Conserving Salmon Habitat in the Mat-Su Basin



The Strategic Action Plan

of the

Mat-Su Basin Salmon Habitat Partnership

2008

Mat-Su Basin Salmon Habitat Partnership Steering Committee

Acknowledgements

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This Strategic Action Plan was developed by the Mat-Su Basin Salmon Habitat Partnership under guidelines provided by the National Fish Habitat Board's National Fish Habitat Action Plan. This Strategic Action Plan was created through the dedication of its partners. Local agencies and organizations provided hours of in-kind support. We would especially like to thank the following for lending their staff to this project: Alaska Department of Fish and Game; Alaska Department of Environmental Conservation; Alaska Department of Natural Resources; Alaska Department of Transportation; Alaskans for Palmer Hay Flats; Aquatic Restoration and Research Institute; Chickaloon Village Traditional Council; Cook Inlet Aquaculture Association; Cook Inletkeeper; Environmental Protection Agency; Fishtale River Guides; Friends of Mat-Su; Great Land Trust; Matanuska-Susitna Borough; Mayor's Blue Ribbon Sportsmen's Committee; National Park Service; Natural Resources Conservation Service; NOAA's National Marine Fisheries Service; The Nature Conservancy; US Army Corps of Engineers; U.S. Fish and Wildlife Service; U.S. Geological Survey; and the Wasilla Soil and Water Conservation District. A complete list of participants in is Appendix 1.

Financial support was provided by the National Fish Habitat Action Plan, the U.S. Fish and Wildlife Service, The Nature Conservancy, and ConocoPhillips Alaska.

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I. Executive Summary

Chinook, coho, sockeye, pink, and chum salmon all return in great numbers to the streams and lakes of the Matanuska-Susitna (Mat-Su) Basin each summer to spawn. The Susitna River run of Chinook salmon is the fourth largest in the state. Yet rapid growth in the Mat-Su Basin affects quality of life for residents and habitat health for salmon. Across the Mat-Su Basin, residents value healthy fish and wildlife populations, open space, clean air and water, recreational opportunities, and a rural lifestyle. For many, salmon are an integral part of their heritage and culture, and fishing is a regular part of life and an important means of caring for their families. Population growth in the region at its current pace, combined with the current regulatory framework, enforcement, and common development and recreation practices, cause many people concern that these values can not be maintained. The greatest risk to habitat for salmon and other freshwater fish in the Mat-Su Basin may be many small actions compounding over time to degrade riparian habitat and water quality, change water flow and quantity, and block access to habitat.

Mat-Su Basin Salmon Habitat Partnership

The Matanuska-Susitna Basin Salmon Habitat Partnership formed to address increasing impacts on salmon from human use and development in the Mat-Su Basin with a collaborative, cooperative, and non-regulatory approach that would bring together diverse stakeholders. Rapid population growth and the accompanying pressures for development will increasingly challenge the ability of stakeholders to balance fish habitat conservation with these changes over time. 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 fish productivity. *From the beginning, the Partnership has acted with the belief that thriving fish, healthy habitats, and vital communities can co-exist in the Mat-Su Basin.*

There has been a history of fish habitat efforts in the Mat-Su Basin, including culvert replacement, stream restoration, and stream bank stabilization. Many of these were cooperative efforts between government agencies and local organizations. In the fall of 2005, The Nature Conservancy (TNC), the Matanuska-Susitna Borough (MSB), Alaska Department of Fish and Game (ADFG), and U.S. Fish and Wildlife Service (USFWS) formalized a broad-based public and private partnership. From the beginning, this diverse partnership has attracted local community groups; local, state, and federal agencies; businesses; non-profit organizations; Native Alaskans; and individual landowners. The Partnership has sought to include anyone concerned about conserving salmon in the Mat-Su Basin.

This focus on a bottom-up, locally driven, voluntary and non-regulatory effort was inspired by the approach outlined in the National Fish Habitat Action Plan (NFHAP). The mission of NFHAP is to “protect, restore, and enhance the nation’s fish and aquatic communities through partnerships that foster fish habitat conservation and improve the quality of life for the American people.”

The Intent of this Strategic Action Plan

The Partnership Steering Committee developed the Strategic Action Plan to identify Partnership long-term goals and strategies and to provide a tool the Partnership can use to prioritize projects related to fish habitat goals in the Mat-Su Basin. The intent of this Strategic Action Plan is to identify long-term goals, strategies, and voluntary actions that the Partnership and others can undertake to conserve salmon habitat. A subsequent process has been used to prioritize fish habitat related projects and actions. The Steering Committee plans to revisit this Strategic Action Plan every 3 to 5 years. If changes in the Mat-Su Basin significantly affect the situation for salmon habitat before then, the plan will be updated more frequently.

The Partnership developed this Strategic Action Plan to identify collaborative projects and other actions that will protect and restore important habitat for wild salmon in the Mat-Su Basin. The Steering Committee initiated the plan under the guidance of the NFHAP and administered the planning process. The NFHAP clearly identifies fish habitat as the focus for partnerships. The Steering Committee decided that the planning process would focus exclusively on habitat-related issues to remain consistent with the intent of the NFHAP and the Mat-Su Salmon Partnership. The plan scope includes not only freshwater fish habitat in the Mat-Su Basin, but nearshore, estuarine, and marine habitat in Upper Cook Inlet as well (Figure 1).

The Steering Committee identified three specific purposes for the plan:

1. Identify important habitats for salmon and other fish species in the Mat-Su Basin.
2. Prioritize fish habitat conservation actions, including protection, enhancement, and restoration of key habitat, education and outreach, research, and mitigation.
3. Identify potential collaborations and funding sources for partners to address fish habitat conservation.

Several partners raised fishery allocation issues during the planning process. These issues were specifically not included in the scope of this plan because doing so would substantially change the nature of the plan and likely shift the focus away from the purposes for which the Mat-Su Salmon Partnership formed. While the plan does not address fishery allocation, Alaska is uniquely equipped to deal with these issues through the Alaska Board of Fisheries, the state legislature, and local fish and game advisory councils. These processes are open and available to the public, including Mat-Su Salmon Partnership individuals and groups.

Overall Health of Mat-Su Basin Salmon and Habitat

This assessment of the current health of wild salmon and their habitat shows that, *taken as a whole across the Mat-Su Basin*, salmon and most of their habitats are healthy and require minimal human intervention for long term survival. A more local look at individual attributes of health, however, points out concerns about long-term sustainability of Mat-Su Basin salmon and some of the habitats they require for survival. For salmon, this assessment suggests that numbers for some sockeye, pink, and chum salmon runs may be below a sustainable level and that some stocks may be seriously degraded in time without conservation action. Data for Mat-Su salmon populations is limited so the status of many stocks, especially in the Matanuska River watershed, is based on anecdotal information, professional judgment, or is unknown. Some habitat alteration, such as blocked migration, will have cumulative impacts over time to successive salmon populations.

Figure 1. The Scope of the Strategic Plan: Mat-Su Basin and Upper Cook Inlet

Not surprisingly, the health of Mat-Su Basin salmon habitat is linked to the level and location of human activity in the basin. The ecosystems that coincide with the more developed areas of the Mat-Su Basin (i.e. Wasilla and Palmer core area and the transportation corridors) may become seriously degraded without human intervention. Reduced health of these ecosystems is linked to alteration of native riparian vegetation, degraded water quality, and water flow changes, all of which have reached levels that may impair these ecosystems in the long-term. Within these areas, Alaska Department of Environmental Conservation (ADEC) has identified over two dozen waterbodies that lack sufficient data to determine water quality, and has designated four as Impaired and three as High Priority. Some water pollution in these areas may be due to the replacement of more than 10% of native vegetation with impervious surfaces that concentrate stormwater runoff in surface waters.

Ecosystems coinciding with areas of little development (i.e. west of Susitna River, uplands, and upper Cook Inlet) have good overall health. Yet even these terrestrial ecosystems contain waterbodies that lack sufficient data, and ADEC has determined that insufficient information exists to assess how well Cook Inlet meets water quality standards.

The current state of salmon and ecosystem health directs us to which species and ecosystems may require protection and prevention measures versus restoration to regain health. Preventative conservation measures in the areas with less human impact can ensure that these ecosystems remain healthy for salmon and other aquatic species. The more impacted terrestrial ecosystems in the developed areas will require not only protection against additional alteration and degradation but also mitigation and restoration actions to restore health.

Potential Threats to Salmon and Habitat

Many human activities are potential threats to salmon and their habitats. Human activities can affect salmon by degrading or eliminating habitat, removing vegetation from wetlands and the banks of streams and lakes, degrading water quality, changing river flows, disconnecting streams, lakes, and wetlands, or blocking fish passage. Lack of data to make management decisions can also be an impediment to conserving salmon and their habitats. Most of these activities are vital to human communities and can be mitigated to reduce or eliminate negative impacts to salmon and salmon habitat.

This plan focuses on human activities that are currently major sources of stress to salmon and their habitat or are likely to be potential threats in the next 10 years. The severity and scope of particular stresses to each conservation target (Appendix 6) were analyzed in combination with the relative contribution and irreversibility of various sources to those stresses. This combined analysis produced a ranked list of 22 potential threats to Mat-Su Basin salmon and their habitats (Appendix 7). The highest ranked potential threats were compared for impact to habitats, urgency, available information, opportunity, and reversibility, and whether a clear role for the Partnership exists. The impacts of seven potential threats are addressed in this plan.

Potential Threats to Mat-Su Basin Salmon

Housing and Urban Areas
Stormwater and Urban Runoff
Household Septics & Urban Wastewater
Roads and Railroads
Ground and Surface Water Withdrawals
Development in Estuaries
Invasive Northern Pike

Appendix 7 contains more information about the potential threats not selected, but two bear additional explanation here – Climate Change and Recreational Activities. Climate change will warm stream temperatures in the Mat-Su Basin and alter watersheds by affecting flooding frequencies, snow pack depths, precipitation, surface and groundwater volumes, and other hydrologic characteristics. The planning team did not see a clear role for the Partnership to address climate change directly but have placed a priority on protecting and restoring many of the factors that can maintain or increase the resiliency of salmon to a changing climate (e.g., loss of riparian cover, wetlands, connectivity, and reservation of water). The monitoring program will include stream temperature so that the thermal regimes of Mat-Su Basin waterbodies can be tracked and understood as climate and land uses change. Recreational Activities, including boating, ATVs, and access to fishing and hunting, were not chosen as priorities to be included in this plan at this time because the negative impacts of most of these activities are localized, are reversible given a reasonable level of funding and commitment, and identify the need for increased enforcement of existing laws and ordinances. The Partnership plans to revisit the Strategic Action Plan on a regular basis to identify potential threats that could be or should be addressed by the Partnership.

Conservation Strategies

The Mat-Su Salmon Partnership's broad goals are to protect salmon and their habitats in the Mat-Su Basin and Upper Cook Inlet, mitigate potential threats to salmon and their habitats, restore connectivity between salmon habitats, and increase knowledge about salmon and their use of freshwater and marine habitats. The strategies for the Mat-Su Basin echo those that the National Fish Habitat Action Plan drafted to guide work at the national and partnership level: protection of healthy waters, rehabilitation of flows, reconnection of habitat, and reduction of pollutants and sedimentation in waterbodies. Some potential threats have multiple impacts to salmon and their habitat. A situation analysis for each threat brought into focus the more discrete habitat issues upon which the Partnership can act. To conserve salmon in the Mat-Su Basin, the Partnership will address overarching science needs and eight focal issues for salmon and salmon habitat.

> **Focal Issues for Mat-Su Basin Salmon**
>
> *Alteration of riparian areas*
> *Filling of wetlands*
> *Impervious surfaces and stormwater runoff*
> *Septic systems*
> *Culverts that block fish passage*
> *Loss or alteration of water flow or volume*
> *Loss of estuaries and nearshore habitats*
> *Increased predation from Northern Pike*

The Partnership's conservation strategies encourage collaboration among multiple partners to achieve common objectives that would be difficult for any one partner to accomplish alone. In some cases, comprehensive protection can be accomplished with revisions to local and state laws and increased enforcement of such laws; some strategies recommend such changes but in no way bind affected agencies to implement these strategies. What follows are objectives and strategic actions that the Partnership thinks it can accomplish in the next 10 to 20 years.

1. Overarching Science Strategies

Objective 1.1: Anadromous Waters Catalog
By 2020, all anadromous fish habitat in the Mat-Su Basin will be included in the Anadromous Waters Catalog and thus given basic protections afforded under state law. Efforts to catalog anadromous fish should also document non-anadromous fish.

Objective 1.2: Comprehensive Surface & Groundwater Studies
By 2012, a comprehensive water quantity program will increase understanding of surface and groundwater, including quantities, flows, and variability in the Mat-Su Basin, and provide information for implementing and monitoring strategies for instream flow needs, stormwater management, fish passage, and climate change.

Objective 1.3: Water Quality Monitoring
By 2010 a comprehensive baseline and monitoring program for water quality exists to track and manage changes in Mat-Su Basin waterbodies.

2. Alteration of riparian areas

Objective 2.1: Identification of Priority Riparian Areas for Salmon
By 2015, 50% of salmon riparian areas will be mapped and prioritized for long-term legal protection and/or restoration.

Objective 2.2: Protection of Priority Salmon Riparian Habitat
By 2015, secure long-term protective status (e.g., conservation easements, designated parks, land acquisition) of at least 10% of priority riparian habitats that have not been significantly altered.

Objective 2.3: Restoration of Priority Riparian Habitat
By 2015, 5% of priority riparian habitats that have been altered are restored.

3. Filling of Wetlands

Objective 3.1: Conserve Wetlands for Salmon
By 2015, loss of wetlands that are important for salmon either as spawning or rearing habitat, re-charge of streams, or filtration of streams, will be avoided, minimized, or mitigated with protection, management, and enhancement.

4. Impervious surfaces and stormwater runoff

Objective 4.1: Minimization of Imperviousness Impacts on Water Quality
By 2012, effective impervious surfaces will remain below five percent in developing watersheds and new housing and urban development sites will not result in stormwater runoff that alters the quantity or quality of water in streams and lakes. All water flowing into salmon habitat will equal or exceed the quality necessary to protect the growth and propagation of fish as determined by state water quality standards for aquatic life.

Objective 4.2: Imperviousness Impact Assessment
By 2010, understand the magnitude of impact of impervious surfaces and stormwater runoff in the most developed watersheds.

5. Septic systems

Objective 5.1: Improved Wastewater Disposal
By 2010, septic systems are designed and constructed based on parcel size, number of parcels in a subdivision, and soil suitability, with an emphasis on developing community systems and connecting to public systems, so that septic systems do not contribute to degraded water quality.

Objective 5.2: Expanded Wastewater Infrastructure
By 2015, Mat-Su Borough and its communities have a wastewater infrastructure and treatment facilities that can handle most of the wastewater in the Mat-Su Borough.

6. Culverts that block fish passage

Objective 6.1: No New Barriers
By 2010, effective fish passage is maintained at new road crossings through improved coordination between agencies, sufficient resources for applying current state statutes, and use of improved design and construction practices for effective fish passage.

Objective 6.2: Fish Passage Restoration
By 2012, fish passage will be restored in 20 priority culverts that currently block passage of juvenile or adult fish.

7. Loss or alteration of water flow or volume

Objective 7.1: Instream Flow on Anadromous Waters
By 2020, applications for reservations of water filed with Alaska Department of Natural Resources for priority anadromous lakes and stream reaches.

Objective 7.2: Community Water Needs Study
By 2012, current and future use and need of ground and surface water by Mat-Su Basin communities are quantified in order to assess impacts to water quantity.

8. Loss of estuaries and nearshore habitats

Objective 8.1: Salmon Use of Cook Inlet
By 2012, understand salmon use of Cook Inlet, temporally and spatially, by lifestage in estuary, nearshore & deep water habitats, in order to identify habitats critical to Mat-Su Basin salmon.

Objective 8.2: Conserve Estuaries for Salmon
By 2015, loss of estuarine and nearshore habitats that are important to salmon either as rearing or migratory habitat in Cook Inlet will be avoided, minimized, or mitigated through regional cooperation.

9. Invasive Northern pike

Objective 9.1: Pathways Analysis
By 2010 understand pathways to invasion of Northern pike in order to predict future systems at risk and prevent introductions to those systems.

Objective 9.2: Introduction Reduction
By 2012, human introductions of Northern pike to additional Mat-Su Basin waterbodies is significantly reduced through education and outreach to the general public.

Measures of Conservation Success

The partnership will monitor effectiveness of strategy implementation by monitoring target viability and the mitigation of potential threats. Results of implementing strategic actions need to be measured to see if strategies are working as planned and whether adjustments will be needed. Measures also allow the planning team to monitor the status of those targets and threats that were not identified as critical but may need to be reconsidered in the future.

The Future for the Mat-Su Salmon Partnership

The Mat-Su Salmon Partnership has developed this Strategic Action Plan to help partners set priorities for collaborative actions to conserve habitat for wild salmon that spawn, rear, or over-winter in the Mat-Su Basin. Relevant actions that could be guided by this plan include regulatory development; permitting; protection, restoration, and mitigation activities; assessment and research projects; and education and outreach activities.

This Strategic Action Plan sets out priorities for this Partnership to conserve wild salmon and their habitat in the Mat-Su Basin. Achievement of these goals and objectives will depend upon commitment by partner organizations and collaboration between partners. The history of salmon in other parts of the world indicates that wild salmon cannot persist in their full abundance unless stakeholders work together to protect salmon habitat. Within this Partnership, each partner has unique capabilities, responsibilities, and resources that can address a key component for salmon habitat. Only in working together, can all the key components for salmon habitat be protected to ensure healthy, abundant salmon runs in the Mat-Su Basin into the future.

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II. Introduction

Chinook, coho, sockeye, pink, and chum salmon all return in great numbers to the streams and lakes of the Matanuska-Susitna (Mat-Su) Basin each summer to spawn. The Susitna River run of Chinook salmon is the fourth largest in the state. Yet rapid growth in the Mat-Su Basin affects quality of life for residents and habitat health for salmon. Across the Mat-Su Basin, residents value healthy fish and wildlife populations, open space, clean air and water, recreational opportunities, and a rural lifestyle. For many, salmon are an integral part of their heritage and culture, and fishing is a regular part of life and an important means of caring for their families. Population growth in the region at its current pace, combined with the current regulatory framework, enforcement, and common development and recreation practices, cause many people concern that these values can not be maintained. The greatest risk to habitat for salmon and other freshwater fish in the Mat-Su Basin may be many small actions compounding over time to degrade riparian habitat and water quality, change water flow and quantity, and block access to habitat.

Mat-Su Basin Salmon Habitat Partnership

The Matanuska-Susitna Basin Salmon Habitat Partnership[1] formed to address increasing impacts on salmon from human use and development in the Mat-Su Basin with a collaborative, cooperative, and non-regulatory approach that would bring together diverse stakeholders. Rapid population growth and the accompanying pressures for development will increasingly challenge the ability of stakeholders to balance fish habitat conservation with these changes over time. 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 fish productivity. *From the beginning, the Partnership has acted with the belief that thriving fish, healthy habitats, and vital communities can co-exist in the Mat-Su Basin.*

There has been a history of fish habitat efforts in the Mat-Su Basin, including culvert replacement, stream restoration, and stream bank stabilization. Many of these were cooperative efforts between government agencies and local organizations. In the fall of 2005, The Nature Conservancy (TNC), the Matanuska-Susitna Borough (MSB), Alaska Department of Fish and Game (ADFG), and U.S. Fish and Wildlife Service (USFWS) formalized a broad-based public and private partnership. From the beginning, this diverse partnership has attracted local community groups; local, state, and federal agencies; businesses; non-profit organizations; Native Alaskans; and individual landowners. The Partnership has sought to include anyone concerned about conserving salmon in the Mat-Su Basin.

This focus on a bottom-up, locally driven, voluntary and non-regulatory effort was inspired by the approach outlined in the National Fish Habitat Action Plan[2] (NFHAP) (NFHB 2005). The mission of NFHAP is to "protect, restore, and enhance the nation's fish and aquatic communities through partnerships that foster fish habitat conservation and improve the quality of life for the American people." NFHAP further identifies four goals:

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[1] The partnership originally formed as the Mat-Su Basin Salmon Conservation Partnership and changed the name in spring 2008. For more about the partnership, visit www.nature.org/wherewework/northamerica/states/alaska/preserves/art18561.html

[2] www.fishhabitat.org

1. Protect and maintain intact healthy aquatic systems;
2. Prevent further degradation of fish habitats that have been adversely affected;
3. Reverse declines in the quality and quantity of aquatic habitats to improve the overall health of fish and other aquatic organisms, and;
4. Increase the quality and quantity of fish habitats that support a broad natural diversity of fish and other aquatic species[3].

Fish habitat partnerships form the core force for accomplishing NFHAP goals. The National Fish Habitat Board (NFHB) formally recognized the Mat-Su Salmon Partnership in 2007 as one of the first four fish habitat partnerships in the country. The Partnership operates under the guidance of NFHAP and currently includes over 36 individuals and organizations (Table 1; Appendix 1). A Steering Committee composed of seven Partner organizations meets monthly to actively seek and encourage Partner membership and to schedule and coordinate Partnership activities. The purposes of the Partnership are to:

1. improve communication between partners to increase opportunities to work together on fish, fish habitat, and water quality issues;
2. address common goals together to provide efficiencies and determine priorities, and;
3. enhance funding opportunities for fish conservation through public and private sources.

Table 1. Mat-Su Basin Salmon Habitat Partnership
AK Dept of Commerce, Community & Economic Development
AK Dept of Environmental Conservation
** AK Dept of Fish & Game*
AK Dept of Natural Resources
AK Dept of Transportation & Public Facilities
Alaska Center for the Environment
Alaska Outdoor Council
Alaska Railroad Corporation
Alaskans for Palmer Hay Flats
Aquatic Restoration & Research, Inc.
Bureau of Land Management
Butte Area Residents Civic Organization
** Chickaloon Village Traditional Council*
ConocoPhillips Alaska, Inc.
Cook Inlet Aquaculture Association
Cook Inletkeeper
Environmental Protection Agency
** Friends of Mat-Su*
Glacier Ridge Properties
Great Land Trust
Knik River Watershed Group
Matanuska River Watershed Coalition
** Matanuska-Susitna Borough*
** National Marine Fisheries Service*
National Park Service
Native Village of Eklutna
Natural Resources Conservation Service
Palmer Soil & Water Conservation District
Paul McLarnon
Sierra Club
The Conservation Fund
** The Nature Conservancy*
Upper Susitna Soil & Water Conservation District
US Army Corps of Engineers
** U.S. Fish and Wildlife Service*
US Geological Survey
USDA Forest Service
Wasilla Soil & Water Conservation District
Note: *indicates Steering Committee member Partners as of July 2008

The Intent of this Strategic Action Plan

The Partnership Steering Committee developed the Strategic Action Plan to identify Partnership long-term goals and strategies and to provide a tool the Partnership can use to prioritize projects related to fish habitat goals in the Mat-Su Basin. The intent of this Strategic Action Plan is to identify long-term goals, strategies, and voluntary actions that the Partnership and others can undertake to conserve salmon habitat. A subsequent process has been used to prioritize fish habitat related projects and actions in this plan[4]. The Steering Committee plans to revisit this Strategic Action

[3] National Fish Habitat Board has drafted interim strategies and targets for the NFHAP that could be implemented prior to completion of the first national fish habitat assessment in 2010. These are detailed at fishhabitat.org/images/documents/science/final_interim_strategies_targets.pdf.

Plan every 3 to 5 years. If changes in the Mat-Su Basin significantly affect the situation for salmon habitat before then, the plan will be updated more frequently.

The Partnership developed this Strategic Action Plan to identify collaborative projects and other actions that will protect and restore important habitat for wild salmon in the Mat-Su Basin. The Steering Committee initiated the plan under the guidance of the NFHAP and administered the planning process[5]. The NFHAP clearly identifies fish habitat as the focus for partnerships. The Steering Committee decided that the planning process would focus exclusively on habitat-related issues to remain consistent with the intent of the NFHAP and the Mat-Su Salmon Partnership. The plan scope includes not only freshwater fish habitat in the Mat-Su Basin, but nearshore, estuarine, and marine habitat in Upper Cook Inlet as well (Figure 1).

The Steering Committee identified three specific purposes for the plan:

1. Identify important habitats for salmon and other fish species in the Mat-Su Basin.
2. Prioritize fish habitat conservation actions, including protection, enhancement, and restoration of key habitat, education and outreach, research, and mitigation.
3. Identify potential collaborations and funding sources for partners to address fish habitat conservation.

Several partners raised fishery allocation issues during the planning process. These issues were specifically not included in the scope of this plan because doing so would substantially change the nature of the plan and likely shift the focus away from the purposes for which the Mat-Su Salmon Partnership formed. While the plan does not address fishery allocation, Alaska is uniquely equipped to deal with these issues through the Alaska Board of Fisheries, the state legislature, and local fish and game advisory councils. These processes are open and available to the public, including Mat-Su Salmon Partnership individuals and groups.

Many agencies and organizations have undertaken planning efforts in the Mat-Su Basin that directly or indirectly include fish habitat issues (Appendix 3). These plans addressed land management (e.g., ADNR Recreation Rivers and Susitna Area Plan), large-scale development (e.g., Susitna hydroelectric studies), population growth (e.g., MSB Comprehensive Plan), fish conservation (e.g., ADFG sportfish implementation), overall conservation goals (TNC Cook Inlet Basin Ecoregional Assessment), and watershed management (Matanuska River studies by Natural Resource Conservation Service). The Cook Inlet Regional Salmon Enhancement Plan (CIRPT 2007) addresses the rehabilitation of natural stocks and identifies natural stocks sanctuaries and preserves. The Alaska Clean Water Actions (ACWA) program brings three state agencies together to share data and expertise and to identify projects that will restore, protect or conserve water quality and quantity, and aquatic habitat on waters that have been identified to have impaired water quality. Many of the people involved in other planning efforts are Mat-Su Salmon Partners who also participated in this planning process. This Strategic Action Plan

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[4] *Prioritization of Strategic Actions Identified in the Mat-Su Basin Salmon Strategic Action Plan, 2008,* is available at conserveonline.org/workspaces/MatSuSalmon.

[5] The next chapter provides an overview of the planning process. Notes and materials from planning workshops can be found at conserveonline.org/workspaces/MatSuSalmon.

Figure 2. The Scope of the Strategic Plan: Mat-Su Basin and Upper Cook Inlet

therefore benefits from past planning efforts through the participation, experience, and knowledge those people brought to address fish habitat in the Mat-Su Basin.

A cooperative and voluntary approach to protection and restoration of salmon habitat can ensure that healthy salmon populations and healthy human populations co-exist in the Mat-Su Basin. This Strategic Action Plan is the Mat-Su Basin Salmon Habitat Partnership's vision for doing that. The plan is non-binding on any partner and collaboration is emphasized as the vehicle for increasing effectiveness. These strategies will be implemented by the Partnership as a whole or by individual partners. Funding sources may include annual agency budgets, state and federal grants, private foundations, corporate gifts, and in-kind contributions of time, supplies, and equipment. In accordance with its formation under the National Fish Habitat Action Plan, the Partnership will focus on ensuring that wild salmon have healthy habitat in the Mat-Su Basin.

Mat-Su Basin Landscape and Species

The Matanuska and Susitna watersheds encompass about 24,500 square miles, roughly the combined size of Vermont, New Hampshire, and Massachusetts (Figure 1). The combined Mat-Su Basin extends from near the highest point in North America (Mount McKinley at 20,320 feet) to sea level at Cook Inlet. Three mountain ranges – the Alaska, Chugach, and Talkeetna – ring the Mat-Su Basin. Glaciers, which still remain in some places, shaped these mountains, so cirques and U-shaped valleys are common features due to extensive glaciation. At the higher elevations, vegetation is sparse. Willow, birch, and alder shrubs occupy the more protected lower slopes and valley bottoms.

Small streams from the mountains combine to form larger creeks and rivers at lower elevations. Many of these rivers, including the Susitna, Little Susitna, Matanuska, and Knik, terminate in broad estuarine areas along Cook Inlet. Alder and willows dominate river floodplains. The uplands between streams are mostly forests of white spruce, birch, and aspen. Wetlands are common in the Mat-Su Basin, and can be characterized by grasses, small shrubs or black spruce trees. Lakes and ponds are also numerous and may be connected by small streams and fringed with wetlands. Within the Mat-Su Basin, more than 23,900 miles of streams and 1,340,000 acres of wetlands have been mapped; yet much of the basin has not been adequately surveyed so the total extent of salmon habitat streams, wetlands, and lakes is still being documented.

The Mat-Su Basin provides all the freshwater life history needs of Pacific salmon: Chinook, coho, sockeye, pink, and chum. The Susitna River run of Chinook salmon is the fourth largest in the state, with 100,000 – 200,000 returning each year (ADFG 2006). Other common fishes are Arctic grayling, rainbow trout, Dolly Varden, whitefish, sticklebacks, sculpin, lamprey, burbot, and eulachon. The many lakes in the Lake Louise area at the headwaters of the Susitna River support a unique freshwater fish assemblage, including lake trout and pond smelt, not present in most other areas of the Mat-Su Basin. These salmon and other fish are a vital food source for many terrestrial species in the Mat-Su Basin, including brown bear, black bear, and bald eagles.

Upper Cook Inlet, approximately 3,700 square miles north from Anchor Point on the Kenai Peninsula (Figure 1), provides nearshore rearing habitat for juvenile Mat-Su salmon (Nemeth et al. 2007) and migration corridors for returning salmon. Much of the shoreline is characterized by mixed sand and gravel beaches, and exposed tidal flats. Past glaciation left silty, fine-grained mudflats along the inlet's shores. Coastal wetlands and bays along the shores of Cook Inlet provide staging areas for large seasonal aggregations of waterfowl and shorebirds. Beluga whale and harbor seals feed on salmon and other fish, including Pacific herring.

Just as glaciers contributed to formation of the mountains and mudflats, other natural disturbances shape the landscape and create the diverse habitat that is required to support salmon and other aquatic life in the Mat-Su Basin (Pickett and Thompson 1978). Natural disturbances such as flooding, fire, volcanic eruptions, and earthquakes are often most noticeable for their quick and significant impacts. Fires are common in the Susitna River drainage and often left to burn when homes and communities are not threatened. Flooding can cause erosion and greatly affect the deposition of gravel and sediments along streams. High water flows occur annually, usually in August and September due to heavy precipitation. Eruptions from volcanoes on the west side of Cook Inlet can play a significant disturbance role through ash deposition and coastal elevation change. In 1964 the largest earthquake recorded in North America permanently changed the elevations of many coastal areas around Cook Inlet. Forests changed to salt marsh where ground settlement allowed coastal flooding (UAF Sea Grant 2002).

Other natural processes change the landscape more slowly over time. Tides in Cook Inlet undergo one of the highest range in the nation, ranging up to 30 feet. Rivers deposit glacial sediment into the Inlet, where much of the sediment is redistributed and deposited onto the extensive tidal flats (ADNR 1999). Mixing of fresh and saltwater influence the high productivity found within the inlet. Erosion from moving ice can also affect the surrounding coastline. Climate shapes the land and affects the type of vegetation that occurs on the landscape, affects stream-flow, and influences many other ecological processes (e.g., fires, insects, etc.). Evidence is growing that climate in Alaska is undergoing an unusual degree of change. When compared to the rest of the U.S., Alaska is thought to have experienced the largest regional warming of all states (ARAG 1999). Using predictive models, USGS (2001) reported that 15 non-glacial streams in the Cook Inlet Basin are expected to have a water temperature change of $3^{o}C$ or more, which is considered significant for the incidence of disease in fish populations.

People in the Mat-Su Basin

The human population of the Mat-Su Basin is one of the fastest growing in the United States. From 1990 to 2000, the population grew at a rate of 49% – nearly four times the statewide growth rate of 13%. In 2005, the population was roughly 74,000 (Fried 2007). The state projects that the population of the Mat-Su Borough, whose boundaries roughly correspond to the Mat-Su Basin, will reach 100,000 before 2020 (Fried 2007). A combination of proximity to Anchorage, a rural setting, and lower housing prices is likely stimulating the rapid growth (Brabets et al. 1999; Fried 2007; Leask et. al. 2001). The Mat-Su Basin's many lakes and streams are desirable places to site homes and businesses. Over a third (35%) of Mat-Su Borough residents commute to Anchorage, where housing prices are higher but jobs are more plentiful (Fried 2007). Expansion of residential subdivisions and the development of recreational homes in areas outside established communities is an increasingly common occurrence and has led to the proliferation of homes and cabins along streams and lakes. Tourism, one of the most rapidly growing industries in Alaska, supports much of the population growth (Fried 2007). Health care, retail trade, and government are also major contributors to employment growth in the Mat-Su Borough (Fried 2007). The Mat-Su Basin – in particular the Matanuska watershed – has a rich history of farming. But as in many places in the U.S., agricultural areas are being converted to residential subdivisions and recreational properties, requiring additional service and transportation infrastructure. Extraction of natural resources, including gravel, minerals, timber, and petroleum, occurs here, too.

The Mat-Su Basin offers world-class fly-in and road-accessible sportfishing and sees nearly 300,000 angler days of sportfishing effort annually (Sweet et al. 2003). In 1986, sportfishing contributed over $29 million to the local economy; this figure has likely increased 15 to 25% in the last 20 years (Sweet et al. 2003). Many Alaskans also rely on these fisheries to put food on the table, harvesting roughly 115,000 Chinook and coho from area streams each year. Harvest of fish and wildlife for subsistence purposes in the Mat-Su regions is, on average, 27-40 pounds annually per person compared to Anchorage where it is 16-35 lb per person (Leask et. al. 2001).

Figure 2. Land Management and Ownership of the Mat-Su Basin

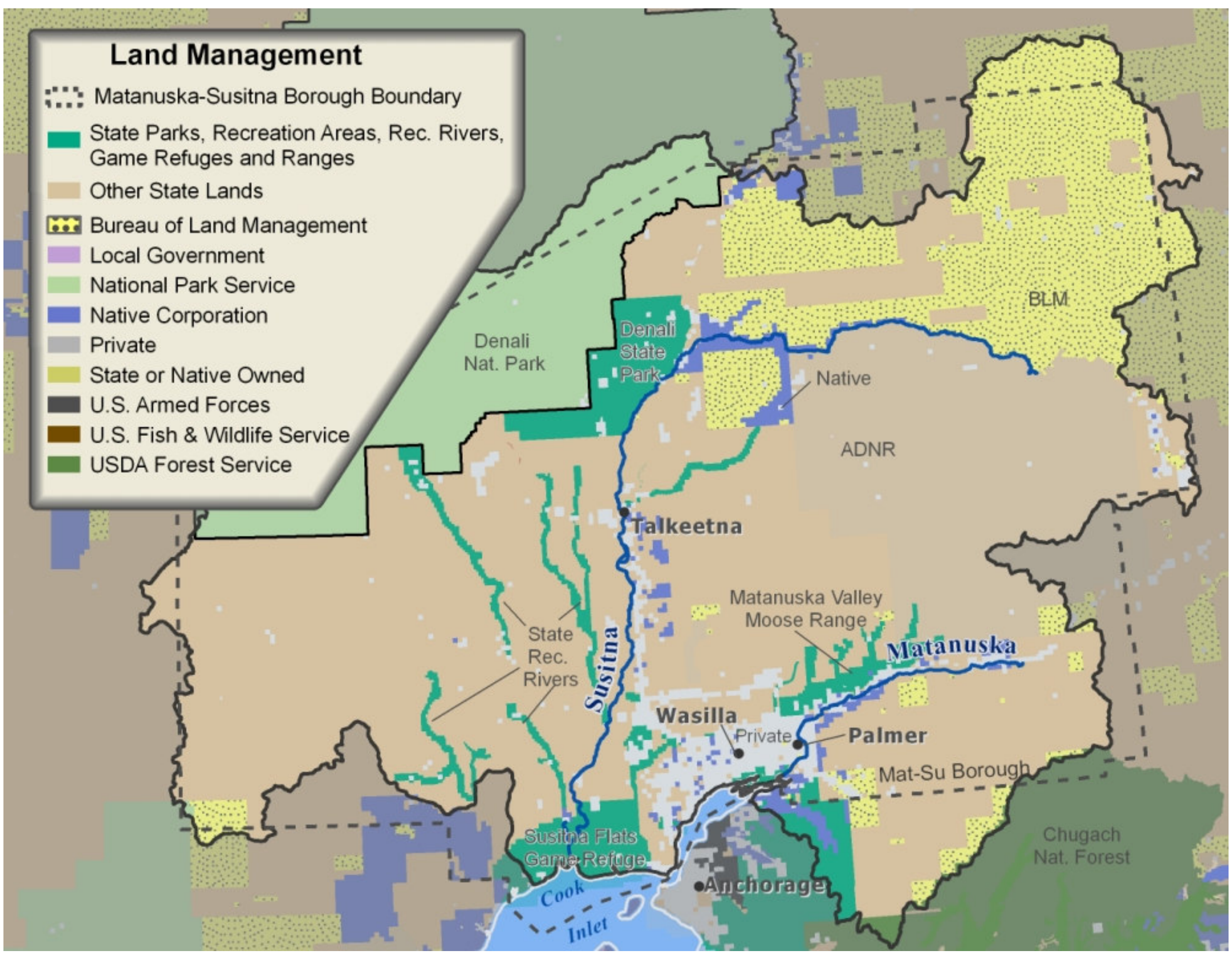


Table 2. Land Ownership in the Mat-Su Basin

Major Landowner	Percent
State of Alaska	63
Federal Government	30
Private	4
Mat-Su Borough	1
Native Corporations	1
Mental Health Land Trust	<1
University of Alaska	<1
Local Cities	<<1
Total	**100%**

As with the State of Alaska as a whole, most of the land within the Mat-Su Basin is owned by the state and federal governments (Table 2; Figure 2). The state owns nearly two-thirds of the Mat-Su Basin, with a small portion of those lands managed by the Mental Health Land Trust and the University of Alaska. The state manages some lands primarily for their natural and recreational values: Denali State Park, Susitna Flats State Game Refuge, Palmer Hay Flats State Game Refuge, Matanuska Valley Moose Range, and several state recreation areas and rivers. The federal government's holdings are mostly in the high elevations of the Northern Susitna watershed. The Bureau of Land Management manages large tracts of land in the headwaters of the Susitna River, and the National Park Service operates Denali National Park in the high mountains of the Alaska Range at the northwest edge of the Mat-Su Basin. Local governments and private entities own less than 7% of the Mat-Su Basin. Most of the private lands are concentrated along the Glenn and Parks Highways and around the cities of Palmer, Wasilla, and Houston.

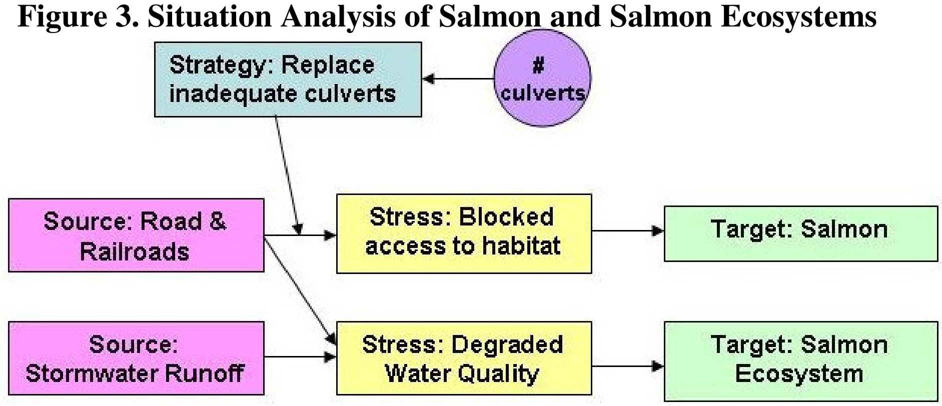
III. Overview of Planning Process

When deciding how to develop a strategic action plan, the Mat-Su Salmon Partnership looked for a process that would enable a broad look at salmon and their habitat and provide an integrated approach for prioritizing issues, implementing strategies, and measuring success of projects. Conservation Action Planning (CAP) is an iterative process that focuses on the biodiversity of concern and emphasizes adaptive management throughout the life of the project[6]. CAP is the emerging planning practice of a wide and expanding set of international conservation organizations (e.g., Conservation Measures Partnership[7]) and an approved method of a growing number of government agencies.

In the CAP methodology, the biodiversity of interest (i.e., **conservation targets**) is identified and current health is diagnosed with a **viability assessment**. The stresses to that health, and the various sources of the stress, are ranked for each target to identify **potential threats**. This situation analysis (Figure 3) helps to identify **conservation strategies** that will have the greatest benefit to the target or mitigation of the threat. Monitoring indicators (i.e., **measures of success**) track effectiveness of strategies so that strategies and target health can be assessed.

What follows is a brief description of the major components of CAP. Its application to this Strategic Action Plan is explained in the following chapters. Appendix 9 summarizes the steps in a CAP process and various appendices provide details on the various components for this Strategic Action Plan.

Figure 3. Situation Analysis of Salmon and Salmon Ecosystems



Conservation targets

Conservation targets are a limited suite of species and ecological systems (i.e., ecosystems) that are chosen to represent and encompass the biodiversity found in the project area. Ecosystems are assemblages of ecological communities that occur together on the landscape and share common ecological processes (e.g., flooding), environmental features (e.g., geology), or environmental gradients (e.g., precipitation) (Low 2003). Targets are the basis for setting goals, carrying out conservation actions, and measuring conservation effectiveness. Conservation of these targets should ensure the conservation of all native biodiversity within functional landscapes. The biodiversity of many places can be reasonably well defined by eight or fewer well-chosen targets. Target selection will also help define the geographical extent of the planning area. With the Partnership's focus on Mat-Su Basin salmon, targets in this plan include salmon and the ecosystems they need to provide habitats throughout their life cycle. Appendix 4 lists other

[6] More information about Conservation Action Planning is available at conserveonline.org/workspaces/cbdgateway/cap.
[7] The Conservation Measures Partnership is composed of conservation organizations that seek better ways to design, manage, and measure the impacts of their conservation actions. www.conservationmeasures.org/CMP.

species, ecological communities, and ecological system targets whose conservation needs are assumed to be subsumed by one or more of the conservation targets.

Viability Assessment

The viability assessment is a science-based foundation for establishing the current health of the conservation targets and setting clear goals linked to target ecology. Each conservation target has certain characteristics or key ecological attributes that can be used to help define and assess its ecological viability. These attributes are critical aspects of the target's biology or ecology that, if missing or altered, would lead to the loss of that target over time. Most attributes have some natural variability over space and time. For Mat-Su Basin salmon, these key attributes are critical components of salmon life history, including physical and biological processes that if degraded or missing would seriously jeopardize the ability for healthy salmon runs to persist over time. Each key ecological attribute can either be measured directly or will have one or more associated indicators that can be measured to represent the attribute's status. Indicators should be biologically and socially relevant, sensitive to changes caused by human activity, measurable, and cost-effective to assess.

Target viability is based on the current status of each key ecological attribute. The current status is determined by ranking each indicator according to whether or not the indictor is functioning within its range of acceptable variation and whether some human intervention may be required. Defining the current status and what a healthy state looks like is the key to knowing which targets are most in need of immediate attention and for measuring success over time.

Potential Threats

Threats are composed of stresses and sources of stress. A stress is defined as a process or event with direct negative consequences on the conservation targets. Stresses are typically expressed as degraded, altered, or impaired key ecological attributes (e.g., degraded water quality). A source is the proximate cause of a stress (e.g., oil spill in freshwater) (Low 2003). Potential threats are based on assumptions about the extent to which each conservation target might be affected over the next 10 years under current circumstances. Natural disturbances can negatively affect targets, but this plan focuses on stresses that are directly or indirectly caused by human sources.

Stresses and sources are ranked for each conservation target. Stresses are ranked based on the severity of impact and scope of damage expected within 10 years under the current circumstances. Sources of stress are ranked based on the relative contribution to the stress and the irreversibility of the stress due to this source. A conservation target's stress and source rankings are analyzed together to identify critical threats for each target.

Conservation Strategies

Conservation strategies are high-level strategic actions that will achieve objectives that abate critical threats and/or enhance target viability (Low 2003). Strategies are developed based on an understanding of the cultural, political and economic situation behind potential threats. Objectives are specific and measurable statements of what success looks like. Objectives define what needs to be accomplished and become the measuring stick against which progress can be gaged. Objectives can be set for and linked to the abatement of threats, restoration of degraded key ecological attributes, or the outcomes of specific conservation actions. A good objective meets the criteria of being specific, measurable, achievable, relevant, and time limited. Strategic actions are sets of interventions that will achieve the objectives.

Measures of Success

Results of implementing strategic actions need to be measured to see if strategies are working as planned and whether adjustments will be needed. Measures also allow the planning team to monitor the status of those targets and threats that were not identified as critical but may need to be reconsidered in the future. An indicator is a measure of a key ecological attribute, critical threat, objective, or other factor. The challenge is to select the *fewest* number of indicators required to measure both the effectiveness of the strategies for the priority objectives and the status of targets and threats that are not initial priorities (e.g., a low-ranked potential threat that might become a major problem).

Data Availability and Assumptions

This strategic plan was developed from existing information sources (literature and data sets), spatial GIS data, and professional opinion. Partners with professional expertise provided information on stock status, habitat connectivity, hydrology, water quality, resource management, restoration, conservation, and other interrelated subjects pertaining to salmon and their habitats. A variety of GIS layers were compiled: transportation, hydrography, freshwater fish distribution, culverts, digital elevation models, impervious surfaces, land cover, wetlands, land management, soil suitability for drainfields, and water rights. Baseline data is a significant limitation throughout Alaska, so some assumptions based on limited information were necessary in the viability, stress, and threats assessments (Appendices 5, 6 and 7). Conservation strategies include actions for addressing these data and information gaps.

The Planning Team

The planning team, composed of three working groups (Appendix 1), met in a series of workshops in 2007 to go through the CAP process to develop the Strategic Action Plan (Appendix 2). The Steering Committee determined the scope of the plan, set parameters for the plan, and monitored the planning process. The Steering Committee ensured that the broad scope of perspective of the Partnership was included by inviting partners to participate on working groups and eliciting partner opinions. Responsibility for updating the Partnership and seeking review also sat with the Steering Committee.

With guidance from the Steering Committee, two working groups, composed of volunteers from partner organizations, used the CAP process to determine priorities for the Partnership. The Science Working Group was composed of people with knowledge about salmon and their habitat in the Mat-Su Basin, including hydrologists, biologists, ecologists, and naturalists. They defined conservation targets for salmon and salmon ecosystems in the Mat-Su Basin, identified the factors that describe the health of salmon and their habitat, and assessed the current state of those factors. They then identified stresses and their sources that affect salmon and their habitats and ranked these potential threats. The Science Working Group recommended which potential threats and stresses to salmon that the Partnership should concentrate conservation effort on and participated in developing strategies for those potential threats.

The Implementation Working Group included people who will carry out conservation strategies in the Mat-Su Basin. The range of strategies is broad, thus requiring a broad range of skilled partners, so this group included parties that are expected to help carry out conservation work for salmon and salmon ecosystems in the Mat-Su Basin. The Implementation Working Group analyzed the situation for each potential threat to look for the root causes and leverage points for successful implementation of conservation strategies. They defined objectives for salmon conservation activities by the partnership and identified the actions required to achieve those objectives. They also identified opportunities for their organization to participate in implementation of the Strategic Action Plan.

IV. Conservation Targets

Because Pacific salmon are the primary focus of the Partnership, the conservation targets are based on conserving all of the life history needs required for wild Mat-Su Basin salmon to thrive. Examples of life history needs include: cold, clean water and suitable amounts in lakes and streams; cover from predators; the ability to migrate within and between streams, lakes, and off-channel habitats; clean spawning gravel; and abundant food resources for juveniles. Although there are many differences in life history needs and habitat requirements for Pacific salmon species in Alaska, there are also some similarities that allow multiple species to be considered together.

In selecting conservation targets, factors that have the potential to affect salmon and their habitat were also considered. Some factors can have direct impacts on fish while others affect terrestrial and aquatic habitats and indirectly affect fish. For example, Northern pike affect salmon populations directly through predation, whereas alteration of riparian habitat affects salmon indirectly through processes that change instream habitat and stream morphology. The geographic extent of these factors can also help to define targets. For example, riparian alteration associated with housing and urban development is more pronounced on the east side of the Susitna River than on the west side. Land status and ownership can also delineate system targets due to ownership influence on stresses and likely mitigation strategies.

The final list of conservation targets includes both salmon species group targets and several ecosystem targets. The salmon species group targets focus on wild salmon (i.e., naturally spawning fish) and were selected based on similarities in freshwater life history needs, current conservation status in the Mat-Su Basin, and level of available species distribution and abundance data. Ecosystem targets were defined by vegetative, landscape, and geomorphological characteristics and prevalent stresses and sources. Broad ecosystems support the ecological processes, landforms, and vegetation that interact to form salmon habitat. The processes that must be maintained or restored if salmon habitat is to remain productive include high water events, groundwater flows, and gravel transport.

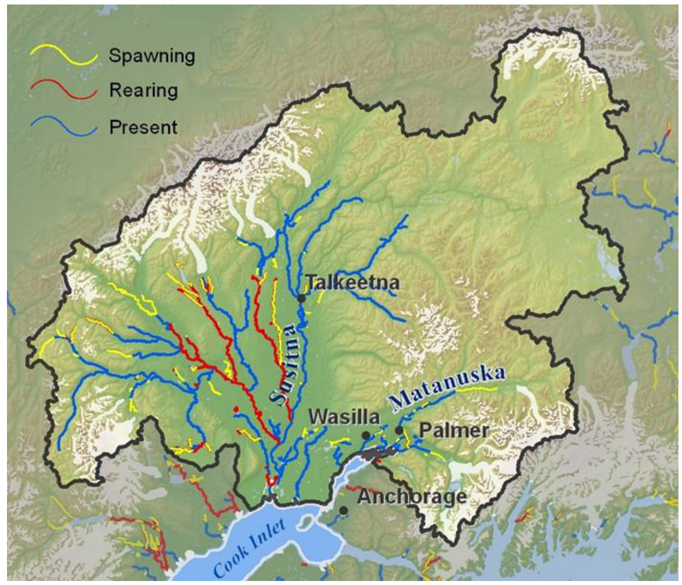
Conservation targets for salmon and their habitat in the Mat-Su Basin:

- Sockeye salmon
- Pink and chum salmon
- Chinook and coho salmon
- Upland Complex
- Lowland Complex – West of the Susitna River
- Lowland Complex – East of the Susitna River
- Lake Complex
- Upper Cook Inlet Marine

Sockeye salmon

Sockeye salmon (*Oncorhynchus nerka*) spawn and rear in numerous lake and river systems in the Mat-Su Basin (Figure 4). Most sockeye salmon spawning occurs in lakes and their associated tributary streams during late summer and fall. After fry emerge from the gravel the following spring, juvenile sockeye typically spend one or two years rearing in lakes before migrating to the ocean. Sockeye spend another one to three years maturing and growing in the ocean before returning to spawn as adults. Sockeye salmon are not grouped with any other species because of the strong dependence on lakes to complete their life cycle in freshwater.

Figure 4. Sockeye Salmon Distribution and Lifestages in the Mat-Su Basin



Sockeye salmon spawning has been identified in over 1845 river miles in the Mat-Su Basin (ADFG 2007). Estimates of total escapement derived from weir, sonar, or tagging data are limited, and ADFG has developed escapement goals for only two stocks – Yentna River and Fish Creek (Hasbrouck and Edmundson 2007). Alaska Department of Fish and Game (ADFG) monitors sockeye escapement with a weir on Fish Creek in the Big Lake drainage, a sonar project on the Yentna River, and an annual index survey of Bodenburg Creek in the Matanuska River drainage. The Department is also conducting a three year project to estimate total escapement to the Susitna River using mark – recapture techniques. Recent data from ADFG suggest that the Yentna system may not be as indicative of other systems in the Susitna River drainage as previously thought. Research is ongoing to address this concern.

Residents of the Mat-Su have expressed concern about the health of sockeye stocks in the Mat-Su Basin. Both Yentna River and Fish Creek have not met escapement goals in some recent years (Hasbrouck and Edmundson 2007), and the Alaska Board of Fisheries has identified the Susitna River sockeye salmon stock as a stock of yield concern (ADFG 2008). At least seven major lakes in the Susitna River drainage provide most of the known rearing and spawning habitat for sockeye production and the loss of any one stock would be significant (Sam Ivey, ADFG, personal communication). Although these lakes receive the majority of spawners, significant contributions toward overall productivity of Mat-Su sockeye comes from minor systems, which include small lakes and streams as well as mainstem and side channel spawning and rearing areas in the Susitna River drainage, Knik Arm streams, and the Knik and Matanuska rivers (Barrett et al. 1985).

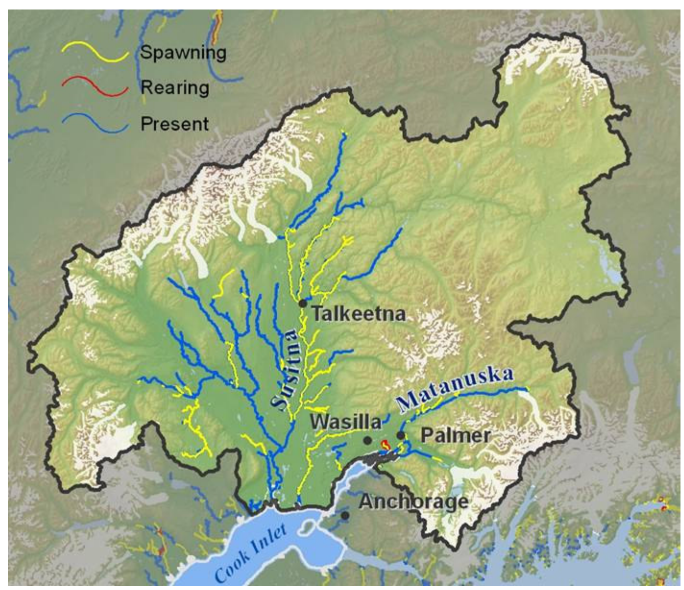
Sockeye salmon stocks originating in the Mat-Su Basin are harvested in mixed-stock set- and drift-gillnet commercial fisheries in Upper Cook Inlet north of Anchor Point (Fox and Shields 2005). Most sockeye harvested in Upper Cook Inlet commercial fisheries are from stocks returning to the Kasilof and Kenai rivers, but stock-specific estimates of contribution for Mat-Su Basin sockeye are unknown at this time. ADFG fisheries management actions to ensure adequate escapement of Mat-Su sockeye stocks usually involve restricting commercial and sport fisheries. The commercial drift gillnet fishery in the Central District and the commercial set gillnet fishery in the Northern District are restricted as needed to ensure adequate escapement, and emergency orders in recent years have restricted sport fishing harvest (E.O. 2-RS-2-18-04, E.O. 2-RS-2-27-05, E.O. 2-RS-2-25-06, and E.O. 2-RS-2-35-07). Over 10,000 sockeye are harvested each year in Mat-Su sport fisheries (Sweet et al. 2003). Sockeye also support a limited subsistence fishery on the Upper Yentna River near Skwentna.

Pink and chum salmon

Because of similarities in life history needs, current conservation status in the Mat-Su Basin, and the level of available data, pink (*O. gorbuscha*) and chum (*O. keta*) salmon are combined as a single conservation target. Pink and chum salmon spawn in many rivers and streams in the Mat-Su Basin (Figure 5). Pink and chum salmon spawn on gravel bars and pool tail-outs during late summer and fall, and juveniles spend little time in freshwater after emerging from the gravel in spring before migrating to the ocean. Pink salmon only spend one year in the ocean before returning to spawn the following summer, whereas chum salmon can spend between one and five years maturing in the ocean before returning as adults to spawn. Pink salmon runs in Upper Cook Inlet are dominated by returns in even-numbered years (Fox and Shields 2005).

Pink salmon have been documented to occur in over 1227 river miles in the Mat-Su Basin, and chum salmon have been documented in 1141 river miles (ADFG 2007). ADFG has not developed escapement goals for either species (Hasbrouck and Edmunson 2007). Pink and chum salmon escapement is only monitored incidentally at other locations, and no targeted escapement data are collected. Little is known about the status of populations in the Mat-Su Basin for either species, although commercial harvests and incidental escapement counts in recent years seem to indicate that pink and chum salmon populations are recovering from record low returns attributable to severe fall flooding in 1986 (Fox and Shields 2005).

Figure 5. Pink & Chum Salmon Distribution and Lifestages in the Mat-Su Basin



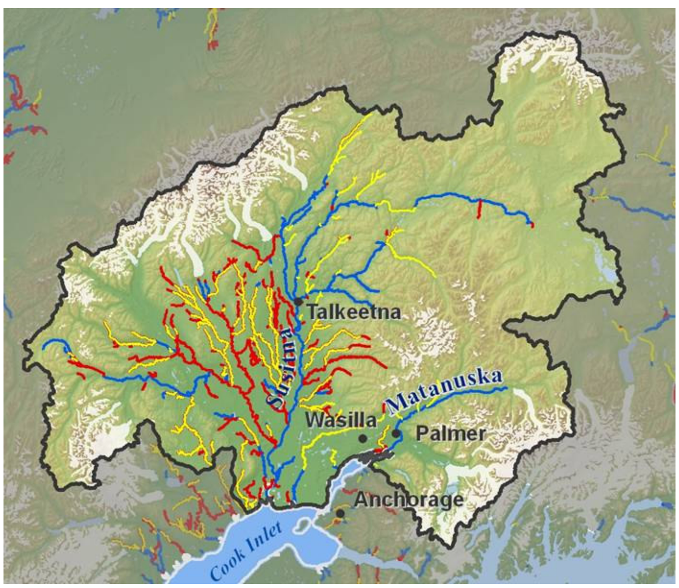
Commercial harvest of pink salmon in Upper Cook Inlet totaled over 2 million fish in the 1960's, but harvests have declined dramatically following severe fall flooding in 1986 – averaging less than 350,000 for even numbered years from 1996 to 2004 (Fox and Shields 2005). Chum salmon commercial harvests have also declined dramatically since 1986, and less than 200,000 fish have been harvested in most years from 1996 to 2004 (Fox and Shields 2005). Although harvest levels for pink and chum have been low in recent years, harvest of both species in the commercial fishery is affected by closures and restrictions to protect sockeye salmon stocks.

Low prices have also reduced fishing effort in recent years. Average sport harvest of pink salmon exceeds 10,000 fish and average sport harvest of chum salmon is over 5,000 fish (Sweet et al. 2003); neither species supports subsistence or personal use fisheries in the Mat-Su Basin. Since harvest of chum and pink salmon is limited due to preference for sockeye and coho salmon in the sport fishery, catch is the best indicator of stock status within the sport fishery; catch rates on the Susitna River have declined since 2003 (Sam Ivey, ADFG, personal communication).

Chinook and coho salmon

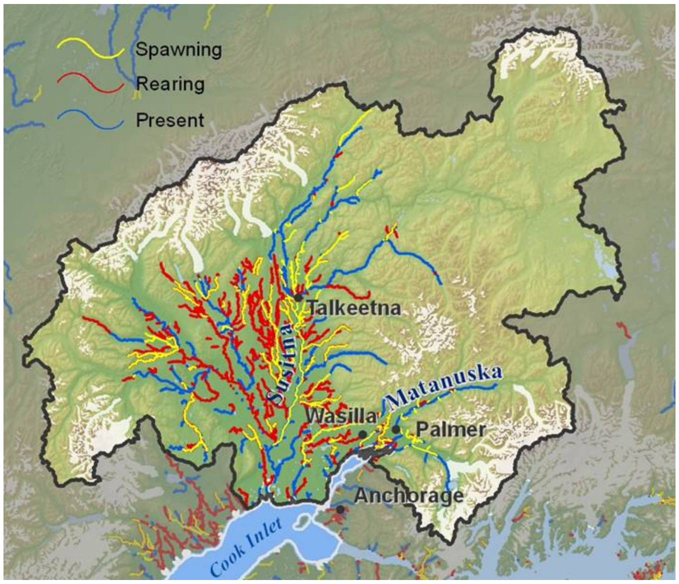
Chinook (*O. tshawytscha*) and coho (*O. kisutch*) salmon were also combined as a single conservation target because of similarities in life history needs, current conservation status in the Mat-Su Basin, and the level of available data. Chinook salmon generally spawn in deeper flowing waters during late summer (Figure 6), whereas coho salmon generally spawn throughout many headwaters during the fall (Figure 7). Juvenile Chinook emerge from the gravel as fry in the spring and spend one year rearing in freshwater before migrating to the ocean the following year. Chinook salmon spend between one and five years in the ocean before returning to spawn as adults. Coho juveniles can spend from one to three years rearing in freshwater, and usually spend one year maturing in the ocean before returning to spawn. Juvenile Chinook salmon generally rear in pools of larger streams and rivers, whereas coho juveniles prefer smaller tributary streams, backwater and off-channel habitats, and beaver ponds.

Figure 6. Chinook Salmon Distribution and Lifestages in the Mat-Su Basin



Chinook salmon have been documented in 2,815 river miles in the Mat-Su Basin (ADFG 2007), and escapement goals have been developed for 15 streams (Sweet et al. 2003; Hasbrouck and Edmundson 2007). Escapement monitoring for Chinook salmon is largely conducted with aerial surveys. Coho salmon spawning has been documented in 3,218 river miles (ADFG 2007). Escapement goals have been established for the Little Susitna River and McRoberts Creek in the Jim Creek drainage (Hasbrouck and Edmundson 2007). Total escapements of coho salmon are monitored with weirs on the Deshka and Little Susitna rivers. ADFG uses the Little Susitna River weir count as an index of coho salmon escapement for all Knik Arm stocks (Fox and Shields 2005). Several other Knik Arm stocks continue to be monitored with foot surveys, which were shown to be highly correlated with weir data (Hasbrouck and Edmundson 2007). Escapement monitoring of other coho stocks outside of Knik Arm is difficult and many escapements are not monitored. Where data exist, Chinook and coho salmon stocks in the Mat-Su Basin appear to be doing well and escapement goals have generally been met or exceeded on a regular basis (Fox and Shields 2005). One exception is

Figure 7. Coho Salmon Distribution and Lifestages in the Mat-Su Basin



Alexander Creek, a tributary to the Susitna River. The escapement goal (range of 2,100 to 6,000) has not been met for the last two years and ADFG expects it will be a chronic problem.

A commercial fishery (set gillnet) for Mat-Su Basin Chinook salmon stocks occurs in the Northern District of Upper Cook Inlet, and harvest is limited to 12,500 fish; harvests from 1996 to 2004 have been below 3,000 (Fox and Shields 2005). Chinook salmon support large and popular sport fisheries in the Mat-Su Basin and average annual sport harvest of Chinook salmon exceeds 20,000 fish (Sweet et al. 2003). Few Chinook salmon are harvested in subsistence or personal use fisheries in the Mat-Su Basin.

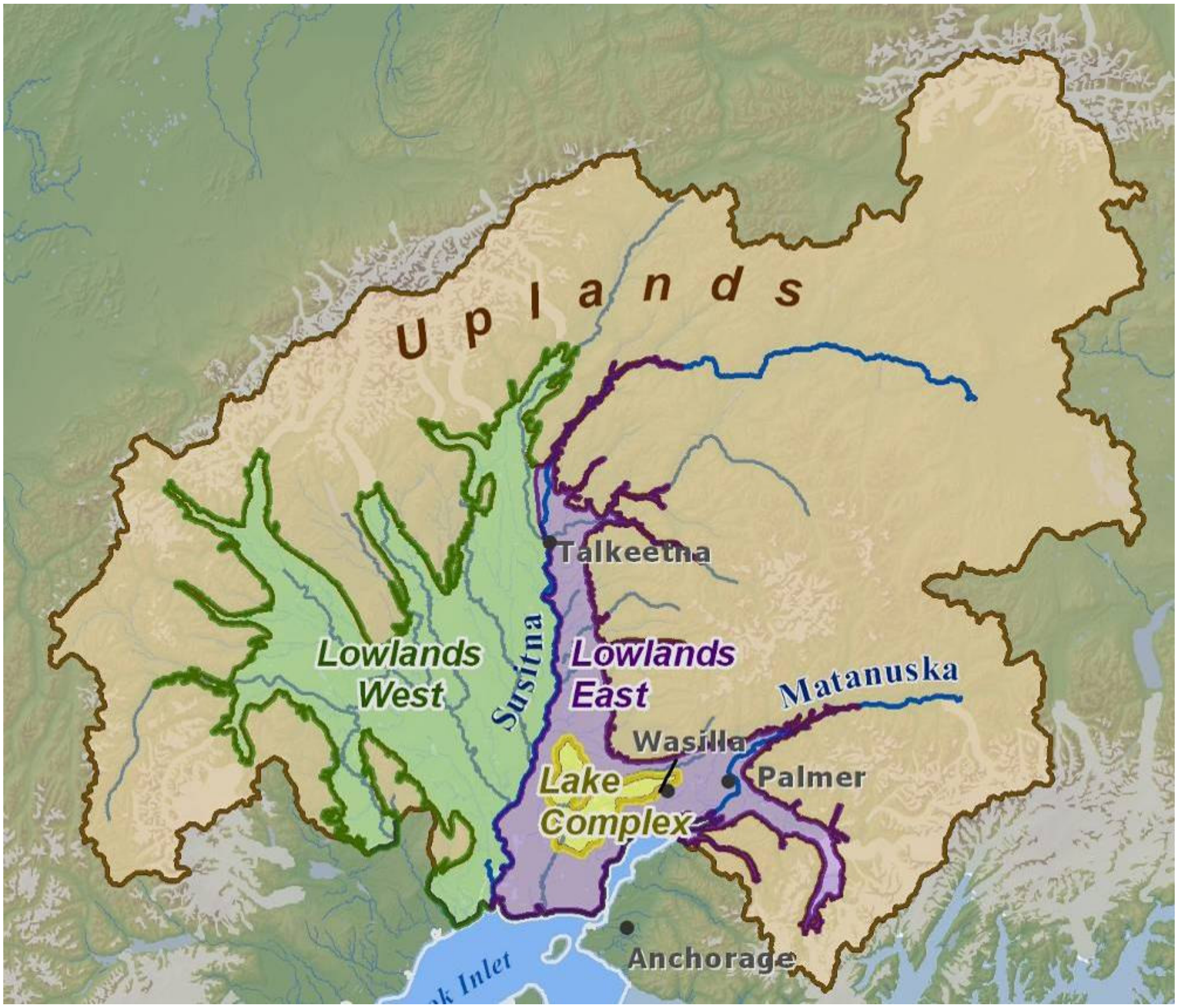
Commercial harvest of Mat-Su Basin coho salmon occurs in Upper Cook Inlet mixed stock fisheries and harvest opportunities can be limited by actions to conserve sockeye stocks. Total harvest of coho salmon in Upper Cook Inlet averaged nearly 250,000 fish from 1994 to 2003 (Fox and Shields 2005), but it is unknown what portion of those fish were bound for Mat-Su Basin streams. Previous research indicates that the Central District drift net and Northern District west-side set net fisheries harvest mainly Susitna River coho (Vincent-Lang and McBride 1989). Coho in the Mat-Su Basin support the area's largest recreational harvest, averaging over 50,000 fish per year (Sweet et al. 2003). Coho salmon are not targeted in subsistence or personal use fisheries in the Mat-Su Basin.

Upland Complex

The Upland Complex target includes all terrestrial and aquatic ecosystems above 1,000 feet in elevation extending to the watershed divides in the Mat-Su Basin (Figure 8). This system target includes all higher gradient streams, beaver complexes, off-channel ponds, lakes, riparian vegetation, and associated upland vegetation communities. Prominent vegetation communities include willow and alder, scrub-shrub, grasslands, spruce/birch mixed forest, and tundra; wetlands are less common in the Upland Complex than in the Lowland targets.

The 1,000 foot contour was used to delineate between the Upland and Lowland Complex targets for several reasons. In the Mat-Su Basin this elevation generally corresponds with a break in geomorphology, with stream gradient increasing from less than 2% in the lowland areas to greater than 4% in the Upland Complex. This break in geomorphology also affects fish distributions. Less salmon spawning and rearing occurs in the Upland Complex (15% of total documented anadromous waters in the Mat-Su Basin) compared to the other terrestrial system targets (Figure 9). The 1,000 foot contour also delineates the upper boundary for the Alaska

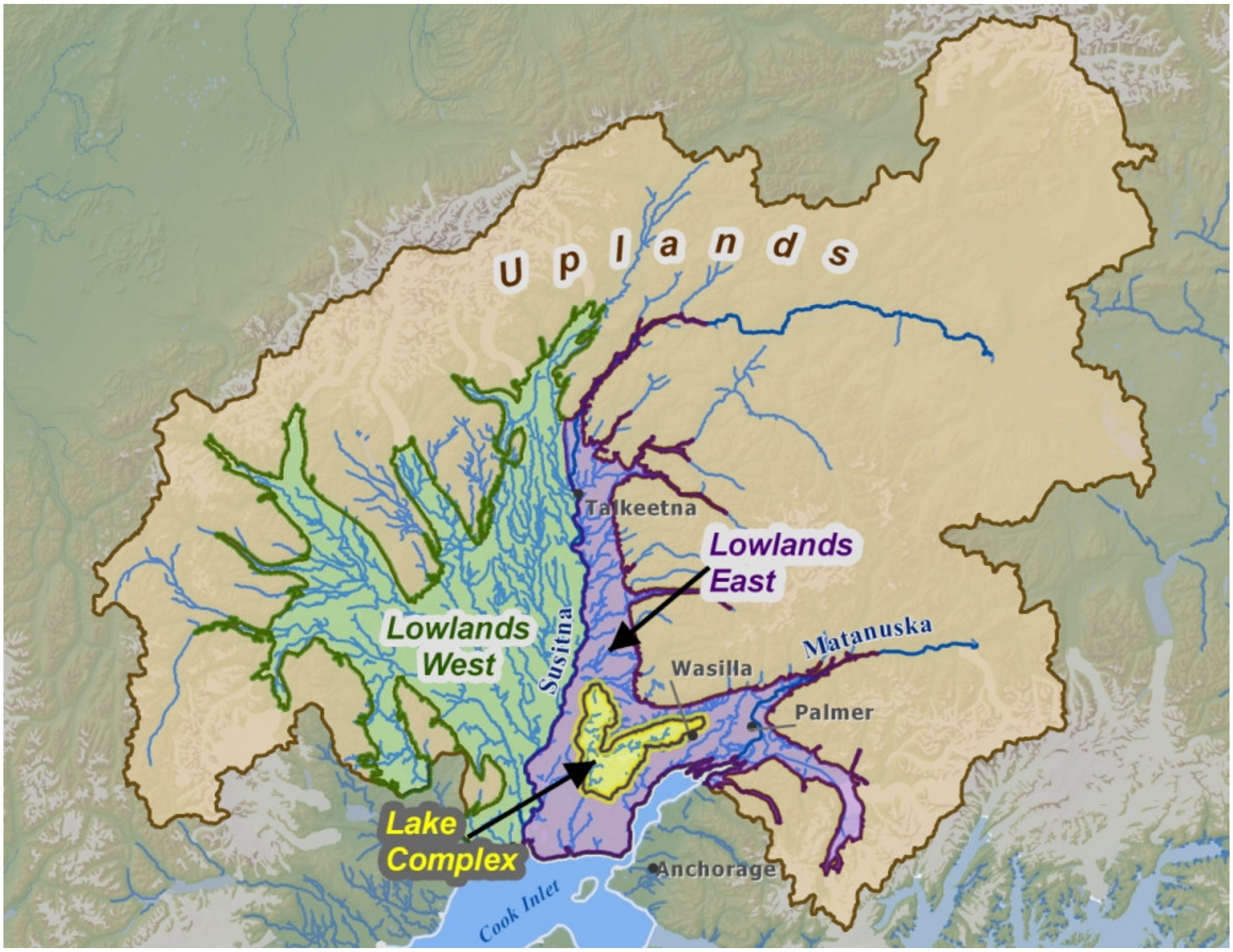
Figure 8. Terrestrial Ecosystem Targets in the Mat-Su Basin



Coastal Management Program (ACMP), which provides additional regulatory oversight for development projects in coastal lowlands; therefore the Upland Complex is outside of the ACMP boundaries.

Although the Upland Complex may be less important for salmon spawning and rearing compared to other terrestrial system targets, the health and function of the upper watersheds is crucial for maintaining productive salmon habitat lower in the valleys. Headwater streams depend heavily on riparian areas for energy and nutrient inputs, some of which is transferred to downstream aquatic communities (Vannote et al. 1980; Wipfli and Gregovich 2002). Healthy headwater reaches are also important for maintaining the dynamic equilibrium between water and sediment which can affect channel morphology further downstream (Murphy and Meehan 1991; Gomi et al. 2002). All five Alaska salmon species spawn and rear in Upland Complex streams even though their distribution there may be limited compared to other target areas.

Figure 9. Anadromous Waters and Terrestrial Ecosystem Targets in the Mat-Su Basin



The majority of land in the Upland Complex is state (65%) or federally (31%) owned public lands, with most management authority residing with the State of Alaska and Bureau of Land Management. The Upland Complex has few established communities, a limited road network, and is relatively remote and undeveloped. The Upland Complex provides a wide variety of recreational activities to tourists as well as local residents, including hunting, fishing, hiking, wildlife viewing, camping, bicycling, backcountry and cross-country skiing, whitewater rafting, all-terrain vehicle use, and numerous other outdoor activities.

Lowland Complex – West of the Susitna River

The Lowland West Complex target includes all terrestrial and aquatic ecosystems below 1,000 feet in elevation west of and including the Susitna River (Figure 8). This target includes all streams, wetland complexes, forests, floodplains, and distinct aquatic habitat types such as run-of-river lakes, side channels, backwater sloughs, springs, and large wood complexes (logjams). Streams in the Lowland West tend to be low gradient, slow moving, and long. The amount and diversity of wetlands in the Lowland West are extensive compared to other areas in the Mat-Su

Basin, and these wetlands are crucial for maintaining the productivity of aquatic ecosystems in the area. Other prominent vegetation types in the Lowland West Complex include mixed forests, dwarf scrub, and grasslands.

The Lowland West Complex is crucial for salmon production in the Mat-Su Basin. Over 2,000 miles of anadromous streams are documented in the Lowland West (ADFG 2007), which comprises 48% of all documented anadromous waters in the Mat-Su Basin (Figure 9). Pacific salmon are abundant in the Lowland West, and the area is responsible for much of the sockeye, Chinook, and coho salmon production in the Mat-Su Basin. The Lowland West Complex corresponds to most of the ADFG Westside Susitna Management Unit, and receives about 25% of the total sport fishing effort in the Northern Cook Inlet management area (Sweet et al. 2003).

Most land (85%) in the Lowland West Complex is owned and managed by the State of Alaska. The area has few communities, a limited road network, and is relatively remote and undeveloped. Access to the area is primarily by boat and small aircraft. Numerous private cabins, lodges, and other recreational sites are present in the Lowland West. Recreational development and activities are currently the primary human impacts. Similar to the Upland Complex target, the Lowland West provides a wide variety of recreational activities to tourists and local residents including hunting, fishing, hiking, wildlife viewing, camping, bicycling, backcountry and cross-country skiing, whitewater rafting, all-terrain vehicle use, and numerous other outdoor activities. The Lowland West Complex is included in the Alaska Coastal Management Program.

Lowland Complex – East of the Susitna River

The Lowland East Complex target includes all terrestrial and aquatic ecosystems below 1,000 feet in elevation east of the Susitna River except for the area corresponding to the Lake Complex target (Figure 8). This target includes all streams, wetlands, forests, floodplains, and distinct aquatic habitat types such as run-of-river lakes, side channels, backwater sloughs, springs, and large wood complexes (logjams). Streams in the Lowland East Complex tend to be higher gradient, clear water, and fast moving compared to Lowland West streams, especially those originating in the Talkeetna Mountains (Figure 9). Although wetlands are still important in the Lowland East, their diversity and distribution is substantially less than in the Lowland West Complex. Prominent vegetation types in the Lowland East Complex are similar to the Lowland West and include mixed forests, dwarf scrub, and grasslands.

The Lowland East Complex provides important spawning and rearing habitat for all five salmon species (ADFG 2007), representing 26% of documented anadromous waters in the Mat-Su Basin (Figure 9). Over 40% of documented pink and chum habitat occurs here. Major salmon producing streams in the target area include tributaries to the Susitna River, the Little Susitna River, and other Knik Arm drainages. The Lowland East Complex encompasses most of the Eastside Susitna and Knik Arm Management Units for ADFG, and accounts for over 50% of all sport fishing effort in the Northern Cook Inlet management area (Sweet et al. 2003). The high sport fishing effort is in large part due to available access via the road system.

The Lowland East Complex is the most developed area of the Mat-Su Basin and includes the communities of Wasilla, Palmer, Talkeetna, Willow, Houston, Sutton, and Eklutna. Although public lands are extensive in the Lowland East (60%), individual private (28%) and Mat-Su Borough lands (8%) make up a large portion of the landscape. Alaska Native corporations own an additional 4%. The Lowland East Complex is included in the Alaska Coastal Management Program. Many areas in the Lowland East can be accessed via an extensive and expanding road network, especially near Wasilla and Palmer. The Parks and Glenn Highways also provide access through the target area. Major human impacts in the Lowland East are associated with residential and urban development. Despite the current development, recreational opportunities for tourists and local residents in the Lowland East are numerous and similar to those listed for the Lowland West and Upland Complexes.

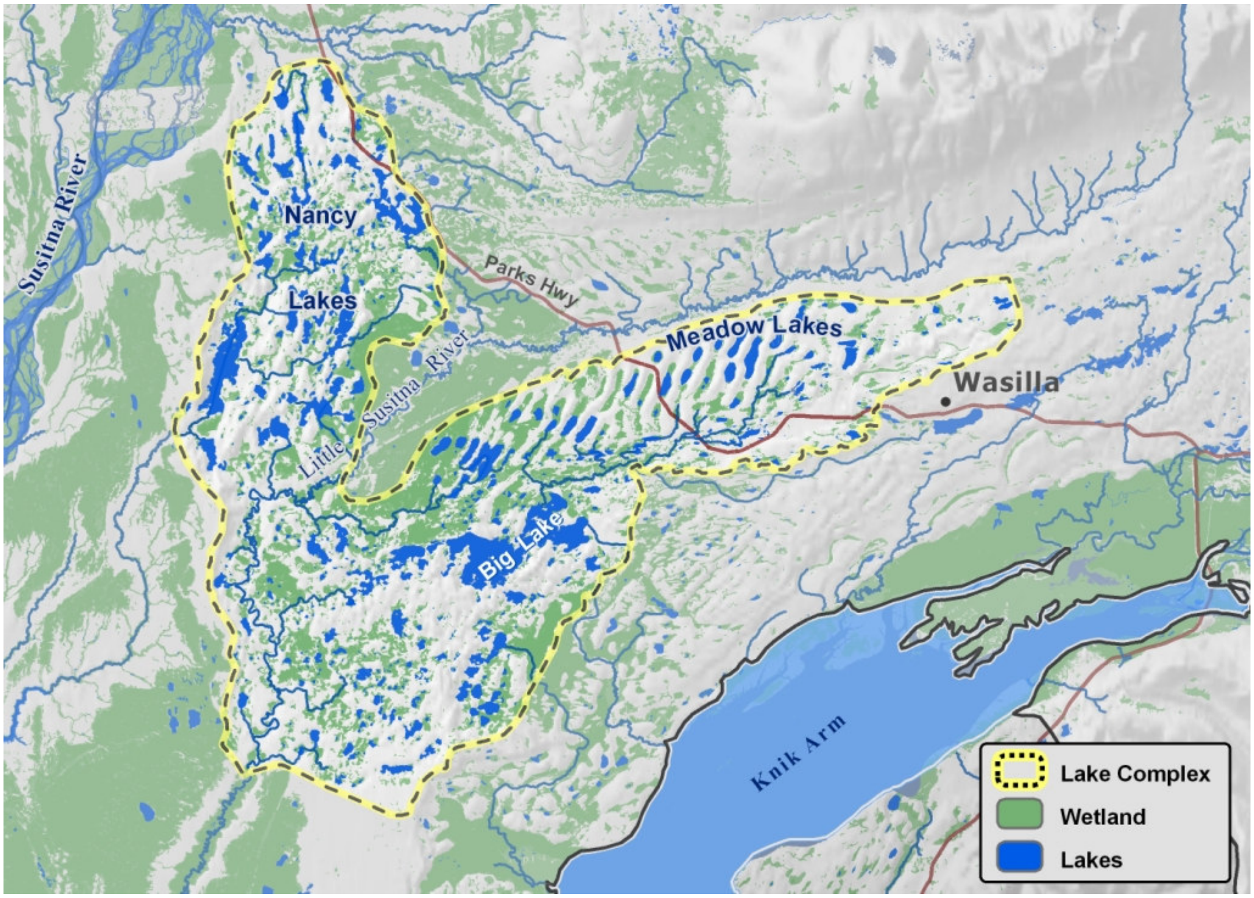
Lake Complex

The Lake Complex target encompasses the lake-rich area surrounding the Meadow Lakes and Nancy Lakes regions (Figure 10). The Lake Complex target also includes the Big Lake drainage and a portion of the Little Susitna River. The area is characterized by a high density of lakes, wetlands, and short, connective stream segments, features commonly found near the former terminus of a glacier. Surface water in the target area is prominently influenced by groundwater, and most streams originate in lakes. The surface water-groundwater interconnection controls the hydrograph on most streams. Although other lake-rich areas exist in the Mat-Su Basin (e.g., Lake Louise area), the geographic extent of the Lake Complex represents the largest concentration of interconnected lakes and streams in the Mat-Su Basin and differs from other high lake density areas because of the key interconnection between the lakes, streams, and groundwater.

Pacific salmon spawn and rear in Lake Complex streams and lakes (Figure 9). The Lake Complex target area is contained in the Knik Arm Management Unit for ADFG and major sport fisheries occur in the Little Susitna River, the Big Lake drainage, and numerous other lakes and streams (Sweet et al. 2003).

Land ownership in the Lake Complex is a mix; major ownership categories are private (40%), Mat-Su Borough (15%), Mental Health Trust lands (5%), Alaska Native corporations (4%), and state lands (22%). The Lake Complex is included in the Alaska Coastal Management Program. Major human impacts in the Lake Complex are associated with residential development. Recreation is important for local residents as well as tourists, and the Lake Complex includes the Nancy Lake State Recreation Area.

Figure 10. Lake Complex System Target

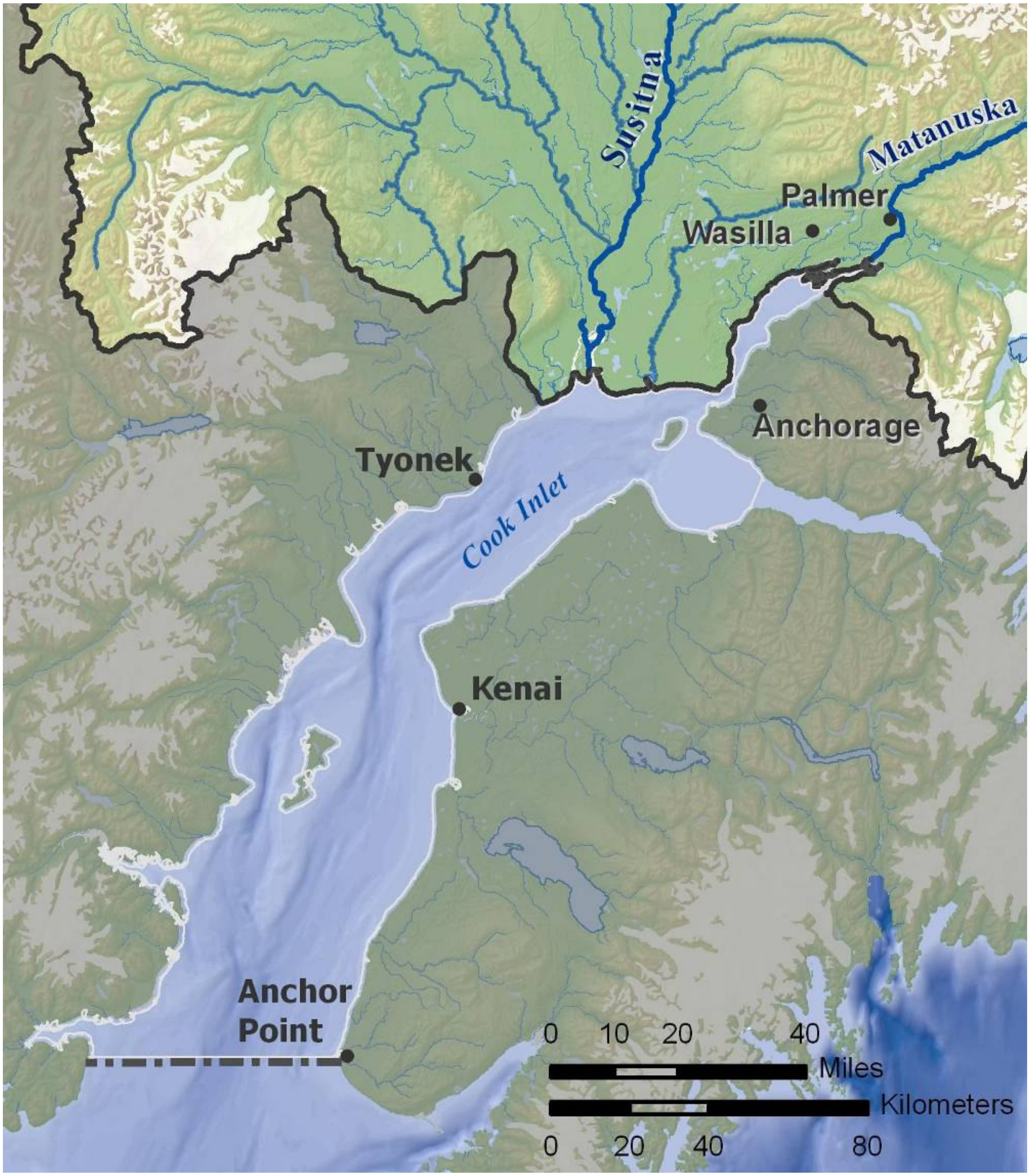


Upper Cook Inlet Marine

The Upper Cook Inlet Marine target encompasses all salt water in Cook Inlet from Anchor Point in the South, through Knik Arm to the North and includes all estuaries to mean high tide, tidal zones, and deep water (Figure 11). The nearshore marine environment in the target area includes a diversity of habitat types including sand, gravel, cobble, and boulder beaches, exposed and sheltered tidal, sand, mud flats, and marshes. This designation corresponds with the ADFG Upper Cook Inlet commercial fisheries management area.

Few site specific studies have been conducted to characterize the dynamics of the northern most portions of the Cook Inlet ecosystem, though its role as a migratory corridor for Mat-Su Basin salmon is widely accepted. Of studies conducted to date, several in the form of presence and absence surveys, over 36 fish species including Pacific salmon and four other salmonid species (trout and char) have been collected and identified (Houghton et al. 2005b, Moulton 1997, Rodriques et al. 2006). In general, these studies document adult salmon in tidal riffs, mid channel and forage zones, and juvenile salmon using shallow littoral zones for out migration, rearing habitat and refuge from tidal currents and predators. Recognized literature on the subject of salmonid life history and ecology substantiate these findings and the importance of these zones in migration, transition, and rearing (Quinn 2005, Groot and Margolis 1991).

Figure 11. Upper Cook Inlet Marine system target (from Anchor Point north to Wasilla & Palmer)



Marine estuarine literature (Day 1989, Kennish 1986, Stevenson 1973), indicate estuaries and associated mud and tidal flats are very diverse and complex ecosystems. Fresh water tributary outflows rich in organic detrital material and microbial organic decomposers such as bacteria, fungi, and algae form the foundation of complex food chain dynamics (Simenstad 1985). The byproduct of these microbial interactions support meio and macro fauna populations such as isopods, amphipods and nematodes, in turn supporting phyto and zoo plankton populations and larval, juvenile and adult fish populations.

Some of the recent studies conducted to characterize the contribution of nutrients and forage fish to trophic interactions and energy flow in Cook Inlet waters, conclude that Lower Cook Inlet is part of a dynamic marine estuary with complex oceanography, resulting in significant spatial variability in every physical variable measured (Speckman 2004). Both species richness and diversity are highest in warm, low salinity, weakly stratified waters near Chisik Island (Abookire 2005). Availability and length of time spent in estuarine habitats may be especially important as juvenile salmon transition to marine conditions (Linley 2001; Simenstad et al. 1998). Surveys conducted of the Western shoreline of Upper Cook Inlet, including waters near Tyonek, Susitna Flats and lower Knik Arm (Nemeth, 2006), further suggest evidence of a far richer marine estuarine ecosystem than once presumed.

Several other families of fish, including Pacific and saffron cod and pollock (*Gadidae*), eulachon, capelin and smelt (*Osmeridae*), Pacific herring (*Clupeidae*), Pacific halibut, flounders and soles (*Pleuronectidae*), sculpin (*Cottidae*), greenling (*Hexagrammidae*), shark (*Lamnidae/Squalidae*), and skates (*Rajidae*), reside in Cook Inlet (Rodriques et al. 2006). In addition, over 23 species of marine invertebrates, larval fish, and eight species of insect have been confirmed in plankton surveys or stomach content studies of juvenile salmon (Rodriques et al. 2006). Upper Cook Inlet is also important habitat for marine mammals, including Beluga whales (*Delphinapterus leucas*), harbor seals (*Phoca vitulina*), and harbor porpoises (*Phocoena phocoena*); all of these are predators of salmon (Rodriques et al. 2006). Killer whales (*Orcinus orca*), though seldom seen in Upper Cook Inlet have been confirmed in Knik and Turnagain Arm waters (Rodriques et al. 2006), as have Stellar sea lions, minke, and beaked whales (Hanson 2008).

The primary human impacts to salmon and habitat in Upper Cook Inlet include development associated with ports and harbors, oil and gas production and exploration, shipping and associated dredging operations, and commercial and sport fishing. Urban development also threatens these waters in the form of both point source and non-point sources of pollution and discharge. Future impacts may also include proposed terrestrial mining operations which threaten water quality of local watersheds, estuaries, and associated salmon populations.

V. Viability Assessment

Each conservation target has certain characteristics or key ecological attributes that can be used to help define and assess its current health and viability. For Mat-Su Basin salmon, these key ecological attributes are critical components of salmon life history, including physical and biological processes, which if degraded or missing would seriously jeopardize the ability for healthy salmon runs to persist over time. Identifying and assessing these attributes provides a basis for determining current health, identifying stresses, and setting conservation goals. For salmon, three basic components are critical for long-term viability:

1. good habitat for spawning and rearing,
2. ability to move between habitats of different lifestages, and
3. sufficient fish to sustain healthy populations through time.

With the conservation targets selected for the Mat-Su Basin, key ecological attributes of population size and migration are assessed for each of the salmon group targets. Key ecological attributes of habitat are assessed for each of the ecosystem targets. Each key ecological attribute has one or more indicators that can be used to measure and assess the attribute's current status. This chapter explains key ecological attributes for each conservation target and qualifies current status for each indicator. Appendix 5 provides more detail on indicator rankings and current status, and summarizes viability across conservation targets.

Salmon Targets

Sockeye, Chinook & coho, pink & chum

Key Attribute 1: Connectivity between habitats for different life stages

Salmon need the ability to move between streams, lakes, sloughs, and other aquatic habitats to complete their freshwater life history. If migration barriers in an area prevent fish from moving between habitats, healthy salmon runs in that area could be jeopardized. Barriers may be natural, such as beaver dams and waterfalls, or caused by humans, such as culverts, dams, and other instream structures. Migration barriers may be complete or partial. Partial barriers may affect only one life stage, such as undersized culverts that create flow velocity barriers for juveniles, or trash screens on culverts that block adults while allowing juveniles to pass. Partial barriers may also be temporal, affecting all life stages but only at certain times of the year. Examples of this would be perched or improperly bedded culverts that are passable only at high tide or streamflow stages. A second example would be undersized culverts that present a velocity barrier to both juveniles and adults during high flow periods. This plan focuses on barriers constructed by humans with an emphasis on correcting present barriers and preventing future barriers.

Indicator 1.1: Percent of spawning & rearing habitat accessible

Currently, sockeye salmon can access the majority of mainstem spawning and rearing habitats across the Mat-Su Basin. Some mainstem habitats, as well as those in tributaries are not fully accessible due to human-caused barriers. For Chinook, coho, pink, and chum salmon, spawning habitat in mainstems is accessible but some tributaries are blocked. Culverts are blocking access to rearing habitat for juvenile coho salmon in some tributary streams in the Palmer-Wasilla area.

Key Attribute 2: Population Size
Salmon runs in the Mat-Su Basin support economically important sport and commercial fisheries. When runs are strong, harvest opportunities are maximized and when returns are weak, harvest opportunities are restricted. Enough salmon also need to reach the spawning grounds to sustain their populations and ecosystems. Salmon populations need to exceed a minimum size threshold to be self-sustaining and maintain genetic diversity. Salmon carcasses also provide nutrients that help maintain the food chain necessary for juvenile salmon, provide food for other animals, and enrich stream ecosystems.

Indicator 2.1: Maintenance of escapement & sustainable yield of wild fish
Available data indicates that most Chinook and coho salmon fisheries (sport, subsistence, and commercial) are currently intact and almost all escapement goals are being achieved. For sockeye salmon, however, the only two stocks in the Mat-Su Basin with escapement goals (Yentna River and Fish Creek) are not meeting those goals on a regular basis and the public has expressed concerns about sustainability of some stocks. The Alaska Board of Fisheries has identified the Susitna River sockeye salmon stock as a stock of yield concern (ADFG 2008). Fishery biologists are also concerned about the Alexander Creek Chinook salmon escapement, which has not been met for four of the past six years. Managers are also uncertain of the status of pink and chum salmon across the Mat-Su Basin because there are no targeted data collected to assess escapement. Although commercial harvest of chum salmon has dropped dramatically in the last two decades, variable harvest effort between years can mask population trends. Sport harvest of chum salmon has declined in recent years (Sam Ivey, ADFG, personal communication).

Terrestrial System Targets

Upland Complex, Lowland Complex West of the Susitna, Lowland Complex East of the Susitna, Lake Complex

Key Attribute 1: Hydrological regime
The magnitude, duration, timing, frequency, and rate of change of the hydrological regime in Mat-Su Basin streams is critical both for providing enough water at the right time of year for salmon to complete their freshwater life cycle and for creating and maintaining fish habitat (Bartholow and Henriksen 2006). Sufficient instream flows are necessary throughout the year to provide rearing habitat for juvenile fish and access to spawning habitat for adult salmon. Flood flows from snowmelt runoff and rainfall help shape stream channel features and maintain the dynamic equilibrium between a stream and its floodplain. This process maintains habitat complexity in streams to provide good rearing habitat for juvenile salmon, and good spawning habitat and cover for adult salmon.

Alaska state law allows public and private entities to reserve water in streams and lakes for one or several reasons, including maintenance of fish habitat and water quality. Reservations of water are specific quantities of water required to remain in the stream or lake, and other allocative uses can withdraw additional water if it is present. The amount of water allocated for specific purposes on Mat-Su Basin streams, including reservations of water, can be used as a surrogate for determining if adequate stream flow occurs at low flow stage or if water withdrawals are negatively altering flows.

Indicator 1.1: Magnitude and timing of annual peak flows in index watersheds
Based on the professional judgment of the Science Working Group and available data, the magnitude and timing of peak flows across the Mat-Su Basin are currently within the range of natural variability for the Upland, Lowland West, and Lake Complex targets. Within the Lowland East Complex target, however, magnitude and timing of annual peak flows are judged to occasionally be outside the range of natural variability. Land use practices that create impervious surfaces and stream channel alteration are beginning to affect the magnitude and timing of flood flows in some streams in the Lowland East Complex.

Indicator 1.2: Stream flow at low flow stage in index watersheds
Based on available data, stream flow at low flow stage in the Upland and Lowland West Complex targets is currently not affected by water withdrawals. Water withdrawals on some streams in the Lowland East Complex target are starting to affect stream flows during summer and fall, and no reservations of water have been allocated to ensure adequate low flows. (This indicator was not assessed for the Lake Complex target.)

Key Attribute 2: Water quality
Cold, clean water is necessary to support healthy salmon populations. Water quality criteria and standards necessary to support aquatic life have been implemented by the State of Alaska (18 AAC 70). Federal and state resource agencies along with local citizens groups monitor water quality in many Mat-Su Basin streams and lakes. The Alaska Department of Environmental Conservation (ADEC) reviews water quality data to determine whether a waterbody meets water quality standards for a particular pollutant and then lists it as an impaired waterbody when it does not. Other waters may not be listed as impaired but are considered high priority for completing specified actions. These designations focus attention on identifying and addressing sources of degradation; these waterbodies are typically included in stewardship actions identified by the Alaska Clean Water Actions program.

Indicator 2.1: ADEC water quality standards for freshwater aquatic life
Although very little monitoring data exists, it is believed that water quality for most waterbodies in the Lowland West Complex target meets or exceeds water quality standard criteria for aquatic life on a consistent basis. Nonetheless, ADEC has identified several Category 3 waterbodies within this target area. Category 3 waterbodies are those for which insufficient data exists to make a determination as to whether water quality standards are being attained. The Susitna River is the most significant of these.

Development in the rest of the Mat-Su Basin has impacted water quality to a greater degree. Under certain flow conditions, water quality is diminished in the Upland Complex target. Within the Lowland East and Lake Complex targets, many waterbodies do not meet water quality standard criteria on an occasional basis and Impaired

Waterbodies have been designated. Over two dozen waterbodies within these target areas have been identified by ADEC as Category 3. These include Birch, Clear, and Montana creeks near Talkeetna, as well as the Talkeetna River. Bodenburg, Fish, Jim, McRoberts, Meadow, and Wasilla creeks are also on the list, as is the Little Susitna River. There are three Impaired Waterbodies in the Lowland East Complex: Cottonwood Creek, Matanuska River, and Lake Lucille, but most other systems meet or exceed water quality standards (ADEC 2007). ADEC has designated some of the major waterbodies within the Lake Complex: Big Lake is an Impaired Waterbody and Fish Creek, Meadow Creek, and Nancy Lake are High Priority waters (ADEC 2007).

Key Attribute 3: Riparian integrity

The riparian zones of stream ecosystems are critical for providing both food production and suitable physical habitats for salmon, and for maintaining the dynamic equilibrium between healthy streams and their floodplains. Riparian vegetation contributes leaf litter and other organic matter that feeds aquatic invertebrates as well as terrestrial insects that fall into the water. In turn, these invertebrates are the primary food for juvenile salmon (Healy 1991; Sandercock 1991). Healthy riparian areas also contribute logs and branches that help shape and maintain channel morphology, increase salmon habitat complexity, and retain and periodically release spawning gravel and organic matter. Logs and root wads enable carcass retention in streams, thereby making the marine-derived nutrients that salmon bring back from the ocean available to the freshwater ecosystem (Cederholm et al. 1989). Riparian vegetation helps stabilize streambanks and maintains undercut banks that provide cover for juvenile and adult salmon. On smaller streams, the riparian canopy is important for regulating stream temperature, both in summer and in winter, which is critical for salmon survival and productivity. Though actual riparian zone width varies based on vegetation, geomorphology, and sensitivity of land to disturbance (Phillips et al. 2000), most researchers recommend at least 50 - 100' buffers along streams to protect water quality and fish (Schueler & Holland 2000). Within these buffers, native vegetation should be retained (assumed 95% or more) to maintain riparian function.

Indicator 3.1: Percent of native vegetation remaining along stream and lake shorelines (within 100' of ordinary high water boundary)

Aerial photographs were used to analyze 92 miles of the Little Susitna River and found that only 1% of the riparian zone (50 meters wide) had been developed, mostly for agriculture, residential, and recreation. The most concentrated development occurred between Shrock and Edgerton Roads, with 3% of the riparian zone altered (Davis and Davis 2007). In a similar analysis, 4% of the riparian zone along Montana Creek had been developed (Davis et al. 2006). Montana Creek and the Little Susitna River span the Upland and Lowland East targets, and the Little Susitna also passes through the Lake Complex target, so development along these two streams provides a basis for some initial assumptions about how much native vegetation remains along shorelines across the four terrestrial targets. Given that Montana Creek and the Little Susitna River are in less developed areas than many other waterbodies in the Lowland East and Lake Complexes, it can be assumed that 5% or more of native vegetation in riparian areas across these targets has likely been removed. The Upland and Lowland West targets are much less developed, so clearing around lakes and streams is likely similar to the Little Susitna.

Key Attribute 4: Size & extent of native communities

Native vegetation communities across watersheds are important for maintaining watershed function and healthy salmon habitat in the Mat-Su Basin. In undisturbed watersheds, most rainfall is absorbed into soils (infiltration), stored as groundwater, and slowly discharged to streams through seeps and springs. Flooding is less severe in these conditions because some of the runoff during a storm is absorbed into the ground which lessens the amount of runoff into a stream during the storm.

As watersheds are developed and urbanized, vegetation is removed and replaced with non-native vegetation or covered with gravel, paving or buildings. These converted areas are partially to totally impervious, thus reducing the area where infiltration to groundwater can occur. Streams in watersheds with more highly impervious surfaces, such as pavement and buildings, fill more quickly than their natural counterparts. This causes more frequent and severe flooding and can cause greater stream channel erosion. Streams in watersheds with less than 10% impervious cover are typically resistant to impacts of stormwater runoff, streams in watersheds with 11 to 25% impervious cover are at risk for water quality problems, and streams in watersheds with greater than 25% impervious cover are likely to face serious degradation (CWP 2000). However, research indicates that variable responses can be detected at impervious thresholds around 5% in some Alaska streams in developed watersheds (Glass et. al. 2004; Ourso and Frenzel 2003). Many developed areas have non-native vegetation in lawns and gardens, which may have a lesser impact than impervious surfaces on runoff and infiltration to groundwater, but can have negative impacts to salmon ecosystems through use of fertilizers and loss of native vegetation in the ecosystem.

Wetlands also help provide healthy habitat for salmon in the Mat-Su Basin by controlling flooding. They are important for groundwater recharge and discharge, may act as filters to maintain water quality by removing pollutants and sediment, and are important for nutrient cycling. Wetlands provide primary productivity in systems to drive the food chain and provide rearing habitat for juvenile fish. Wetlands may also provide refugia for temperature-sensitive salmonids. Many of the wetlands within the Mat-Su Basin are net receivers of groundwater. This groundwater inflow moderates water temperatures, maintains dissolved oxygen levels, and prevents thorough freezing in the winter. If connected to anadromous waters, such wetlands provide productive rearing habitat. These wetlands store and release groundwater slowly, serving to moderate streamflows and lake levels.

Within the Mat-Su Basin, wetlands are associated with lakes (lacustrine), rivers (riverine), uplands (palustrine), and the coast (estuarine) and have vegetation varying from emergent plants to shrubs to forests. A 2001 study of wetlands between Palmer and Houston (an area including all of the Lake Complexes and part of the Lowland East), identified approximately 22% of the total land surface as wetlands (Hall 2001). Palustrine wetlands with small shrubs were the dominant type, constituting approximately 85% of the wetland area (Hall 2001). Wetlands are also essential habitat for numerous other plant and animal communities.

Indicator 4.1: Percent of impervious surfaces within subwatersheds

This indicator was assessed for the most developed targets – Lowland East and Lake Complexes. Using USGS data from 2000 – 2001, an analysis of impervious surfaces for selected subwatersheds in the Lowland East Complex showed that Wasilla Creek and the Lower Matanuska River-Knik River subwatersheds have the greatest impervious surfaces at 11%, and the Upper Little Susitna River subwatershed has the least at 1% (TNC 2007). While the extent of impervious surfaces is high in Wasilla Creek and adjacent subwatersheds, most subwatersheds across the Lowland East target have a lower development density and thus less are below the 5% threshold. Within the Lake Complex target, impervious surfaces range from less than 1% in the Susitna subwatershed to 12% for Meadow Creek (TNC 2007). Most subwatersheds in this target area are above the 5% threshold.

Indicator 4.2: Percent of lands converted from natural state across the target (i.e., cleared, replaced with non-native vegetation, or covered with gravel, paving, or buildings)

This indicator was assessed for all four terrestrial ecosystem targets. Little land (<10%) has been converted from its natural state across the Upland and Lowland West Complex targets. More conversion (10-20%) has occurred for housing and urban development and agriculture in the Lowland East and Lake Complex targets yet these levels are estimated to have only minimal impact to stormwater runoff, groundwater infiltration, and surface water quality. Based on a GIS analysis of landcover data for two of the most developed subwatersheds in those targets, 14% of the Wasilla Creek watershed and 16% of the Meadow Creek watershed has been converted (TNC 2007). Less developed subwatersheds like the Little Susitna River and Fish Creek have 4% conversion (TNC 2007).

Indicator 4.3: Diversity & distribution of wetlands types

Wetlands diversity and distribution was assessed for the Lowland West Complex and Lake Complex targets because of the prominence of wetlands in the landscape and their critical role in maintaining watershed function. The Big Lake Watershed Atlas identifies six wetland types in the Lake Complex (MSB 2006). As development occurs, it is important that some wetland types are not disproportionately lost in either extent or location. The historic diversity and distribution of wetland types in the Lowland West Complex has been maintained. In the Lake Complex, documented wetland losses have been proportional by wetland type (Hall 2001). Major causes of wetlands loss identified by Hall (2001) include construction of housing and associated roads and driveways, development of roads, and the development of light industrial facilities.

Marine System Target

Upper Cook Inlet Marine

Key Attribute 1: Freshwater inflow

The timing, quantity, and quality of freshwater entering Upper Cook Inlet is crucial for maintaining this ecosystem. Freshwater containing organic debris and nutrients are required to maintain estuaries and nearshore habitat used by rearing juvenile and migrating adult salmon. The natural balance between fresh and salt water maintains a narrow range of salinity necessary for salmon smolt survival and a salt-fresh water transition zone for both migrating juvenile (smoltification) and adult salmon (Quinn 2005, Groot and Margolis 1991). Changes to freshwater discharge from rivers and streams into Upper Cook Inlet can influence salinity gradients and nearshore habitat, and alter food chain dynamics and trophic levels. The early marine life stage of salmon is when the greatest mortality often occurs. Therefore, variation from optimal natural habitat parameters in the marine estuarine environment can be particularly significant for salmon populations. The Susitna River provides the greatest amount of freshwater input into Cook Inlet of all rivers emptying into the inlet (ADNR 1999).

Indicator 1.1: Salinity & Turbidity in estuaries and river deltas
Currently there are few alterations of freshwater inflow to Upper Cook Inlet, and salinity and turbidity are estimated to be at historic levels.

Key Attribute 2: Water quality
Just as in fresh water, cold, clean water in the marine estuarine environment is necessary to support healthy salmon populations. Water quality standards necessary to support marine aquatic life have been implemented by the State of Alaska and include criteria for water temperature, dissolved oxygen, sediment levels, and chemical and nutrient concentrations.

Indicator 2.1: ADEC water quality standards for marine aquatic life
Most water testing locations in Upper Cook Inlet meet ADEC water quality standard criteria except under certain flow conditions. In spite of this, Upper Cook Inlet is listed by ADEC as Category 3, meaning there is not enough information to determine attainment of water quality standards or impairment. The Municipality of Anchorage has been issued a mixing zone for metals and turbidity in the vicinity of the Point Woronzof treatment facility outfall (ADEC 2006), and water quality standards are rarely met near the outfall. In addition, water quality within Upper Cook Inlet is affected by streamflow from impaired waters and nonpoint source discharges.

Key Attribute 3: Size & extent of characteristic nearshore habitats
A variety of nearshore habitats in Upper Cook Inlet are important for juvenile and adult salmon: brackish/tidal influenced channels, cobble beaches, mudflats, salt marshes, and tidal sloughs. Conservation of salmon depends upon ensuring that each of these habitats is maintained in sufficient quantities and located where salmon need them. Some nearshore habitats may be more vulnerable than others or more likely to be developed due to patterns of human settlement and development.

Indicator 3.1: Diversity & distribution of nearshore habitat types
To date, changes in the distribution and diversity of nearshore habitats in Upper Cook Inlet have been localized. The greatest change has occurred, and is predicted to occur, near the mouth of Knik Arm, where the development and expansion of the Port of Anchorage (POA) and Port MacKenzie has resulted in the loss of several hundred acres of intertidal habitat. The future development of infrastructure to support ferry service and the Knik Arm crossing in this same area will result in similar losses of intertidal and nearshore habitats.

Key Attribute 4: Soil/sediment stability and movement
The tides in Upper Cook Inlet are important for sediment transport. If Cook Inlet's tides are impeded, transport of sediments will change and affect salmon habitats. Nearshore developments can affect tidal flows.

Indicator 4.1: Tidal flow to distribute sediments
For the most part, sediment distribution in Upper Cook Inlet is estimated to be occurring naturally. Development in the intertidal and nearshore environment, once again focused near the mouth of Knik Arm, has changed some tidal flows and the resultant patterns of sediment distribution. Both the POA and Port MacKenzie interfere with the natural distribution of sediment. The POA dredges substantial volumes of sediment each year, and the disposal of these sediments near Fire Island alters sediment distribution in Upper Cook Inlet.

Key Attribute 5: Abundance of food resources
The early marine survival of juvenile salmon depends on an abundance and diversity of food resources in Upper Cook Inlet.

Indicator 5.1: Status of marine invertebrates, forage fish, etc.
Although no real baseline data exists, it is generally believed that only minor changes in status of these various food sources has occurred from historic numbers in Upper Cook Inlet.

Key Attribute 6: Abundance of key functional guilds
Beluga whales and harbor seals are predators whose populations are dependent on strong salmon runs. If populations of these predators decline, it may indicate declining salmon populations. Conversely, other factors that affect these predators could also affect salmon populations.

Indicator 6.1: Status of predator populations (e.g., beluga whales, harbor seals)
The petition to list the Cook Inlet population of beluga whales, a genetically and geographically isolated stock (NMML 1999), as an endangered species under the federal Endangered Species Act raises questions about underlying causes of beluga population decrease that may also impact salmon populations. NMFS has designated belugas as 'Depleted' (Angliss & Outlaw 2007). Harbor seal numbers aren't tracked in Cook Inlet, but populations are declining in other parts of the Gulf of Alaska (Angliss & Outlaw 2007).

Overall Health of Mat-Su Basin Salmon and Habitat

This assessment of the current health of wild salmon and their habitat shows that, *taken as a whole across the Mat-Su Basin*, salmon and most of their habitats are healthy and require minimal human intervention for long term survival. A more local look at individual attributes of health, however, points out concerns about long-term sustainability of Mat-Su Basin salmon and some of the habitats they require for survival. For salmon, this assessment suggests that numbers for some sockeye, pink, and chum salmon runs may be below a sustainable level and that some stocks may be seriously degraded in time without conservation action. Data for Mat-Su salmon populations is limited so the status of many stocks, especially in the Matanuska River watershed, is based on anecdotal information, professional judgment, or is unknown. Some habitat alteration, such as blocked migration, will have cumulative impacts over time to successive salmon populations.

Not surprisingly, the health of Mat-Su Basin salmon habitat is linked to the level and location of human activity in the basin. The ecosystems that coincide with the more developed areas of the Mat-Su Basin – the Lowland East Complex and Lake Complex targets – may become seriously degraded without human intervention. Reduced health of these ecosystems is linked to alteration of native riparian vegetation, degraded water quality, and water flow changes, all of which have reached levels that may impair these ecosystems in the long-term. Within these areas, ADEC has identified over two dozen waterbodies that lack sufficient data to determine water quality, and has designated four as Impaired and three as High Priority. Some water pollution in these areas may be due to the replacement of more than 10% of native vegetation with impervious surfaces that concentrate stormwater runoff in surface waters.

Ecosystems coinciding with areas of little development – Upland Complex, Lowland West Complex, and Upper Cook Inlet Marine targets –have good overall health. Yet even these terrestrial ecosystems contain waterbodies that lack sufficient data, and ADEC has determined that insufficient information exists to assess how well Cook Inlet meets water quality standards.

The current state of salmon and ecosystem health directs us to which species and ecosystems may require protection and prevention measures versus restoration to regain health. Preventative conservation measures in the Upland Complex, Lowland West Complex, and Upper Cook Inlet Marine can ensure that these ecosystems remain healthy for salmon and other aquatic species. The more impacted terrestrial ecosystems of the Lowland East Complex and Lake Complex will require not only protection against additional alteration and degradation but also mitigation and restoration actions to restore health.

VI. Potential Threats to Salmon & Their Habitats

Many human activities are potential threats to salmon and their habitats. Human activities can affect salmon by degrading or eliminating habitat, removing vegetation from wetlands and the banks of streams and lakes, degrading water quality, changing river flows, disconnecting streams, lakes, and wetlands, or blocking fish passage. Lack of data to make management decisions can also be an impediment to conserving salmon and their habitats. Most of these activities are vital to human communities and can be mitigated to reduce or eliminate negative impacts to salmon and salmon habitat.

This plan focuses on human activities that are currently major sources of stress to salmon and their habitat or are likely to be potential threats in the next 10 years. The severity and scope of particular stresses to each conservation target (Appendix 6) were analyzed in combination with the relative contribution and irreversibility of various sources to those stresses. This combined analysis produced a ranked list of 22 potential threats to Mat-Su salmon and their habitats (Table 3, Appendix 7). Two human activities ranked as High potential threats, twelve as Medium, and eight as Low.

Table 3. Ranked Potential Threats
HIGH
Housing & Urban Areas
Roads & Railroads
MEDIUM
Climate Change
Dams and Hydroelectric Power
Developed Recreational Areas
Development in estuaries
Ground & Surface Water Withdrawals
Household Septics & Urban Waste Water
Invasive Northern pike
Logging & Wood Harvesting
Mining & Gravel Quarrying
Oil, Gas, and Coalbed Methane Drilling
Stormwater & Urban Runoff
Utility & Service Lines
LOW
Agriculture
Coal Power Plant
Fishing (commercial, sport, subsistence)
Invasive Alien Plant Species (Terrestrial & Aquatic)
Invasive Alien Marine Species
Marine Shipping Lanes & Platforms
Recreational Activities
Tidal Energy Development

This ranked list provided an overall picture for Mat-Su Basin salmon and a starting point for selecting potential threats that the Partnership could address. The ranking system tends to emphasize existing threats that require restoration. The working groups tried to find a balance with prevention and protection opportunities when selecting threats for the Strategic Action Plan. The working groups examined the High and Medium ranked potential threats with the following considerations in mind:

- How many targets are impacted?
- How urgent is it?
- Is there a clear role for a habitat-focused partnership?
- Is there available information for addressing it?
- Is there opportunity to prevent, mitigate, or restore impacts?
- How easily reversed are the impacts?

The working groups and steering committee agreed on seven potential threats to address in this plan:

1. Housing and Urban Areas
2. Roads and Railroads
3. Stormwater and Urban Runoff
4. Household Septics and Urban Wastewater
5. Ground and Surface Water Withdrawals
6. Development in Estuaries
7. Invasive Northern Pike

Appendix 7 contains more information about the potential threats not selected, but two bear additional explanation here – Climate Change and Recreational Activities. Climate change will warm stream temperatures in the Mat-Su Basin and alter watersheds by affecting flooding frequencies, snow pack depths, precipitation, surface and groundwater volumes, and other hydrologic characteristics. The working groups did not see a clear role for the Partnership to address climate change directly but have placed a priority on protecting and restoring many of the factors that can maintain or increase the resiliency of salmon to a changing climate (e.g., loss of riparian cover, wetlands, connectivity, and reservation of water). The monitoring program will include stream temperature so that the thermal regimes of Mat-Su Basin waterbodies can be tracked and understood as climate and land uses change. Recreational Activities, including boating, ATVs, and access to fishing and hunting, were not chosen as priorities to be included in this plan at this time because the negative impacts of most of these activities are localized, are reversible given a reasonable level of funding and commitment, and identify the need for increased enforcement of existing laws and ordinances. The Partnership plans to revisit the Strategic Action Plan on a regular basis with an eye for identifying potential threats that could be or should be addressed by the Partnership.

Housing and Urban Areas

Development and uses associated with housing and urban areas include the actual clearing of land, construction of buildings, and the various activities on those cleared lands that have direct and indirect impacts on waterbodies. The primary affects of housing and urban development on salmon and their habitat are the loss of wetlands, alteration of riparian habitat, degraded water quality, and creation of impervious surfaces.

Wetlands are often disturbed, drained, and filled to provide developable land. Hall (2001) found residential development to be the activity responsible for the most wetland loss within his study area (i.e. Palmer-Wasilla). The individual effect of a small wetland fill from the development of a residential subdivision may be minimal, but the cumulative effects of filling numerous wetlands across the landscape alter watershed functions and remove salmon rearing habitat, thus negatively affecting salmon and other habitats.

Riparian areas around streams and lakes are often altered or cleared to improve views or facilitate construction. Alteration of riparian habitat can have numerous negative consequences for healthy salmon populations. As riparian areas are altered, the supply of large woody debris to the system decreases. This loss of large wood can lead to reductions in available cover from predation for juvenile and adult salmon, loss of pool habitat for rearing, reduced protection from peak flows for weak swimming juveniles and spawning redds, reduced storage of gravel and organic matter for spawning and rearing, and loss of hydraulic and thus habitat complexity in the system. Some potential consequences to salmon from loss of wood include increased vulnerability to predation, lower winter survival, less spawning gravel, and reduced food availability. The result of these consequences ultimately reduces the capacity of the waterbody in question to produce salmon.

Human impacts to water quality from housing and urban development can be direct, such as point source discharges, or indirect, such as fertilizer runoff from numerous lawns in a subdivision. Degradation of water quality below established standards can alter aquatic invertebrate communities, disrupt the food chain, and decrease survival of salmon at different life stages.

As watersheds are developed and urbanized, vegetation is replaced by impervious surfaces including rooftops, asphalt or concrete roads, parking lots, and sidewalks. This limits the amount of rainfall that can infiltrate the soils and be stored as groundwater. Runoff from watersheds with more impervious surfaces can cause more frequent and severe flooding, which can accelerate stream channel and bank erosion which in turns impacts spawning beds and rearing habitat. Severe flooding can also reduce salmon production by flushing juveniles out of the system before they are ready to survive in the ocean. By increasing the rate of runoff, impervious surfaces also reduce base flows. Reduced base flows exacerbate temperature and dissolved oxygen problems; reduce the capacity of the water body to dilute pollution; reduce the area available to over wintering salmon; and expose spawning beds to drying up and freezing during winter and spring when low flows may already limit salmon production. Water quality can also be affected by increased development because runoff from roads, parking lots, and yards can add contaminants to streams.

Most housing and urban development is occurring in the Palmer-Wasilla core area, so this human activity is a major source of stress to the Lowland East Complex and Lake Complex targets. Residential development has been the largest contributor to wetlands loss in this area, with construction of housing and associated roads and driveways accounting for 28% of the total acreage loss between Palmer and Houston (Hall 2001). Growth is expected to continue to cause substantial landcover change in the next 50 years with a doubling of urbanized areas (Schick 2006). In particular, housing and urban areas alter riparian vegetation, increase the amount of impervious surfaces, alter stormwater runoff, degrade water quality, and remove wetlands.

Roads and Railroads

Other human activities accompany development of housing and urban areas, and contribute their own particular impacts to aquatic habitat. In the Mat-Su Basin, additional and improved roads and railroad routes are required to accommodate population growth. Two major transportation corridors pass through the Mat-Su Basin. The Parks Highway and the Alaska Railroad follow the Susitna River north toward Fairbanks and the Glenn Highway heads northeast along the Matanuska River to Glenallen. Secondary road construction for housing, urban, and industrial development and for the development of natural resources will continue as the population in the Mat-Su Basin continues to grow.

Roads can modify natural drainage networks and can affect all aspects of a stream ecosystem. Improperly sited and designed roads can accelerate erosion and sediment loadings by destroying or altering wetland, riparian, and other native vegetation, and channel bank and bed characteristics. These alterations often result in loss of cover, degraded water quality, and increased flows. Roads and railroads can also separate wetlands and stop the surface flow of water, which results in downstream wetlands drying. This can be seen most easily along the Glenn Highway through the Palmer Hay Flats State Game Refuge. Wetlands remain on the east side of the road, but on the west side, birch and other non-wetland plants are gradually establishing as the soils dry permanently.

Improperly designed and maintained roads and railroad corridors can interfere with the upstream migration of both adult and juvenile salmon, and resident fish in many ways. Culverts pose the most common migration barriers associated with road networks and railroads. Although some fish passage barriers are reversible because they can be removed with a reasonable commitment of resources, it is more effective to prevent the creation of barriers during design and planning processes than to correct problems at a later date.

Because most housing and urban development continues to occur in the Palmer-Wasilla core area and along the Parks and Glenn Highways, the greatest impact from roads and railroads occur in the Lowland East Complex target and along the Parks Highway. Existing infrastructure is already contributing to altered riparian vegetation, loss of natural communities, and degraded water quality there. These same effects are seen to a lesser degree in the Lowland West Complex, Lake Complex, and Upland Complex targets. Culverts under roads and railroads are major contributors to blocked migration paths for sockeye, coho and Chinook salmon. Road construction is the second most common activity resulting in wetland loss in the Mat-Su Basin after residential development (Hall 2001).

Stormwater Runoff

Another potential threat related to Housing and Urban development is stormwater runoff. Stormwater runoff occurs when precipitation from rain or snowmelt flows over the ground. Impervious surfaces such as parking lots, driveways, sidewalks, roads and streets not only prevent stormwater from naturally soaking into the ground, but they also serve to collect and channel its flow. This can result in greatly increased volumes of runoff and changes to surface and subsurface hydrology, including an increase in flood flows.

The major source of water pollution in Alaska's urban areas is polluted runoff. Fecal coliform, sediment, and petroleum are the most common forms of pollution (ADEC 2006). Stormwater and urban runoff in the developed areas of the Mat-Su Basin can contain debris, chemicals, nutrients, excess sediment, and other pollutants that directly affect water quality. Runoff typically flows untreated into storm sewer systems or directly into lakes, streams, rivers, wetlands, or coastal waterbodies. Storm drains and drainage ditches serve to concentrate runoff.

This often causes erosion at the discharge site, alteration of the natural hydrograph, and overwhelms the absorptive capacity of the receiving water.

Stormwater runoff has the greatest current and potential impacts in the most developed areas – the Lowland East Complex and Lake Complex targets – where impacts alter hydrology and degrade water quality. Cottonwood Creek is currently listed as impaired due to urban runoff. Stormwater runoff is also a high contributor to degraded water quality and altered freshwater inflow to the Upper Cook Inlet Marine target. However, these particular stresses are still low in that system.

Household Septics & Urban Wastewater

Household and urban wastewater can contaminate fresh and marine waters with fecal coliform bacteria, chlorine, and excessive nutrients (phosphorous and nitrogen). Excessive nutrients can cause eutrophication, which can change the biotic community of waterbodies and lower the amount of dissolved oxygen. Septic systems can fail due to improper installation, poor siting, inadequate maintenance, or damage due to earthquake or freeze-thaw cycles, resulting in degraded water quality. Faulty septic systems will first impact groundwater, which may then contribute to surface water pollution. Urban wastewater systems can release contaminants before reaching treatment facilities due to storm events, overflows, and improper connections.

Household septics have the greatest potential impact to water quality in the more densely developed areas of the Mat-Su Basin – the Lowland East and the Lake Complexes. The Lake Complexes are especially vulnerable due to the influence of groundwater. Within the Lake Complex target area, the Meadow Creek watershed has approximately 3,100 septic systems around more than 30 lakes in only 33,700 acres (TNC 2007). Urban wastewater and transported septic wastewater directly affect water quality of the Upper Cook Inlet Marine target near Point Woronzof where treated wastewater from Mat-Su Basin communities and Anchorage is discharged.

Ground & Surface Water Withdrawals

Water is withdrawn from underground aquifers and surface waterbodies for human consumption, agriculture, and industrial uses. Groundwater can supply some surface waterbodies as springs or through subsurface flow into streambeds, so groundwater withdrawals can affect quantities of surface water. Excessive withdrawals can alter the hydrologic regime of streams and lakes, alter channel-forming processes, dry wetlands, degrade water quality, and impair salmon migration. Within the Mat-Su Basin, flow for most streams increases in late May or June with snowmelt; peaks in July; is sustained by rain or continued snowmelt into September; and then decreases substantially through the winter (Lamke 1986). Considering prevalent low flow conditions in winter, withdrawals at this time could decrease water levels below volumes necessary to sustain fish (Mouw 2003).

Salmon have adapted to, and their productivity is directly related to, the flow regime of the waterbody in which they are spawned and reared. Significant changes in the flow regime, whether from impervious surfaces that raise the high flows and lower the low flows, or water withdrawals which remove water and alter flows at all flow stages and at all times of year, can significantly impact salmon productivity and migration. By significantly altering flows during key life history periods, salmon spawning areas can be lost, side channels and other rearing areas can be lost, pollution can be less diluted and more toxic, and fish passage can become blocked.

Water withdrawals are anticipated to have the greatest impact on the hydrological regime to the Lowland West, Lowland East, and Lake Complexes in the next 10 years. In the Lowland West and Lake Complexes, this can also decrease extent and diversity of wetlands.

Development of Estuaries

Development in the estuaries of Upper Cook Inlet includes ports, docks, bulkheads, roads and bridges that provide transportation corridors for ships, ferries, cars and the railroad. The construction of these facilities alter coastal habitat through filling, dredging, or hardening of shorelines. Periodic dredging is required at many facilities to maintain water depth for ships. Construction and subsequent maintenance of these facilities can further impede fish migration due to noise disturbance and physical blockage.

It is essential to the health and condition of marine and estuary ecosystems to maintain connectivity to nearshore habitat and associated biological processes. Just as in the freshwater environment, maintaining the continuity of nearshore habitats, particularly marine estuaries, is paramount to provide for the movement of both adult and juvenile salmon. Recent sampling of nearshore waters of Upper Cook Inlet have shown that these estuaries provide not only a migratory corridor but juvenile salmon actively rear in these waters (Nemeth et al. 2007). Large scale development or the cumulative impact of several smaller projects in marine estuaries could compromise important rearing areas for juvenile salmon by degrading water quality and hardening banks (Gelfenbaum et al. 2006, Small 2005, Johannessen 2001, Broadhurst 1998).

Once constructed, these facilities are likely permanent and the habitat it replaced is either altered or gone forever. These impacts are often irreversible. Development in estuaries is the primary source of wetland and nearshore habitat loss, degraded water quality, altered water course, tides, elevated sediment load and transport (Small 2005, Williams 2001).

Invasive Northern Pike

While Northern pike (*Esox lucius*) are native north and west of the Alaska Range, they are an introduced species to the Mat-Su Basin, where they are voracious predators of juvenile salmon and other native resident fish. Impacts of Northern pike predation on native fish populations can be devastating where their habitats overlap. Northern pike prefer cold shallow freshwaters and are saltwater tolerant when salinities are low (ADFG 2006b). They spawn in marshy areas with shallow water, emergent vegetation, and mud bottoms covered with mats of aquatic vegetation (Inskip 1982). Northern pike have direct impacts on salmon populations and indirect impacts on ecosystem health through decreasing biodiversity, removing salmon as a food source for terrestrial predators like bears and eagles, and reducing transfer of marine-derived nutrients to terrestrial ecosystems through decaying salmon carcasses.

The potential threat of Northern pike is greatest for sockeye and coho salmon due to a preference for similar habitats. Northern pike have already eliminated sockeye salmon from several small streams which flow into the westside of the Susitna River. Coho salmon also have a high vulnerability to Northern pike predation because they rear in lakes, ponds, sloughs, and other preferred pike habitat. Several Chinook salmon systems have been severely impacted by Northern pike predation as well. In 2007 one of the most popular Chinook salmon streams (Alexander Creek) in the Matanuska Susitna Valley was closed to Chinook salmon fishing by the Alaska Board of Fisheries because Northern pike reduced the Chinook salmon population to an unsustainable level. Pink and chum salmon are the least affected because juvenile time in freshwater is limited.

VII. Conservation Strategies

The Mat-Su Salmon Partnership's broad goals are to protect salmon and their habitats in the Mat-Su Basin and Upper Cook Inlet, mitigate potential threats to salmon and their habitats, restore connectivity between salmon habitats, and increase knowledge about salmon and their use of freshwater and marine habitats. The strategies for the Mat-Su Basin echo those that the National Fish Habitat Action Plan drafted to guide work at the national and partnership level: protection of healthy waters, rehabilitation of flows, reconnection of habitat, and reduction of pollutants and sedimentation in waterbodies.

The working groups performed a situation analysis for each of the seven potential threats. The situation analysis examines what is already being done to address the problem and identifies the gaps in resources, knowledge, regulation, or enforcement. Then the potential role for the Partnership to act to protect salmon habitat given the human context becomes clearer. Some potential threats have multiple impacts to salmon and their habitat. The situation analysis brought into focus the more discrete habitat issues upon which the Partnership can act. To conserve salmon in the Mat-Su Basin, the Partnership will address 8 focal issues for salmon and salmon habitat (Table 4).

Table 4. Focal Issues for Salmon and Salmon Habitat

Potential Threat	Focal Issue
Housing and Urban Areas	Alteration of riparian areas
	Filling of wetlands
	Impervious surfaces and stormwater runoff
Stormwater and Urban Runoff	Impervious surfaces and stormwater runoff
Household Septics & Urban Wastewater	Septic systems
Roads and Railroads	Culverts that block fish passage
Ground and Surface Water Withdrawals	Loss or alteration of water flow or volume
Development in Estuaries	Loss of estuaries and nearshore habitats
Invasive Northern Pike	Increased predation from Northern Pike

Conservation strategies are composed of objectives, which define a vision of success, and strategic actions that will achieve the objectives. The Partnership's strategies fall into four broad categories: protection, restoration, education, and science. In many places in the Mat-Su Basin, salmon and their habitats are healthy so protective measures, like reservations of water, land use planning, and voluntary land protection, can prevent degradation. In other places, restoration is necessary to re-establish fish passage and productive habitat. Public education, including best management practices, can prevent and mitigate impacts from human activities and help the general public connect their own individual actions to impacts on salmon habitat and water quality. Better understanding of salmon's needs throughout the Mat-Su Basin and Cook Inlet would improve management of salmon habitat and implementation of the recommendations in this plan. Three science strategies are highlighted outside the focal issues because the information they will gather will inform multiple focal issues.

The Partnership's conservation strategies encourage collaboration among multiple partners to achieve common objectives that would be difficult for any one partner to accomplish alone. In some cases, comprehensive protection can be accomplished with revisions to local and state laws and increased enforcement of such laws; some strategies recommend such changes but in no way bind affected agencies to implement these strategies. What follows are objectives and strategic actions that the Partnership thinks it can accomplish in the next 10 to 20 years.

1. Overarching Science Strategies

In Alaska, the fundamental conservation tool to protect salmon and their habitats is the Anadromous Fish Act (AS 41.14.870). The Anadromous Fish Act requires a state permit for most activities that might affect the bed or banks of waterbodies that support salmon. The Alaska Department of Fish and Game (ADFG) maintains the Anadromous Waters Catalog that documents spawning, rearing or migration of anadromous fishes in Southcentral Alaska. Streams must be included in the Anadromous Waters Catalog (ADFG 2007) for Anadromous Fish Act regulations to apply. Currently the catalog contains only 4,200 miles of the more than 23,900 miles of streams that have been mapped in the Mat-Su Basin. Documenting anadromous waters in Alaska is complicated by remoteness, short field seasons and limited number of biologists. Non-ADFG biologists can document anadromous waters and submit the information to ADFG for inclusion in the catalog. Completion of the Anadromous Waters Catalog is a foundational conservation strategy for addressing four focal issues: alteration of riparian habitats; filling of wetlands; impervious surfaces and stormwater runoff; and culverts that block fish passage.

Objective 1.1: Anadromous Waters Catalog

By 2020, all anadromous fish habitat in the Mat-Su Basin will be included in the Anadromous Waters Catalog and thus given basic protections afforded under state law. Efforts to catalog anadromous fish should also document non-anadromous fish.

Strategic Action 1.1.1: Complete Anadromous Waters Catalog

Develop a cooperative, long term implementation and funding plan that accomplishes inventories of all anadromous fish habitat for inclusion in the Catalog and identifies fish species present on the following schedule and in the following order of priority:

- Lowland Complex East and Lakes Complex – 2012,
- Lowland Complex West – 2017
- Upland Complex – 2020.

Information on water flow and levels of ground and surface water in the Mat-Su Basin is limited compared to other parts of the country. U.S. Geological Survey (USGS) maintains continuous gages on 7 streams in the Mat-Su Basin, compared to an average of 61 gages in a similar area in the lower 48 states. The Alaska Department of Natural Resources (ADNR) Alaska Hydrologic Survey is also mandated with the collection, evaluation, distribution, and quality of ground and surface waters of the state. USGS began a groundwater mapping pilot project in the Mat-Su

Basin in 2005 and has mapped the water table depth for approximately 590 square miles, or 2.5% of the basin. Beyond that area, some information for groundwater can be gleaned from well logs at ADNR. The relationship between groundwater and surface water is not well understood in the Mat Su Basin. Increasing information on ground and surface water is important for addressing five focal issues: impervious surfaces and stormwater runoff; loss or alteration of water flow or volume; filling of wetlands; septic systems; and culverts that block fish passage.

Objective 1.2: Comprehensive Surface & Groundwater Studies
By 2012, a comprehensive water quantity program will increase understanding of surface and groundwater, including quantities, flows, and variability in the Mat-Su Basin, and provide information for implementing and monitoring strategies for instream flow needs, stormwater management, fish passage, and climate change.

Strategic Action 1.2.1: Implement Study Plan and Water Data Clearinghouse
Develop a cooperative baseline & monitoring plan by winter 2008. Seek funding sources to implement and sustain plan. Develop clearinghouse to oversee funding efforts & identify lead entity to manage data by winter 2008.

Strategic Action 1.2.2: Support USGS Groundwater Program
Work with USGS groundwater modeling and monitoring program to ensure consistency with Partnership goals. Support and help secure funding for USGS program.

Strategic Action 1.2.3: Monitor Groundwater Use
Implement comprehensive well log database by 2009 and house information in a central location with public access. ADNR, Mat-Su Borough (MSB), or USGS may house this.

Strategic Action 1.2.4: Collect Hydrologic Data
Continuously gather hydrologic data with stream gages in three to five index watersheds. These index watersheds will be important to salmon and representative of Mat-Su Basin streams, and/or vulnerable to human activities and change in the Mat-Su Basin. USGS and other partners will collaborate on operating and securing funding for this stream gage network.

Federal and state resource agencies, the Mat-Su Borough, and local soil and water conservation districts monitor water quality in many Mat-Su Basin streams and lakes. Baseline monitoring programs in Alaska Department of Environmental Conservation (ADEC) are also done by the Alaska Monitoring and Assessment Program (AKMAP), which is currently scheduled to survey water quality in the Cook Inlet Basin during the summer of 2008. A comprehensive water quality monitoring program would aid in identifying waterbodies which are beginning to have degraded water quality. This information could help address two focal issues: impervious surfaces and stormwater runoff; and septic systems.

Objective 1.3: Water Quality Monitoring
By 2010 a comprehensive baseline and monitoring program for water quality exists to track and manage changes in Mat-Su Basin waterbodies.

Strategic Action 1.3.1: Develop Comprehensive Water Quality Monitoring Program
Work with Alaska Clean Water Actions program and other partners to develop a comprehensive water quality monitoring program for the Mat-Su Basin.

Strategic Action 1.3.2: Strengthen and Expand Water Quality Monitoring
Support and help secure funding for existing water quality programs. Seek long-term funding for a comprehensive program in the Mat-Su Basin.

Strategic Action 1.3.3: Support Baseline Data for Stream Temperatures
Support monitoring of temperatures in Mat-Su Basin waterbodies.

2. Alteration of riparian areas

Development in riparian areas is regulated at the federal, state and local level. Floodplains within the Mat-Su Borough (MSB) are mapped and regulated by the Federal Emergency Management Administration (FEMA) through a MSB flood plain permit process. Existing floodplain maps from the FEMA need to be updated with a finer resolution (i.e., 2ft contour maps) to be more accurate, and additional mapping is needed to cover areas that are currently unmapped.

Several state regulations provide some protections for riparian areas. The Anadromous Fish Act provides a degree of protection for riparian areas. The State of Alaska has regulations through the Forest Resources Practices Act (FRPA) for timber operations along anadromous waterbodies in Southcentral Alaska (Freeman and Durst 2004). These regulations provide protection for salmon-bearing streams, including retention of vegetation along streams based on the stream size. These regulations apply to logging for commercial timber on sites larger than 40 acres, regardless of land ownership. They do not apply to harvest on smaller sites or to clearing land to convert forest lands to another use, such as for commercial or residential development.

The Anadromous Fish Act (AS 41.14.870) requires a state permit for most activities that might affect the bed or banks of waterbodies that support salmon. This indirectly provides a degree of protection for riparian areas. The Alaska Department of Fish and Game (ADFG) maintains the Anadromous Waters Catalog that documents spawning, rearing or migration of anadromous fishes in Southcentral Alaska. Streams must be included in the Anadromous Waters Catalog (ADFG 2007) for Anadromous Fish Act regulations to apply. Currently the catalog contains only 4,200 miles of the more than 23,900 miles of streams that have been mapped in the Mat-Su Basin. More funding and resources are needed to map additional streams in the MSB.

The MSB has a 75ft setback for all habitable structures on the shores of waterbodies within the borough. This ordinance does not apply to non-habitable buildings, such as garages, nor address activities and vegetation clearing that may occur in riparian areas. The MSB is examining its setback ordinance to incorporate some of its Voluntary Best Management Practices for Development Around Waterbodies.

Objective 2.1: Identification of Priority Riparian Areas for Salmon
By 2015, 50% of salmon riparian areas will be mapped and prioritized for long-term legal protection and/or restoration.

Strategic Action 2.1.1: Identify and Prioritize Riparian Habitats
Identify, assess, map and prioritize riparian habitats (both stream and lake) for protection and/or restoration within the Lowland East and Lake Complex target areas by 2010. Map and prioritize riparian habitats for protection and restoration within the Upland and Lowland West Complex target areas by 2012. Identify priority salmon watersheds within the Mat-Su Basin according to vulnerability and importance to salmon.

Objective 2.2: Protection of Priority Salmon Riparian Habitat
By 2015, secure long-term protective status (e.g., conservation easements, designated parks, land acquisition) of at least 10% of priority riparian habitats that have not been significantly altered.

Strategic Action 2.2.1: Synthesize Existing Riparian Habitat Protections
Compile information and develop maps of all existing regulations and plans governing publicly and privately owned riparian habitats in the Mat-Su Basin.

Strategic Action 2.2.2: Protect Riparian Habitat With Local Mechanisms
Support development of local land use planning mechanisms (e.g., setback ordinances, Green Infrastructure plans) that secure riparian function on Mat-Su Borough, city, community, and private lands by providing technical assistance and educating the public and decision-makers.

Strategic Action 2.2.3: Protect State Lands Through Area Plans
State Land Use Plans often provide for the establishment and maintenance of riparian buffers to protect water quality, maintain wildlife habitat, and provide for public access. These provisions may include use restrictions to protect the functions of the buffer. Recommend the state consider applying FRPA riparian standards to other uses addressed by area plans, including the Southeast Susitna Area Plan update (ADNR 2008). The science behind FRPA buffers could be applied to other land uses to define adequate buffers. Where the state is disposing of lands to the public, such as through recreational land sales and subdivision development, one method of protecting riparian areas, including floodplains, is to retain these lands in state ownership. Wherever possible, riparian lands could be retained, unless another mechanism (e.g., establishment of conservation easement prior to disposal, transfer to MSB) can be shown to provide an equal or greater degree of protection.

Strategic Action 2.2.4: Promote Best Management Practices
Promote Best Management Practices for riparian habitat standards that can be applied to all ownerships.

Strategic Action 2.2.5: Protect Riparian Areas with Easements
Protect riparian habitat important to salmon through voluntary conservation easements and/or fee acquisition from willing sellers.

Objective 2.3: Restoration of Priority Riparian Habitat
By 2015, 5% of priority riparian habitats that have been altered are restored.

Strategic Action 2.3.1: Implement Pilot Project to Protect and Restore
Implement a pilot project in a priority subwatershed that is known to have a high importance for salmon, an expected high return on investment, and has been already identified by partner programs (e.g., Alaska Clean Water Actions[8]). "No Regrets" pilot project sites include the Deshka River, Cottonwood Creek, Wasilla Creek, Little Susitna River and Big Lake. The pilot project would include comprehensive actions to protect and restore salmon habitat, such as mapping current condition of riparian habitats, completing a survey for the Anadromous Waters Catalog, identifying priorities for restoration and protection, and establishing a monitoring program.

Strategic Action 2.3.2: Conduct Riparian Restoration Projects
On an annual basis, identify funding sources, partners and technical expertise to conduct restoration projects for salmon riparian habitats. Encourage partners who conduct projects to apply for funding through National Fish Habitat Action Plan (NFHAP), U.S. Fish and Wildlife Service (USFWS) Coastal Program, National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service's (NMFS) Community Based Restoration Program, and other funding sources.

3. Filling of Wetlands

Currently, development in wetlands (i.e., filling, draining, or dredging) is regulated through Clean Water Act Section 404 permits issued by the Army Corps of Engineers (ACOE). ACOE jurisdiction is limited to navigable waterbodies, including permanent and non-permanent streams which flow into navigable waters as well as wetlands with surface connectivity to navigable waters. Certain small-scale developments are authorized by Nationwide and General Permits issued by the ACOE to the public, and are not tracked locally. By some estimates, up to ninety percent (90%) of all wetland fill actions are covered under Nationwide or General permits. Of those permits that are tracked, over 3,100 wetlands permits have been filed in the Mat-Su Basin, with the greatest number (1,582) filed in the Lowland East Complex and the greatest density in the Lake Complex (one permit per 188 acres) (TNC 2007).

Activities in wetlands that are authorized by individual 404 permits undergo a public review. The ACOE cannot authorize projects within the coastal zone until they are found consistent with the standards of the Alaska Coastal Management Program. In a similar manner, 404 permits cannot be issued unless the Alaska Department of Environmental Conservation (ADEC) issues or waives a 401 certification stating that the project will not result in the violation of state water quality standards. The Environmental Protection Agency evaluates ACOE jurisdiction of wetlands, and U.S. Fish and Wildlife Service (USFWS) has authority under the Fish and Wildlife Coordination Act to review 404 permits. The National Marine Fisheries Service has this same authority, as well as that under the Magnusson Stevens Act to review wetlands permits in the

[8] http://www.dec.state.ak.us/water/acwa/acwa_index.htm

Mat-Su Basin. ADNR's Office of Habitat Management and Permitting, and the Mat-Su Borough also participate in permit reviews.

There are some other restrictions on development of or near wetlands at the local, state, and federal levels. Wetlands that are documented in the Anadromous Waters Catalog as salmon-bearing waters are subject to the protections under the Anadromous Fish Act. NRCS performs wetlands delineations and determinations on agricultural and wildlife lands, and prohibits wetlands fills on lands within its programs. Although the Mat-Su Borough has ordinances that regulate development along waterbodies and in floodplains, local governments currently have no direct control over wetlands through regulation, mitigation, or enforcement.

The Mat-Su Borough is creating a wetlands mitigation bank with undeveloped, borough-owned wetlands. The "bank" ensures the long-term protection of wetlands and provides an opportunity for land owners and developers to mitigate development of private wetlands by paying to protect banked wetlands. Initially the "bank" will only include borough-owned lands.

A lack of information about Mat-Su Basin wetlands often complicates their protection. USFWS maintains the National Wetlands Inventory (NWI) to document wetlands in the United States. Within the Mat-Su Basin, the NWI is estimated to include roughly half of all wetlands. An overlay of a map of hydric soils by the Natural Resources Conservation Service indicates that forested wetlands are most likely to be missing from the NWI. The functional quality of most wetlands in the Mat-Su Basin has not been assessed. Scientists are still discovering how salmon use wetlands near lakes and rivers and how the presence of wetlands affects habitats salmon use in nearby lakes and streams. The role of wetlands in groundwater recharge in the Mat-Su Basin is also poorly understood.

The current situation leaves small privately-owned and isolated wetlands at risk from development. The cumulative loss of individual wetlands is not being measured, and the full extent of Mat-Su Basin wetlands that could be developed has not been assessed. Without a functional assessment methodology specific to Mat-Su Basin wetlands[9], comparisons of wetlands to be developed versus wetlands to be protected as mitigation are difficult.

Objective 3.1: Conserve Wetlands for Salmon

By 2015, loss of wetlands that are important for salmon either as spawning or rearing habitat, re-charge of streams, or filtration of streams, will be avoided, minimized, or mitigated with protection, management, and enhancement.

Strategic Action 3.1.1: Protect Vulnerable Wetlands in the Short Term

If initiated locally, support local government's establishment of a short term moratorium on development near anadromous streams within the watersheds undergoing the greatest development. The moratorium would provide time to map priority wetlands for protection, and to institute protection measures. A public outcry on the Kenai River in the late 1970s resulted in a short-term moratorium while ACOE conducted a watershed study. A

[9] A wetland functional assessment guidebook has been published for the Cook Inlet Ecoregion, which includes the Mat-Su Basin. The **Cook Inlet Basin Ecoregion Wetland Functional Assessment Guidebook for Slope/Flat Wetland Complexes** can be found online at http://www.dec.state.ak.us/water/wnpspc/wetlands/cookinlethgm.htm.

jurisdictional assessment of the most-developed watersheds, like Wasilla and Cottonwood Creeks, may show that a majority of the remaining wetlands would not require a 404 permit and thus are not regulated.

Strategic Action 3.1.2: Map Priority Wetlands for Salmon
Identify priority salmon watersheds within the Mat-Su Basin according to vulnerability and importance to salmon. Map wetlands within these priority watersheds. Develop functional assessment methodology and a Mat-Su wetlands management plan to aid in prioritization for protection.

Strategic Action 3.1.3: Protect Wetlands with Easements
Protect wetlands important to salmon through voluntary conservation easements and/or fee acquisition from willing sellers.

Strategic Action 3.1.4: Enhance degraded wetlands
Enhance degraded wetlands through activities such as reconnection of isolated wetlands and improvement of water quality.

Strategic Action 3.1.5 Strengthen Agency Review Process
Strengthen review of 404 permits by ensuring that federal agencies (USFWS, EPA, NOAA, ACOE) have sufficient resources available in the Mat-Su Basin.

Strategic Action 3.1.6: Expand Wetlands Mitigation Bank
Expand the capacity of the Wetlands Mitigation Bank to include high value wetlands on private lands, especially within the most developed watersheds (e.g., Wasilla Creek, Cottonwood Creek).

Strategic Action 3.1.7: Develop Protection Mechanisms
Develop a suite of protection mechanisms for long-term protection of wetlands that are important for salmon. In addition to strategic actions above, options could include a local ordinance, public education, use of Green Infrastructure methods with communities, and land swaps.

4. Impervious surfaces and stormwater runoff

Impervious surfaces created by housing and urban development (driveways, rooftops, sidewalks, roads and streets) prevent infiltration of storm water into the ground and generate large volumes of runoff that can cause erosion, rapidly transmit pollutants to surface waters, and alter the hydrology of the receiving water. The developed areas of the Mat-Su Basin currently have the highest levels of impervious surfaces (12% in Meadow Creek, 11% in Wasilla Creek).

Storm and melt-water runoff in the Mat-Su Basin is generally untreated. When this runoff flows into streams, rivers, lakes and wetlands, it may result in impacts to the receiving waterbody. Uncontrolled runoff from construction sites carries sediment, which is the major cause of nonpoint source pollution nationwide. In addition to sediment, runoff from roads and parking lots often contains hydrocarbons from fuel and oils, coolants, heavy metals, and salts. Several rivers and lakes within the Mat-Su Basin are currently classified by ADEC as either impaired or priority waterbodies due to pollutants contained in runoff (e.g., Cottonwood Creek). Pollution from urban runoff and development has been identified as a primary contributing factor for impairment.

Combining storm and meltwater from several sources and concentrating it in drainage ditches or storm drains for discharge into surface waters creates pollution point sources that often cause erosion at the discharge site, disrupt the natural stream flow, and overwhelm the absorptive capacity of the receiving water. Retaining stormwater on site and allowing it to infiltrate into the ground results in the filtration and storage of this water before it flows to a stream or other waterbody. This helps to maintain water quality and to stabilize both stream flows and water levels in lakes.

No specific regulations or Mat-Su Borough codes currently address the creation or management of impervious surfaces in the Mat-Su Basin. Once a community reaches a certain population density, stormwater discharges from impervious surfaces may be addressed under the Environmental Protection Agency's (EPA) Municipal Separate Storm Sewer System (MS4) program. The program is intended to be a comprehensive approach to managing runoff. In addition to requiring the authorization and monitoring of individual stormwater outfalls, the program involves the assessment of issues such as post construction storm water, floodplain management, and the use of pesticides, herbicides and fertilizers. Anchorage and Fairbanks are currently the only communities in Alaska subject to the program.

The Mat-Su Borough and state and federal agencies directly regulate stormwater runoff from construction activities. The Mat-Su Borough addresses stormwater runoff in new subdivisions in its Title 27, requiring that drainage from construction activities be managed and accommodated onsite. The EPA's National Pollutant Discharge Elimination System (NPDES) General Permit for Construction Activities applies to all areas of land disturbance of one acre or greater, if runoff from the site has the potential to discharge to waters of the U.S[10]. If the disturbed site is greater than five acres, the developer must also submit a Stormwater Pollution Prevention Plan (SWPPP) to ADEC. The EPA also has a Multi-Sector General Permit that regulates runoff from industrial sites, such as large gravel pits.

Objective 4.1: Minimization of Imperviousness Impacts on Water Quality
By 2012, effective impervious surfaces will remain below five percent in developing watersheds and new housing and urban development sites will not result in stormwater runoff that alters the quantity or quality of water in streams and lakes. All water flowing into salmon habitat will equal or exceed the quality necessary to protect the growth and propagation of fish as determined by state water quality standards for aquatic life.

Strategic Action 4.1.1: Support Local Land Use Planning Mechanisms
Support development of local land use planning mechanisms that 1) promote the mimicking of pre-development runoff and infiltration conditions in new developments; 2) maintain vegetated buffers around surface waters; and 3) prohibit direct discharges of

[10] Alaska Department of Conservation (ADEC) has applied for primacy of the NPDES permitting program and may receive by the end of 2008.

stormwater runoff to surface waters. Support could include technical assistance, education of the public and decision makers, and seeking funding for monitoring and code enforcement.

Strategic Action 4.1.2: Promote Best Management Practices
Promote Best Management Practices (BMP) for new developments on municipal, state and private lands. BMPs should include methods to reduce impervious surfaces and eliminate stormwater runoff (e.g., buffers, rain gardens, detention, and retention).

Strategic Action 4.1.3: Educate the Public
Create a public outreach program about the need and methods for reducing impervious surfaces. Promote demonstration projects with local developers to show methods and benefits.

Strategic Action 4.1.4: Implement Green Infrastructure
Work with land management planning processes to include Green Infrastructure principles to direct development of impervious surfaces away from waterbodies.

Strategic Action 4.1.5: Encourage Drainage Districts
Encourage establishment of drainage districts to reorient districts to follow watershed boundaries rather than be based on road service areas so impacts of road construction can be more easily monitored and assessed.

Objective 4.2: Imperviousness Impact Assessment
By 2010, understand the magnitude of impact of impervious surfaces and stormwater runoff in the most developed watersheds.

Strategic Action 4.2.1: Map Impervious Surfaces & Stormwater Network
Map current data on impervious surfaces and relationships with water bodies. Map and identify stormwater drainage network that includes pipes and ditches. Map accumulations of stormwater runoff in streams.

Strategic Action 4.2.2: Assess Runoff Impact to Water Quality
Assess current impact of runoff to water quality and hydrograph of streams and lakes in the watersheds with the greatest levels of imperviousness (i.e., > 5%).

Strategic Action 4.2.3: Assess Current Regulatory Effectiveness
Assess adequacy of current NPDES permitting under EPA and adequacy of ADEC monitoring. If inadequate, seek funds to assist ADEC with monitoring of water quality.

Strategic Action 4.2.4: Reduce Runoff Impact through Planning
Develop plan to reduce impact of stormwater runoff in watersheds having the greatest impact. Plan may include education, monitoring, remediation, ordinances, and BMPs.

5. Septic systems

Septic systems are regulated by the Alaska Department of Environmental Conservation (ADEC). ADEC offers certification to install conventional septic systems for single family and duplex residences and systems that serve small commercial facilities that generate less than 500 gallons per day of domestic wastewater. Certified installers do not need to seek ADEC approval before installing these conventional systems. Larger septic systems and all systems that dispose of non-domestic wastewater require approval from ADEC prior to construction. Certified installers or engineers for non-conventional systems must submit system details to ADEC within 90 days after construction with a request for approval to operate.

Siting of septic systems is controlled by requirements for separation from drinking water sources, soil and site conditions, and Mat-Su Borough property setbacks. State regulations require 100 ft separation distance between septic systems or outhouses and mean high water level of waterbodies and drinking water wells, and four feet vertical separation to groundwater. ADEC also requires a soil survey by a professional engineer. To address site conditions where the standard setback is not adequate, ADEC seeks review of system design and sets higher standards for sites with steep slopes, high water tables, and low-permeability soils. In most areas of the state, ADEC does not inspect existing septic systems. However, because the Mat-Su Basin lies in a coastal zone area, ADEC will include it under the Coastal Non-Point Source program and plans to schedule inspections of existing septic systems in the future.

Within the Mat-Su Basin, only the cities of Palmer and Wasilla operate limited wastewater collection networks. All houses, commercial, and industrial buildings outside these city limits use septic systems; these may be individual or community systems. In 2006 ADEC inferred the location of septic systems in the Mat-Su Borough based on known building locations beyond the wastewater collection networks. Based on this database, there are approximately 21,000 onsite waste systems in the Mat-Su Basin, concentrated around the communities of Wasilla and Palmer, and along the Parks and Glenn Highway corridors; these onsite systems may be septic systems or outhouses. Many of these onsite systems are concentrated along streams and lakes.

Septic systems in the Mat-Su Borough are pumped into tanks and trucked to the wastewater treatment facility in Anchorage at Port Woronzof. The Anchorage facility is permitted through EPA's National Pollutant Discharge Elimination System (NPDES) and has an exemption which allows it to use only primary treatment of wastewater before discharging the wastewater into Knik Arm. Primary treatment includes gravity separation of solids and either chemical or biological breakdown of organics in aerobic settling tanks. The growing population of the Mat-Su Borough and current problems at the Palmer wastewater treatment facility point to a need for a new facility that can handle most Mat-Su Borough waste and result in less discharge into Cook Inlet and the path of migrating salmon.

The Natural Resource Conservation Service (NRCS) has assessed site and soil properties to determine drain field characteristics. Within some watersheds within the Lowland East and Lake Complex targets, one-third to two-thirds of the watershed area was assessed as "severely limited" (TNC 2007) due to shallow water tables, steep slopes, or any flooding hazard. Soil properties or site features at these locations are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased system maintenance are required. Many of the severely limited soils correspond with steep slopes, wetlands, or riparian areas.

Existing controls on septic systems could prevent some contamination of water quality if ADEC knew about all septic systems, if the Mat-Su Borough or the state monitored system maintenance and abandonment, and if the public understood the existing regulations and site limitations better. Not all septic installations are reviewed by ADEC, so conventional systems have been installed on marginal or inappropriate locations. State law requires that records of system construction be filed, but ADEC does not have records or locations for all systems.

Objective 5.1: Improved Wastewater Disposal
By 2010, septic systems are designed and constructed based on parcel size, number of parcels in a subdivision, and soil suitability, with an emphasis on developing community systems and connecting to public systems, so that septic systems do not contribute to degraded water quality.

Strategic Action 5.1.1: Encourage Community Systems
Encourage developers and the Mat-Su Borough to promote the installation of community water wells and septic systems through Best Management Practices, incentives, education and regulation.

Strategic Action 5.1.2: Map Septic Suitability
Identify areas that are poorly-suited to onsite systems and/or that are subject to existing ADEC regulations and make that information readily available to developers, realtors, the general public, and the Mat-Su Borough. This information should include instructions for a review process by the Mat-Su Borough (MSB), Alaska Department of Environmental Conservation (ADEC), and/or Environmental Protection Agency (EPA). Ideally this information will be available on a website with other information important for developing parcels.

Strategic Action 5.1.3: Educate with Land Use Permits
Make septic suitability information part of the Mat-Su Borough's land use permit and subdivision processes, so that landowners and developers are informed of soil suitability for wells and septic systems when they begin the process of building.

Objective 5.2: Expanded Wastewater Infrastructure
By 2015, Mat-Su Borough and its communities have a wastewater infrastructure and treatment facilities that can handle most of the wastewater in the Mat-Su Borough.

Strategic Action 5.2.1: Encourage Construction of Wastewater Treatment Facility
Provide technical assistance and other support to help local governments to construct a wastewater treatment facility that can handle all septic systems in the Mat-Su Borough.

Strategic Action 5.2.2: Encourage Expanded Wastewater Infrastructure
Provide technical assistance and other support to help local governments develop a wastewater network that can handle most, if not all wastewater in the Mat-Su Borough.

6. Culverts that block fish passage

Culverts, including round and arched pipes, are located under four types of infrastructure: local roads, state roads, private roads and the railroad. All landowners – private, state, federal and railroad – must apply for and receive a permit for any work that occurs within the ordinary high water mark of anadromous fish-bearing waters in the State of Alaska. Alaska State law requires a permit to install a culvert on any fish-bearing stream[11]. Some culvert projects may also require permits from the Mat-Su Borough, Army Corps of Engineers, and the Coastal Zone Management program.

Assessment of culverts that provide for adequate fish passage, particularly for juveniles, is a priority for anadromous waters identified in the Anadromous Waters Catalog (ADFG 2007). Alaska Department of Fish and Game (ADFG) also maintains an inventory of the location of over 320 culverts under state and Mat-Su Borough roads and the railroad in the Mat-Su Basin (ADFG 2007b)[12]. Most publicly owned culverts are in the inventory, but many private culverts are not. ADFG assesses the culverts initially for fish passage based on juvenile (55 mm length) coho salmon. The assessment considers culvert slope, stream constriction, and culvert embedment or perch. Culverts receiving a 'Red' rating are considered inadequate for juvenile fish passage. A 'Green' rating indicates the culvert is adequate, and 'Gray' denotes culverts that require additional data and analysis to categorize fish passage. Within the Mat-Su Basin, more than one-third (130) of culverts are inadequate for fish passage, and another 140 are considered unlikely to allow for adequate fish passage, and require additional data and analysis to be assessed completely.

In other parts of the state, ADFG has prioritized culverts for replacement based on an analysis of costs versus benefit to fish. The Mat-Su Borough and the U.S. Fish and Wildlife Service have prioritized work on borough-owned culverts based on borough road maintenance and construction projects, and degree of impediment to fish passage.

As past culvert assessments have shown, there is a legacy of fish passage barriers in the Mat-Su Basin. These barriers are a result of historic state of knowledge, inadequate design or permit requirements, or lack of maintenance. In the past, biological considerations were not always incorporated, and little was known about local hydrology or the impacts of habitat fragmentation on fish distribution or populations. Today, much more is known about these issues and technology has improved culvert design options. Conditions at a culvert that create a barrier or impedance condition are primarily high water velocity, turbulence, inadequate water depth, and elevated outfalls at stream crossings. In some cases, culverts that were designed to provide for fish passage may have not been installed properly or were inadequately maintained, becoming a fish passage impediment over time.

Efforts have been made to streamline understanding between permitting agencies and the four infrastructure landowners. For instance, ADFG and the Alaska Department of Transportation and Public Facilities (ADOT&PF) signed a Memorandum of Agreement concerning fish passage

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[11] Through EO114, Governor Sarah Palin transferred state habitat permitting authority from the Alaska Department of Natural Resources to the Alaska Department of Fish and Game.
[12] This inventory is publicly available at www.sf.adfg.state.ak.us/SARR/Fishpassage/FP_mapping.cfm.

and road projects[13], yet coordination can be ineffective with changing staff, administrations, and department authorities.

Objective 6.1: No New Barriers
By 2010, effective fish passage is maintained at new road crossings through improved coordination between agencies, sufficient resources for applying current state statutes, and use of improved design and construction practices for effective fish passage.

Strategic Action 6.1.1: Develop Local Design Standards
Develop design standards to maximize fish passage in all new construction activities in the Mat-Su Basin, including private and public roads, in coordination with ADFG, ADNR and USFWS. These standards would include state-of-the-art fish passage standards, guide a user to the most reasonable type of culvert design, specify maximum design flows, and minimize debris clogging and icing issues.

Strategic Action 6.1.2: Develop Fish Passage Hydraulic Criteria Specific to the Mat-Su Basin
An interagency committee will review and develop Mat-Su Basin-specific hydraulic criteria for fish passage based on information gathered in surface water quantity studies, including recurrence intervals and high and low flow exceedances.

Strategic Action 6.1.3: Monitor Culverts
Develop and implement culvert monitoring plan to ensure fish passage is maintained or improved.

Strategic Action 6.1.4: Improve State Coordination
Recommend that the Memorandum of Agreements (MOA) between ADOT&PF and ADFG for culverts be updated to address changes in state departments, advances in fish passage standards, and links to habitat permitting. Evaluate need and potential formation of a MOA with the Alaska Railroad. Hold an annual meeting between agencies, ADOT&PF and Alaska Railroad to discuss and coordinate improving fish passage and upcoming projects. Promote and conduct status meetings of fish passage in the Mat-Su Borough on a recurring basis.

Strategic Action 6.1.5: Improve State-Local Coordination
Hold annual meetings between agencies (e.g., ADFG, ADNR, USFWS, ACOE, EPA) and Mat-Su Borough Public Works to discuss upcoming public works projects, improving fish passage and coordinating permit needs and activities.

Strategic Action 6.1.6: Enhance Habitat Permitting and Monitoring
Support sufficient resources in the state budget for habitat permitting and monitoring by state agencies. Discuss and coordinate basic fish passage standards between all agencies. Promote and conduct status meetings of fish passage in the Mat-Su Borough on a recurring basis.

[13] Available at www.sf.adfg.state.ak.us/SARR/Fishpassage/FP_regs.cfm.

Objective 6.2: Fish Passage Restoration
By 2012, fish passage will be restored in 20 priority culverts that currently block passage of juvenile or adult fish.

Strategic Action 6.2.1: Complete Culvert Inventory
Assess and inventory fish passage status on all culverts on state and Mat-Su Borough roads by Fall 2010. Assess and inventory all culverts on private roads and the railroad by 2011.

Strategic Action 6.2.2: Develop and Implement Fish Passage Improvement Plan
Develop and implement a multi-agency fish passage improvement plan that includes budget and priorities for culvert replacement. Prioritize culverts based on an analysis of benefit to fish versus cost of replacement. The plan will include short and long term actions, determine retrofit and replacement options, identify potential funding resources, and integrate with local, state, and railroad reconstruction & maintenance plans.

Strategic Action 6.2.3: Educate Agencies and Private Developers About Fish Passage
Develop a fish passage educational and outreach program for both agencies and the general public that explains the value of and legal requirements for maintaining fish passage and successful methods for achieving fish passage influence. Promote and conduct educational workshops on state-of-the-art design and status of fish passage in the Mat-Su Borough on a recurring basis.

7. Loss or alteration of water flow or volume

The constitution of the State of Alaska reserves all surface and subsurface waters as a common public resource for the people of the state. All significant water use, even by landowners adjacent to a water body, requires a water right. A water right allows a specific amount of water from a specific water source to be diverted, impounded, or withdrawn for a beneficial use. The constitution also allows water rights for water to remain instream, that is, not to be removed for consumptive or non-consumptive use. A reservation of water application can be for one or a combination of four purposes: protect fish and wildlife habitat, migration, and propagation; recreation and park purposes; navigation and transportation purposes; and sanitary and water quality purposes.

Withdrawals of surface and groundwater are permitted through the Alaska Department of Natural Resources (ADNR). Permits are required for most groundwater and surface withdrawals that exceed 500 gallons per day. ADNR encourages but does not require the application of permits for all other groundwater and surface withdrawals including residential wells. ADNR maintains a well log that includes well depth or waterbody, type of water use, water quantity, period of water use, water right priority date, and location. However, submittal of well logs may not be complete. In 1991, the ADNR, Division of Geological and Geophysical Surveys, published a Report of Investigations 90-4: *Ground-Water Resources of the Palmer-Big Lake Area, Alaska: A Conceptual Model* (ADNR 1991), which provided a conceptual groundwater model to help with land use planning and groundwater protection. Additionally, U.S. Geological Survey (USGS) has a well log database. Despite the efforts of several agencies, groundwater resources lack adequate study and documentation within the Mat-Su Basin.

ADNR also adjudicates applications for reservations of water, which may be applied for by government agencies, other organizations, and private individuals. In the Mat-Su Basin, ADFG has filed reservations of water on reaches of eight streams (Fish Creek, Meadow Creek, Cottonwood Creek, Willow Creek, Deception Creek, and the Talkeetna, Little Susitna, and Deshka rivers). Current Alaska state law allows for 100% allocation of water if there is no reservation of water for instream use, but such an appropriation has never been issued in a fish-bearing waterbody.

Information on water flow and levels of ground and surface water in the Mat-Su Basin is limited compared to other parts of the country. USGS maintains continuous gages on 7 streams in the Mat-Su Basin, compared to an average of 61 gages in a similar area in the lower 48 states. The ADNR Alaska Hydrologic Survey is also mandated with the collection, evaluation, distribution, and quality of ground and surface waters of the state. USGS began a groundwater mapping pilot project in the Mat-Su Basin in 2005 and has mapped the water table depth for approximately 590 square miles, or 2.5% of the basin. The relationship between groundwater and surface water is not well understood in the Mat-Su Basin.

Objective 7.1: Instream Flow on Anadromous Waters
By 2020, applications for reservations of water filed with ADNR for priority anadromous lakes and stream reaches.

Strategic Action 7.1.1: Prioritize Anadromous Streams and Lakes
Prioritize anadromous streams and lakes for reservations of water based on importance to salmon and vulnerability.

Strategic Action 7.1.2: Establish Mat-Su Basin Water Reservation Protection Program
Develop a cooperative program to implement a cost-effective water reservation protection program.

Strategic Action 7.1.3: File for Reservations of Water
File for reservations of water on priority anadromous lakes and stream reaches.

Strategic Action 7.1.4: Evaluate Water Withdrawal Laws and Practices
Evaluate adequacy of current water withdrawal laws, regulations and administrative practices to protect salmon and salmon habitat and propose solutions as needed to strengthen state protections for salmon (e.g., amendments to state water withdrawal laws to prevent impacts to salmon).

Objective 7.2: Community Water Needs Study
By 2012, current and future use and need of ground and surface water by Mat-Su Basin communities are quantified in order to assess impacts to water quantity.

Strategic Action 7.2.1: Analyze Future Water Needs
Identify current and future water needs based on population trends. Assess capacity of groundwater supply. Identify potential conflicts between community water needs and fish water needs and provide strategies and solutions to planners to balance these.

8. Loss of estuaries and nearshore habitats

Most loss of estuaries and nearshore habitats is due to development of the transportation infrastructure that uses the waters of Cook Inlet. Currently the transportation infrastructure is limited to a few locations in Cook Inlet (e.g., Port of Anchorage, Point MacKenzie, Seward Highway). As population and industrial growth continues, however, more infrastructure will be required to move people and goods. Potential projects include dock and port facilities associated with the development plans for the Chuitna coal project; a bridge to span Knik Arm; and the construction and operation of a ferry terminal to support development and transportation to the Susitna Valley. Additionally, several hydroelectric projects are proposed that could effect the Susitna, Chakachama and McArthur rivers. Offshore gold mines near Anchor Point are also proposed, and several alternative energy projects are proposed for Upper Cook Inlet waters to harness potential tidal power.

Federal regulation of impacts from coastal development (e.g., wetland fills, structures in navigable waters, point source discharges) is by the Army Corps of Engineers under the Federal Water Pollution Control Act and by the Environmental Protection Agency under the National Pollutant Discharge Elimination System. Through various other legislation (Fish and Wildlife Coordination Act, Endangered Species Act, Migratory Bird Treaty Act, Magnusson Stevens Fisheries Management Conservation Act), the USFWS and NOAA Fisheries comment and consult on federal permits and licenses.

Under the Alaska Coastal Management Program (ACMP) coastal projects undergo a consistency review process by local, state and federal agencies. The Mat-Su Borough's Coastal Zone Management Program also has input on coastal development. Non-governmental organizations that monitor coastal development include Cook Inlet keeper and Cook Inlet Regional Citizens Advisory Council.

A comprehensive plan for development and management of Upper Cook Inlet estuary and nearshore areas does not exist, though smaller efforts address parts of the inlet or particular species. The state's revision of the Willow Sub-Basin Area Plan (renamed the Southeast Susitna Area Plan) will include basic land use designations for the tidelands west of the Knik River to the Susitna River. The Mat-Su Borough's Coastal Zone Management Plan addresses the upper part of Cook Inlet. If the beluga whale is listed as endangered under the Endangered Species Act, the critical habitat study is expected to address human use of some parts of Cook Inlet.

Two large-scale programs have mapped the shoreline, including the estuaries, of Upper Cook Inlet. NOAA's Office of Response and Restoration developed the Environmental Sensitivity Index (ESI) to identify coastal locations that would be vulnerable to oil and gas spills. ESI maps delineate three kinds of data: shoreline type, biological resources (e.g., seabird colonies, marine mammal rookeries), and human-use areas (e.g., marinas, beaches). ESI maps have been completed for most of the United States, including Alaska. The Cook Inlet and Kenai Peninsula atlas was first completed in 1994 and then updated in 2002 and is available in a digital format.

The Shorezone methodology is a coastal habitat mapping and classification system that uses aerial imagery to interpret and integrate geological and biological features of the intertidal and nearshore areas. In addition to videotapes of flights, GIS datasets delineate biological resources (e.g., splashzone, kelp) and geomorphology (e.g., dominant morphology, sediment type). The Shorezone database can be used for habitat suitability modeling. Data for the Gulf of Alaska, including Cook Inlet, has been sponsored by a broad consortium, including the Exxon Valdez Oil Spill (EVOS) Trustee Council, U.S. Fish and Wildlife Service (USFWS), NOAA, and Alaska Department of Fish and Game (ADFG)[14].

Despite a greater understanding of estuarine ecology, little detail is known regarding Upper Cook Inlet and how salmon use this habitat for rearing or over-wintering. Some potential development projects in Upper Cook Inlet (e.g., Port of Anchorage, Knik Arm Bridge, and Chuitna coal mine) have commissioned studies that show some salmon have a significant resident time in the nearshore environment. Other studies indicate Upper Cook Inlet waters are a more species diverse and richer marine estuarine ecosystem than previously presumed (Nemeth, 2007).

Objective 8.1: Salmon Use of Cook Inlet
By 2012, understand salmon use of Cook Inlet, temporally and spatially, by lifestage in estuary, nearshore & deep water habitats, in order to identify habitats critical to Mat-Su Basin salmon.

Strategic Action 8.1.1: Identify and Map Habitat Types
Identify habitat types in Cook Inlet and map with Shorezone, ESI or additional survey.

Strategic Action 8.1.2: Map Salmon Distribution and Movements
Use sampling telemetry to map salmon distribution and movements through the inlet. Use this information to determine use of and productivity of various habitat types.

Strategic Action 8.1.3: Study Salmon Interactions
Study processes in the inlet and interactions with salmon, similar to studies undertaken by EVOS in Prince William Sound.

Strategic Action 8.1.4: Map Critical Habitats for Salmon
Map critical habitats for salmon in the estuary and nearshore habitats.

Objective 8.2: Conserve Estuaries for Salmon
By 2015, loss of estuarine and nearshore habitats that are important to salmon either as rearing or migratory habitat in Cook Inlet will be avoided, minimized, or mitigated through regional cooperation.

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[14] www.coastalaska.net

Strategic Action 8.2.1: Create Cook Inlet Alliance
Create Cook Inlet Alliance of government, NGOs, communities, fishing, University of Alaska, and industry interests to address Cook Inlet marine and coastal issues. The three National Fish Habitat Partnerships that are anticipated on the east side of Cook Inlet (i.e., Mat-Su, Anchorage, and Kenai) could play a central role in forming and coordinating this alliance.

Strategic Action 8.2.2: Plan Regionally for Marine Transportation Infrastructure
Write a comprehensive regional plan for directing development of marine transportation infrastructure around Cook Inlet. The Cook Inlet Alliance could be the body that coordinates this effort.

Strategic Action 8.2.3: Improve management and construction of coastal facilities
Improve construction techniques and methods for new facilities, or expansion or rehabilitation of existing facilities to minimize short and long-term impacts to salmon habitat. Best Management Practices should be developed to address construction and on-going operations.

Strategic Action 8.2.4: Improve Water Quality
Reduce and mitigate the level of point and nonpoint pollution discharge into Upper Cook Inlet waters to improve water quality for migrating and rearing salmon.

9. Invasive Northern pike

Northern pike were introduced into the Yentna River drainage in the early 1950's and eventually spread to the Susitna River drainage during high water events. Pike populations established in the Susitna River drainage and spread to adjacent Cook Inlet watersheds. Over half of the Susitna River Basin contains shallow, vegetated, and slow-moving lakes and sloughs, which are suitable habitat for pike (ADFG 2006b). Several waterbodies in the Mat-Su Basin that once contained resident fish now contain only pike: Alexander Lake and all inlet streams, Fish Creek within the Nancy Lake canoe system, Fish Creek of Kroto slough, and Fish Lake Creek of the Yenta River (ADFG 2006b). At least seven additional waterbodies in the Mat-Su Basin are at risk for pike invasion: Mama and Papa Bear Lake in Talkeetna, Caswell Creek along the Parks Highway, Rabideux Creek near the Susitna River bridge, the Big Lake system, Little Susitna River system, Jim Creek system, and Cottonwood Creek system (ADFG 2006b).

The Alaska Department of Fish and Game (ADFG) recently released a *Management Plan for Invasive Northern Pike in Alaska* (ADFG 2006b). The overall objectives of the management plan are to: increase public awareness of invasive pike; prevent pike introductions; gain public support for management actions; implement activities to control or eradicate pike; improve resident fish populations that have been impacted by pike; and restore enhanced fisheries that have been reduced or eliminated by pike. ADFG has identified outreach and education, building partnerships, interagency coordination, research investigations, and pathway analyses as methods to achieve these objectives.

Objective 9.1: Pathways Analysis
By 2010 understand pathways to invasion of Northern pike in order to predict future systems at risk and prevent introductions to those systems.

Strategic Action 9.1.1: Research Invasion Pathways
Develop and implement a collaborative research plan with state and federal agencies and the University of Alaska to study Northern pike invasion pathway by 2009.

Strategic Action 9.1.2: Control Northern Pike Populations
Develop and implement a collaborative control program between ADFG and other partners in systems where salmon are most vulnerable.

Objective 9.2: Introduction Reduction
By 2012, human introductions of Northern pike to additional Mat-Su Basin waterbodies is significantly reduced through education and outreach to the general public.

Strategic Action 9.2.1: Educate the Public
Develop a collaborative outreach program with ADFG to educate the public about the loss of native salmon fisheries from introductions of Northern pike. Outreach could include school programs, information in fishing regulations, websites, brochures, signs at lakes and streams, and special events like a pike derby.

VIII. Measures of Conservation Success

The partnership will monitor effectiveness of strategy implementation by monitoring target viability (Table 5) and the mitigation of potential threats (Table 6). Results of implementing strategic actions need to be measured to see if strategies are working as planned and whether adjustments will be needed. Measures also allow the planning team to monitor the status of those targets and threats that were not identified as critical but may need to be reconsidered in the future.

An indicator is a measure of a key ecological attribute, critical threat, objective, or other factor. The challenge is to select the *fewest* number of indicators required to measure both the effectiveness of the strategies for the priority objectives and the status of targets and threats that are not initial priorities (e.g., a low-ranked potential threat that might become a major problem). Indicators identified during the viability assessment of the conservation targets provide a starting point for choosing indicators to monitor how strategy implementation is maintaining or improving target viability.

Table 5. Viability Monitoring

Ecological Attribute	Indicator
Status of Pacific salmon stocks	• Maintenance of Alaska Department of Fish and Game (ADFG) escapement goals & sustainable yield of wild salmon
Connectivity between habitats for different life stages of Pacific salmon	• Percent of spawning & rearing habitat accessible • Map of salmon use of Upper Cook Inlet
Hydrological regime	• Magnitude and timing of annual peak flows in index watersheds in terrestrial systems • Seasonal and long-term flow characteristics in index watersheds in terrestrial systems • Freshwater input to Cook Inlet
Riparian integrity	• Percent of native vegetation within riparian corridors along stream and lake shorelines
Size & extent of native communities	• Percent of lands converted from natural state in all terrestrial systems • Diversity & distribution of wetlands types in Lowland East and Lake Complexes • Diversity & distribution of nearshore habitat types in Upper Cook Inlet Marine
Abundance of key functional guilds	• Status of predator populations (e.g., beluga whale, harbor seals)

Table 6. Threat Monitoring	
Ecological Attribute	**Indicator**
Water Quality	• Number of waterbodies not meeting Alaska Department of Environmental Conservation (ADEC) water quality standards for freshwater aquatic life; including water temperature • Number of locations in Upper Cook Inlet not meeting ADEC water quality standards for marine aquatic life • Existence of a comprehensive baseline and monitoring program for water quality in the Mat-Su Basin • Dissolved oxygen in Lake Complexes
Imperviousness within developed areas	• Percent of impervious surfaces in Lowland East and Lake Complexes
Priority riparian habitats	• Map of riparian areas important for salmon • Percent of priority riparian habitats with voluntary conservation easements or those included in conservation units • Percent of priority riparian habitats restored to 'fair' condition • Existence of effective local ordinances that protect riparian habitats on Mat-Su Borough and private lands • Percent of state lands subject to Forest Resources Practice Act (FRPA)-based riparian standards
Wetlands important for salmon	• Existence of wetlands mitigation bank that protects high-value wetlands on Mat-Su Borough and private lands • Map of wetlands with functional assessment • Percent of wetlands restored
Water flow and volume	• Existence of a comprehensive baseline and monitoring program for water quantity for surface and groundwater in the Mat-Su Basin • Number of gages on Mat-Su Basin waterbodies • Number of reservations of water on Mat-Su Basin waterbodies

Ecological Attribute	Indicator
Fish Passage	• Percent of Mat-Su Basin waterbodies surveyed for Anadromous Waters Catalog • Percent of Mat-Su Basin waterbodies surveyed for fish passage database (i.e., culvert inventory) • Percent of 'Red' and 'Gray' culverts replaced • Agreements and plans between local, state, and federal agencies for transportation and fish passage
Invasive Northern Pike	• Number of waterbodies with Northern pike
Development of Estuaries	• Regional marine transportation plan developed by Cook Inlet stakeholders, including Fish Habitat Partnerships
Septic Systems	• Percent of Mat-Su Basin residences and businesses on community septic systems or municipal wastewater systems

VIIII. The Future for the Mat-Su Salmon Partnership

The Mat-Su Salmon Partnership has developed this Strategic Action Plan to help partners set priorities for collaborative actions to conserve habitat for wild salmon that spawn, rear, or over-winter in the Mat-Su Basin. Relevant actions that could be guided by this plan include regulatory development; permitting; protection, restoration, and mitigation activities; assessment and research projects; and education and outreach activities. Specifically, the Strategic Action Plan addressed three purposes to provide this guidance:

1. **Identifies important habitats for salmon and other fish species in the Mat-Su Basin:** Through the selection of salmon groups and ecosystems,and identification of key ecological attributes, the plan outlines what habitat and lifestage components are critical for ensuring long-term health of Mat-Su Basin salmon (see Conservation Targets, Section IV).
2. **Prioritizes fish habitat conservation actions, including protection, enhancement, and restoration of key habitat, education and outreach, research, and mitigation**: The viability assessment (see Section V) points out the current health of salmon and their habitats; targets and attributes that are in fair condition become priorities for restoration. The analysis of potential threats (see Section VI) identifies the stresses that can be expected in the next 10 years if preventative measures, like protection and education, are not implemented. Specific conservation strategies (see Section VII) are identified for each of nine focal issues. Throughout the planning process, lack of information and data led to priorities for research and monitoring, and the plan makes recommendations for research needs (Appendix 8).
3. **Identifies potential collaborations and funding sources for partners to address fish habitat conservation:** Each of the strategies in this 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). We anticipate that 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.

This Strategic Action Plan sets out priorities for this Partnership to conserve wild salmon and their habitat in the Mat-Su Basin. Achievement of these goals and objectives will depend upon commitment by partner organizations and collaboration between partners. The history of salmon in other parts of the world indicates that wild salmon cannot persist in their full abundance unless stakeholders work together to protect salmon habitat. Within this Partnership, each partner has unique capabilities, responsibilities, and resources that can address a key component for salmon habitat. Only in working together, can all the key components for salmon habitat be protected to ensure healthy, abundant salmon runs in the Mat-Su Basin into the future.

Glossary of Terms and Acronyms

Acceptable Range of Variation

Key ecological attributes of focal targets naturally vary over time. The acceptable range defines the limits of this variation which constitute the minimum conditions for persistence of the target. If the attribute drops below or rises above this acceptable range, it is a degraded attribute.

ACOE

Army Corps of Engineers

ACWA

Alaska Clean Waters Action

Adaptive Management

An approach to resource management where management policies and actions are used as a tool not only to change the system, but for managers and others to learn about the system. Under this approach, management interventions are designed as experiments to test key hypotheses about ecosystem functionality and to improve our understanding of how the ecosystem responds to change.

ADEC

Alaska Department of Environmental Conservation

ADFG

Alaska Department of Fish and Game

ADNR

Alaska Department of Natural Resources

ADOT&PF

Alaska Department of Transportation and Public Facilities

Anadromous

Pertaining to fish that spend a part of their life cycle in the sea and return to freshwater streams to spawn, for example, salmon, steelhead, and shad. This document refers to streams with anadromous fish habitat as Anadromous Streams, though the more correct terminology is Anadromous Fish Streams.

Basin; river basin; (Mat-Su Basin)

A geographic area drained by a single major stream; consists of a drainage system comprised of streams and often natural or man-made lakes. Also referred to as Drainage Basin, Watershed, or Hydrographic Region.

Biodiversity

Refers to the variety and variability of life, including the complex relationships among microorganisms, insects, animals, and plants that decompose waste, cycle nutrients, and create the air that we breathe. Diversity can be defined as the number of different items and their relative frequencies. For biological diversity, these items are organized at many levels, ranging from complete Ecosystems to the biochemical structures that are the molecular basis of heredity. Thus, the term encompasses different ecosystems, species, and genes.

Biotic
Pertaining (1) to life or living things, or caused by living organisms; (2) or to biological factors or influences, concerning biological activity.

Biotic Community
A naturally occurring assemblage of plants and animals that live in the same environment and are mutually sustaining and interdependent.

Buffers
Also called buffer zones or buffer strips. A strip of grass, shrubs, and trees used to separate a watercourse (creek, lake, etc.) from an intensive land-use area (housing, roads, cultivated fields, etc) to protect water quality, prevent bank erosion, and maintain in-stream habitat values.

CAP, Conservation Action Planning
An iterative process that focuses on the biodiversity of concern and emphasizes adaptive management throughout the life of the project.

Channel morphology
The physical features of stream channel shape, pattern and profile, including width, depth, slope, type of substrate (bottom), frequency of pools, and sinuosity of the channel.

Complex (as in Lake Complex or Lowland Complex)
A unit of land made up of interconnected or related structures and parts.

Conservation
The protection, improvement and responsible use of natural resources to provide social and economic value for the present and future.

Conservation easement
An agreement between a landowner and a private land trust or government. The agreement limits certain uses on all or a portion of a property for conservation purposes while keeping the property in the landowner's ownership and control. The agreement is usually tailored to the particular property and to the goals of the owner and conservation organization. It applies to present and future owners of the land.

Conservation Strategy
Composed of an objective, which defines a vision of conservation success, and strategic actions that will achieve the objective.

Conservation Targets
A limited suite of species, communities, and ecological systems that are chosen to represent and encompass the full array of biodiversity found in a project area. They are the basis for setting goals,

carrying out conservation actions, and measuring conservation effectiveness. In theory – and hopefully in practice – conservation of the focal targets will ensure the conservation of all native biodiversity within functional landscapes. Often referred to as just Targets.

Contribution
One of the criteria used to rate the impact of a source of stress. The degree to which a source of stress, acting alone, is likely to be responsible for the full expression of a stress within the project area within 10 years.

Critical Threats
Sources of stress that are most problematic. Most often, these are the "very high" and "high" rated threats based on the rating criteria of the scope, severity, contribution, and reversibility of their impact on the focal targets

Current Status
An assessment of the current "health" of a target as expressed through the most recent measurement or rating of an indicator for a key ecological attribute.

Direct Threats
Used as a synonym for sources of stress. Agents or factors that directly degrade targets.

Ecological processes
Natural disturbances that shape the landscape and affect biodiversity by maintaining heterogeneity of habitat patches.

Ecosystem
A community of plants, animals and microorganisms that interact with each other, occur together on the landscape, and share common ecological processes (e.g. flooding), environmental features (e.g. geology), or environmental gradients (e.g. precipitation). May be part of the terrestrial, freshwater, or marine environment. Rain forests, deserts, coral reefs, grasslands and a rotting log are all examples of ecosystems. Also called System.

Effectiveness Measures
Information used to answer the question: Are the conservation actions we are taking having their intended impact? Compare to status measures.

EPA
Environmental Protection Agency

Escapement
The number of mature salmon that pass through (or escape) the fisheries and return to their rivers of origin to spawn.

Estuary
Somewhat enclosed coastal area at the mouth of a river where nutrient rich fresh water meets with salty ocean water.

Eutrophication
The process whereby a water body becomes rich in dissolved nutrients (mostly nitrates and phosphates) from erosion and runoff of surrounding lands. Eutrophication is natural, but can be greatly accelerated by human activities. This often results in a deficiency of dissolved oxygen, producing an environment that favors plant over animal life.

Floodplain
Relatively flat area found alongside the stream channel that is prone to flooding and receives alluvium deposits from these inundation events.

Focal Issue
The particular negative impact to salmon habitat from the source of a threat (e.g., filling of wetlands due to urban development).

Geomorphology
The field of knowledge that investigates the origin of landforms on the Earth.

GIS
Global Information System. A computer information system that can input, store, manipulate, analyze, and display geographically referenced data to support the decision-making processes of an organization. A map based on a database or databases.

Glacial moraine
A hill of glacial till or sediment deposited directly by a glacier.

Goal
Synonymous with vision. A general summary of the desired state or ultimate condition of the project area that a project is working to achieve. A good goal statement meets the criteria of being visionary, relatively general, brief, and measurable.

Green Infrastructure
Green infrastructure is the interconnected network of open spaces and natural areas, such as greenways, wetlands, parks, forest preserves and native plant vegetation, that naturally manages stormwater, reduces flooding risk, improves water quality, and contributes to the health and quality of life citizens. Green Infrastructure can be integrated into local, regional, state and national land use plans, policies, practices, land protection strategies, watershed planning, and community decisions. Used as a noun, green infrastructure refers to the interconnected green space network. Used as an adjective, green infastructure describes a process that promotes a systematic and strategic approach to land conservation at the national, state, regional, and local scales, encouraging land-use planning and practices that are good for nature and for people.

Heterogeneity
State of being dissimilar or diverse.

Hydrograph
A graph describing stream discharge over time. Stream discharge is the stream's rate of flow over a particular period of time, usually expressed in cubic feet or meters per second.

Hydrological regime / Hydrologic flow regime
The characteristic pattern of precipitation, runoff, infiltration, and evaporation affecting a water body or region.

Hyporheic
The hyporheic zone is a region beneath and lateral to a stream bed, where there is mixing of shallow groundwater and surface water.

Impervious surfaces
Surfaces of land where water cannot infiltrate back into the ground such as roofs, driveways, streets and parking lots. Lawns with underlying soils compacted by heavy machinery can be impervious.

Indicators
Measurable entities related to a specific information need (for example, the status of a key ecological attribute, change in a threat, or progress towards an objective). A good indicator meets the criteria of being measurable, precise, consistent, and sensitive.

Indirect Threats
Factors identified in an analysis of the project situation that are drivers of direct threats. Often an entry point for conservation actions. For example, “logging policies” or “demand for fish.”

Instream habitat
The physical structure of a stream and the associated aquatic and riparian vegetation that provides a variety of habitats for different species and life stages of aquatic organisms. Examples of instream habitats include pools, overhanging vegetation, submerged log complexes, undercut banks, gravel substrate, boulders, backwater sloughs, side channels, etc.

Invasive species
A species of plant, animal or insect that is 1) non-native (or alien) to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health. Invasive species are most often spread through deliberate or accidental human transport.

Irreversibility
One of the criteria used to rate the impact of a source of stress. The degree to which the effects of a source of stress can be restored. Typically includes an assessment of both the technical difficulty and the economic and/or social cost of restoration. Sometimes referred to as “irreversibility.” See also contribution.

Key Ecological Attributes, Key Attributes, KEAs

Aspects of a target's biology or ecology that, if missing or altered, would lead to the loss of that target over time. As such, KEAs define the target's viability or integrity. More technically, the most critical components of biological composition, structure, interactions and processes, environmental regimes, and landscape configuration that sustain a target's viability or ecological integrity over space and time. "Attribute" used as shorthand in this document.

Lacustrine

Pertaining to, produced by, or inhabiting a lake.

Littoral zone

The zone along a coastline that is between the high and low-water tide marks.

Macrofauna

Macrofauna are benthic or soil organisms which are at least one millimeter in length.

Marine-derived nutrients

Marine-derived nutrients are nutrients that are transferred from the marine environment to freshwater ecosystems when anadromous salmonids make their spawning migrations. These nutrients are important to the productivity of the lakes and streams in which the fish spawn and to their progeny. Fish carcasses are directly consumed by fishes or are reduced by bacteria, invertebrates, and fungi and the nutrients released into the system.

MOU

Memorandum of Understanding – a document describing an agreement between parties.

MSB

The Matanuska-Susitna Borough, often referred to as the "Mat-Su Borough."

Nested Targets

Species, ecological communities, or ecological system targets whose conservation needs are subsumed by one or more focal conservation targets.

NFHAP

National Fish Habitat Action Plan

NOAA

National Oceanic and Atmospheric Administration

NMFS

National Marine Fisheries Service

NPDES

National Pollutant Discharge Elimination System – a permitting program administered by the Environmental Protection Agency.

NRCS
Natural Resource Conservation Service

Objectives
Specific statements detailing the desired accomplishments or outcomes of a particular set of activities within a project. A good objective meets the criteria of being: impact oriented, measurable, time limited, specific, practical, and credible.

OHMP
Office of Habitat Permitting and Management – a subunit within the Alaska Department of Natural Resources.

Pacific salmon
Refers to salmon species in the genus *Oncorhynchus* (Pacific salmon and trout). In the Mat-Su Basin, this includes Chinook or king salmon (O. tshawytscha); coho or silver salmon; (O. kisutch); sockeye, red, or kokanee salmon (O. nerka); chum or dog salmon (O. keta); and pink or humpback salmon (O. gorbuscha). Other species in the genus found in Alaska include steelhead or rainbow trout (O. mykiss) and cutthroat trout (O. clarki). There are several other species of salmon and trout in this genus, some of which occur only in the western Pacific Ocean (in Asian and Russian waters). See also Salmon and Salmonids.

Palustrine
A category of wetland. Wetlands within this category include inland marshes, swamps, bogs, fens, wet meadows, tundra and floodplains.

Point source discharges
Any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged.

Rain garden
A landscaping feature that is planted with native perennial plants and is used to manage stormwater runoff from impervious surfaces such as roofs, sidewalks, and parking lots.

Riparian / riparian habitat
The riparian zone is the area of land and vegetation adjacent to a stream, including the stream bank and adjoining floodplain, and is distinguishable from upland areas in terms of vegetation, soils, and topography. Zone width varies based on vegetation, geomorphology, and sensitivity of land to disturbance, though standard widths can be defined for classes of waterbodies.

Salmon
Salmon is the common name for several species of large, anadromous fishes including Pacific salmon (genus *Oncorhynchus)* and Atlantic salmon (*Salmo salar*), which are all members of the family Salmonidae. See also Pacific Salmon and Salmonids.

Salmonid
Any member of the taxonomic family Salmonidae, which includes all species of salmon, trout, char, whitefish and grayling. See also Pacific Salmon and Salmon.

Salmon population – A discrete group of a single species that is defined by its reproductive isolation and/or geographical distribution (e.g. management unit).

Salmon stock
A locally interbreeding group of salmon which is distinguished by a combination of genetic, phenotypic, life history, and habitat characteristics or an aggregation of two or more interbreeding groups which occur within the same geographic area and are managed as a unit (Alaska State Policy for the Management of Sustainable Salmon Fisheries).

Scope
In the context of a threat assessment, one of the measurements used to rate the impact of a stress. Most commonly defined spatially as the proportion of the overall area of a project site or target occurrence likely to be affected by a threat within 10 years. See also severity.

Sedimentation
The process that deposits soils, debris and other materials in water bodies and watercourses. Formation of sediment. A sediment is a natural deposit created by the action of dynamic external agents such as water, wind, and ice.

Severity
One of the criteria used to rate the impact of a stress. The level of damage to the conservation target that can reasonably be expected within 10 years under current circumstances (i.e., given the continuation of the existing situation). See also scope.

Sources of Stress
Proximate agents or factors that directly degrade targets. Synonymous with direct threats.

Stakeholders
Individuals, groups, or institutions who have a vested interest in the natural resources of the project area and/or who potentially will be affected by project activities and have something to gain or lose if conditions change or stay the same.

Status Measures
Information used to answer the questions: “How is the biodiversity we care about doing?” and/or "How are threats to biodiversity changing?" for key ecological attributes and/or threats that are not currently the subject of conservation actions. Compare to effectiveness measures.

Strategic Actions
Interventions undertaken to reach the objectives. A good action meets the criteria of being linked (to threat abatement or target restoration/protection), focused, strategic, feasible, and appropriate.

Strategies
Broad courses of action that include one or more objectives, the strategic actions required to accomplish each objective, and the specific action steps required to complete each strategic action.

Stresses
Disturbances that are likely to destroy, degrade, or impair targets that result directly or indirectly from human sources. Generally equivalent to degraded key ecological attributes.

System
See Ecosystem

Threats
Agents or factors that directly or indirectly degrade targets. See also direct threat, indirect threat, and critical threat.

TNC
The Nature Conservancy

USFWS
U.S. Fish and Wildlife Service

USGS
U.S. Geological Survey

Viability
The status or "health" of a population of a specific plant or animal species. More generally, viability indicates the ability of a conservation target to withstand or recover from most natural or anthropogenic disturbances and thus to persist for many generations or over long time periods.

Vision
A general summary of the desired state or ultimate condition of the project area or scope that a project is working to achieve. A good vision statement meets the criteria of being visionary, relatively general, brief, and measurable.

Watershed
A watershed is the area of land where all of the water drains to the same place (river, lake, estuary, or ocean) – this includes water that flows on the surface and water located underground. Watersheds come in all shapes and sizes. Large watersheds may be composed of several smaller "subwatersheds", each of which contributes runoff to different locations that ultimately combine at a common delivery point.

Wetland
Wetlands are those areas where water saturation is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the surrounding environment. Wetlands are typically defined by one or more attributes: at some point of time in the growing season the substrate is periodically or permanently saturated with or covered by water; periodically, the land supports predominantly water-loving plants such as cattails, rushes, or sedges; the area contains

undrained, wet soil which is anaerobic, or lacks oxygen in the upper levels. Wetlands subject to Clean Water Act Section 404 are defined as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."

Wild salmon

Salmon produced in natural rivers and lakes unaided by human management. Excludes hatchery and farmed salmon.

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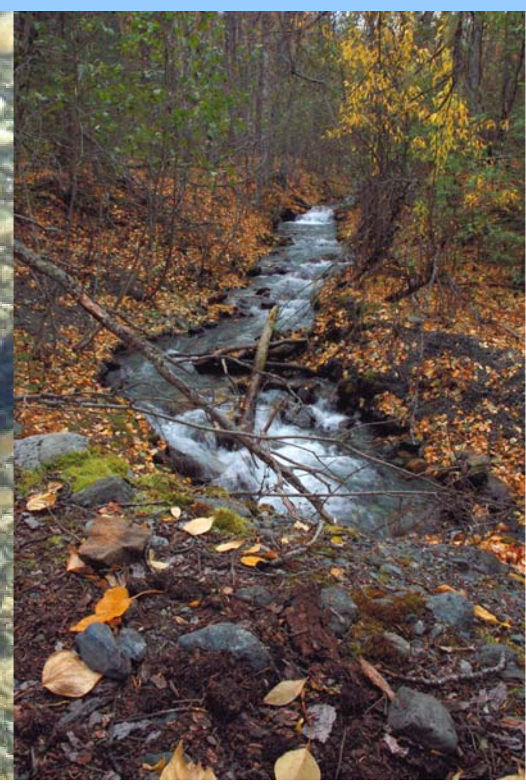

Thriving fish, healthy habitats, and vital communities in the Mat-Su Basin

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