red-fleshed sockeye of Bristol Bay commanded a premium price. The rush was on. Within six years there were four operating canneries on Nushagak Bay. Two canneries were built on the Naknek River and one on the Egegik River by 1895. The first canneries on the Kvichak and Ugashik Rivers appeared in 1896. Bristol Bay commercial fishing boomed in the first decade of the twentieth century. By 1910 Bristol Bay produced about 40% of Alaska's canned salmon. Over time more than 50 canneries would be built in Bristol Bay.

Fishing in the early days was done with traps. However traps were discontinued by 1924 in favor of drift gillnet fishing from sailboats, in particular the Columbia River sailboat with double-ended hulls and distinctive sprit sails. In their heyday the sailboats netted 20 million salmon in a season; all snared in linen nets and pulled by hand. Sailboats were replaced in the early 1950's when a federal ban on the use of power boats for fishing was lifted in 1951. Today the salmon of Bristol Bay are harvested by modern vessels that can cost hundreds of thousands of dollars. Vessels, however, cannot exceed 32 feet in length. All fishing is done by fishermen who own limited entry permits issued by the State of Alaska. In addition to the commercial fishing fleet, salmon are harvested by set nets anchored on local beaches.

I. Recreational Fishing and Hunting Economy

The bounty and world record size of rainbow trout in Bristol Bay is responsible for the emergence of sport fishing as an important component of the visitor industry in Alaska. Unlike commercial fishing, the business of recreational fishing got its start on the east side of the Bristol Bay when Ray Peterson built the Angler's Paradise Lodgeand hosted his first guests in 1950. John Pearson's Wood River Trout Camp, operating from an old scow was the first lodge to open on the west side of Bristol Bay in 1959. Now

there are more than one hundred lodges ranging from luxurious complexes to tent camps scattered throughout Bristol Bay catering to a world-wide customer base of recreational fishermen.

In the 1980's the Chinook salmon run on the Nushagak River began to attract more interest. The village corporation landowners along the river met the demand by making land available for temporary lease. Today a river management program operated by all of the village corporations under the management of Choggiung Ltd. accommodates some 40 commercial sportfishing camps during the short Chinook salmon season.

To a lesser extent big game hunting in the fall provides a significant source of income for some local residents. The creation of new national parks and wildlife refuges in 1980 with the passage of the Alaska National Interest Lands Conservation Act has fostered a small but emerging ecotourism industry. The attractiveness of Bristol Bay as a tourist destination, however, is tempered by remoteness and the cost of access.

Include chart of revenue associated with sport fishing in Bristol Bay

V. Assessment of Salmon Habitat Viability in Bristol Bay

Salmon habitat within each of the twelve watersheds feeding Bristol Bay is intact. Maintaining and protecting this habitat and ultimately the biological diversity and sustainability of salmon is the primary focus of the Partnership's efforts. Habitat degradation is generally localized and site specific. The Partnership does not expect to become significantly involved in habitat restoration or enhancement in the foreseeable future. A measure of the Partnership's success will be the prevention of the kinds of habitat degradation that requires restoration and enhancement to revitalize fish and wildlife populations in the other areas.

Fish habitat within each of the twelve major watersheds of Bristol Bay is functioning at its ecologically desirable status. Landscapes and watersheds supporting salmon and other fish have not been significantly altered by human activity. Bristol Bay provides healthy habitat for five species of wild Pacific salmon as well as numerous other fish species. Intact habitat provides for high natural salmon biocomplexity and the result is sustainability of salmon populations over time. Overall, the returns of salmon to the watersheds of Bristol Bay during recent times do not appear significantly different from historic returns. Human intervention is not necessary to maintain viability at present, but long-term viability of salmon habitat and biocomplexity is not guaranteed. In this Strategic Plan, the Partnership identifies potential threats to long-term viability of salmon habitat and strategic actions which can be undertaken to address these threats. Maintaining and protecting the quality and quantity of salmon habitat, and ultimately biocomplexity and salmon sustainability is the primary focus of Partnership conservation efforts in Bristol Bay. The Partnership does not expect to become

significantly involved in habitat restoration or enhancement activities in the foreseeable future. A measure of the Partnership's success will be the prevention of the kinds of habitat loss and degradation that requires extensive and relatively ineffective restoration and enhancement to revitalize salmon populations in the lower 48 states and other parts of Alaska. Restoration efforts are extremely expensive and risky, and they do not produce long-term results that approach protection of pristine ecosystems, especially when irreversible losses of biocomplexity occur. The Partnership may undertake restoration and enhancement activities as part of an effort to protect a specific parcel of private property where the parcel is acquired and some measure of clean-up or restoration is appropriate.

Objectives for Habitat Protection in Bristol Bay Watersheds.

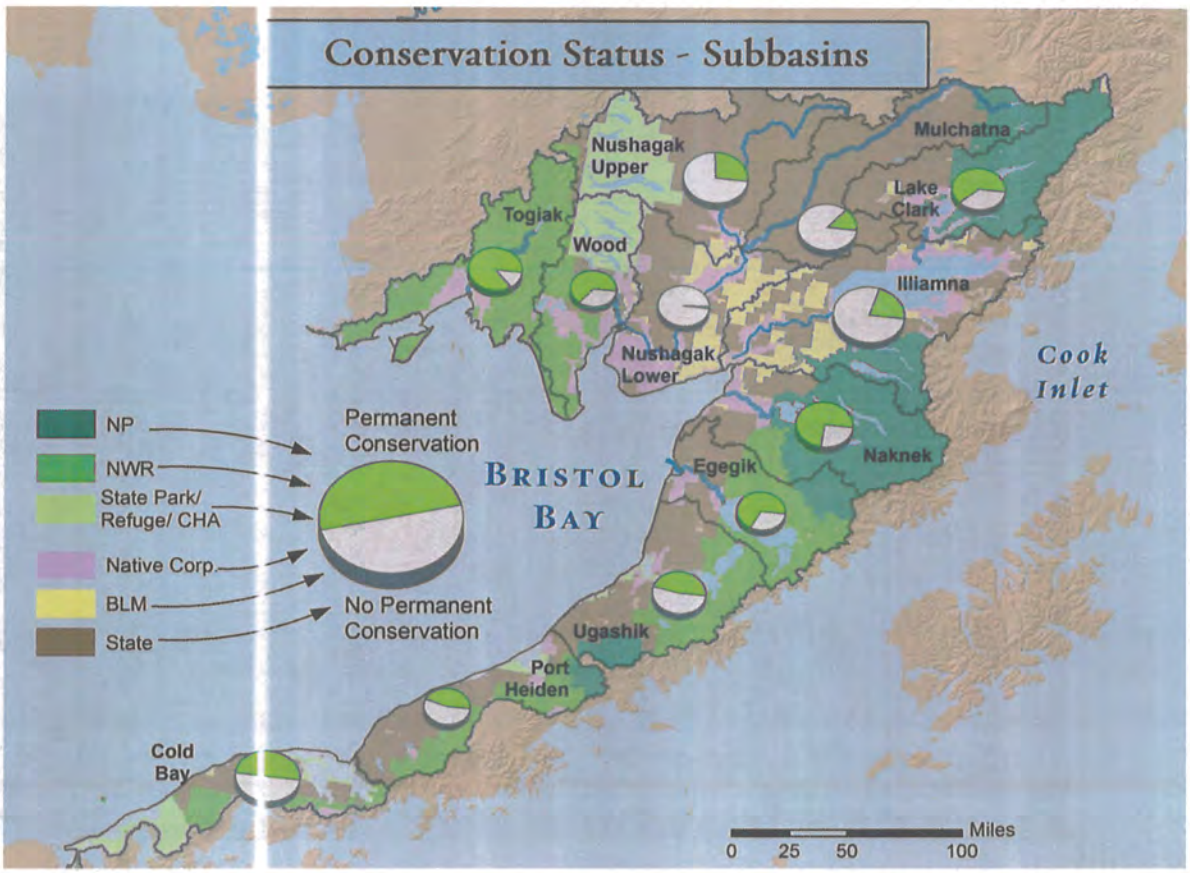
To protect salmon habitat and biocomplexity and to assure salmon sustainability, the objectives of the Partnership are to: preserve the integrity of federal and state conservation units; and to secure protection of salmon habitat outside of conservation units.

The twelve major watersheds of Bristol Bay exhibit four important habitat characteristics which support a fully functioning freshwater wild salmon ecosystem. These habitat characteristics provide for high salmon biocomplexity and result in long-term sustainability of salmon populations. The four habitat characteristics are:

1. An intricate landscape complex of rivers, streams, lakes, ponds, estuaries and riparian habitat.
2. Connectivity within and among habitat types which allows fish to move during all life stages and nutrients to flow through the ecosystem.
3. Water of adequate quality (free of environmental contaminants) which maintains and supports all life cycle stages of salmon.
4. A sufficient quantity of water to maintain and support all life cycle stages of salmon.

To date, human activity in Bristol Bay watersheds has not, except in a few small local areas, significantly altered these four important habitat characteristics. In large part this is because Bristol Bay remains a remote region accessible only by air or water and human populations are low. The Partnership recognizes, however, that remoteness will diminish over time and therefore greater human impact to salmon habitat is likely. However, the Partnership does not believe destructive human impact is inevitable. Although greater human access is a reason for concern, it does not have to be a reason for despair. There is much we still do not know about wild salmon, but there is much we do know about the kinds of human activities that threaten them. In Bristol Bay the Partnership has the opportunity to apply the lessons learned that led to the loss of wild salmon populations in other parts of the world. The imperative is to focus efforts on conserving and protecting pristine habitat critical for maintaining biocomplexity.

In Bristol Bay, we have already made significant progress in institutionalizing safeguards to protect habitat, biocomplexity and long-term sustainability of salmon at the ecosystem level. A system of federal and state parks and refuges that protects large areas of important salmon habitat has been created. This foresight, though praiseworthy, did not see far enough. For example, within many of these parks and refuges private inholdings are permitted, which if inappropriately developed could compromise habitat connectivity, water quality and quantity, or fracture landscape complexity. Also, vast areas of pristine salmon habitat are not within parks or refuges and are open and available for the kind of landscape level habitat modification that can cause the loss of salmon populations, including populations we thought were protected by parks and refuges. That being said, it is not the purpose of the Partnership to prevent development. Rather, it is the purpose of the Partnership to promote and support activities directed to assuring that protection of wild salmon and their habitats are given priority consideration when development decisions are being made so that biocomplexity is maintained and the long-term sustainability of salmon populations is assured.



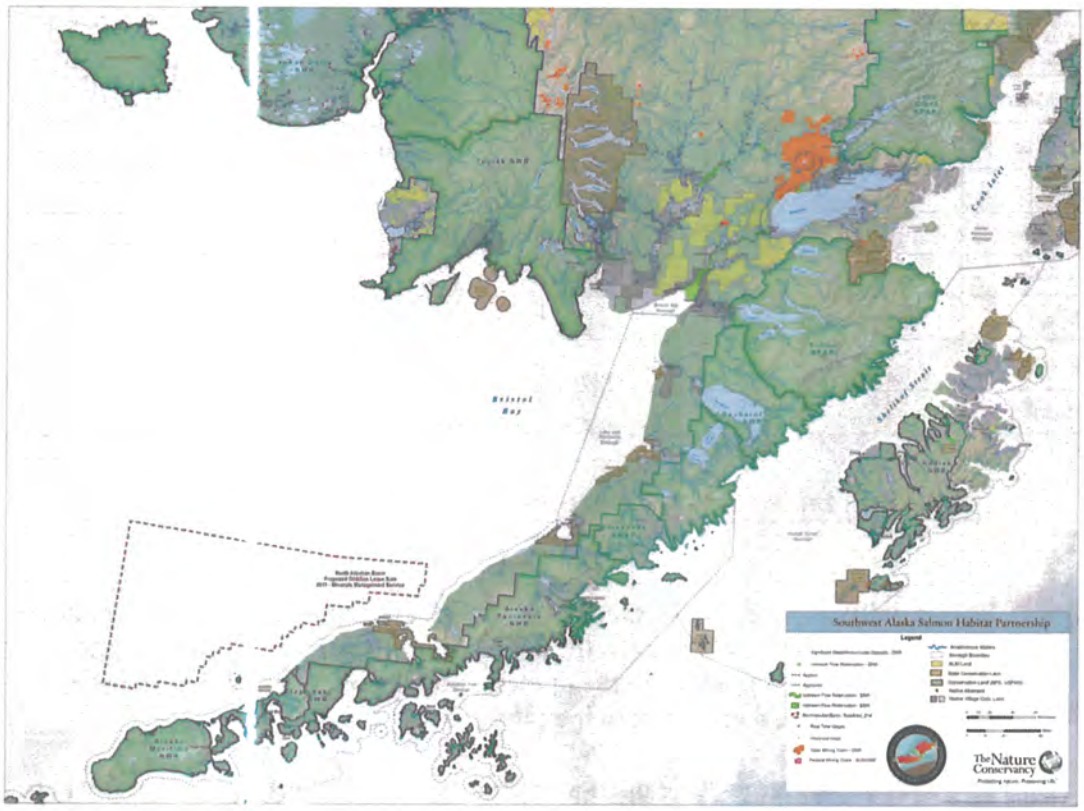
The broad goal of protecting salmon habitat and biocomplexity in Southwest Alaska and within each of the twelve key watersheds can be broken down into two primary objectives as follows:

1. Preserving the integrity of the protections for salmon habitat provided by virtue of inclusion within a federal or state conservation unit. It is the position of the Partnership that salmon habitat already protected by virtue of inclusion within a federal or state conservation unit should not be compromised by changes in land or water use or inappropriate development of private lands within conservation units.

2. Securing appropriate protection for important salmon habitat located outside conservation units. It is the position of the Partnership that all protections for salmon habitat available under federal, state or local law should be in place and enforced before development is permitted to occur on lands or in waters outside conservation units, particularly where such development may collaterally impact salmon that pass a life stage within a conservation unit.

Threats to Habitat

Several threats to salmon habitat currently exist or are known to likely occur in Bristol Bay. Other threats are not presently occurring, but may in the future. For these threats the Partnership must be prepared to take action to preempt possible degradation to salmon habitat.



The Partnership reviewed many possible threats (see Appendix A) and has identified the following human activities as existing or likely threats to salmon habitat in the Bristol Bay Region:

Table 1. Overview of likely threats to salmon habitat in watersheds of Bristol Bay.

Watersheds	Percent Land not in Conservation Status	Mineral Development	Climate Change	Fragmentation of Land Ownership	Energy Development	Invasive Species	Community Development	Transportation Infrastructure
Lower Nushagak River	98.0%	Low	High	High		Low	High	Medium
Mulchatna River	85.6%	High	High	High		Low		
Lake Iliamna - Kvichak	80.4%	High	High	High		Low	Low	High
Upper Nushagak River	70.3%	High	High	High		Low		Low
Port Heiden	55.0%		High	Low		Low		
Ugashik Bay	50.4%		High	Low		Low		
Cold Bay	37.6%		High	Low		Low		
Wood River	37.5%		High	Medium	Medium	Low		
Lake Clark	36.9%	Low	High	Medium		Low		
Egegik	27.9%		High	Low		Low		
Naknek River	24.1%		High	high		Low	High	Low
Estuaries			High	Low	Medium	Low	Low	

1. Mining and Related Infrastructure

The feasibility of large scale open pit mining of any deposit in Bristol Bay has not been determined. However, given the presence of a highly mineralized areas throughout the region, mining development, unless prohibited by law, must be considered likely at some point in the future.

The possibility of large-scale open-pit mining poses the most significant threat to the integrity of salmon habitat within two watersheds of Bristol Bay, the Nushagak and the Kvichak. . The potential impacts are both direct and indirect. The development of an open pit with the attendant processing facilities, waste storage areas, dams, roads and tailings ponds will destroy the habitat that falls within this footprint. Direct habitat alteration can also result from airborne or waterborne contaminants that escape from the mining site and from the diversion and pollution of surface and ground water. The legacy of mining around the world is unfortunately one of serious and long-term environmental damage to freshwater habitats. Although mining practices have improved, the risk of long-term environmental damage cannot be eliminated. The indirect result of mining could be an acceleration of the impacts from some of the other threats we have identified. A mine will create a sizeable population base at the mine site and will likely result in more people moving into existing communities. A mine will create the need for roads. Roads will also provide access for recreational users. More recreational users will likely create a greater

demand for guide services, lodges, and land for both commercial and private use. These impacts may be viewed favorably by those who value development and access. However, the impact of increased population and the accompanying pressure on fish and wildlife habitat cannot be overlooked. (See Appendix ___ for a specific discussion of the various aspects of mineral mining that are problematic for salmon)

2. <u>Climate Change</u>

In the face of climate change, the Partnership proceeds on the belief that protecting habitat promotes the conditions that will favor adaptability and long-term survival of salmon and all species in Southwest Alaska.

Climate change may, over time, have the most significant impact salmon habitat and salmon populations in Southwest Alaska. The most likely affects of climate change in Southwest Alaska will be: a rise in water temperature of local rivers, streams and lakes; an increase in total annual precipitation; and a change in the periodicity of precipitation (more will fall as rain and less as snow). These changes could prove catastrophic for salmon and other fish, particularly when combined with stresses from other threats. However, climate change may prove beneficial to some species as new habitat is opened for exploitation. Low elevation floodplains and wetlands will flood as continental ice sheets melt, increasing sea-levels. Although salmon exist over a wide range of climatic conditions along the Pacific coast, individual stocks have adapted life history strategies—time of emergence, run timing, and residence time in freshwater—that are often unique to region and watersheds.

The response of salmon will differ among species depending on their life cycle in freshwater. For pink and chum salmon that migrate to the ocean shortly after they emerge from the gravel, higher temperatures during spawning and incubation may result in earlier entry into the ocean when food resources are low. Shifts in thermal regimes in lakes will change trophic conditions that may affect juvenile sockeye salmon growth and survival. Decreased summer stream flows and higher water temperatures may affect growth and survival of juvenile coho salmon. Rising sea-levels will inundate low elevation spawning areas for pink salmon and floodplain rearing habitats for juvenile coho salmon. Rapid changes in climatic conditions may not extirpate salmon in the region, but these changes will impose greater stress on many stocks that are adapted to present climatic conditions. Survival of sustainable populations will depend on the existing genetic diversity within and among stocks, conservative harvest management, and habitat conservation.

3. Fragmentation of Land Ownership

What good does it do to create a federal park and provide 100 percent protection to some fish and game habitat onto which caribou and salmon migrate, if the desecration allowed to occur outside its borders in the same ecosystem is left to the discretion of state or private owners.

– Jay Hammond, "Tales of Alaska's Bush Rat Governor"

The decline of salmon worldwide can largely be attributed to the fragmentation by humans of the interconnected complex of land and water they need to survive. Most of the threats to salmon habitat identified in this plan are the means of fragmentation.

The fragmentation of habitat begins with the distribution of land and water to legally recognized persons – individuals, corporations or otherwise – who are generally accorded all the rights to use the land or water to maximum economic advantage without regard for the fish and wildlife that may also be using the water or the land.

The watershed is the basic ecological unit that supports a population of salmon. The likelihood of protecting or restoring a population of salmon diminishes as the land within that watershed is divided among more and more owners and the water is appropriated by more and more users.

Until the grant of statehood in 1959 most of the land in Alaska, including Bristol Bay, remained in Federal ownership. Under the Alaska Statehood Act the new state was accorded the right to select 104 million acres. This right was temporarily suspended as a result of a Federal settlement of aboriginal rights. The Alaska Native Claims Settlement Act of 1971 accorded Alaska's Native peoples the right to select 40 million acres prior to state selection and also required the Federal government to withhold from State selection land deemed to be in the National interest to protect. The passage of the Alaska National Interest Lands Conservation Act in 1980 removed additional millions of acres from State selection by placing these "national interest" lands into national parks, preserves and wilderness areas. For the salmon in Bristol Bay it meant that within a span of 25 years their habitat went from unified ownership to ownership by dozens of Alaska Native corporations and government entities and several thousand individual Native allottees. The division of ownership was also not limited to the surface. Ownership of lands conveyed to Alaska Native corporations were further split into surface and subsurface estates. Mineral rights were also reserved to the Federal Government on most Native allotments.

To date the fragmentation of ownership in Bristol Bay has not resulted in significant fragmentation of salmon habitat. In part this is because the region is remote, but it is also because land selection, survey, title preparation and transfer had to occur before any new owner was entitled to exercise the rights of ownership. These administrative tasks were overwhelming and cumbersome, but are now mostly

complete. In those parts of Bristol Bay not subject to the conservation status of new parks, refuges or wilderness the rights of ownership are just beginning to be exercised. The result is a growing number of mining claims and mineral leases, and an increase in the sale and conversion of Native allotments and the development of lodges and subdivisions.

Within Bristol Bay there is no single entity that can implement all of the strategic actions necessary to protect salmon because land ownership and regulatory authority within Bristol Bay is shared among many different private and public organizations. Further, these organizations, many of whom participate in this partnership have different policy imperatives that will drive their priorities. This a circumstance of concern for the partnership, but not despair. Although land ownership and regulatory control in the watershed has becomemore fragmented since statehood, there has nevertheless been an enduring deference to traditional use and the protection of subsistence resources, particularly salmon,among most of the new landowners and regulators. Unlike other parts of the country, all the watersheds within the partnership service area in Bristol Bay are intact and most of the land within these watersheds is within the control of a few owners. In most watersheds these owners are the federal or state government and in many the watersheds are within a conservation designation. Where significant lands within a watershed are privately owned, it is a Native corporation whose shareholders likely still depend upon the abundance of salmon to support their livelihoods.

To date, land ownership patterns in Bristol Bay are not so fragmented as to make large scale conservation efforts impractical. The owners are few and the areas are vast. A viable opportunity still remains in Bristol to protect whole salmon ecosystems for a fraction of the cost it currently takes to restore small runs of salmon in the lower 48.

There is a measure of urgency, however, to take protective actions sooner rather than later. Vast mineral resources have been discovered on State lands in Bristol Bay that contain salmon spawning and rearing habitat for two of the largest salmon watersheds. Significant portions of these watersheds are now subject to mineral claims. Also, there is a trend in ownership of Native corporations away from local control. Shareholders increasingly move to urban areas and become less dependent on the salmon resources supported by their corporate lands. In time these shareholders are more likely to favor development of land as opposed to protection of habitat, especially if the latter produces no economic benefit for the corporation or dividend for the shareholder.

The problem this partnership needs to address is the fact that each landowner and regulator is legally free to decide for itself what actions protect or threaten salmon, or for that matter, is free to decide that protection of salmon is no longer a priority. For this reason it is a goal of the partnership to secure active participation from Native corporations and each federal and state agency with management or regulatory authority over lands and waters in Bristol Bay. Salmon do not respect

legal boundaries drawn on a map. It is, therefore, essential to the long-term viability of salmon in any watershed of Bristol Bay that a cooperative management structure exist in which landowners, land management agencies and regulators can institutionalize a shared vision for the region that balances development with the absolute need to protect salmon habitat, such a vision entails a mutually agreeable system of restrictions, incentives, and trade-offs that deter some human activities and encourage others.

4. Energy Develop,emt

The presence of commercially viable deposits of oil or gas in the Bristol Bay region is considered remote. The location of potentially viable deposits are in the offshore regions of Bristol Bay in the vicinity of Port Moller. Onshore deposits may also exist along the Alaska Peninsula. The development of these deposits may threaten populations of salmon that are bound for Bristol Bay watersheds. A federal moratorium on oil and gas development in Bristol Bay was extended in 2010 to 2017.

Local need for cheaper energy may also pose a threat to salmon. Several sites throughout the region, including sites within conservation units, are currently under investigation for hydroelectric potential.

5. Invasive Species

Salmon and their habitats are particularly susceptible to negative impacts resulting from the introduction and widespread establishment of invasive plants and animals. Invasive species are defined as non-native species whose introduction does or is likely to cause economic or environmental harm or harm to human health. Invasive species often spread aggressively and may quickly become difficult and costly to manage and control. Invasions can lead to the loss of biological diversity, barriers to fish passage, changes to food webs, altered water chemistry, stream temperatures and habitat structure. Invasive species can also be introduced diseases and parasites.

By definition, invasive species are initially spread by human activity, including ballast water, hull fouling, and equipment transportation in the marine environment and vehicles, heavy equipment, boats, airplanes, resource development, animal feed and straw, fill material, and even personal outdoor and fishing gear. Once introduced, natural forces like wind, water, and native species can enable further spread. Fishing waders, boots, nets, ropes, and other gear can move invasive species into remote areas, including tiny organisms such as *Myxobolus cerebralis* causing Whirling Disease, which can damage nerves and spines of several fish species, and New Zealand mudsnails (*Potamopyrgus antipodarum*), which can rob streams of food for juvenile salmonids. A single angler can devastate an entire fishery with contaminated gear.

While Alaska currently experiences fewer problems related to invasive species than the Lower 48, all ecosystems - even the most intact and pristine ecosystems in SW Alaska- are susceptible to invasion. Baseline surveys conducted by the Bristol Bay Native Association have shown than in Dillingham and Aleknagik, invasive plants, such as orange hawkweed, yellow toadflax, and oxeye daisy, have taken hold along the road system. Others, like reed canary grass, have not yet been found in the region but are likely to show up in the future. If allowed to spread, these species can out-compete native plants to form monocultures, alter nutrient inputs to streams, and impede water flow. Other land managers in the region, including the National Park Service, actively survey for invasive plant infestations and implement control actions as needed.

No wild animal is more important to the region's economy than salmon. Southwest Alaska offers world class recreational and commercial fishing. The region has a vibrant subsistence culture. The region's salmon contribute to the local economy and attract people from all over the world, underscoring both the likelihood of invasions and the importance of preventing the introduction of invasive species.

6. Community Growth

Though all of the communities in Bristol Bay would be considered small by any standard, each in time could experience significant growth. Other than hub communities like Dillingham and King Salmon / Naknek most community growth in the region has come from within, as opposed to people moving into the community. Community growth simply puts more people into the region, increasing pressure on resources and resulting in the inevitable tension between habitat preservation and needed community infrastructure like fuel storage, sewage disposal, landfills, roads, and gravel.

Archeological evidence suggests the region may have supported more people in the past, providing some assurance that more community growth can be absorbed without significant impact. However, any assurance must be tempered by the observations made by many elders of the region: life in the old days was hard. There were no snowmachines, no boats with motors; people followed the seasons and moved to where the game and fish were. If a hunter saw moose tracks, he followed those tracks for days if necessary to catch it. People died of more diseases, people died of starvation, and many people died young. This kind of hard life existed well into the 20th century. Life is easier today. People don't fall victim to disease so easily, starvation is no longer a worry, and more people live into old age. Even though the number of people may be smaller, they can have as much or more impact on the environment than their ancestors. Today, people use tools like boats and snowmachines that can pollute and can take them quickly to places were game were once relatively unthreatened. People now heat their homes and travel using hazardous substances like diesel fuel and gasoline that must be carefully stored. The trash and garbage that people generate no longer degrades innocuously into the environment, but must now be contained in sanitary landfills. Although it may be

difficult, it is possible to plan for community growth and to develop infrastructure in such a way as to minimize the risk of damage to critical salmon habitat.

7. Transportation Infrastructure

Roads and related transportation infrastructure are a constant concern because they must often cross anadromous streams and extensive wetlands. Road crossings have the potential, if poorly constructed and maintained, of blocking or disrupting the migration routes of salmon and other fish. Roads can also foul salmon spawning and rearing areas. Major road construction in the region would most likely follow the development of mines, so at this time the impact from roads is speculative. Roads will continue to be built within the communities of the region, and the construction of intercommunity roads within the next 50 years is likely.

VI. Strategic Plan

Priority Conservation Targets Within Each Watershed

The following are the Partnership's priority conservation targets within each watershed of Bristol Bay:

1. ***All fresh waters that support the five species of Pacific salmon***
2. ***All adjacent terrestrial, riparian habitat***
3. ***All upstream waters that are not known to support salmon, but which water quality and quantity functions are important***
4. ***Estuaries***

Strategic Conservation Actions

To pursue our conservation objectives, the partnership will promote and support the following strategic conservation actions in the twelve key watersheds. These actions will be directed to watersheds on a priority basis. Priority will be determined by a periodic threat analysis in which Partnership resources are directed to watersheds in which the greatest threats to salmon habitat are occurring or are reasonably likely to occur. The science and technical committee will meet annually to make recommendations regarding priorities to the steering committee.

Table 2. Overview of conservation strategies to address likely threats to salmon habitat in Bristol Bay.

Conservation Strategies -->	Protect water quantity and flow	Preserve connectivity between habitats	Protect water quality	Protect riparian habitat / ecosystem processes from Fragmentation	Prevent invasive species	Respond to climate change	Review land use and development plans	Develop Informed constituency that values salmon
Mineral Develoopment	High	High	High	High		Low	High	High
Climate change	High	High	High	High	Medium	High		High
Fragmentation of Land Ownership	High	High		High		Low	Low	High
Energy Development	High	High	High	High		Low	High	High
Invasive Species					High	Low		High
Community Development	High	High	High	High		Low	High	High
Transportation Infrastructure	High	High	High	High		Low	High	High

The strategy for the long term protection of water quantity in the lakes and rivers of each watershed is to take advantage of those provisions in Alaska law that permit private individuals and organizations to secure legally enforceable rights to keep water in rivers and lakes for fish. Funds raised by the Partnership may be used to support partners applying for instream flow reservations to maintain water levels critical for the life stages of salmon and other fish. Priority use of Partnership funds will be directed to supporting partners applying for instream flow reservation to protect fish in those watersheds most likely to be threatened by industrial or commercial development.

B. **Protecting Connectivity**

- Anadromous Waters Catalog

The most basic legal protection afforded in Alaska to a stream or lake containing salmon is to include it in Alaska's Anadromous Waters Catalog (AWC), as described in A.S. 16.05.871 (Anadromous Fish Act). Once included in the AWC, a waterbody cannot be disturbed without prior notice to and a permit from the Alaska Department of Fish and Game. To nominate a waterbody for inclusion in the AWC it is necessary to survey the stream for the presence of anadromous fish (primarily salmon) and credibly document any observation of presence. It is the position of the partnership that all streams and lakes within Bristol Bay should be surveyed for inclusion within the Anadromous Waters Catalog. This task remains large given the number of unsurveyed streams. Accordingly, priority use of partnership funds raised for this purpose will be directed to supporting partners conducting fish distribution surveys in those watersheds most likely to be threatened by industrial or commercial development.

Special Note: It is the position of the Partnership that a waterbody not included in the AWC should not be disturbed before that waterbody has been surveyed for the presence of anadromous fish.

- Connectivity Between Surface and Groundwater

Upwelling groundwater is critical for the early life stages of developing salmon and for the overwinter survival of rearing salmon. Areas that are under consideration for future industrial or commercial development should be surveyed for groundwater interaction with surface water and to the greatest extent possible development should avoid places where such interactions have been identified. Priority use of Partnership funds will be directed to supporting partners that seek to identify ground and surface water interactions in watersheds most likely to be threatened by industrial or commercial development.

- Connectivity Between Watersheds

Studies conducted in conjunction with mineral exploration have confirmed groundwater connectivity between tributaries flowing into the Nushagak and Kvichak watersheds. Similar connectivity may exist between other watersheds in Bristol Bay. Areas that are under consideration for future industrial or commercial development should be surveyed for groundwater connections between watersheds and to the greatest extent possible development should avoid places where such connections have been identified. Priority use of Partnership funds will be directed to supporting partners that seek to identify groundwater connections between watersheds in areas most likely to be threatened by industrial or commercial development.

C. Protecting Water Quality

Maintenance of clean water for salmon spawning, rearing and migration is a key strategy for preserving pristine salmon habitat found throughout Bristol Bay. Changes in water chemistry or temperature could prove toxic and reduce or destroy salmon production in affected areas. The current status of water quality should be measured and defined as a baseline. Priority areas include waters near communities to ensure that anthropogenic contaminants (e.g. human waste, fuel and landfill leachate) are adequately contained; and waters within the ecological footprint of potential commercial development such as oil and gas or mineral development. Evaluation of contaminant levels that impact salmon, including sub-lethal toxicity that affects fitness (including avoidance behavior and functioning of the olfactory system), are vital information that can define the resiliency of salmon populations to contaminants that may enter the water as a result of commercial or industrial activity. The Partnership encourages projects to characterize water quality and chemistry that can be used as a baseline for monitoring changes that may indicate an occurring or developing threat to salmon viability. The Partnership also encourages evaluation and updates to water quality standards, to ensure that they accurately reflect onsite water conditions and provide realistic protection for the species and life stages in question. Of concern is providing protection to salmon

during sensitive life stages, and from chronic toxicity that could affect fitness. Specific actions that should be completed by 2015 include:

- Work with regulatory agencies, local communities, and other partners to conduct a vulnerability assessment to document potential contaminant sources of concern and specific contaminants that should be monitored. The assessment should address identification, prioritization, and ranking of potential water quality issues. Likely priorities include waters near communities and waters within the ecological footprint of potential commercial development.

- Work with Alaska Clean Waters Actions Program, local communities, and other partners to develop a comprehensive water quality monitoring program in high-risk areas throughout Bristol Bay. Seek long-term funding for a comprehensive program in select drainages.

- Develop a comprehensive water temperature monitoring program similar to the Stream Temperature Modeling Network in Cook Inlet. Seek long-term funding for a comprehensive program in select drainages.

- Provide continuing educational opportunities to understand the effects of contaminants on fish and aquatic life.

- Conduct site-specific toxicology tests for copper and other possible metal contaminants in mineral claim areas of the Nushagak and Kvichak river watersheds to evaluate the extent to which local water chemistry modifies the toxicity of inorganic contaminants. Toxicity tests should assess both acute and sublethal toxicity levels to salmon during sensitive life stages.

- Encourage review of state water quality standards for temperature and toxicity to provide protection to spawning, rearing and migrating salmon.

D. Protecting Riparian Habitat / Ecosystem Processes from Fragmentation

The key to assuring that habitat for salmon remains viable is to protect the vegetative complex within the riparian corridors of the many rivers, streams and lakes of the partnership area. Different areas within a riparian corridor have different vegetative features that are largely determined by an interaction of climate, geology, landform, soils, and hydrology (surface and groundwater flows). These features define the unique role that any given location plays in the life stage of salmon. A vegetative complex can straddle both public lands and private lands, and it is this difference in land ownership that largely directs the conservation strategies of the partnership for protecting that complex.

- Alaska Native Corporation Lands Located Outside of Conservation Units

The strategy for the long term protection of Alaska Native corporation lands outside of conservation units is to harness financial resources that make it possible for these corporations to use best management practices and conservation easements to perpetuate land management programs that continue to protect habitat and recognize subsistence as the priority use of these lands. Funding raised by the Partnership that can be used for Alaska Native corporation lands will be directed first to lands of significant habitat value within watersheds most likely to be threatened by industrial or commercial development. Preference shall be extended to corporations who are willing partners and who have land use management plans that dedicate habitat for permanent protection.

- Small Parcels Located Outside of Conservation Units

The strategy for the long term protection of small parcels, primarily Alaska Native allotments, located outside of conservation units is to encourage partners to prioritize parcels for protection. The Partnership will help secure funding to conserve the highest priority parcels. Priority parcels are those parcels which, if developed beyond low impact use, are most likely to lead to the destruction or diminishment of important salmon habitat. In all cases where an ownership interest is to be acquired by funds raised by the Partnership the preferred interest is a fee acquisition. However, conservation easements are the preferred interest where the seller is an Alaska Native or Alaska Native corporation and the retained rights support the continuation of subsistence use. As a guiding principle, the Partnership encourages conservation efforts on Native owned land that does not result in the alienation of that land from Native ownership.

- Alaska Native Corporation Lands Located Within Conservation Units

The strategy for the long term protection of Alaska Native corporation lands outside of conservation units is to harness financial resources that make it possible for these corporations to use best management practices and conservation easements to perpetuate land management programs that continue to protect habitat and recognize subsistence as the priority use of these lands. Preference shall be extended to corporations who are willing partners and who have lands identified as habitat priorities by the land management plan of the conservation unit in which the lands are located.

- Small Parcels Located Within Conservation Units

The strategy for the long term protection of small parcels, primarily Alaska Native allotments, located within conservation units is to acquire fee or conservation easement interests for those parcels identified as priorities by the land management plans of the conservation units in which the lands are located. However, conservation easements are the preferred interest where the seller is an Alaska Native or Alaska Native corporation and the retained rights support the continuation of subsistence use. As a guiding principle, the Partnership encourages conservation efforts on Native owned land that do not result in the alienation of that land from Native ownership.

- Lands Outside Conservation Units Managed by the State of Alaska and the Federal Government.

Millions of acres of land throughout the partnership area are not in conservation status. Lands in State ownership are managed by the Alaska Department of Natural Resources (ADNR). Lands in Federal ownership are managed by the Department of the Interior, Bureau of Land Management (BLM). The future of salmon productivity in Bristol Bay may well be determined by how these agencies manage lands within their respective jurisdictions. ADNR revised its Bristol Bay Area Plan in 2005 and BLM revised its Bristol Bay Resource Management Plan in 2007. Both of these plans have relaxed prior restrictions that protected salmon habitat in deference to policies that favor mineral development. While mineral development may not necessarily be harmful to salmon, it cannot be ignored that such development has been a major contributing factor to the loss of salmon habitat and productivity in other parts of the United States. It also cannot go unobserved that most of the land within the two watersheds that have historically produced the most Chinook and Sockeye salmon in Bristol Bay, the Nushagak and Kvichak watersheds, are managed by ADNR and BLM.

The partnership strategy for protecting salmon habitat on these lands is one of thoughtful engagement with both ADNR and BLM. The partnership will:

- Serve as a resource for each agency providing recommendations for the long term protection of salmon habitat on these lands;
- Serve as a resource for each agency providing comment and evaluation of development projects to assure to the greatest extent possible that such development does not result in the irretrievable loss of salmon habitat such that salmon productivity is placed at significant risk;
- Serve as a resource for each agency providing recommendations regarding mitigation measures within the region as an offset for development activities;
- Assist each agency with the identification of salmon habitat and with implementing measures available under State and Federal law to provide protection for that habitat before development activities occur.

E. Preventing the Establishment of Invasive Species

The region's world class recreational and commercial fishing attracts people from all over the world underscoring the likelihood for introduction of invasive species in SW Alaska and economic importance of implementing early detection and prevention programs. Additional collaborative detection and assessment work is needed to understand the current and potential threat to fish and wildlife habitat in the Region and to design and implement control and eradication programs. In the near term, the partnership intends to:

In order to reduce the threat of invasive species in the region, the Partnership will support projects that:

- Enact prevention measures;
- Result in early detection of and rapid response to invasive species;
- Increase understanding of the current and potential threat of invasive species to salmon and their habitats;
- Convene public and private land owners to compile the current state of knowledge and control activity in the Region; understand vectors for the introduction of invasive species; identify priority watch-list species (Key partners include BBNA, ADFG area biologist, EPA/IGAP coordinators, UAF Cooperative Extension Service, Alaska Association of Conservation Districts, Nushagak Mulchatna Watershed Council, and State, Federal and Native land managers);
- Devise and implement species-specific early detection, prevention, and control strategies for both public and private lands.
- Conduct assessments to document invasive species along riparian corridors in the Partnerships' priority watersheds.
- Conduct surveys at entry points to the region (e.g. airports, docks and barge ports) to detect and destroy invasive species
- Implement projects with the Bristol Bay Native Association, private lodge owners, recreational fishing outfits, and others to increase invasive species awareness and prevention among local residents and visitors to the region.

F. Responding to Climate Change

Near term: In the short term, the partnership expects to continue its core work that also includes linkages to climate change response

Habitat protection is an important component of the partnership's climate change strategy. Safeguarding coastal, wetland and upland areas now provides a hedge against the uncertainty of how physical and ecological processes within the region will actually change and what it means for salmon and their habitat. Protecting key spawning and rearing habitats will help sustain salmon population and potentially salmon resiliency to climate-related ecological changes. To the greatest extent possible the Partnership will help implement the climate change strategies of the State of Alaska as outlined in Special Publication 10-14 of the Alaska Department of Fish and Game.

In addition, the Partnership is working to add water bodies to the Anadromous Waters Catalog, thus providing significant habitat protections to these salmon-bearing waters under state law. Documentation of specific salmon spawning and rearing areas are important in land use planning to ensure adequate fish protection measures are in place and avoid more costly restoration work in the future.

Identifying distribution of native salmon species in intact watersheds will help protect these habitats by identifying no or limited development zones. Protecting already intact habitats will help maintain habitat and species connectivity and persistence in the face of climate change and other threats.

Southwest Alaska is a significant producer of all species of Pacific salmon. These salmon support multi-million dollar commercial, subsistence, and sport fisheries in Bristol Bay, the Alaska Peninsula, and Kuskokwim River. Protection of these vital habitats was recently recognized in formation of the SW Alaska Salmon Habitat Partnership.

Areas opened to mineral and energy development in portions of SW Alaska may affect and possibly destroy important habitats that support area fisheries. Many waterways in SW Alaska have not been assessed for inclusion in the Anadromous Waters Catalog (AWC), necessary for regulatory protection under State of Alaska law.

Long term: In addition to continuing its near term habitat protection strategies, the partnership will implement the following longer terms actions:

- Collaborate with the Western Alaska Landscape Conservation Cooperative (LCCs)
- Inform LCC research needs assessment to address priorities of the Partnership
- Develop programs and projects in response to identified needs

LCCs are solution-oriented science cooperatives dedicated to identifying and addressing climate change and other scientific information needs within discrete geographic areas. Once the cooperative identifies what needs to be done to further conservation goals in an area, they work with others to collaboratively make those things happen.

LCCs are being initiated with funding from the Department of Interior (DOI), but the same need for collaboration has been identified by the State of Alaska and Departments of Commerce (NOAA and NMFS) and Agriculture (USFS). The Western AK LCC will serve to bring together federal, state, tribal, and local governments, and private landowners to develop landscape-level strategies for understanding and responding to impacts from climate change and other sources.

The borders of LCCs are flexible as we take stock of our respective resource bases and individual suite of conservation issues. In working with Cooperative members and USGS's Regional Climate Science Centers (RCSC), LCCs will provide a better understanding of biotic responses to ecological process changes that are important for resource management. In doing so, they will be better able to help implement landscape-scale conservation and management decisions. The Western LCC will not limit the scope of its operations solely to climate-driven issues. Rather, it will seek to

address any issue where there is the potential to achieve landscape-level natural resource conservation.

LCCs are not: LCCs are not usurping any agency responsibilities or decision-making authorities, nor will they initiate regulatory actions. They are not intended to negate any aspect of existing partnerships, cooperatives, or joint ventures.

LCC Organization: In 2010, the first steps are underway to form the Western AK LCC. Representatives from State and Federal agencies have discussed broader partnerships. The cooperative hopes to expand to include participation by these and other organizations, including local Borough governments, Native Tribal organizations, and NGOs.

LCC Expected Products and Outcomes:

- Increased access to, and integration of, baseline data;
- Application of down-scaled climate models to spatially explicit management actions
- Landscape level analyses that support conservation planning;
- Identification of locations for high priority on-the-ground conservation efforts;
- Risk and vulnerability assessments for species, habitats and ecological processes;
- Evaluation of conservation strategies.

G. Review Land Use and Development Plans

When asked to do so, the Partnership will review and comment on Land Use and Development Plans for consistency with this Strategic Plan and will lend technical support where appropriate to further the mission of the Partnership.

H. Maintain a Constituency that Values Salmon

Alaskan's in general and Bristol Bay residents in particular have consistently articulated their dependence upon and interest in protecting the state's wild salmon. Educational programs that help maintain this interest should be an important component of Partnership efforts. In addition, the Partnership recognizes it is also important to develop vibrant communities and a local economy that thrive upon salmon and a local culture of caring for them. For this reason it is well within the Partnership's mission to support activities directed to educational efforts that focus on the current and historic economic importance of salmon to Bristol Bay and supporting efforts that retain or expand local participation in the economic activities of the region that rely upon salmon. Such activities might include efforts to retain commercial fishing permits for local residents, or increase local participation in the commercial lodge industry.

VII. Project Needs for Southwest Alaska Salmon and Habitat

Information on salmon and salmon habitats, as well as assessment of development, restoration, and mitigation measures; are essential components to effective salmon conservation. Development of accurate and predictive models is critical for effective conservation actions. Projects specific to watersheds will likely require a gap analysis for the watershed in question. During development of the Strategic Action Plan, the Technical Working Group identified general and specific needs. The needs were then presented to a panel of experts at a symposium held by the partnership on Salmon Biodiversity in Bristol Bay.

General Project Needs:

- Fully assess the distribution of salmon by completing the Anadromous Waters Catalog, and develop predictive models of fish distribution and communities to economize that effort.

- Assess the probable impacts of climate change. Priorities for research that all or in part address the conservation strategy for assessing the probable impacts of climate change on salmon include: (1) monitoring of physical parameters such as flows and freshwater/estuarine water temperatures; (2) assessment of freshwater smolt production to partition freshwater from marine effects on survival; (3) incorporate genetic or within-watershed population data into fishery management strategies such as escapement goals or ceilings on exploitation; (4) assessment of economic impacts of climate change such as furthering assessment of population diversity on stability in fisheries; (5) improve assessment of salmon other than sockeye such as Chinook or coho salmon.

- Assess impacts to salmon habitat from changes in hydrography.

- Develop and assess water quality and quantity baselines, including instream flow reservations, and freshwater and estuarine water temperatures.

- Map wetlands and conduct functional assessment.

- Estimate salmon distribution and abundance; and assess stock status and limiting factors.

- Assess juvenile salmon migration and habitat use.

- Assess the cumulative impacts of development in riparian areas.

- Identify representative streams and stream reaches to conduct baseline and long-term monitoring.

- Complete genetic baselines for all salmon species. Assess effects on genetic or population diversity under different fishery management strategies such as escapement goal or exploitation rate policies.

- Assess economic benefits from alternative development and maintenance of population diversity.

- To cost-effectively develop projects and assessments, sites for additional monitoring such as physical parameters (water flow and temperature) should include existing monitoring sites for salmon escapement (such as tower or smolt sites). Data archiving and accessibility should be addressed in every project. For many of these assessments, there is a premium on long-term time series data sets. Where practical, mining of existing data sets is a very cost-effective approach. Most of the current assessments for salmon are for fisheries management. Many of these assessments can have added value for assessment of climate change or population resiliency. For instance, assessment of smolt production partitions survival from the freshwater and marine environments.

Bristol Bay Commercial Fishing Fleet circa 1940

Appendix A

Other Potential Threats Identified by Committee

1. Gravel mining
2. Catastrophic spills – threat is fuel storage/transportation, limited pipelines
3. Migration into region as a result of mining
4. Sea level rise
5. Lack of zoning– no current enforcement of riparian setbacks; incorporate into other sections
6. Lack of committed participation in Partnership from major landowners

Appendix B

Comprehensive Conservation Plans, General Management Plans, Watershed Plans, and other management plans available for use by the Partnership.

A. Comprehensive and Master Plans

Wood-Tikchik State Park Master Plan
Alaska Peninsula National Wildlife Refuge Comprehensive Conservation Plan
Becharof National Wildlife Refuge Comprehensive Conservation Plan
Togiak National Wildlife Refuge Comprehensive Conservation Plan
Izembek National Wildlife Refuge Comprehensive Conservation Plan
Yukon Delta National Wildlife Refuge Comprehensive Conservation Plan
Alaska Maritime National Wildlife Refuge Comprehensive Conservation Plan
Lake Clark National Park and Preserve General Management Plan
Katmai National Park and Preserve General Management Plan
Aniakchak National Monument General Management Plan
Alagnak Wild River Management Plan
Bristol Bay Resource Area Management Plan

B. Fisheries Management Plans

Alaska Peninsula National Wildlife Refuge Fisheries Management Plan
Becharof National Wildlife Refuge Fisheries Management Plan
Togiak National Wildlife Refuge Fisheries Management Plan
Izembek National Wildlife Refuge Fisheries Management Plan
Yukon Delta National Wildlife Refuge Fisheries Management Plan

C. Land Protection Plans

Alaska Peninsula National Wildlife Refuge Land Protection Plan

Becharof National Wildlife Refuge Land Protection Plan
Togiak National Wildlife Refuge Land Protection Plan
Izembek National Wildlife Refuge Land Protection Plan
Yukon Delta National Wildlife Refuge Land Protection Plan

D. Other Relevant Plans

Nushagak Bay Watershed Plan
Nushagak River Watershed Traditional Use Area Conservation Plan
Bristol Bay Coastal Zone Resource Area Management Plan
Bristol Bay Ecoregional Plan
Wood-Tikchik Site Conservation Plan
Pacific Coast Joint Venture Strategic Plan

Appendix C

Specific Concerns Regarding Mineral Mining in Bristol Bay

Mining and mineral extraction activities take many forms though mining and its associated activities have the potential to cause environmental impacts from exploration through post-closure. Some of the most severe damage, however, occurs in remote areas, where some of the most productive fish habitat is often located (Sengupta 1993). While the intention of environmental regulations may avoid, limit, or offset many of these potential impacts, mining will, to some degree, always alter landscapes and environmental resources (National Research Council [NRC] 1999). Mining in the form of open pit and underground mining will always impact or effect surrounding surface and ground water hydrology, simply because no mine can be operated without the removal of all surrounding ground water.

Regarding water specifically, potential impacts from mining include.
1) Dewatering of the mine site and surrounding aquifers that could flood the mine site.
2) Altering and depleting natural ground water regimes and hydro-geomorphic processes surrounding the mine site.
3) Unseen and unpredicted modification of instream water quality and habitat in surrounding unmined areas.
4) Seepage of contaminated leachate from waste rock piles, both liberated metals and sulfides as well as metal processing chemical residues.
5) Eventual flooding of open pits or underground workings after mining ceases.
6) Eventual seepage and discharge of untreated water leachate from mine workings.

HYDROLOGY

Water quality and availability are obviously an essential component to productive salmon habitat and associated ecosystem processes. To access mineral and ore deposits, many mining methods and operations necessitate the complete withdrawl of groundwater aquifers. These naturally occurring often saturated ground water substrates and aquifers support surface water and instream flow regimes that support head waters and streams and rivers. At landscape scales, such water withdrawls negatively impact surface and ground water supplies by depleting local water tables, disrupting aquifers or compromising natural recharge (Sophocleous 2002, Younger 2002, Brown 1997, Bonta 1992). Altered water regimes change instream channel morphologies, stream gradients, bank and benthic substrates and disrupt the equilibrium between flow and sediment transport in tributaries (Sophocleous 2002, Johnson 1997). Often these impacts are seen many miles upstream and downstream of the actual mine site (NAS-1999), thus influencing anadromous species access to migratory corridors and reducing available spawning and rearing habitat.

HYDROLOGIC UNCERTAINTY

There is a high degree of uncertainty associated with methods and models used to predict water quality, quantity and availability for large scale mining, especially those influenced by dramatic seasonal rain fall, winter snow accumulation and runoff. Studies assessing current technologies and methods used for instream flow predictions advise caution because models fail to accurately predict available water, habitat impact, or predict the effects of seasonal influences to instream flow volumes on fish populations (Hudson 2003, Railsback 2000, Kondolf 2000). Methods currently used to predict ground water processes often fail to accurately characterize ground water availability or predict post mining water quality conditions (Malmström 2008, Kuipers, 2006, Maest 2005). Stochastic models, those methods that actually discuss and introduce levels of uncertainty regarding parameter and prediction, should be considered when addressing long term cumulative impacts to water sheds and aquatic ecosystems (Schafer 1998).

The scientific literature is abundant with examples of salmonid species (anadromous and resident) selecting spawning and rearing substrates influenced by hyporheic and riparian processes (see Ecological Processes). These processes are influenced by the constant physical interaction and exchange of chemical and biological processes such as instream and inter-substrate flow, flushing of dissolved gases, and introduction of nutrient sources and removal of wastes. Mining activities disrupt these physical systems initiating and promulgating mineral
dissolution or precipitation reactions that can alter pre-mining ground water quality and chemistry in ways that may be difficult to predict (Lewis-Russ, 1997). Recent studies suggest
that diffuse mine related pollution in rivers may significantly contribute to the loading of metals, principally because mine water contribution may be influenced by altered water tables (Kimball 2010, Younger 2000).

Minerals and metals liberated from rock substrates interact with atmospheric oxygen and water (Jennings 2008, Younger 2002, Jennings 2001, Younger 2001, Edwards 1999). The introduction of metal and mineral rich runoff or Acid Mine Drainage (AMD) or Acid Rock Drainage (ARD) into the aquatic ecosystems can have adverse impacts on the ecology of entire watersheds and can result in the death of hyporheic metabolism, associated organisms and interchange (Gandy 2007, Nelson 1999, Brunke 1997). The hyporheic zone is particularly vulnerable since it is exposed to up-welling groundwater contaminants before they reach, and are subject to dilution within, the surface water ecosystem (Biksey 2001). Results of studies conducted on rivers recovering from metal and mineral contamination conclude, despite efforts to remediate surface water pollution, community recovery in the hyporheic zone may take longer than surface macroinvertebrate recovery due to the continued release of metals by reductive dissolution and exposure to AMD (Neal 2005, Jarvie 2005).

TOXICITY TO FISH AND AQUATIC ORGANISMS

The body of literature is replete and growing with scientific books and papers documenting the adverse impacts of exposure to liberated metals and processing chemicals on aquatic ecosystems and ultimately aquatic organisms. Two recently published books provide an accurate assessment and discussion of potential impacts including the numerous variables that influence true levels of toxicity (Di Giulio 2008, Meyer 2005). Many current studies and papers addressing liberated metals and processing chemicals have demonstrated toxicity to fish as well as aquatic invertebrate populations at the ecosystem, metabolic and cellular level (Iwasaki 2009, Dsa 2008, Freund 2007, Peplow 2004, Peplow 2003, Hansen 2002, Barry 2000, Beltman 1999, Saiki 1995, West 1995, Buhl 1991). Some metal contamination and exposure has been shown to influence simple migratory behavior and avoidance mechanisms in fish populations (Hecht 2007, Faraq 2003, Brix 2001, Hansen 1999, Goldstein 1999, Baatrup 1991). Additional studies indicate that salmonids exposed to chronic sub-lethal levels of metals have weakened immune response and become suscepetable to increasing levels of fish pathogens they would normally be tolerant to (Arkoosh 1998).

The adverse impacts to fish populations and habitat in natural settings are well documented (Faraq 2003, Hansen 2002, Brix 2001, Goldstein 1999, Baatrup 1991). There are also several other literature reviews of numerous studies designed to quantify the adverse environmental effects of acid mine drainage on aquatic resources (Di Giulio 2008, Jennings 2008, Trasky 2008, Meyer 2005). These assessments include water and sediment chemistry, benthic macroinvertebrate sampling for taxa richness and abundance, laboratory acute water column evaluations, laboratory chronic sediment testing, caged fish within impacted streams, and development of models to explain and predict impacts of acid mine drainage on various aquatic species.

TAILINGS and TREATMENT, SCALE in PERPETUITY

The creation of waste dumps, tailings impoundments, mine pits and other facilities that become
permanent features of the post-mining landscape can cause fundamental changes in the physical characteristics of a watershed (O'Hearn, 1997). The ability to predict, treat or neutralize AMD is very site specific, and often very unpredictable. Mine waste will be exposed to the natural elements of weathering for a long time (CSS 2002, EPA 2007). Depending on the scale of the mining operation and associated topography and hydro-geomorphic processes, active treatment to neutralize AMD may last in perpetuity (Jennings 2008, Kuipers 2000).

Although reclamation efforts and mitigation practices may restore topographic land forms to mine sites these efforts fail to restore natural hydro-geomorphic and aquatic function and associated water quantity and quality within measurable time frames (Mutz 1999, Kilmartin 1998).

OTHER IMPACTS

Commercial mining operations may also involve road building, tailings disposal, and leaching of extraction chemicals, all of which may create serious impacts to water sources and subsequent fish and aquatic resources. Cyanide, sulfuric acid, arsenic, mercury, heavy metals, and reagents associated with mining operations and mineral development all threaten aquatic habitat and species, and have cumulative effects to terrestrial habitat and species. Improper or in-water disposal of tailings may be toxic to managed species or their prey downstream. Upland disposal of tailings in unstable or landslide prone areas can cause large quantities of toxic compounds to be released into streams or to contaminate groundwater (Council 1999).