Conserving Salmon Habitat in the Mat-Su Basin

The Strategic Action Plan of the Mat-Su Basin Salmon Habitat Partnership

2013 Update

Mat-Su salmon PARTNERSHIP

Mat-Su Basin Salmon Habitat Partnership Steering Committee

Frankie Barker
Matanuska-Susitna Borough

Roger Harding
Alaska Department of Fish and Game

Bill Rice
U.S. Fish and Wildlife Service

Jessica Winnestaffer
Chickaloon Village Traditional Council

Eric Rothwell
NOAA's National Marine Fisheries Service

Corinne Smith
The Nature Conservancy

Kim Sollien
Great Land Trust

Jeff Davis
Aquatic Restoration and Research Institute

Laura Allen
Upper Susitna Soil & Water Conservation District

Acknowledgements

2008 Editors — Corinne Smith, The Nature Conservancy; Jeff Anderson, U.S. Fish and Wildlife Service

2013 Editors — Corinne Smith and Jessica Speed, The Nature Conservancy

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 Association of Conservation Districts; 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; Envision Mat-Su; Fishtale River Guides; Friends of Mat-Su; Great Land Trust; Matanuska-Susitna Borough; Mat-Su Borough Fish and Wildlife Commission; Mat-Su Conservation Services; National Park Service; Natural Resources Conservation Service; NOAA's National Marine Fisheries Service; Palmer Soil and Water Conservation District; The Nature Conservancy; US Army Corps of Engineers; U.S. Fish and Wildlife Service; U.S. Geological Survey; USKH; and the Wasilla Soil and Water Conservation District. A complete list of participants is in Appendix 1.

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

Cover photos by Clark James Mishler (left), Jeremiah Millen (top), Katrina Mueller (bottom), and Corinne Smith (back).

Table of Contents

Appendices

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 and urbanization in the Mat-Su Basin is threatening the fish habitat necessary to sustain healthy salmon populations and ultimately the quality of life for residents. 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. The current pace of population growth in the region, combined with the current regulatory framework, enforcement, and common development and recreation practices, have many people concerned that these life-quality values cannot be maintained. The greatest risk to habitat for salmon and other freshwater fish in the Mat-Su Basin may be many small actions that compound over time to degrade riparian habitat, block fish passage, and impact water quality, quantity and flow.

Mat-Su Basin Salmon Habitat Partnership

The Matanuska-Susitna Basin Salmon Habitat Partnership formed to address increasing impacts on salmon habitat 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 conservation efforts in the Mat-Su Basin, including upgrading traditional culverts to improve fish passage and maintain natural stream processes, 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 (ADF&G), 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[1]. The mission of the National Fish Habitat Partnership 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.”

[1] www.fishhabitat.org

The Intent of this Strategic Action Plan

In 2007 the Mat-Su Salmon Partnership embarked on an 18-month-long process to develop a Strategic Action Plan. In the 2008 plan, the Partnership selected eight areas of conservation strategies to address plus three over-arching science strategies to increase our knowledge about the location and characteristics of salmon habitat in the Mat-Su: fish distribution and life-cycle use, water quantity, and water quality.

In the last five years, much has happened in the Mat-Su Basin. Population growth and the accompanying development have continued in the Knik-Wasilla-Palmer core area and along the Parks Highway. Industry interest in coal mining in the Matanuska Valley has returned, and the state is reconsidering a decades-old plan to dam the upper Susitna River for hydroelectric power. Invasive aquatic plants have found their way to southcentral Alaska. Scientists have learned more about predicting climate change and the impacts it will have to precipitation, temperatures, and other climatic attributes. By the summer of 2013, the State of Alaska had designated seven salmon populations as Stocks of Concern,[2] resulting in sportfishing closures and restrictions on commercial fishing in Cook Inlet.

The Mat-Su Salmon Partnership has also been busy in the last five years addressing the strategies of the 2008 Strategic Action Plan. Partners have replaced over 70 culverts that prevented adult and juvenile salmon from accessing key spawning and rearing habitat in Mat-Su streams. The state started a streambank restoration cooperative program that has helped restore riparian areas on private and public lands. Over 5000 acres of wetlands, riparian areas, and uplands important for salmon habitat have been protected through conservation easements, transfer to state conservation units, and wetland preservation banks. In the core area, wetlands have been mapped and characterized more accurately, the borough has a Wetlands Management Plan, and the Corps is working with partners to develop a functional assessment of wetlands. Throughout the borough, a higher resolution and more recent map of impervious surfaces has been created, and the borough is working on a Stormwater Management Plan.

One thing that hasn't changed since 2008 is the purpose 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. The Steering Committee planned to revisit the original Strategic Action Plan every 3 to 5 years, and this edition is that first update to address changes in the Mat-Su Basin that could significantly affect the situation for salmon habitat.

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 NFHP and administered the planning process. The NFHP 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 NFHP and the Mat-Su Salmon Partnership. The

[2] Note that as this updated 2013 plan 'went to press,' the Alaska Board of Fisheries listed the Sheep Creek population of Chinook as a Stock of Concern.

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.

The future of Mat-Su salmon depends upon what happens to them during each life stage, from their incubation and rearing in freshwater, to their maturation in saltwater, and during their return back to freshwater to spawn. While debate continues about the reasons for decline of some salmon stocks across Alaska and in the Mat-Su, it is well-known that freshwater habitat loss and fragmentation are some of the primary drivers in the decline of anadromous fish elsewhere in the U.S. and the world. The Partnership's goal is to ensure that Mat-Su salmon have healthy habitats in the Mat-Su and upper Cook Inlet so that habitat loss does not contribute to the other stresses that Mat-Su salmon must endure. In the Mat-Su, healthy salmon habitat exists throughout the basin, and our top priority is to protect and maintain that habitat wherever possible.

Overall Health of Mat-Su Basin Salmon and Habitat

In 2008, the assessment of the health of wild salmon and their habitat indicated that, *taken as a whole across the Mat-Su Basin*, salmon and most of their habitats were healthy and required minimal human intervention for long term survival. A more local look at individual attributes of health, however, pointed out concerns about long-term sustainability of Mat-Su Basin salmon and some of the habitats they require for survival. For salmon, that assessment suggested that numbers for some sockeye, pink, and chum salmon runs may have been below a sustainable level and that some stocks might 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.

Since 2008, it has become evident that some Susitna salmon are experiencing significant declines. That year, the Alaska Board of Fisheries listed Susitna sockeye salmon as a Stock of Concern. Chinook salmon in that drainage missed their escapement goals for six years, and the Alaska Board of Fisheries listed six populations as Stocks of Concern in 2011. Little Susitna Coho salmon have missed escapement goals for the past four years.

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 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. 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 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. These are also largely the areas where the Stocks of Concern live out the freshwater portions of their life.

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 undeveloped areas can ensure that these ecosystems remain healthy for salmon and other aquatic species. The more impacted terrestrial ecosystems of 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 & Their Habitats

Many human activities pose 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 flows between 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.

For the 2013 plan update, the scoping process confirmed that the seven potential threats in the 2008 plan were still important areas for the Partnership and recommended that four more potential threats be included in the Strategic Action Plan. An existing threat was expanded to include invasive aquatic plants along with northern pike. Climate change was included in this updated plan because more information exists and a clearer role for the Partnership emerged. Motorized off-road recreation has continued to negatively impact some salmon habitat in the Mat-Su, and some partners have been working with user groups to address the problem. Large-scale resource development includes diverse activities like hydropower and coal mining because the Partnership's roles around these potential threats – science and education – are anticipated to be similar. This plan outlines the potential impacts to salmon habitat from each threat and summarizes the current status or level of activity of the threat in the Mat-Su Basin.

Potential Threats to Mat-Su Basin Salmon
Aquatic Invasive Species
Climate Change
Development in Estuaries and Nearshore Habitats
Ground & Surface Water Withdrawals
Household On-site Septic Systems & Wastewater
Large-scale Resource Development
Motorized Off-road Recreation
Residential, Commercial, & Industrial Development
Roads & Railroads
Stormwater Runoff

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 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 Partnership uses to guide work at the national and partnership level.

A situation analysis for each threat brought into focus the more discrete issues upon which the Partnership can act and identified 11 conservation strategies to conserve salmon in the Mat-Su Basin. These strategies address the sources of the impacts and the impacts themselves. Some impacts have multiple sources that can be addressed collectively. Other potential threats have unique situations that lend themselves to being addressed specifically. For that reason, the conservation strategies are organized around a mix of impacts and threats.

Conservation Strategies	
1	Overarching Science Strategies
2	Alteration of Riparian Areas
3	Climate Change
4	Culverts that Block Fish Passage
5	Filling of Wetlands
6	Impervious Surfaces & Stormwater Pollution
7	Aquatic Invasive Species
8	Large-scale Resource Development
9	Loss or Alteration of Water Flow or Volume
10	Loss of Estuaries & Nearshore Habitats
11	Motorized Off-road Recreation
12	Wastewater Management

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 because the information they will gather will inform multiple conservation strategies.

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, ensure that all anadromous fish habitat in the Mat-Su Basin is included in the Anadromous Waters Catalog and thus given basic protections afforded under state law. Efforts to catalog anadromous fish should identify life stage information and document non-anadromous fish.

Objective 1.2: Habitat Quality

By 2020, characteristics of habitats that are critical for salmon at each life stage (spawning, rearing, and overwintering) will be identified and used to develop critical habitat definitions to identify places that provide these habitats.

Objective 1.3: Comprehensive Surface and Groundwater Studies

By 2018, an increased understanding of surface and groundwater exchange, including locations, quantities, flows, and variability in the Mat-Su Basin, will be sufficient to aid in identifying critical salmon habitat for each life stage.

Objective 1.4: Water Quality Monitoring

By 2018, a comprehensive baseline and monitoring program for water quality exists to track and manage changes in Mat-Su Basin waterbodies.

Objective 1.5: Index Watersheds

By 2016, a minimum of three index watersheds are locations for long-term, interdisciplinary monitoring needed to understand the relationships between salmon, habitat health, and changes induced by human activities and climate change.

2. Alteration of Riparian Areas

Objective 2.1: Identification of Priority Riparian Areas for Salmon

By 2018, 50% of salmon riparian areas will be field surveyed, mapped and prioritized for long-term legal protection and/or restoration.

Objective 2.2: Protection of Priority Salmon Riparian Habitat

By 2018, 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 2018, 5% of priority riparian habitats that have been altered are restored.

3. Climate Change

Objective 3.1: Comprehensive Baseline and Monitoring for Stream Temperatures

By 2015, comprehensive baseline and monitoring program for stream temperatures exists to track and manage changes in priority Mat-Su Basin waterbodies and impacts on salmon and salmon habitat.

Objective 3.2: Integrate Climate Change into Priorities
By 2015, integrate climate change into habitat conservation strategies and prioritizations.

4. Culverts that Block Fish Passage

Objective 4.1: No New Barriers
By 2015, 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 4.2: Fish Passage Restoration
By 2015, fish passage will be restored in 65 priority culverts that currently block passage of juvenile or adult fish.

5. Filling of Wetlands

Objective 5.1 Identify, Map and Assess Functions of Wetlands for Salmon
By 2018, wetlands that are important for salmon will be identified, mapped and assessed for their functional importance for salmon.

Objective 5.2: Conserve Wetlands for Salmon
By 2020, 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.

6. Impervious Surfaces and Stormwater Pollution

Objective 6.1: Minimization of Impacts on Water Quality
By 2018, 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 6.2: Minimize Road Runoff
By 2018, the extent and potential of road runoff as a contributor to water quality issues at salmon streams will be known and Best Management Practices developed to minimize impacts.

Objective 6.3: Imperviousness Impact Assessment

By 2018, understand the magnitude of impact of impervious surfaces and stormwater runoff in the most developed watersheds.

7. Aquatic Invasive Species

Objective7.1: Prevention

By 2016, identify potential vectors for introducing or spreading Aquatic Invasive Species (AIS) in the Mat-Su and conduct outreach to inform and influence target audiences so that their activities do not introduce or spread AIS.

Objective 7.2: Early Detection and Surveillance

By 2015, periodic surveillance surveys designed to have a high likelihood of detecting AIS at an incipient stage of infestation will be completed at priority waterbodies. Priorities are determined based on level of risk for introduction of AIS.

Objective 7.3: Rapid Response

By 2015, procedures are in place to respond rapidly to any newly discovered introductions or to newly detected expansion of existing AIS.

Objective 7.4: Control

By 2015, an effective program of integrated pest management for invasive species is developed and implemented, including elements of containment, eradication, control, and restoration.

8. Large-scale Resource Development

Objective 8.1 Education and Outreach about Large-scale Resource Projects

By 2017, the public will have access to information about proposed large-scale resource development projects and their potential to affect salmon and their habitats.

Objective 8.2: Agency Assistance for Large-scale Resource Projects

By 2017, state and federal agencies and stakeholders involved in permitting processes for large-scale resource development projects have the data, analytical tools, and expertise that they need to understand the potential to affect salmon and their habitat.

Objective 8.3: Address Data Gaps

By 2017, data gaps for large-scale resource development projects will be identified and filled as feasible for the licensing and permitting processes.

9. Loss or Alteration of Water Flow or Volume

Objective 9.1: Instream Flow on Anadromous Waters

By 2020, partner organizations have filed applications for reservations of water with ADNR to preserve the flow regimes of priority anadromous lakes and streams.

Objective 9.2: Community Water Needs Study

By 2020, 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.

10. Loss of Estuaries and Nearshore Habitats

Objective 10.1: Salmon Ecology of Cook Inlet
By 2018, implement the Knik Arm Salmon Ecology Integrated Research Plan (HDR, 2010) to significantly improve the understanding of salmon ecology in Knik Arm.

Objective 10.2: Conserve Estuaries for Salmon
By 2018, assure no long-term impairments of vulnerable coastal habitats from incompatible shoreline developments.

11. Motorized Off-road Recreation

Objective 11.1: Impacts to Salmon and Salmon Habitat
By 2018, qualify the impacts to salmon and salmon habitat from off-highway vehicles (OHV) use regarding stream morphology and water quality to specifically determine physical damage to the stream and banks and hydrocarbon and sedimentation inputs to streams.

Objective 11.2: Mitigate OHV Use at Streams
By 2018, establish effective and publicly acceptable mechanisms to support stream health near OHV trails and at stream crossings.

12. Wastewater Management

Objective 12.1: Improved Wastewater Disposal
By 2018, 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 12.2: Expanded Wastewater Infrastructure
By 2018, Mat-Su Borough and its communities have a wastewater infrastructure and treatment facilities that can handle sewage discharges in the Mat-Su Borough.

Objective 12.3 Wastewater Pollution Prevention
By 2018, quantify the extent and sources of possible wastewater pollution to surface and ground waters from on-site septic systems and wastewater discharge.

The Future for the Mat-Su Salmon Partnership

The Mat-Su Salmon Partnership developed its first Strategic Action Plan in 2008 and updated the plan in 2013 in an effort 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.

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

This page intentionally left blank.

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 and urbanization in the Mat-Su Basin is threatening the fish habitat necessary to sustain healthy salmon populations and ultimately the quality of life for residents. 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. The current pace of population growth in the region, combined with the current regulatory framework, enforcement, and common development and recreation practices, have many people concerned that these life-quality values cannot be maintained. The greatest risk to habitat for salmon and other freshwater fish in the Mat-Su Basin may be many small actions that compound over time to degrade riparian habitat, block fish passage, and impact water quality, quantity and flow.

Mat-Su Basin Salmon Habitat Partnership

The Matanuska-Susitna Basin Salmon Habitat Partnership[3] formed to address increasing impacts on salmon habitat 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 conservation efforts in the Mat-Su Basin, including upgrading traditional culverts to improve fish passage and maintain natural stream processes, 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 (ADF&G), 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[4] (NFHP 2012). The mission of the National Fish Habitat Partnership[5] (NFHP) is to "protect, restore, and enhance the nation's

---

[3] 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.matsusalmon.org

[4] www.fishhabitat.org

[5] This national effort originally operated under the name National Fish Habitat Action Plan, and later renamed the effort the National Fish Habitat Partnership.

fish and aquatic communities through partnerships that foster fish habitat conservation and improve the quality of life for the American people." NFHP further identifies four goals (NFHP 2012):

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.

Table 1. Mat-Su Basin Salmon Habitat Partnership

AK Dept of Commerce, Community & Economic Development	Cook Inlet Aquaculture Association	Pioneer Reserve
AK Dept of Environmental Conservation	Cook Inletkeeper	Pound Studio
* AK Dept of Fish & Game	Environmental Protection Agency	Sierra Club
AK Dept of Natural Resources	Envision Mat-Su	Southeast Alaska Guidance Association(SAGA)
AK Dept of Transportation & Public Facilities	Fishtale River Guides	The Conservation Fund
Alaska Center for the Environment	Glacier Ridge Properties	* The Nature Conservancy
Alaska Outdoor Council	*Great Land Trust	The Wildlifers
Alaska Pacific University	HDR Alaska Inc.	Three Parameters Plus, Inc
Alaska Railroad Corporation	Knik River Watershed Group	Tyonek Tribal Conservation District
Alaska Salmon Alliance	Matanuska River Watershed Coalition	United Fishermen of Alaska
AlaskaChem Engineering	* Matanuska-Susitna Borough	Upper Cook Inlet Drift Association
Alaskans for Palmer Hay Flats	Mat-Su Anglers	*Upper Susitna Soil & Water Conservation District
*Aquatic Restoration & Research Institute	Mat-Su Conservation Services	US Army Corps of Engineers
Bureau of Land Management	Montana Creek Campground	* U.S. Fish and Wildlife Service
Butte Area Residents Civic Organization	* National Marine Fisheries Service	US Geological Survey
* Chickaloon Village Traditional Council	National Park Service	USDA Forest Service
City of Palmer	Native Village of Eklutna	Wasilla Soil & Water Conservation District
ConocoPhillips Alaska, Inc.	Natural Resources Conservation Service	
	Palmer Soil & Water Conservation District	

Partners as of December 2013 *indicates Steering Committee member

Fish habitat partnerships form the core force for accomplishing NFHP 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 NFHP and currently includes over 50 individuals and organizations (Table 1; Appendix 1). A Steering Committee composed of nine 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 habitat conservation through public and private sources.

2013 Updated Plan

In 2007 the Mat-Su Salmon Partnership embarked on an 18-month-long process to develop a Strategic Action Plan. In the 2008 plan, the Partnership selected eight areas of conservation strategies to address plus three over-arching science strategies to increase our knowledge about the location and characteristics of salmon habitat in the Mat-Su: fish distribution and life-cycle use, water quantity, and water quality.

In the last five years, much has happened in the Mat-Su Basin. Population growth and the accompanying development have continued in the Knik-Wasilla-Palmer core area and along the Parks Highway. Industry interest in coal mining in the Matanuska Valley has returned, and the state is reconsidering a decades-old plan to dam the upper Susitna River for hydroelectric power. Invasive aquatic plants have found their way to southcentral Alaska. Scientists have learned more about predicting climate change and the impacts it will have to precipitation, temperatures, and other climatic attributes. By the summer of 2013, the State of Alaska had designated seven salmon populations as Stocks of Concern[6], resulting in sportfishing closures and restrictions on commercial fishing in Cook Inlet.

The Mat-Su Salmon Partnership has also been busy in the last five years addressing the strategies of the 2008 Strategic Action Plan. Partners have replaced over 70 culverts that prevented adult and juvenile salmon from accessing key spawning and rearing habitat in Mat-Su streams. The state started a streambank restoration cooperative program that has helped restore riparian areas on private and public lands. Over 5000 acres of wetlands, riparian areas, and uplands important for salmon habitat have been protected through conservation easements, transfer to state conservation units, and wetland preservation banks. In the core area, wetlands have been mapped and characterized more accurately, the borough has a Wetlands Management Plan, and the Corps is working with partners to develop a functional assessment of wetlands. Throughout the borough, a higher resolution and more recent map of impervious surfaces has been created, and the borough is working on a Stormwater Management Plan.

Given all these changes and activities, the Partnership's original intent to revisit the plan in 3 to 5 years seems warranted. A scoping process to gauge the need to update or revise the plan began in late 2011. This document is the updated Strategic Action Plan that is a result of that process.

---

[6] Note that as this updated 2013 plan 'went to press,' the Alaska Board of Fisheries listed the Sheep Creek population of Chinook as a Stock of Concern.

The Intent of this Strategic Action Plan

One thing that hasn't changed since 2008 is the purpose 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[7]. The Steering Committee planned to revisit the original Strategic Action Plan every 3 to 5 years, and this edition is that first update to address changes in the Mat-Su Basin that could significantly affect the situation for salmon habitat.

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 NFHP and administered the planning process[8]. The NFHP 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 NFHP 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.

Ensuring healthy populations of Pacific salmon in the Mat-Su is dependent upon many factors. The State of Alaska is undertaking numerous studies to understand the declines in Chinook salmon returns (ADF&G 2013). Many partnership members attended a two-day workshop that ADF&G hosted in October 2012 to explore the possible reasons why Chinook salmon numbers are down across the state, including the Mat-Su[9]. Factors that are likely contributors to the decline include changes in the marine condition due to climate change, bycatch in other fisheries, and reduced estuarine survival. Some are concerned about how the reduced amount of marine nutrients returned to freshwater habitats over time may degrade overall health of salmon habitat. Fisheries management is another relevant issue that some partnership members are trying to address through the Alaska Board of Fisheries, the state legislature, and local fish and game advisory councils.

Most of these factors are beyond the sphere of the Partnership. However, while there continues to be much debate about the reasons for these salmon population declines, it is well-known that freshwater habitat loss and fragmentation are some of the primary drivers in the decline of

---

[7] A subsequent process prioritized fish habitat related projects and actions in this plan. *Prioritization of Strategic Actions Identified in the Mat-Su Basin Salmon Strategic Action Plan, 2008,* is available at www.matsusalmon.org.

[8] The next chapter provides an overview of the planning process.

[9] Conclusions and next steps from that workshop are summarized at http://www.adfg.alaska.gov/static/home/news/hottopics/pdfs/chinook_research_plan.pdf

anadromous fish elsewhere in the U.S. So as in 2008, these marine and allocation issues are not included in the scope of the 2013 plan because doing so would substantially change the nature of the plan and shift the focus away from the purposes for which the Mat-Su Salmon Partnership formed.

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

While factors outside the Partnership's scope play a role in the long-term health of Mat-Su salmon, a cooperative and voluntary approach to protection and restoration of salmon habitat can help to 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 NFHP, 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 20,237 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 salmon. The Susitna River run of Chinook salmon is the fourth largest in the state, with 100,000 – 200,000 returning each year (ADF&G 2006). Other common fishes are Arctic grayling, rainbow trout, Dolly Varden, Arctic char, lake trout, 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, and marine mammals in Cook Inlet.

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. When fires occur in the undeveloped parts of the basin, they are often left to burn if homes and communities are not threatened. Flooding can cause erosion and greatly affect the deposition of gravel and sediments along streams. Winter flows tend to be low and stable after freeze-up until spring warming and breakup. Flows and ice transport associated with breakup and snowmelt is associated with a high water period in the spring, usually in May or June, that forms and maintains riverine habitats. A second high water period occurs 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).

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

Other natural processes change the landscape more slowly over time. Tides in Cook Inlet undergo one of the highest fluctuations 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 shows 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). Temperatures and precipitation are expected to increase across the state throughout the next century. The growing season will lengthen, and glaciers, sea ice, and permafrost will be reduced. Significant ecosystem shifts are likely statewide. In southcentral Alaska, temperatures are projected to increase over the coming decades at an average rate of about $1^{o}C$ per decade (SNAP 2013). 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 could affect fish populations.

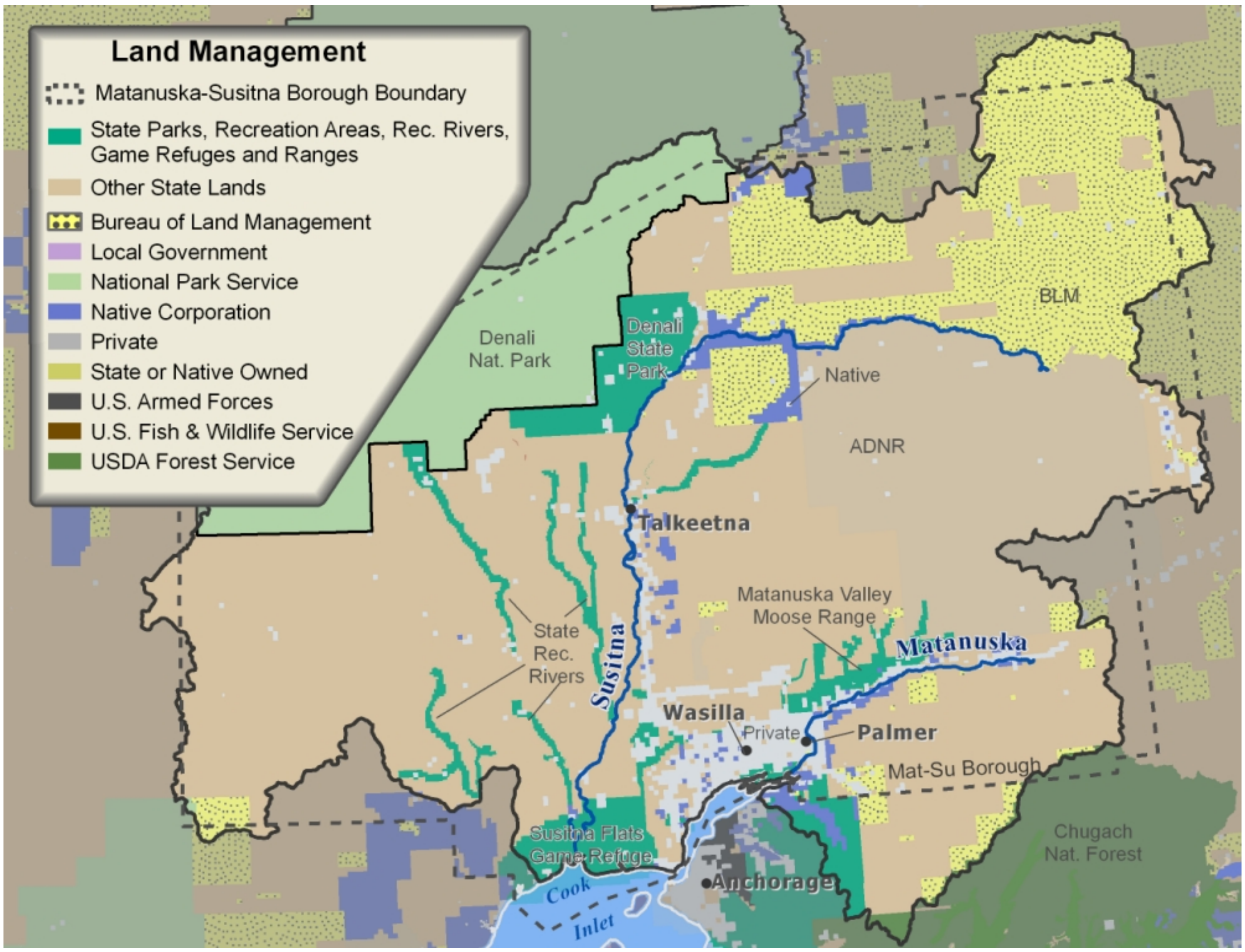
People in the Mat-Su Basin

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. Almost a third (31%) of Mat-Su Borough residents commute to Anchorage, where housing prices are higher but jobs are more plentiful (Fried 2013). 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, Fried 2013). 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 salmon 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 pounds per person (Leask et. al. 2001).

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



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.

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%**

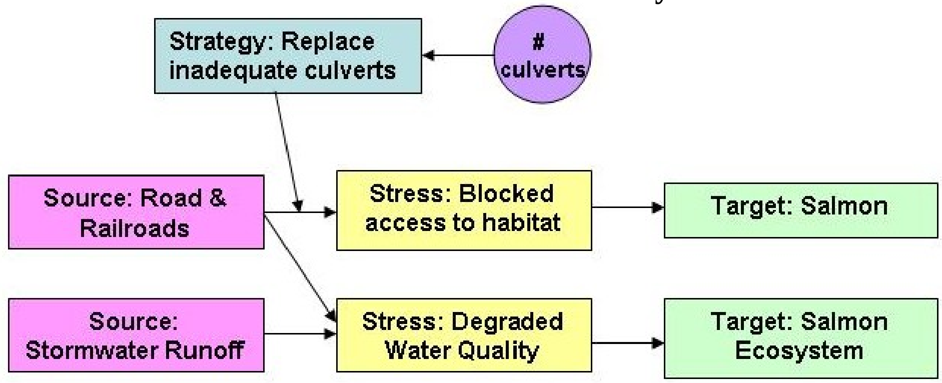
III. Overview of Planning Process

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[10]. CAP is the standard planning practice of a wide and expanding set of international conservation organizations (e.g., Conservation Measures Partnership[11]) 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. Example Situation Analysis of the CAP Framework for Effect of Culverts on 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

[10] More information about Conservation Action Planning is available at www.conservationgateway.org.
[11] 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 drain fields, 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 2008

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.

2013 Update to the Strategic Action Plan

Given the changes and activities since 2008, the Partnership's original intent to revisit the plan in 3 to 5 years seemed warranted. A scoping process to gage the need to update or revise the plan began in late 2011[12]. TNC solicited partner input through discussions with individual partners and the Steering Committee and in a session at the Mat-Su Salmon Science and Conservation Symposium in November 2011. To ensure that all partners had the opportunity to share their thoughts, an online survey was used to solicit opinions on the greatest threats to salmon habitat in the Mat-Su and the priorities of the Partnership. Presentations at the symposium also provided a starting point for tracking progress on the Strategic Action Plan to gage where the Partnership had reached or is nearing its goals.

As would be expected in a diverse partnership, there were many ideas about what the priorities of the Partnership should be, yet consensus on some areas existed.

- The greatest potential threat to salmon habitat in the Mat-Su Basin is still development due to population growth.
- Science is a core need and tool for conserving salmon habitat.
- Five human or human-induced activities not in the 2008 plan have potential to negatively impact salmon habitat: climate change; dams and hydroelectric projects; movement of aquatic invasive species; mining; and motorized off-road recreational activities.
- Protection of salmon habitat is a top priority

The Steering Committee decided to update the plan to add threats while mostly maintaining the goals and strategies for potential threats in the current plan. Based on likely Partnership strategies, the Steering Committee decided to combine invasive aquatic plants and northern pike into one threat of Aquatic Invasive Species and to lump hydropower and mining into a category of Large-scale Resource Development. Working groups were formed to develop conservation strategies for new threats and to review those included in the 2008 plan. As in the first version, the CAP framework was used to focus on human activities that have the greatest potential impact to salmon habitat and to hone in on the most significant stresses from those activities.

---

[12] More about the scoping process and conclusions are included in *Mat-Su Salmon Partnership, Revisiting the Strategic Action Plan: A Scoping Document*, available at www.matsusalmon.org.

IV. Organizational Goals

In 2008, one of the goals of the planning process was to build the partnership through creating consensus about its purpose and priorities. At that time the partnership was new and still developing its organizational structure. In this update to the plan, this new chapter outlines the organizational goals of the Mat-Su Salmon Partnership as it continues to grow and conserve salmon habitat in the Mat-Su.

Organizing and Operating Principles

The partnership formed and operates with these principles for decision-making and collaboration:

- Strive to work and make decisions by consensus;
- Ensure accountability and transparency for all Partnership activities;
- Focus Partnership activities on issues pertaining to habitat conservation - **not** fishery management allocation decisions. For purposes of the Partnership, 'conservation' includes land and water protection, habitat and fish passage restoration, and habitat enhancement, and the development of scientific information that informs decisions about salmon conservation;
- Apply the best available scientific information to Partnership funding and management decisions and the development and evaluation of partnership projects;
- The Partnership is a voluntary self-directed organization actively working to achieve the goals and Strategic Actions of its Strategic Action Plan;
- Individual member groups of the Partnership retain their various missions and activities and participate in the Partnership to the extent they are able to support the Partnership's vision, mission, and strategic plans. All resource agencies who are members of the Mat-Su Salmon Partnership maintain all statutory authorities and do not relinquish any of their responsibilities for managing fish and wildlife resources or budgetary responsibilities per their agency missions through partnership participation.

A. Governance

The Mat-Su Salmon Partnership works to achieve the goals of its Strategic Action Plan through guidance from a Steering Committee and collaboration of its partners through committees and working groups. The Steering Committee establishes committees and working groups as needed. Participation on committees and working groups is open to all member organizations, except the Steering Committee, which has restrictions on membership and term limits. Established on an ad-hoc basis, working groups implement particular projects or tasks of the partnership and its plan. Four committees handle the ongoing activities of the Partnership:

1. Steering Committee

The Steering Committee is the governing body for the Partnership. The Steering Committee shall:

- Act as the guiding body for the Partnership;

- Serve as a forum and mechanism to work jointly and promote cooperation to restore, enhance and protect habitat that supports the fishery and aquatic resources of the Mat-Su Basin;
- Actively seek and encourage partner participation;
- Participate in outreach activities to gain additional resources to build the Partnership;
- Support partner projects through endorsements for funding, technical assistance, and recommendations for collaboration and funding sources;
- Make recommendations, as requested by granting agencies and organizations, on distribution of funds for fish habitat projects in the Mat-Su Basin;
- Prepare an annual report of Partnership activities for the partners, NFHP, and other funding organizations;
- Work with the Partnership Coordinator to achieve goals and develop an annual work plan;
- Complete, maintain, and implement a strategic action plan that prioritizes conservation strategies and locations for fish habitat in the Mat-Su Basin;
- Ensure that the Mat-Su Salmon Partnership follows guidelines set forth by the NFHP;
- Convene meetings of the Partnership annually or more frequently as required;
- Coordinate with other NFHP Partnerships (FHPs) where there is geographic overlap with species and habitats;
- Establish committees and working groups as needed to implement the strategies of the Strategic Action Plan.

The Steering Committee is structured to be consistent in composition with the National Fish Habitat Board with representation from local, state, and federal governments, conservation, fisheries interests, and Native Alaskans. The Steering Committee is comprised of nine seats. The four government seats are permanent to maintain continuity at a governmental level. The Native Alaskan, Conservation, and three At-large seats rotate to bring in local interests and new perspectives. The geographic boundary of the partnership is coincident with that of the Matanuska-Susitna Borough, which is the local government with the broadest influence on local habitat management. The seats on the Steering Committee are:

1. Local government: Matanuska-Susitna Borough
2. State fisheries management: Alaska Department of Fish and Game
3. Federal fisheries management: US Fish and Wildlife Service
4. Federal fisheries management: National Marine Fisheries Service
5. Partnership Administration: This is a permanent seat held by the organization that employs the Partnership Coordinator and manages partnership finances other than NFHP grant funds. This seat has no term limits and changes when these responsibilities are transferred to another organization.

6. Native Alaskan representative: Tribal, corporate, or non-profit Native Alaska organization. This is a two-year seat without term limits.
7. – 9. Three At-large seats: Organizations that have been active in the Partnership or with local fish habitat conservation are encouraged to apply for these seats. The At-large seats are for two-year terms with a limit of two consecutive terms. Organizations may reapply after a one-year break.

The Steering Committee solicits interest in the Native Alaskan and At-large seats in the fall. Interested organizations submit a letter indicating why they would like to be on the Steering Committee and committing to participating. Sitting Steering Committee members fill the open seats in time for new members to participate in the January meeting. Committee members who are reapplying for seats cannot participate in the discussion or decision making for filling their seat. If there are not sufficient applications to fill expiring At-large seats, organizations in those seats may reapply. To stagger committee turn-over, seats are filled on the following schedule:

- Terms starting January odd years (e.g. 2015): Native Alaskan, one At-large seat
- Terms starting January even years (e.g. 2014): two At-large seats

Steering Committee uses the following operating procedures:

- The committee meets bimonthly on the 2nd Tuesday afternoon of odd months in Palmer. These meetings shall be open to all partners and the public. The steering committee may also meet at other times and may change meeting times and days to accommodate committee members and business to be covered. Members may attend in person or via telephone.
- Positions of Facilitator and Notetaker shall rotate by meeting among Steering Committee members.
- Five member organizations constitute a quorum, and decisions will be made by consensus.
- If a member organization has not attended three consecutive Steering Committee meetings either in person or by teleconference (including special meetings set up between regular bimonthly meetings), the Steering Committee shall ask that organization to find another staff person to attend meetings or to withdraw from the Steering Committee. If an organization leaves the Steering Committee during its terms, the Steering Committee shall solicit interest in a process similar to filling At-large seats. The organization selected shall fill out the remainder of the seat's term and be eligible to reapply for two full-length terms.

2. Outreach Committee

This committee works to build the partnership through outreach to potential partners, supporters, and funders. Activities include creating and contributing to Partnership media including web site, newsletters and annual reports.

3. Salmon Symposium Committee

This committee is responsible for planning the annual Mat-Su Salmon Science and Conservation Symposium, traditionally a two-day event held in the fall. The committee meets as needed, primarily by teleconference, to develop the agenda, select speakers, and manage logistics of the event.

4. Science and Data Committee

This committee ensures that the Partnership's efforts have a strong science foundation, including development of the Strategic Action Plan and decisions about allocating project funds. Members of this group are biologists, hydrologists, and ecologists from partner organizations. This committee acts as liaison with the NFHB Science and Data Committee and assists with development of the national assessment for Alaska. This committee also consults and advises partner organizations who are implementing science and data strategies in the Strategic Action Plan.

Overall Governance Goal: To effectively oversee and manage the activities of the Mat-Su Basin Salmon Habitat Partnership for the long term health of salmon and the region.

Objective A1: Steering Committee

Local, state and federal agencies and communities represented on the Steering Committee are engaged in activities of the Partnership in order to ensure their continued commitment to Steering Committee participation.

Strategic Action A1.1: Agency and Organization Updates

Steering Committee members shall annually update their agency supervisors and directors about the activities of the Partnership and their organization's role.

Strategic Action A1.2: Recruit At-Large Members

Steering Committee shall announce Steering Committee vacancies a minimum of 60 days in advance of end of member terms and invite Partnership members to apply

Strategic Action A1.3 Steering Committee Composition Review

Steering Committee will periodically review the committee structure for representativeness of the partnership membership and capacity to accomplish the goals of the partnership.

Objective A2: Committees

Committees are clear about their roles and responsibilities and have the resources needed to accomplish their tasks.

Strategic Action A2.1: Membership Participation

Annually review committee membership and solicit new members as needed from the Partnership members.

Strategic Action A.2.2: Committee Leadership
Each committee shall appoint a chair who will set the agendas, schedule meetings and report committee activities to the Steering Committee.

Strategic Action A2.2: Committee Resources
The Steering Committee shall identify funds, in-kind services and other resources available to each committee.

Objective A3: Ad-hoc Working Groups
Working groups have clear direction about the project or task they are addressing and have the resources needed to accomplish their tasks.

Strategic Action A3.1: Working Group Roles
The Steering Committee shall provide each working group with a written statement describing their roles and responsibilities, timelines and tasks to be accomplished**.**

Strategic Action A3.2: Working Group Resources
The Steering Committee shall identify funds, in-kind services and other resources available to each working group**.**

B. Membership

The membership of the Partnership includes federal, state and local government agencies, non-profit and non-governmental organizations, businesses, Native Alaska entities, and private citizens (Table 3). Membership is open to any entity or individual who agrees with the goals of the Partnership and is willing to participate in Partnership activities. To become a member, individuals and organizations shall complete a membership application and submit the application to the Steering Committee for approval.

Table 3. Mat-Su Salmon Partnership Representation

Category	**Total Number**	**Percentage**
Non-Profit	18	33%
Government (local, state, federal)	18	33%
Business (including consultants)	9	17%
Fishing (interest groups & guides)	5	9%
Native Alaskan	3	6%
Academic	1	2%
	54	**100**

The members shall:

- Promote conservation of fish habitat in the Mat-Su Basin;
- Work to meet Partnership goals by contributing funds, people, equipment, or access to shared activities;
- Attend annual meetings of the Partnership;
- Serve on Partnership committees and working groups;
- Be listed on all Partnership publications;

- Endorse and support the implementation of the Strategic Action Plan;
- Be eligible for funding that comes through the Partnership to implement the Strategic Action Plan, if eligible by the criteria of the funding source.

Overall Membership Goal: To recruit, engage and support members for the Partnership who will further the mission of the organization.

Objective B1: Membership Engagement
Partners are actively engaged in the projects, committees and events of the Partnership.

Strategic Action B1.1: Identify Member Interests and Skills
Conduct a survey of current members to identify their interests, skills and capacity to contribute to Partnership activities

Strategic Action B1.2: Invite Membership Participation
Based on survey results, invite members to participate in Partnership activities, such as committees, working groups and symposium presentations**.**

Strategic Action B1.3: Member Contacts
Annually update contact information for existing members

Objective B2: Member Recruitment
The Partnership is diversified through the recruitment of five new members from the non-profit, fishing, and business communities by 2015.

Strategic Action B2.1: Recruitment Tools
Review and update Partnership publications and media to be used for member recruitment.

Strategic Action B2.2: Recruitment Strategy
Develop member recruitment goals, strategy and actions to diversify and sustain membership

C. Staff

Since its inception, the Partnership has had one part-time staff person to coordinate its activities; the Partnership Coordinator has been an employee of the Nature Conservancy (TNC) located in TNC's Anchorage office.   Funding for the Partnership Coordinator has come from the U.S. Fish and Wildlife Service and Alaska Sustainable Salmon Fund with matching funds procured from private sources. The Steering Committee reviews and approves the job description for the Partnership Coordinator.

Partnership Coordinator

The Mat-Su Salmon Partnership Coordinator facilitates the Steering Committee and members in accomplishing the goals and strategic actions of the Strategic Plan. The coordinator provides primary staff support to the Steering Committee. He/she is responsible for disseminating information, coordinating meetings, coordinating and facilitating overall implementation of actions and projects of the Partnership, outreach activities, pursuing funding and grant opportunities and managing Partnership funds. The Coordinator serves as the liaison between the Steering Committee and the NFHB. A full position description is in Appendix 13.

Overall Staff Goal: To coordinate activities of the partnership and work with committees and partners to implement the strategic plan to further the mission of the organization.

Objective C1: Partnership Coordinator
By 2015, the Partnership has sufficient funding to support a full-time coordinator to help achieve its goals.

Strategic Action C1.2: Coordinator Funding
The Steering Committee shall assist TNC in seeking funding to support the coordinator position.

Strategic Action C1.1: Coordinator Work Plan
The Partnership Coordinator shall develop an annual work plan, to be reviewed and approved by the Steering Committee, to set priorities to use resources efficiently and effectively to accomplish the Partnership's goals.

D. Financial Management

The Partnership's annual expenses and revenues are managed by partner organizations because the Partnership is not a legal entity with fiscal capacity. Funds for projects, the coordinator, and the symposium have come through grants from the U.S. Fish and Wildlife Service, Alaska Sustainable Salmon Fund, private corporations and foundations, and partner organizations. TNC has been the fiscal agent for funds that support the Partnership Coordinator, the symposium, and other miscellaneous activities and thus has held the Partnership Administration seat on the Steering Committee. U.S. Fish and Wildlife Service (USFWS) manages and distributes the NFHP funds for partner projects. The Steering Committee develops guidelines and rankings to distribute NFHP funds that go to applicants annually. Projects that meet objectives outlined in the Strategic Action Plan and approved by the Steering Committee may receive NFHP funds if they meet USFWS requirements and sufficient funding is available.

Overall Financial Management Goal: To responsibly manage and obtain funding resources to accomplish the goals and objectives of Partnership.

Objective D1: Annual Budget
The Steering Committee develops, approves, and manages an annual budget with income and expense projections for partnership coordination and activities.

Strategic Action D1.1 Budget Development and Management
Steering Committee shall work with the Partnership Coordinator and their employing organization to establish a fiscal calendar (fiscal year July 1 – June 30) and to develop and approve an annual budget including expenses and revenues.

Strategic Action D1.2 Partnership Funding
Using the annual budget as a guideline, the Steering Committee shall assist the organization that employs the Coordinator in seeking funding to support annual activities of the Partnership that the Coordinator manages, including the symposium and some outreach activities.

Objective D2: Sustainable Funding
The Partnership has sustainable funding from multiple sources and good relationships with its funders through grant reporting, recognition, and appreciation activities.

Strategic Action D2.1: Funding Resources
Develop summary of funding sources that have contributed to the Partnership over the past five years and identify private and public funding resources for future activities.

Strategic Action D2.2: Donor Contacts
Conduct field trips for public and private donor representatives; Salmon Partnership tour (e.g. restoration, hands-on science) during fish return with media coverage; 'open houses' at activities and projects.

Strategic Action D2.3: Donor Recognition
Acknowledge contributions of donors in public presentations, at the symposium, on printed Partnership materials, and on the web site.

E. Communications & Outreach

The Outreach Committee develops an Outreach Plan to guide the Partnership in informing potential and existing partners, supporters, and funders about the Partnership, the problems facing salmon in the Mat-Su, and the Partnership's goals in addressing or preventing those problems. Outreach information should result in action, whether it is joining the partnership or contributing in-kind services or funds to Partner projects.

Overall Communications & Outreach Goal: To develop positive awareness and build community engagement for the Partnership and its activities to conserve salmon habitat in the Mat-Su region and beyond.

Objective E1: Build Community Awareness of the Partnership
A broad representation of fish interests in the Mat-Su are members of the Partnership.

Strategic Action E1.1: Public Presentations and Events
Present at events and meetings of organizations that might become members of the Partnership and/or provide support and funding (i.e. business, sportsmen's' groups).

Strategic Action E1.2: Media Outreach
Create news articles for reporters at newspapers & radio; press releases, Compass pieces, and letters to the editor about Partnership activities.

Strategic Action E1.3: Field Trips
Conduct field trips or open houses for public to showcase activities and projects.

Objective E2: Government Support
Elected officials, fisheries managers and other government decision-makers know about the Partnership and support its efforts.

Strategic Action E1.1: Elected Officials
Meet with elected officials or their staffs to provide information packets and invite to Partnership events like celebrations, symposium or field trips.

Strategic Action E2.2: Agency Managers
Meet with staff and directors of local, state and federal agencies that are active in the Partnership to update on activities.

Objective E3: Partnership Information
Effective information publications and media educate a broad and varied audience about the problems facing salmon in the Mat-Su and what the Partnership is doing to address those problems.

Strategic Action E3.1: Outreach Information Packet
Create an outreach information packet to be used as a communication tool that would be available to Partnership to include newsletters, annual report and other publications.

Strategic Action E3.2: Website and Social Media
Continue to develop website and social media presence to distribute news and information about the Partnership.

V. 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: cool, 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.

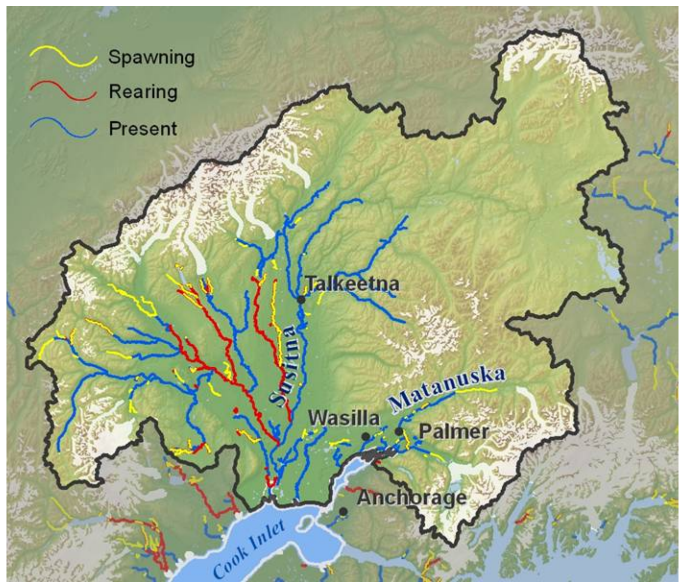
Conservation targets for salmon and their habitat in the Mat-Su Basin:

- 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, although sockeye spawning also occurs in non-lake systems (Yanusz et al. 2011), during late summer and fall. After fry emerge from the gravel the following spring, juvenile sockeye salmon typically spend one or two years rearing in lakes before migrating to the ocean. Sockeye salmon 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 (Johnson and Daigneault 2013). Estimates of total sockeye escapement are derived from weir, index surveys, or tagging data. ADF&G has developed eight escapement goals for all of the upper Cook Inlet with four goals in the northern Cook Inlet (ADF&G 2012). Alaska Department of Fish and Game (ADF&G) monitors sockeye escapement with a weir on Fish Creek in the Big Lake drainage, an annual index survey of Bodenburg Creek in the Matanuska River drainage, and up until 2009, a sonar project on the Yentna River. Due to issues of accuracy, however, the sonar was replaced with weirs and sustainable escapement goals for Larson Lake on the mainstem of the Susitna and Judd and Chelatna Lakes in the Yentna River drainage. In 2006 ADF&G also started a mark recapture study to produce independent estimates for sockeye salmon abundance on the Yentna River. An additional mark recapture project was initiated in 2009 to estimate the species selectivity of the Yentna fish wheels and thereby formulate a correction that can be applied to the fish wheel catch to produce more accurate sockeye salmon estimates (ADF&G 2013).

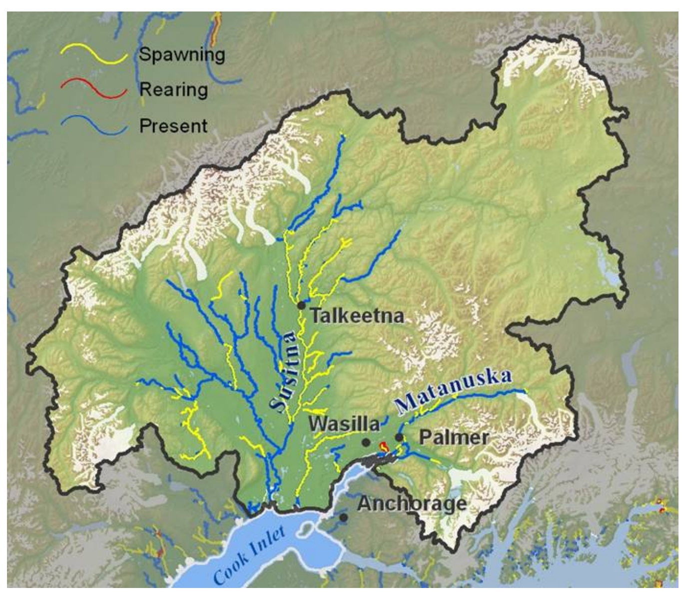
Residents of the Mat-Su have expressed concern about the health of sockeye salmon stocks in the Mat-Su Basin. Fish Creek, Chelatna Lake, Larson Lake and Judd Lakes have not met escapement goals in some recent years (Fair et al. 2013), and while the Susitna River remains Upper Cook Inlet's third most productive sockeye salmon drainage, the Alaska Board of Fisheries identified the Susitna River sockeye salmon stock as a stock of yield concern in 2008 (ADF&G 2013). At least seven major lakes in the Susitna River drainage provide most of the known rearing and spawning habitat for sockeye salmon production and the loss of any one stock would be significant (Sam Ivey, ADF&G, personal communication). Although these lakes receive the majority of spawners, significant contributions toward overall productivity of Mat-Su sockeye salmon 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 (Yanusz et al, 2007-2011, 2011b), 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 salmon harvested in Upper Cook Inlet commercial fisheries are from stocks returning to the Kasilof and Kenai rivers. Based on genetic samples taken from the commercial catch, biologists estimate Susitna sockeye salmon represent about 5% of the Upper Cook Inlet sockeye harvest (ADF&G 2013). In-season ADF&G fisheries management actions to ensure adequate escapement of Mat-Su sockeye stocks usually involve restricting commercial and sport fisheries opportunities. 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. Over 10,000 sockeye salmon are harvested annually in most years in Mat-Su sport fisheries (Oslund et al. 2010). Fish Creek supports the only personal use fishery for sockeye salmon in northern Cook Inlet, and the Upper Yentna River near Skwentna has been identified as a limited subsistence fishery for sockeye salmon.

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 within 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. UCI pink salmon runs are dominated by returns in even-numbered years (Fox and Shields 2005).

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



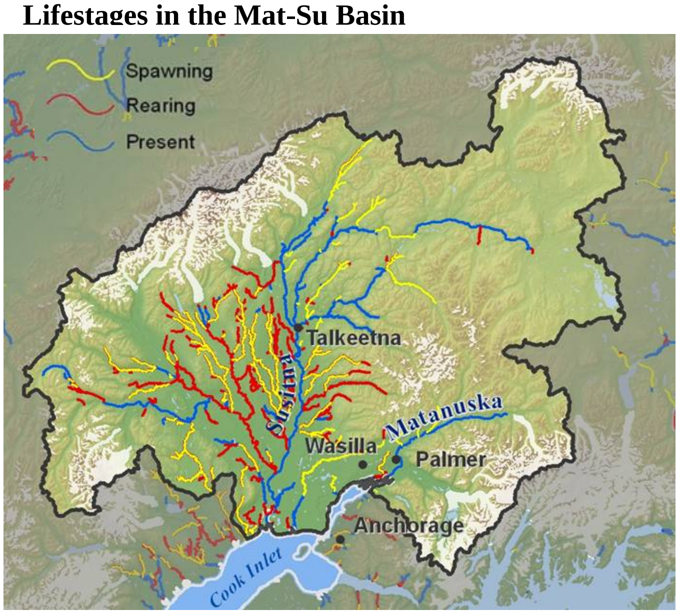
Pink salmon have been documented to occur in over 1,227 river miles in the Mat-Su Basin, and chum salmon have been documented in 1,141 river miles (Johnson and Daigneault 2013). ADF&G has one escapement goal for chum salmon on Clearwater Creek in the Upper Cook Inlet, but none specifically for either species in the Northern section of the Cook Inlet (ADF&G 2012). Pink salmon escapement is monitored incidentally at other locations, such as the Deshka River. Although there are large chum salmon runs on the Susitna River, knowledge of their total abundance, spawning areas, and distribution throughout the drainage is minimal. However, ADF&G has completed a three year (2010-2012) abundance and spawning distribution study of chum and Coho salmon in the Susitna River drainage through a mark recapture and radio tagging effort (Cleary 2010 et al.).). 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 in no danger of overfishing (Shields and Dupuis 2013).

Commercial harvest of pink salmon in Upper Cook Inlet totaled over 2 million fish in the 1960's, but harvests have declined, averaging less than 326,000 for even numbered years from 1996 to 2010 (Shields and Dupuis 2013). Although harvests are still below 1960 harvest levels, in 2012 the UCI commercial harvest of pink salmon was estimated to be about 44% higher than the average annual harvest (Shields and Dupuis 2013). Chum salmon commercial harvests follow a similar pattern with dramatic declines since 1986, and less than 200,000 fish harvested in most years from 1996 to 2004 (Fox and Shields 2005). Although harvest levels for pink and chum salmon have been low in the last decade, harvest of both species in the commercial fishery is affected by closures and restrictions to protect sockeye salmon stocks. Low commercial harvest monetary values 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 (Oslund et al. 2010); neither species supports subsistence or personal use fisheries in the Mat-Su Basin.

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 and importance to area fisheries. The level of available data varies by species and stock; generally, escapements of Chinook salmon are better monitored. The conservation status for these species varies and there have been significant downturns in production for both species. Currently, returns of most Chinook salmon stocks in the Mat-Su Basin are in decline, and some Coho salmon runs are not meeting escapement goals. ADF&G recommends further monitoring of twelve indicator stocks statewide, including the Susitna River (ADF&G 2013).

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



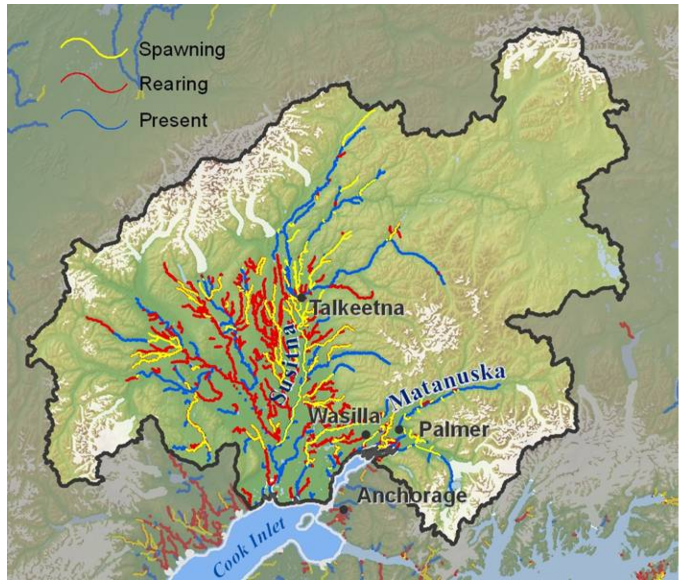
Chinook salmon generally spawn in deeper flowing waters during late summer, whereas Coho salmon generally spawn throughout many headwaters during the fall. Juvenile Chinook salmon emerge from the gravel as fry in the spring and spend one year rearing in freshwater before migrating to the ocean. Chinook salmon spend between one and five years in the ocean before returning to spawn as adults. Juvenile Coho salmon can spend from one to three years rearing in freshwater, and usually spend one year maturing in the ocean before returning to spawn. Rearing juveniles of both species are highly migratory within freshwater drainages and utilize a variety of habitats including pools of larger streams and rivers, smaller tributary streams, backwater and off-channel habitats, lakes, and beaver ponds.

Chinook salmon have been documented in 2,815 river miles in the Mat-Su Basin (Johnson and Daigneault 2013; Figure 6), and escapement goals have been developed for seventeen stocks (Sweet et al. 2003; Fair et al. 2013). Escapement monitoring for Chinook salmon has largely been conducted with aerial surveys. However, the need for more accurate and timely escapement data for fisheries management has resulted in addition of weirs on the Deshka (1995 – 2013) and Little Susitna Rivers (1988, 1989, 1994, 1995 and 2013). As part of increased monitoring of salmon escapements for the proposed Susitna-Watana Hydroelectric Dam on the upper Susitna River, one additional weir was installed and operated and two sonar units were tested in 2013. The Deshka River is the only system in northern Cook Inlet where a Chinook salmon escapement goal is monitored in-season with a weir (ADF&G 2012). Although the 2012 minimum escapement goal was met at the Deshka weir, it required closures and restrictions to both sport and commercial fisheries to ensure goal attainment (ADF&G 2012).

Of the 11 stocks of concern designated statewide by the Board of Fisheries by 2012, seven of them are in the northern Cook Inlet. In addition to low Chinook salmon returns throughout the Mat-Su, 12 of 17 Chinook salmon escapement goals were missed in 2011 and 13 of 17 in 2012. Additionally, many Chinook salmon escapements in the Susitna drainage have not been met for 6 consecutive years. Chinook salmon have supported a large and popular sport fishery in the Mat-Su Basin which is being challenged by poor returns and increased restrictions and closures aimed to help meet escapement goals. The average annual sport harvest of Chinook salmon typically exceeds 20,000 fish (Sweet et al. 2003). At the 2011 Board of Fisheries meeting, six Chinook salmon runs in the Northern District were found to be stocks of concern, and an action plan was developed for Chuitna, Theodore, and Lewis Rivers and Alexander, Willow and Sheep creeks which aimed to reduce Chinook harvests in both sport and commercial fisheries. In 2012, low Chinook salmon returns caused closures and restrictions to commercial and sport fisheries (ADF&G 2012). Few Chinook salmon are harvested in subsistence or personal use fisheries in the Mat-Su Basin.

Coho salmon spawning has been documented in 3,218 river miles (Johnson and Daigneault 2013; Figure 7). Only three escapement goals for upper Cook Inlet Coho salmon have been established; one is monitored by an annual foot survey of a tributary to Jim Creek, and two are monitored with weirs at the Little Susitna River and Fish Creek (Fair et al 2013). The only other time series of Coho salmon escapements are 11 area streams monitored with foot surveys (ADF&G, 2013); however, the degree to which these counts reflect total escapement is unknown. Additional weir counts for Coho salmon have been collected on Fish Creek, although inconsistently. With a substantial Coho salmon run but little knowledge of their spawning, abundance and distribution, ADF&G has established a mark-recapture program on the Susitna River that aims to improve understanding of total Coho salmon abundance and spawning distribution within the Susitna drainage. Escapement monitoring of other Coho salmon stocks outside of Knik Arm is difficult and many escapements are not monitored, but Coho salmon

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



escapement has been enumerated at the Deshka weir since 1995. There are no listed Coho salmon stocks of concern in the Mat-Su, and the overall health status appears better than Chinook and Sockeye salmon. Although escapement goals on the Little Su were not met for 4 consecutive years (2009 – 2012), the Coho escapement goal was made in 2013 and the 2012 count was incomplete.

Commercial harvest of Mat-Su Basin Coho salmon occurs in Upper Cook Inlet mixed stock fisheries. Total harvest of Coho salmon in Upper Cook Inlet averaged nearly 187,000 fish from 2002 to 2011 (Shields and Dupuis 2013), 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 salmon (Vincent-Lang and McBride 1989). A Coho salmon genetic baseline has been developed which may be helpful in determining the origin of the Upper Cook Inlet harvest of Coho salmon. Coho salmon in the Mat-Su Basin support the area's largest recreational harvest, averaging over 50,000 fish per year (Oslund and Ivey 2010). 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 (approximately 15% of total documented anadromous waters in the Mat-Su Basin) compared to the other terrestrial system targets (Figure 9).

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 8. Terrestrial Ecosystem Targets in the Mat-Su Basin

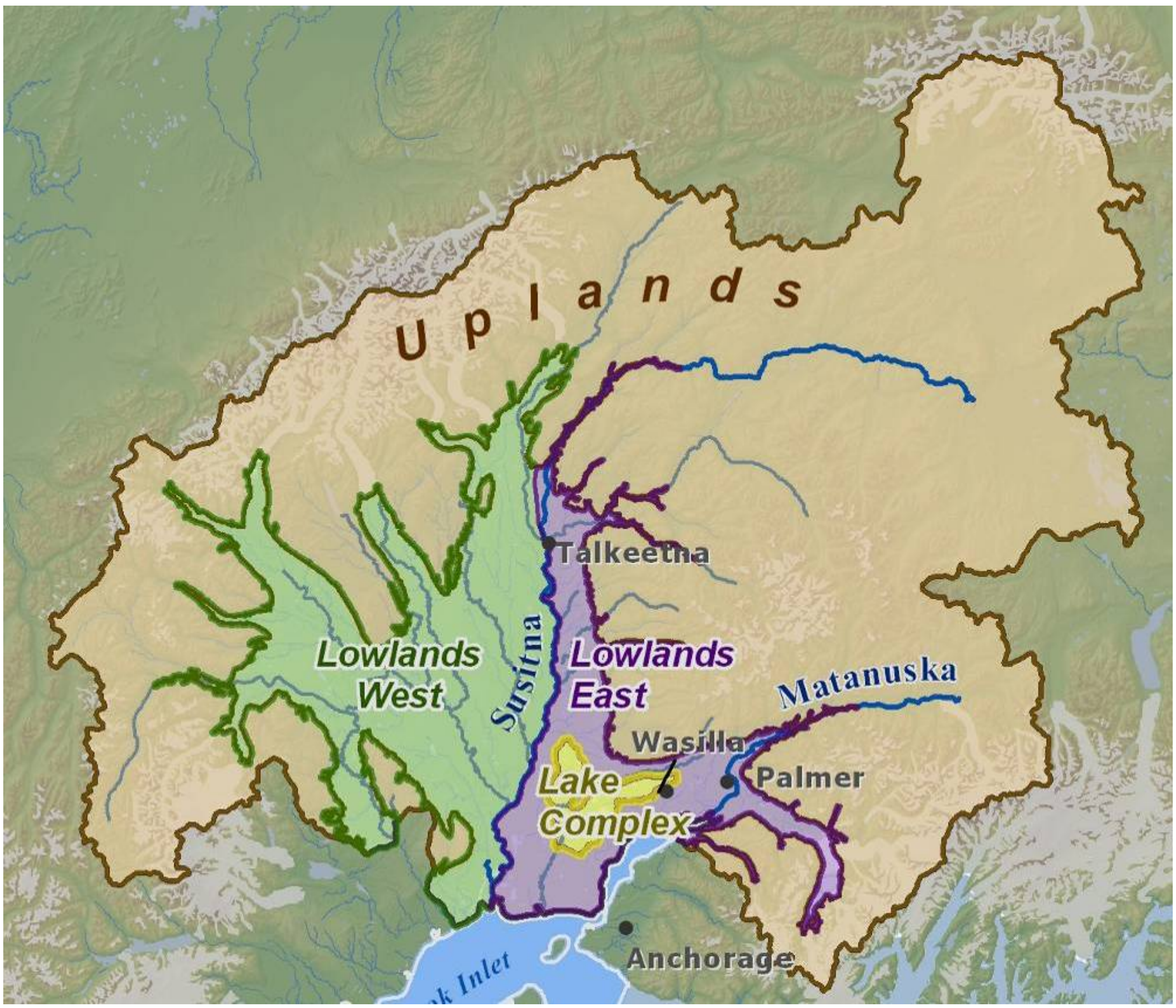
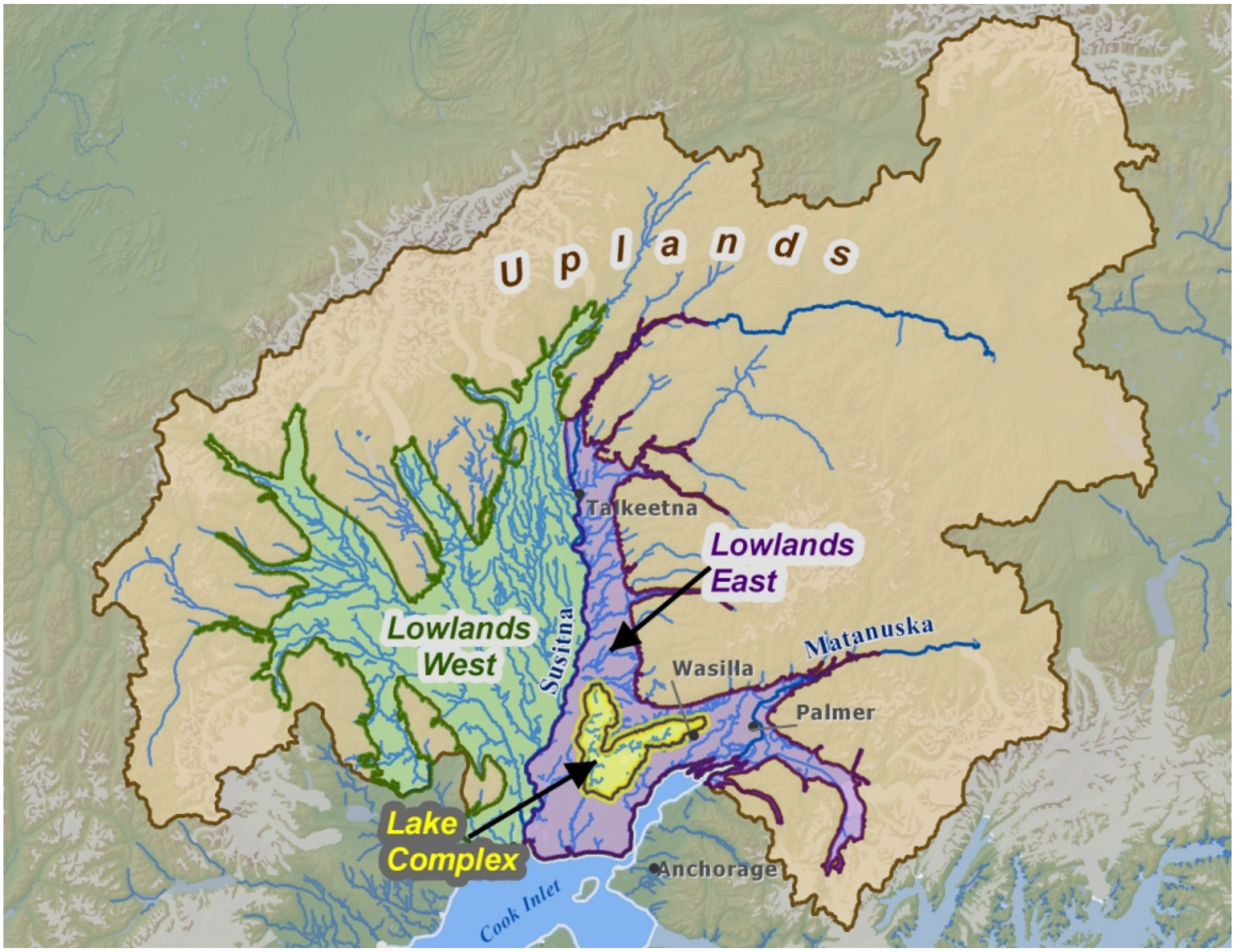


Figure 9. Anadromous Waters and Terrestrial Ecosystem Targets in the Mat-Su Basin



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. As of 2012, however, the state is pursuing construction of a large-scale development project, in the upper Susitna River. 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 (Johnson and Daigneault 2013), which comprises 48% of all documented anadromous waters in the Mat-Su Basin (Figure 9). The Lowland West area is responsible for much of the sockeye, Chinook, and Coho salmon production in the Mat-Su Basin. Recent significant declines in Chinook salmon stocks and less dramatically sockeye and Coho illustrate, however, that there is cause for concern. The Lowland West Complex corresponds to most of the ADF&G 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.

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 (Johnson and Daigneault 2013), representing 26% of documented anadromous waters in the Mat-Su Basin (Figure 9). Over 40% of documented pink and chum salmon 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 ADF&G, 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, Knik, 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%. Many areas in the Lowland East can be accessed via an extensive and expanding road network, especially near the cities of 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. Since initial development of this plan in 2008, population growth and accompanying development have continued in the Knik-Wasilla-Palmer core area and along the Parks Highway, and industry interest in coal mining in the Matanuska valley has returned. Three Lowland East waters are listed on Department of Environmental Conservation's list of impaired water bodies: Cottonwood Creek, Lake Lucille and the Matanuska River. High priority or threatened waters also listed are Fish Creek, Jim Lake, Little Susitna River, Jim Creek, Wasilla Lake, Wasilla Creek, Willow Creek, Montana Creek and Lake Louise. 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.

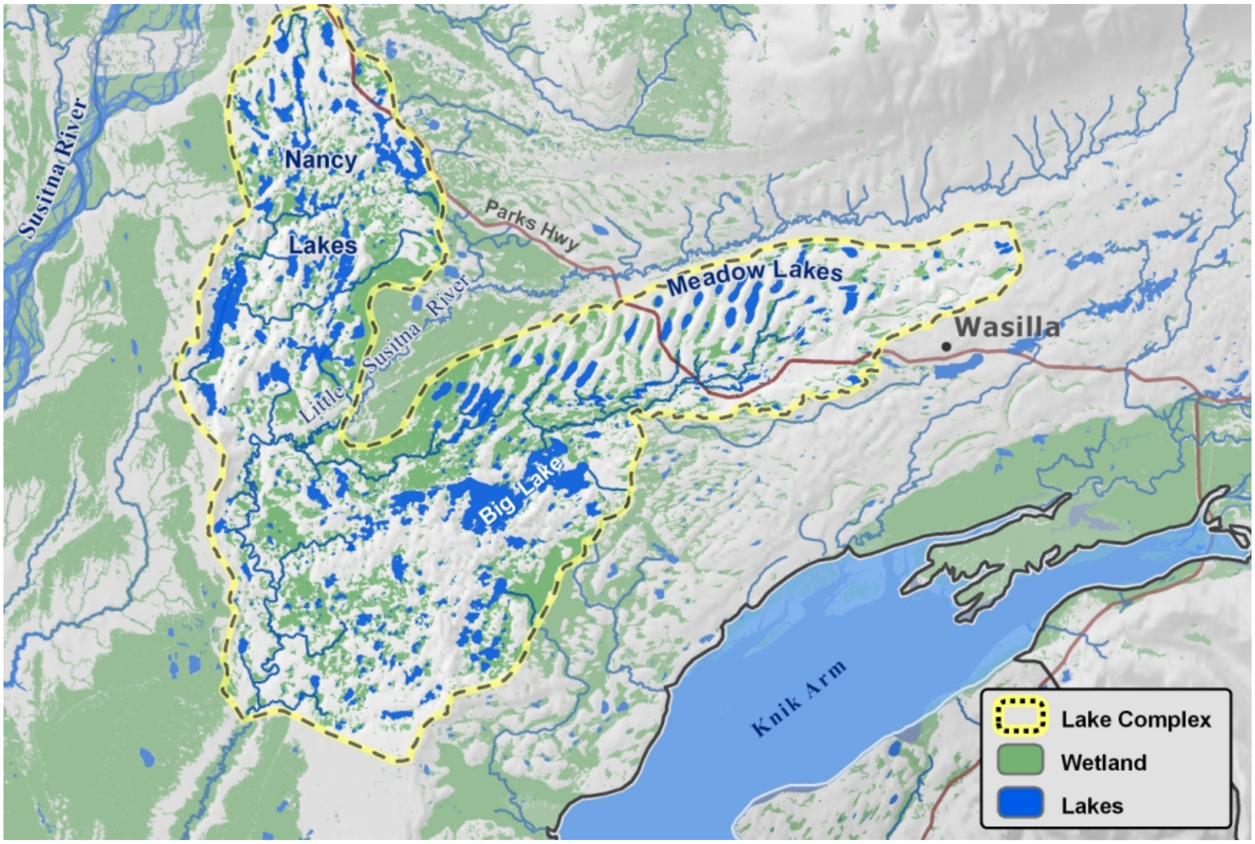
Lake Complex

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 is the primary influence on most stream flows. 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 ADF&G 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%). 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. In Big Lake high hydrocarbon levels from boat traffic contributed to ADEC listing the lake as an impaired water body in 2006. Other High priority or threatened water bodies in the Lake Complex include Nancy Lake and Meadow Creek.

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 ADF&G Upper Cook Inlet commercial fisheries management area and is an area of mutual interest for both the Mat-Su Salmon Partnership and the Kenai Peninsula Fish Habitat Partnership[13].

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). Specific to salmon, these studies document adult salmon in tidal riffs, mid channel and forage zones, and juvenile salmon using shallow littoral zones for out

[13] Kenai Peninsula Fish Habitat Partnership is a conservation partnership on the Kenai Peninsula, Alaska. http://office.kenaiwatershed.org/KPFHP/

migration, rearing habitat and refuge from tidal currents and predators. Both juvenile Chinook and Coho salmon were caught more often in near shore environments of Knik Arm rather than in open water, suggesting that the juveniles remain along the shorelines (Houghton et al. 2005, USFWS 2009). Juvenile Chinook and Coho salmon that were relatively larger, appear to remain in the Knik Arm longer and prefer the near shore environment. 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 (Groot and Margolis 1991, Quinn 2005).

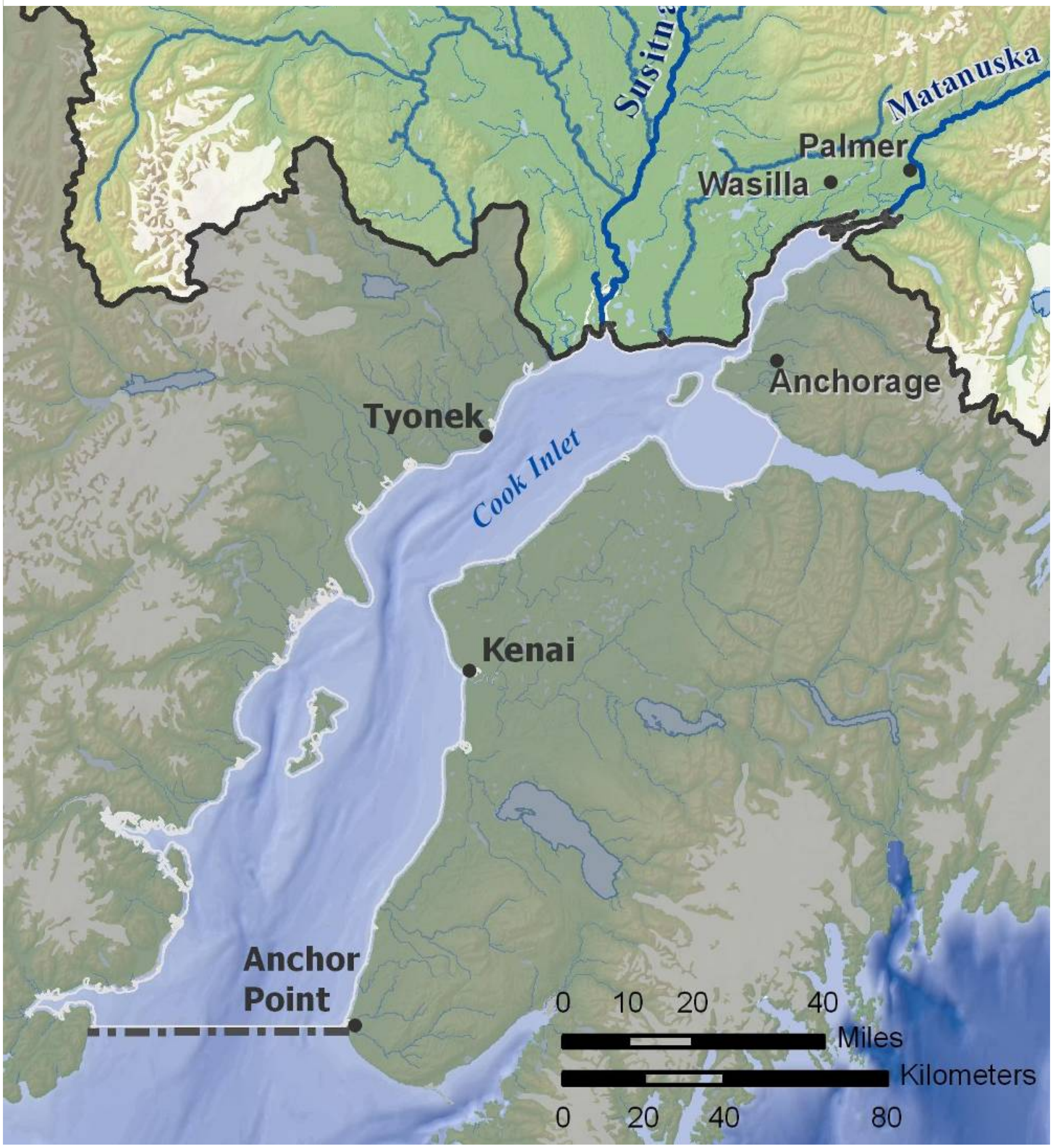
Marine estuarine literature (Stevenson 1973, Kennish 1986, Day 1989), indicate estuaries and associated mud and tidal flats are very diverse and complex ecosystems. Fresh water tributary outflows rich in organic detrital material and microbial organic decomposers such as bacteria, fungi, and algae form the foundation of complex food chain dynamics (Simenstad 1985). The byproduct of these microbial interactions support meso 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 Upper Cook Inlet (Anchor Point to Forelands) 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.

A literature review conducted for the USFWS (2009) provides additional insight on the role and importance of Knik Arm and Northern Cook Inlet estuary habitat. Chinook and Coho salmon smolt enter Knik Arm at a larger body size and appear to use nearshore habitats preferentially. Evidence also suggests that smolt residing for extended periods demonstrate increased size, feeding on an abundance of invertebrate species such as amphipods, mysids and polychaetes, and aquatic and terrestrial insects such as aphids and fly larvae. These observations from Knik Arm populations are supported by results from other regions discussing "critical size" of salmonid smolt.

Though the role and interactions of nutrient dynamics and salmon smolt in Knik Arm and Northern Cook Inlet are not fully understood, accumulated evidence of smolt life history and nutrition from other regions suggest an important relationship. Slower growing smolt experience greater size-selective predation (Parker 1968, Willette et al. 1999). Smolts that fail to achieve a critical threshold size, are stunted, or suffer protein-energy deficiency and are more likely to become prey for other marine species (Mahnken et al. 1982). Smolts need to reach a critical size and strength to survive their first year in open marine waters (Beamish and Mahnken 2001; Beamish et al. 2004). Marine phase studies investigating Bristol Bay salmon, also suggest that reduced growth of some salmon during their first year at sea may lead to substantial mortality (Moss et al. 2005, Farley et al. 2007). Greater nutrition and prey availability lead to larger

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



juvenile salmon which gain a survival advantage over smaller individuals (Farley et al. 2007, Farley et al. and 2011).

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). The Cook Inlet beluga whale population is listed as an endangered species under the Endangered Species Act. 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; large transportation infrastructure; and a large hydropower project on the Susitna River which would dramatically alter the flow regime and morphology of the Susitna River and potentially the associated estuary.

VI. 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 quality habitat for spawning and rearing,
2. ability to move between habitats for different life stages, 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 salmon

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 stream flow 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, tributary, and lake habitats 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 obstructed.

Culverts are blocking access to rearing habitat for juvenile Coho salmon in some mainstem and 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. Salmon populations are dependent upon many factors, including harvest and marine conditions, and monitoring the health of salmon returns only partially reflects upon the effectiveness of habitat protection and restoration.

In Alaska, the Board of Fisheries lists salmon populations as Stocks of Concern when returns have declined and long-term sustainability is in question. The state has identified three levels of concern (Yield, Management, and Conservation) with Yield being the lowest level of concern and Conservation the highest level of concern. No stocks of conservation concern have been listed in the Mat-Su Basin.

Indicator 2.1: Maintenance of escapement & sustainable yield of wild fish
In 2008, available data indicated that most Chinook and Coho salmon fisheries (sport, subsistence, and commercial) were intact and almost all escapement goals were being achieved. Since then, Chinook salmon in the Susitna drainage missed their escapement goals for six years, and the Alaska Board of Fisheries listed six populations as Stocks of Concern in 2011[14]. Little Susitna Coho salmon have missed escapement goals for the past four years. The public has also expressed concerns about the sustainability of some sockeye salmon stocks. Two stocks in the Mat-Su basin (Yentna River and Fish Creek) were not meeting escapement goals on a regular basis by 2008, although not all stocks are assessed for escapement. That year, the Alaska Board of Fisheries identified the Susitna River sockeye salmon stock as a Stock of Concern (ADF&G 2008). 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.

[14] Note that as this updated 2013 plan 'went to press,' the Alaska Board of Fisheries listed the Sheep Creek population of Chinook as a Stock of Concern.

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
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 all terrestrial ecosystem targets. Land use practices that create impervious surfaces and stream channel alteration may be 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
Based on available data, stream flow at low flow stage in all terrestrial ecosystem targets is currently not affected by water withdrawals.

Key Attribute 2: Water quality (physical, biological, and chemical)
Cool, 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 (18AAC 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 in accordance with the federal Clean Water Act (CWA) to determine whether a water body meets water quality standards for a particular pollutant. If persistent pollution exists, ADEC has the authority to list the water body as impaired (CWA Section 303(d)/Category 5). 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 or preventing pollution before it becomes a

problem; these high priority water bodies are identified by the Alaska Clean Water Actions (ACWA) program in the Water body Recovery, Protect and Maintain Water bodies at Risk, Data Collection and Monitoring, or Stewardship categories.

Indicator 2.1: ADEC water quality standards for freshwater aquatic life
ADEC currently lists four water bodies as water quality impaired (Table 4). An additional sixteen water bodies are listed as high priority by ADEC, ADF&G or ADNR (Table 4). Through ACWA, ADF&G lists water bodies as high priority for aquatic habitat concerns. These Mat-Su high priority water bodies provide important salmon spawning and rearing habitat.

Although 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. However, without the water quality data to show compliance with state water quality standards, the ADEC identifies several Category 3 water bodies within this target area. Category 3 water bodies 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 (Table 4). Within the Lowland East and Lake Complex targets, many water bodies do not meet water quality standard criteria on an occasional basis and other water bodies do not meet the water quality standards on a more persistent basis and are designated as being impaired (Category 5). Big Lake is an example of a Category 5 water body in the Lake Complex area. Within the Lowland East target area Lake Lucille, Cottonwood Creek and a portion of the Matanuska River are considered water quality impaired (Category 5).

Table 4. Waterbodies of Concern in the Mat-Su Basin

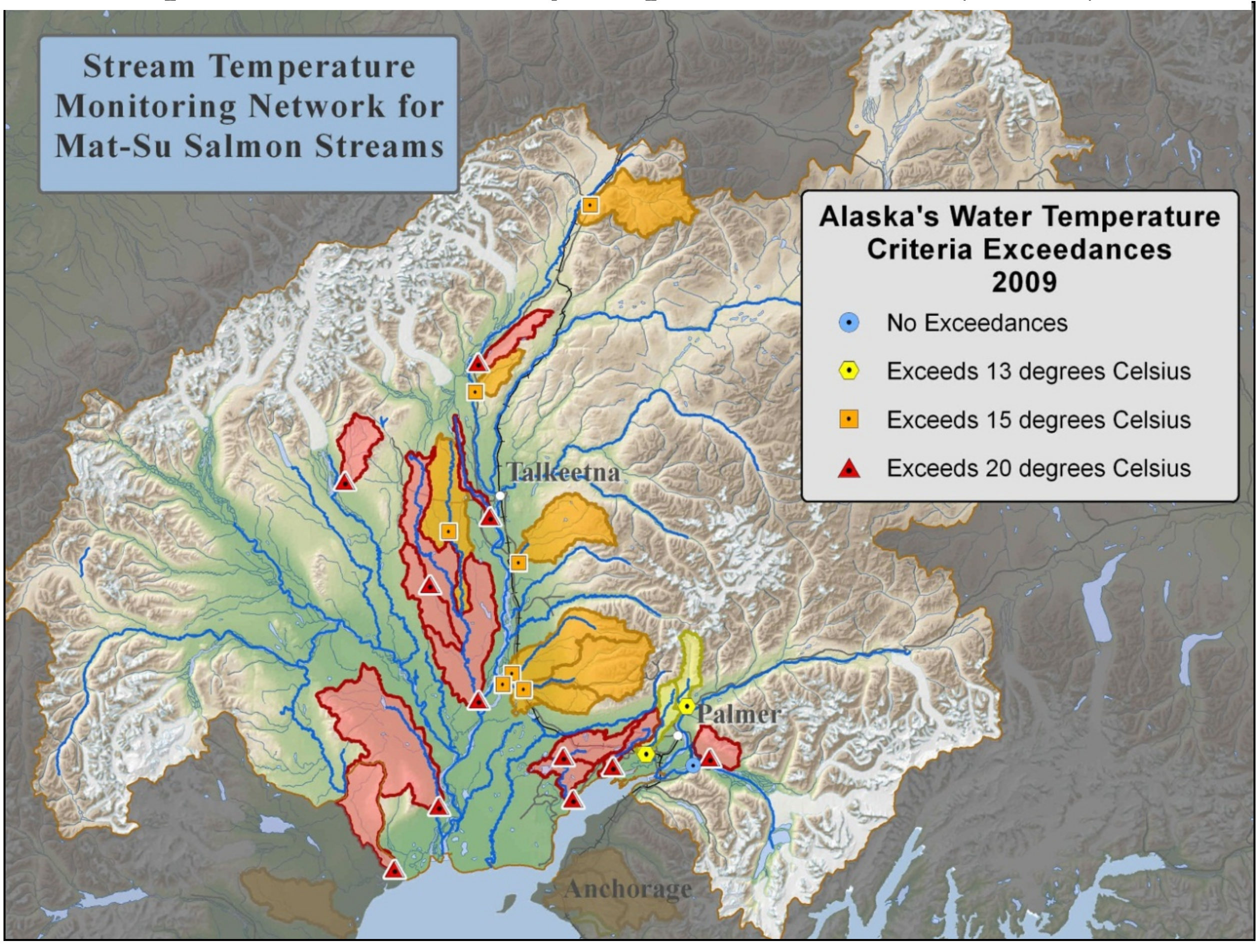
ADEC 303(d) Impairment Listed waterbodies	ACWA high priority waterbodies[15] (includes ADF&G, ADEC and ADNR rankings)	
Big Lake	Bodenburg Creek	Little Susitna River
Cottonwood Creek	Cottonwood Lake	Meadow Creek
Lake Lucille	Deshka River	Montana Creek
Matanuska River	Fish Creek	Nancy Lake
	Jim Creek	Susitna River
	Jim Lake	Wasilla Lake
	Lake Louise	Wasilla Creek
	Lake Lucille	Willow Creek

[15] http://dec.alaska.gov/water/acwa/pdfs/High_Priority_Waters_Region_2013.pdf

Indicator 2.2: Water Temperature

Water temperatures in July have been linked to salmon health when rearing and spawning habitat exceeds a threshold of 15°C. Cook Inletkeeper and partners implemented a Stream Temperature Monitoring Network for Mat-Su salmon streams during open-water periods from 2008-2012. They logged continuous water and air temperatures at 21 non-glacial salmon streams to characterize current water temperature profiles. The majority of streams consistently exceeded Alaska's water temperature criteria set for the protection of fish, especially in 2009, the warmest year of the study period. Summer temperatures exceeded Alaska's Water Temperature Criteria of 13°C at 20 sites, 15°C at 18 sites, and 20°C at 11 sites in 2009 (Figure 12).

Figure 12. Summer temperatures exceeded Alaska's Water Temperature Criteria of 13°C at 20 sites, 15°C at 18 sites, and 20°C at 11 sites in 2009. Temperature logger sites and their contributing watersheds are color-coded by the highest exceedances value. (CIK 2013)



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. More recent surveys of streams in the Lowland East indicate loss of 0 – 5% of riparian vegetation in more developed areas. Roughly 8% of the shoreline of Big Lake in the Lake Complex has been hardened with riprap. The Upland and Lowland West targets are much less developed. We assume that less than 5% native vegetation in riparian areas across the terrestrial ecosystem targets overall has been removed.

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 stream flows 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

In the 2008 plan, 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 had the greatest impervious surfaces at 11%, and the Upper Little Susitna River subwatershed had the least at 1% (TNC 2007). In 2011 impervious surfaces were mapped for most of the basin at a finer scale (TNC 2011). An analysis of subwatersheds showed that seven had passed the 5% threshold: Lucile Creek (14.2%), Meadow Creek (10.3%), Rabbit-Palmer Slough (9.6%), Duck Flats coast of Knik Arm (9.1%), Wasilla Creek (6.5%), Big Lake (6.0%), and lower Matanuska River (5.2%) (TNC 2011). All of these subwatersheds are in the Lowland East and Lake Complexes. Most subwatersheds in the basin are below 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 land cover 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), and twelve wetland types were identified and mapped in the Lake, Lowland East, and Lowland West complexes from 2007 to 2012 (Gracz 2013). As development occurs, it is important that some wetland types are not disproportionately lost in either extent or location. Some wetlands are important for supporting and providing salmon habitat. Due to low levels of development, 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.

Key Attribute 5: Quality of freshwater habitats for critical life-stage functions

Salmon require a diversity of freshwater habitats to complete their life cycle. The selection of habitat timing of spawning by a salmon are linked to success of survival, not only during spawning and incubation of the eggs and alevins, but also in the chain of freshwater and marine environments to which the progeny are subsequently exposed (Groot and Margolis 1991). The quality of habitat within a watershed varies throughout its geographic area. Studies that document preferred habitat characteristics for salmon at different life stages within the Mat-Su, including rearing and overwintering habitat, are limited. USFWS documented that lake habitat is important for juvenile Coho salmon overwintering in the Meadow Creek portion of the Big Lake drainage and that main stem habitat was important for summer rearing (Gerken and Sethi 2013). Future studies should focus on defining what habitat characteristics benefit salmon health. Conservation of salmon depends upon ensuring that each of these habitats is maintained in sufficient quantities and distributed throughout watersheds where salmon need them. Some freshwater habitats are more vulnerable than others to degradation due to human settlement patterns, and the impact may vary for each salmon species.

Indicator 5.1: Quality of freshwater habitat types
Defining habitat characteristics that represent preferred or quality habitat for salmon species at different life history stages are not currently qualified. This indicator can be assessed by identifying quality habitat and typifying these habitats. The Lake and Lowland East complexes are becoming more developed and efforts to conserve quality habitats in these areas will help maintain and increase salmon health.

Indicator 5.2: Diversity & distribution of freshwater habitat types
To date, changes in the distribution and diversity of freshwater habitats for salmon in the Mat-Su has been localized. The greatest changes have occurred in the developed areas of the Lake and Lowland East complexes and can be assumed to continue to be concentrated in those areas. Assessment of this indicator can only be qualified at a basic level at this time until more complete maps or models are produced. The state's Anadromous Waters Catalog provides some information about location of habitats that salmon use, but is limited in identifying critical habitats or providing a comprehensive inventory of salmon habitat in the Mat-Su Basin.

Marine System Target

Upper Cook Inlet Marine

Key Attribute 1: Freshwater inflow
The timing, quantity, and quality of freshwater entering Upper Cook Inlet are 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 (Groot and Margolis 1991, Quinn 2005,). 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 (physical, biological, and chemical)
Just as in fresh water, cool, 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. 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, but are within permit limitations. In addition, water quality within Upper Cook Inlet is affected by stream flow from impaired waters and nonpoint source discharges. In general the water quality is assumed to be meeting standards but additional data would help make a true determination.

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 like 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.
No real baseline data exists about the status of these various food sources or possible changes 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. NMFS has identified salmon as primary prey species for these marine mammals and an essential feature of Cook Inlet critical habitat. 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)
When this plan was first written, NMFS had designated belugas as 'Depleted' (Angliss & Outlaw 2007). On October 22, 2008, National Marine Fisheries Service (NMFS) listed the Cook Inlet beluga whale distinct population segment as an endangered species under the Endangered Species Act. Harbor seals in Cook Inlet are currently classified as part of the Cook Inlet/Shelikof stock. The last survey was in 2006, with an estimated population size of 22,900. (Allen and Angliss 2013). Cook Inlet population trends are unclear but populations have declined in other parts of the Gulf of Alaska (Angliss & Outlaw 2007).

Overall Health of Mat-Su Basin Salmon and Habitat

In 2008, the assessment of the health of wild salmon and their habitat indicated that, *taken as a whole across the Mat-Su Basin*, salmon and most of their habitats were healthy and required minimal human intervention for long term survival. A more local look at individual attributes of health, however, pointed out concerns about long-term sustainability of Mat-Su Basin salmon and some of the habitats they require for survival. For salmon, that assessment suggested that numbers for some sockeye, pink, and chum salmon runs may have been below a sustainable level and that some stocks might 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.

Since 2008, it has become evident that some Susitna salmon are experiencing significant declines. That year, the Alaska Board of Fisheries listed Susitna sockeye salmon as a Stock of Concern. Chinook salmon in that drainage missed their escapement goals for six years, and the Alaska Board of Fisheries listed six Chinook populations as Stocks of Concern in 2011[16]. Little Susitna Coho salmon have missed escapement goals for the past four years.

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

[16] Note that as this updated 2013 plan 'went to press,' the Alaska Board of Fisheries listed the Sheep Creek population of Chinook as a Stock of Concern.

identified over two dozen waterbodies that lack sufficient data to determine water quality and has designated four as Impaired. 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. These are also largely the areas where the Stocks of Concern live out the freshwater portions of their life.

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.

VII. Potential Threats to Salmon & Their Habitats

Many human activities pose 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 flows between 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 is intended to focus on human activities that are currently major sources of stress to salmon and their habitats as well as those that are likely to be potential threats in the next 10 years. In 2008, the Partnership used the CAP framework to identify potential threats based on level of impact to conservation targets. 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 (Appendix 7). That 2008 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 working groups winnowed the list to seven human activities based on urgency; a balance of protection and restoration; a clear role for a habitat-focused partnership; reversibility of impacts; and opportunities to prevent, mitigate, or restore impacts.

For the 2013 plan update, the scoping process confirmed that those seven potential threats were still important areas for the Partnership and recommended that four more potential threats be included in the Strategic Action Plan (Table 5). An existing threat was expanded to include invasive aquatic plants along with northern pike. Climate change was included in this updated plan because more information exists and a clearer role for the Partnership emerged. Motorized off-road recreation has continued to negatively impact some salmon habitat in the Mat-Su, and some partners have been working with user groups to address the problem. Large-scale resource development includes diverse activities like hydropower and coal mining because the Partnership's roles around these potential threats – science and education – are anticipated to be similar.

Table 5. Potential Threats
Aquatic Invasive Species
Climate Change
Development in Estuaries and Nearshore Habitats
Ground & Surface Water Withdrawals
Household On-site Septic Systems & Wastewater
Large-scale Resource Development
Motorized Off-road Recreation
Residential, Commercial, & Industrial Development
Roads & Railroads
Stormwater Runoff

This chapter outlines the potential impacts to salmon habitat from each threat[17] and summarizes the current status or level of activity of the threat in the Mat-Su Basin.

[17] Appendix 11 diagrams the stresses that the potential threats may cause to the salmon and ecosystem targets.

Aquatic Invasive Species

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 (ADF&G 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 Chinook and Coho salmon due to a preference for similar habitats. Coho salmon also have a high vulnerability to northern pike predation because they rear in eutrophic lakes, ponds, sloughs, and other preferred pike habitat. Several Chinook salmon systems have been severely impacted by northern pike predation. In 2007 one of the most popular Chinook salmon streams - Alexander Creek in the 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, and most sockeye salmon rear in oligotrophic lakes were greater depth and less aquatic vegetation is not preferred by northern pike.

In addition to northern pike, invasive reed canarygrass (*Phalaris arundinacea*) is found in an increasing number of riparian wetlands habitats in the Mat-Su Basin. This species poses a threat to native wetland species by forming dense monocultures that inhibit growth of native wetland plants; it has little value for wildlife as it grows too dense for small mammals and waterfowl to use as cover. If introduced to flowing systems, it can slow stream flow and eliminate scouring action needed to maintain salmon spawning gravels.

The invasive submerged aquatic plant *Elodea* has been documented in three lakes in Anchorage, one of which has significant floatplane and motor boat use, vectors that could easily lead to the spread of this aggressive invader to water bodies in the Mat-Su Basin. *Elodea* survives under ice. When introduced to a new waterway, *Elodea* grows rapidly, overtaking native plants, filling the water column, and changing the habitat conditions to which native fish are adapted. Thick mats form at or just below the water surface and can foul boat propellers and floatplane rudders, causing a hazard. In addition to impeding fishing, navigation, boat launching, and paddling, it can also reduce waterfront property values. These thick growths may also increase habitat quality for predatory northern pike, further exacerbating the impacts of pike predation on juvenile salmon and other fish. Fragments of *Elodea* snagged by watercraft, trailers, floats planes or other outdoor equipment are easily spread to new waters. New infestations can also result from intentional (albeit well-meaning) releases from school and home aquariums. In Alaska, live specimens of *Elodea* are used to teach students about cell structure and it’s a popular aquarium plant.

Other aquatic and wetland invasive species of concern that could invade Mat-Su Basin waters include Dreissenid mussels, New Zealand mud snails, other invasive aquatic plants (e.g., hydrilla, Brazilian elodea), purple loosestrife, and didymo.

Climate Change

The change in global climate patterns over the last century has been modeled in many ways. Global Climate Models (GCMs), which represent the atmospheric and oceanic circulation around the world, are widely used by the scientific community to both model historical climate and make projections into the future. In Alaska, SNAP (Scenarios Network for Alaska & Arctic Planning) at the University of Alaska Fairbanks has downscaled the five best performing GCMs to more localized and relevant climate change predictions. SNAP downscaling actions take into account Alaska land features such as slope, elevation, and proximity to coastline, to make these global models to more localized and relevant climate change predictions at the regional scale.

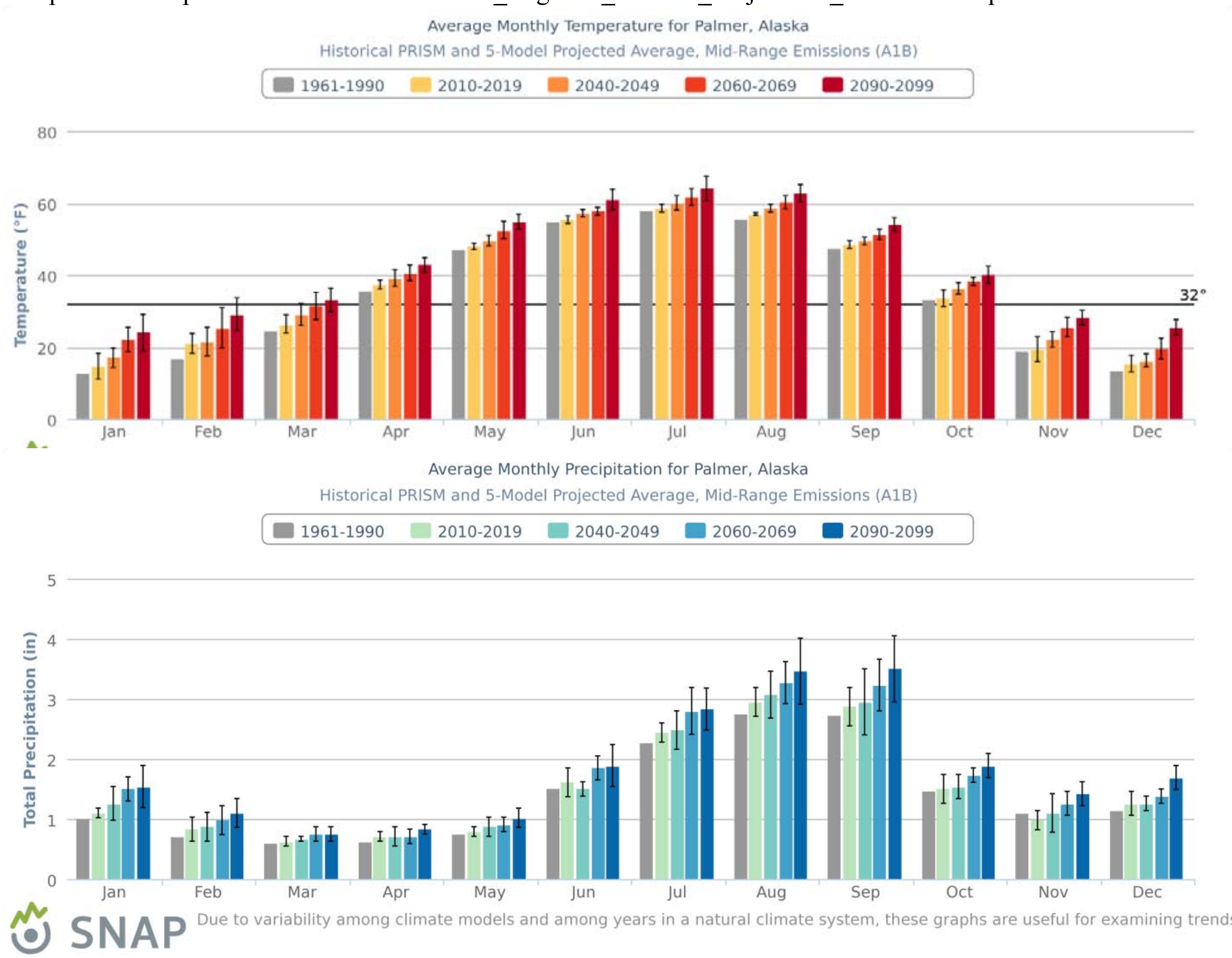
SNAP models project over the next century that temperatures and precipitation are expected to increase across Alaska (Figure 13). The models also project that the growing season will lengthen, and glaciers, sea ice, and permafrost will be reduced. As a result, SNAP projects significant ecosystem shifts are likely statewide.

For Southcentral Alaska, including the Mat-Su Basin, SNAP projects that, "temperatures [will] increase over the coming decades at an average rate of about 1^{o}F per decade. Mean temperatures in Palmer are projected to rise from below freezing in October and March to slightly above freezing. Milder winters will likely result in significant reductions in snowpack, since a higher percentage of precipitation would occur as rain. Precipitation increases may also be offset by an increase in evapotranspiration from warmer temperatures and a longer growing season. As a result, conditions are expected to become substantially drier in the summer and potentially icier in winter" (SNAP 2013). SNAP (2013) projects the resulting impacts of these changes will include but not be limited to:

- Shifts in the distribution of native and invasive species could negatively impact ecosystem function and subsistence activities. In the southcentral boreal forest, invasive species can be a dominant mechanism of change. Invasive plants spread aggressively and out-compete native vegetation. The spread of invasive species alters forest structure and regeneration. The indirect effects on water and nutrient availability will likely determine future productivity of trees in southcentral Alaska.
- Warmer weather and insect-killed trees may also lead to increased incidence and severity of forest fire.
- Higher temperatures result in a longer growing season, which could have significant effects on wildlife mating cycles, plant growth and flowering, water availability in soil and rivers, and hunting and fishing.
- Increase in storm severity and the associated risks from flooding and erosion may increase. The Mat-Su Basin has experienced multiple hundred-year floods in the last couple decades.

- Local lakes and streams will warm and exceed temperatures that salmon and other aquatic species need to survive. Local streams are already showing warming trends (CIK 2013).

Figure 13. Projected Average Change in Monthly Precipitation and Temperature in Palmer, AK
http://www.snap.uaf.edu/attachments/Alaska_Regional_Climate_Projections_SouthCentral.pdf



In consideration of SNAP modeling and other information, the Partnership is concerned about the impacts of flooding, erosion and warmer stream temperatures on salmon sustainability and salmon habitat. Recent monitoring in non-glacial streams in the Partnership service area shows great variability in summer water temperatures across the Mat-Su Basin (CIK 2013). Modeling efforts indicate that large watersheds with low slope and low elevation are inclined to have the warmest temperature profiles and are the most sensitive to climate change impacts. In these warm, highly sensitive streams, average July water temperature is predicted to increase at least 2^{o}C by 2099 increasing physiological stress in salmon and making them more vulnerable to pollution, predation and disease (CIK 2013). Thermal impacts will be more moderate or insignificant in less climate-sensitive systems, which may become increasingly important cold water refugia. Partnership member groups are beginning to factor this information into plans identifying voluntary habitat protection measures for salmon and other habitat improvement projects identified in this plan.

Development in Estuaries and Nearshore Habitats

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).

Ground & Surface Water Withdrawals

Water is withdrawn from underground aquifers and surface waterbodies for human consumption, agriculture, and industrial uses. Some extractive industries, such as gravel pits, can inadvertently withdraw groundwater. 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 (Barlow and Leake 2012), alter channel-forming processes, dry wetlands, degrade water quality, and impair salmon migration and spawning and rearing habitat. 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 or during periods of drought, withdrawals at these times 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.

Protecting the flow regime will increase system resiliency against other changes, such as climate changes.

Water withdrawals are anticipated to have the greatest impact on the hydrological regime in the 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.

Household On-Site Septic Systems & Wastewater Discharge

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.

Household septic systems 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 – where a majority of households use on-site septic systems and minimum required lot sizes have been reduced in size. 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). Cottonwood Creek is listed as an impaired waterbody due to fecal coliform bacteria levels. (ADEC 2010).

When a household on-site septic system in the Mat-Su Borough is pumped, the sewage is currently trucked to Anchorage for treatment at the Municipality's wastewater facility. This wastewater treatment plant is currently permitted by the EPA NPDES program and has a waiver to the secondary treatment requirements to discharge treated primary effluent from the treatment plant with a design flow of 58 million gallons per day. The discharge outfall is located in Knik Arm of Cook Inlet, 800 feet from shore and roughly 15 feet below mean lower low water (EPA NPDES permit #AK-002255-1). This wastewater discharge directly affects water quality of the Upper Cook Inlet Marine target near Point Woronzof at the discharge point.

Large-scale Resource Development

The Matanuska-Susitna Borough has diverse natural resources, and some of these are in various states of development. The Mat-Su has a history of resource extraction and development, including gold mining at Hatcher Pass, coal mining in the Matanuska watershed, logging in the Matanuska and Susitna watersheds, and some placer and small-scale hard rock mining along the Denali Highway. Historically, mines impacted salmon habitats in many ways, including channel straightening, diking, and filling in of riparian habitats. In recent years, two types of large-scale resource development have been proposed that could result in alteration to salmon habitats. Therefore the Partnership is focusing on these types of proposed projects at this time - a large hydropower project and three coal mines.

What these proposed large-scale resource development projects have in common is the potential to change the hydrologic regime (including flow, sediment transport, and water quality), which has many direct and indirect affects to salmon and their habitat. A river's natural hydrologic regime (including flow magnitude, duration, frequency, timing, and rate of change) substantially influence aquatic habitat and ecology. Changes to the flow regime would influence physical habitats and ecological function (Assani 2007; Henriksen et al. 2006; Olden and Poff 2003; Poff and Zimmerman 2010; Poff et al. 1997; Poole 2002; Richter et al. 1997; Trush et al. 2000). Both large hydropower and coal mining can alter the natural flow regime. Hydropower can alter the flow and sediment regimes by trapping sediment behind the dam in the impounded area and by altering the flow to downstream reaches through project operations. Additionally, large-scale hydropower may result in creation of fish passage barriers at the dam and below the dam through the alteration of the flow, geomorphology and sediment of key habitats. Coal mining can alter the flow regime by removing large areas from the contributing drainage area and altering groundwater flow paths, thus affecting water quality, sediment transport, and fish access to habitats.

Three coal mines are proposed in the Matanuska River watershed -- the Wishbone Hill, Jonesville, and Chickaloon coal mines. These mines have the potential to significantly alter the surface and groundwaters of some anadromous rivers in the watershed, including the Matanuska River. The State of Alaska is pursuing a large hydropower project on the Susitna River, approximately 184 river miles upstream of Cook Inlet. The Alaska Energy Authority (AEA) proposes a load-following operation that would be out of phase with the natural hydrograph.

Motorized Off-road Recreation

Most of the Mat-Su Basin is remote and not accessible via the road system. Therefore, the use of off-highway vehicles (OHV) has led to the development of an extensive system of sanctioned and unsanctioned trails. Improperly located or constructed trails may have negative impacts to fish and wildlife habitat. Those impacts from OHV use on the Alaska landscape, including at streams and wetlands, have been documented (Ahlstrand and Racine 1990; ADF&G 1996; Davis and Ryland 2002; Happe et al. 1998; Wilkinson 2001; Rinella and Bogan 2003); however, the specific impacts on fish populations are poorly understood. Of primary concern is how OHV stream and wetlands crossings may degrade salmon habitat and ultimately affect the health and survival of salmon.

At streams, impacts can include changes to a stream's temperature regime, soil, and hydrologic conditions. These changes can create stream bed and bank instability, increased sedimentation, and damage to riparian and instream habitat. Stream banks provide important habitats for salmon at multiple life stages. Shoreline and riparian vegetation along streams stabilizes soil, slows water velocity during high-water events, provides terrestrial inputs (such as leaf litter, terrestrial insects, large and small woody debris), and provides shade that keeps water temperatures cool. OHV trail crossings through streams can reduce shoreline vegetation, which may reduce structural stability, increase erosion, and remove important vegetative cover. Bank erosion may increase sediment into the stream, thus reducing water transparency, smothering fish eggs, entombing sac fry, and filling in pools and shallow habitats. Fish passage at stream crossings can be impaired as stream bank erosion leads to stream widening and a reduced water depth.

Physical damage from OHV use in wetlands includes rutting, soil compaction, and destruction of vegetation. These physical changes may result in changes to the biologic, chemical, and hydrologic processes in the wetland. In addition, as OHV passage becomes more difficult on deeply-rutted trails through wetlands, users may seek other paths and expand damage. OHV use in streams and wetlands may also degrade water quality with the introduction of contaminants, including hydrocarbons in fuel, oil, and lubricants.

Residential, Commercial, and Industrial Development

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 effects of housing and urban development on salmon and their habitat are the loss of wetlands, alteration of riparian habitat, degraded water quality, creation of impervious surfaces, and changes in natural drainage patterns.

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. There is a need for a long-term study of wetlands impacts over the past ten years in the Mat-Su.

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. Loss of riparian vegetation from land clearing removes cover and potentially increases water temperature which is a concern for developing salmon fry. 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 (such as an industrial pipe discharging polluted water), or indirect, such as fertilizer runoff from numerous lawns and gardens or failing septic systems in a subdivision that end up in a nearby stream or lake. Degradation of water quality below state allowed limits can affect human health, alter aquatic invertebrate communities, disrupt the food chain, and decrease survival of salmon at different life stages. Water quality can also be affected by increased development because polluted runoff from roads, parking lots, and yards can add contaminants to streams.

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 or snowmelt 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 not only impacts houses and property but 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.

Most residential, commercial, and industrial development is occurring in the Knik-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 land cover change in the next 50 years with a doubling of urbanized areas (Schick 2006). In particular, development activities alter riparian vegetation, increase the amount of impervious surfaces, alter stormwater runoff, degrade water quality, and remove wetlands. Degraded water quality from stormwater runoff is already documented in several waterbodies including Lake Lucille and Cottonwood Creek (ADEC 2010).

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 and associated road-stream crossings 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. Water quality impacts can result from road runoff in both impervious and non-impervious areas and herbicide treatment along roadways or railroads. Road runoff contains sediment and other contaminants that can affect fish and aquatic habitat over time if proper drainage infiltration is not designed into road projects around streams. 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 Knik-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 Residential, Commercial and Industrial Development is polluted 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. Many pollutants are contained in the runoff and are often attached to sediment particles that then drain into area lakes and streams. Fecal coliform, sediment, metals such as copper and zinc, 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, copper, petroleum, and other pollutants that directly affect water quality. Runoff typically flows untreated into ditches or directly into lakes, streams, rivers, wetlands, or coastal waterbodies. Storm drains and drainage ditches serve to concentrate runoff. This often causes increased pollution at the discharge site along with erosion and alteration of the natural hydrograph and overwhelms the absorptive capacity of the receiving water. Recent studies within developed areas of the Mat-Su Basin have shown a decline in biotic indices of water quality and an increase in sediment-bound metals near stormwater outfalls (Davis, Davis, and Jensen 2013).

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 and Lake Lucille are currently listed as polluted waterbodies due to urban runoff (ADEC 2010). Pollutants in stormwater water runoff have the potential to negatively affect aquatic life. 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 compared to other target areas.

VIII. 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 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 Partnership uses to guide work at the national and partnership level (NFHP 2012).

The working groups performed a situation analysis for each of the potential threats. Some potential threats have multiple impacts to salmon and their habitats, and the Partnership will focus on the *most significant* of those (Table 6).[18] The situation analysis examines what is already being done to address the problem and identifies the gaps in resources, knowledge, regulation, or enforcement. As a result, the potential role for the Partnership to act to protect salmon habitat given the human context becomes clearer.

Table 6. Most Significant Impacts from Potential Threats to Salmon Habitat

		Potential Threats to Salmon Habitat									
		Climate Change	Development in Estuaries & Nearshore Habitats	Ground & Surface Water Withdrawals	Household Septic Systems & Wastewater	Aquatic Invasive Species	Large-scale Resource Development	Motorized Off-road Recreation	Residential, Commercial, & Industrial Development	Roads and Railroads	Stormwater Runoff
Impacts to Salmon Habitat	Alteration of riparian areas						■	■	■		
	Filling of wetlands		■				■		■	■	
	Degradation of water quality	■			■		■				■
	Impairments to fish passage						■			■	
	Loss or alteration of water quantity	■		■			■				■
	Loss of estuaries and nearshore habitats		■				■				
	Alteration of native plant & animal communities	■				■					

[18] Appendix 11 diagrams the most significant stresses that the potential threats may cause to the salmon and ecosystem targets.

The situation analysis brought into focus the more discrete issues upon which the Partnership can act and identified 11 conservation strategies[19] to conserve salmon in the Mat-Su Basin (Table 7). These strategies address the sources of the impacts and the impacts themselves. Some impacts have multiple sources that can be addressed collectively. Other potential threats have unique situations that lend themselves to being addressed specifically. For that reason, the conservation strategies are organized around a mix of impacts and threats.

Table 7. Conservation Strategies	
1	Overarching Science Strategies
2	Alteration of Riparian Areas
3	Climate Change
4	Culverts that Block Fish Passage
5	Filling of Wetlands
6	Impervious Surfaces & Stormwater Pollution
7	Aquatic Invasive Species
8	Large-scale Resource Development
9	Loss or Alteration of Water Flow or Volume
10	Loss of Estuaries & Nearshore Habitats
11	Motorized Off-road Recreation
12	Wastewater Management

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 because the information they will gather will inform multiple conservation strategies.

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

Mat-Su salmon science strategies have been developed to support the overall plan goals to (1) identify important habitats for salmon and other fish species in the Mat-Su Basin, and (2) prioritize fish habitat conservation actions. Identifying important habitats requires an understanding of the geographic location of salmon among area streams for spawning and

[19] The 2008 plan used the term 'focal issue' to refer to the discrete areas where the Partnership would work. In the 2012 update, we use the term 'Conservation Strategy' to be simpler and more direct.

rearing, and the physical, chemical, and biological characteristics of those areas. It is the characteristics of these habitat locations that make them important for successful salmon spawning and egg development, emergence and summer rearing, and overwintering. Science strategies need to improve understanding of how the threats identified in this plan can alter salmon habitat that is important for different life stages and the characteristics of those habitats, so that fish habitat conservation actions can be prioritized. Science strategies should improve our ability to monitor viability of target species and indicators of ecological attributes.

Overall Science Goal: To identify important habitats for salmon to prioritize actions for their conservation in the Mat-Su

In Alaska, the fundamental conservation tool to protect salmon and their habitats is the Anadromous Fish Act (16.05.871). The Anadromous Fish Act requires a state permit for most activities conducted below the ordinary high water line of waterbodies that support anadromous fish. ADF&G 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 (ADF&G 2007) for Anadromous Fish Act regulations to apply. Currently the catalog contains less than 4500 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. However, any credible organization can document anadromous waters and submit the information to ADF&G for inclusion in the catalog. Completion of the Anadromous Waters Catalog is a foundational piece for implementing many of the conservation strategies, in particular alteration of riparian habitats; filling of wetlands; impervious surfaces and stormwater runoff; and culverts that block fish passage.

Identification of the habitats that salmon use is essential to protecting the critical places they need. While the Anadromous Waters Catalog provides an inventory of salmon streams, it does not record habitat quality or include waters that are likely to be salmon habitat and often lacks life stage information for a given stream. Understanding which habitats are critical and of high quality can help to prioritize conservation actions.

Objective 1.1: Anadromous Waters Catalog

By 2020, ensure that all anadromous fish habitat in the Mat-Su Basin is included in the Anadromous Waters Catalog and thus given basic protections afforded under state law. Efforts to catalog anadromous fish should identify life stage information and document non-anadromous fish.

Strategic Action 1.1.1: Complete Anadromous Waters Catalog

Support projects that can improve upon the identification of waters important for salmon, which could result in revisions to the Anadromous Waters Catalog. Priority should be given to adding new streams or stream segments, lakes, and wetlands, and to including additional species and life stages. Priority also should be given to areas that may be subject to threats identified in this plan.

Objective 1.2: Habitat Quality
By 2020, characteristics of habitats that are critical for salmon at each life stage (spawning, rearing, and overwintering) will be identified and used to develop critical habitat definitions to identify places that provide these habitats.

Strategic Action 1.2.1: Habitat Quality Plan
The Science and Data Committee will develop a plan for 1) defining the characteristics of habitats that are critical for salmon at each life stage and 2) identifying places that provide these habitats.

Strategic Action 1.2.2 Life Stage Studies
Support projects that define characteristics of spawning, rearing, and overwintering habitat for Mat-Su salmon species.

Strategic Action 1.2.3 Salmon Habitat Models
Support projects that build upon existing data and contribute new findings to predict the location of critical habitat for salmon at each life stage.

Information on water flow and levels of ground and surface water is important for our understanding of water quantity and locations that provide quality salmon spawning and overwintering habitat. This information is limited in the Mat-Su Basin compared to other parts of the country[20]. Also the relationship between groundwater and surface water is not well understood in the Mat-Su Basin. Increasing information on ground and surface water and their interaction is important for addressing six conservation strategies: impervious surfaces and stormwater runoff; loss or alteration of water flow or volume; filling of wetlands; septic systems; climate change; and culverts that block fish passage.

Objective 1.3: Comprehensive Surface and Groundwater Studies
By 2018, an increased understanding of surface and groundwater exchange, including locations, quantities, flows, and variability in the Mat-Su Basin, will be sufficient to aid in identifying critical salmon habitat for each life stage.

Strategic Action 1.3.1: Ground and Surface Water Data Clearinghouse
Support development of a data clearinghouse with public access, possibly at USGS, ADNR, or ACWA. This clearinghouse should integrate with ADNR's well log database called the Well Log Tracking System (WELTS).

Strategic Action 1.3.2: Support Mat-Su Groundwater Program
Work with the USGS and other organizations to support groundwater modeling and monitoring programs. Support groundwater studies that are consistent with Partnership goals.

Strategic Action 1.3.3: Monitor Surface Flows Continuously gather hydrologic data with stream gages in index watersheds (see Objective 1.5).

[20] More about groundwater and surface water studies and information in the Mat-Su Basin is included in Section 9 *Loss or alteration of water flow or volume* in Chapter VIII Conservation Strategies.

Stream water physical and chemical characteristics are important for Mat-Su salmon survival and production. Federal and state resource agencies, the Mat-Su Borough, and non-governmental organizations monitor water quality in many Mat-Su Basin streams and lakes. The ADEC Monitoring and Assessment Program completed a baseline monitoring study of Cook Inlet lakes in 2008 (ADEC 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 four conservation strategies: impervious surfaces and stormwater runoff; climate change; large-scale resource development; and septic systems. Due to funding constraints, monitoring priority tends to be given to those waters that are considered degraded.

Objective 1.4: Water Quality Monitoring
By 2018, a comprehensive baseline and monitoring program for water quality exists to track and manage changes in Mat-Su Basin waterbodies.

Strategic Action 1.4.1: Support a Water Quality Monitoring Program
Work with ADEC through the Alaska Clean Water Actions (ACWA) program and with other partners to develop a long-term water quality monitoring and tracking program for the Mat-Su Basin. Include existing water quality data for Mat-Su lakes and streams from the various organizations that monitor water quality in the Mat-Su.

Strategic Action 1.4.2: Monitor Water Quality
Continuously monitor water quality in index watersheds (see Objective 1.5) to establish baseline conditions and track changes over time.

Strategic Action 1.4.3: Support Baseline Data for Stream Temperatures
Support monitoring of temperatures in Mat-Su Basin waterbodies.

Strategic Action 1.4.4. Support Biological Monitoring
Support projects that monitor and track changes to biotic communities (e.g. macroinvertebrates) that can be indicators of degrading water quality or physical habitat, following established state methods where developed.

While the overarching Science Strategies are presented here in three distinct categories – salmon habitat and distribution of salmon, ground and surface water quantity, and water quality – an interdisciplinary approach is also implied. For example, water quantity and quality may be important characteristics for identifying salmon habitat. Using a holistic approach by integrating habitat, water quality and quantity studies could help to understand interrelationships better. Looking more comprehensively could also create efficiencies in data collection and provide opportunities to understand linkages between natural and human-caused conditions. In order to protect salmon, science strategies should also identify the pathways through which threats identified in this plan can alter water quantity, water quality, physical habitat, or stream function.

Index watersheds are locations for long-term monitoring and study. Index watersheds will be important to salmon and representative of Mat-Su Basin streams. Some may be vulnerable to human activities and climate change in the Mat-Su Basin and others will be less threatened, providing a reference for comparison. Within these index watersheds a number of features would be monitored: water quality, water quantity, landscape change through use of aerial imagery captured at regular intervals, documentation of salmon habitat location, quality, and quantity, and human activities. These index watersheds could also become pilot project locations for implementing other conservation strategies, such as habitat modeling or restoration.

Objective 1.5: Index Watersheds
By 2016, a minimum of three index watersheds are locations for long-term, interdisciplinary monitoring needed to understand the relationships between salmon, habitat health, and changes induced by human activities and climate change.

> **Strategic Action 1.5.1. Select Index Watersheds**
> The Science and Data Committee will work with partner organizations to identify index watersheds based on multiple criteria: relative importance of the watershed to salmon; how representative the watershed is to other Mat-Su Basin streams; how vulnerable the watershed is to human activities and climate change; and the type and amount of scientific data previously collected within the watershed.
>
> **Strategic Action 1.5.2 Studies in Index Watersheds**
> The Science and Data Committee will work with partner organizations to develop and implement a study plan for each index watershed.

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 16.05.871) requires a state permit for most activities below the ordinary high water line of waterbodies that support anadromous fish. This indirectly provides a degree of protection for riparian areas. The Alaska Department of Fish and Game (ADF&G) 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 for Anadromous Fish Act regulations to apply. Currently the catalog contains less than 4500 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 water bodies 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 (BMPs) for Development around Water bodies; incorporating those BMPs into the ordinance could minimize additional degradation to riparian areas

Overall Riparian Goal: To prevent alteration of riparian areas that provide valuable salmon habitat

Objective 2.1: Identification of Priority Riparian Areas for Salmon
By 2018, 50% of salmon riparian areas will be field surveyed, mapped and prioritized for long-term legal protection and/or restoration.

Strategic Action 2.1.1: Field Survey and Priority Riparian Habitat
Prioritize riparian habitat along stream and shoreline reaches (both stream and lake) for protection and/or restoration within the Lowland East and Lake Complex target areas by 2018. Map and prioritize riparian habitats for protection and restoration within the Upland and Lowland West Complex target areas by 2018.

Objective 2.2: Protection of Priority Salmon Riparian Habitat
By 2018, 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
Develop factsheets for the Partnership website and for print media that clearly define all Federal, State, Borough and City regulations and conservation 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 that maintain a 50 foot riparian buffer along all priority waterbodies in the Mat-Su Borough on both public and private lands.

Strategic Action 2.2.3: Protect Priority Riparian Habitat on State Lands
Work in partnership with ADNR Land Managers, ADF&G, Refuge Managers, Private landowners, and conservation partners to prioritize riparian habitats on State land and develop creative collaboration strategies to establish and maintain riparian buffers to protect water quality, maintain wildlife habitat, and provide for appropriate public access.

Strategic Action 2.2.4: Verify Permitted Stream Crossings are Legal Access
Map and prioritize permitted stream crossings and determine how to minimize impacts to priority riparian habitat. In cooperation with ADF&G, work to ensure that important riparian habitat is protected and/or restored within areas of permitted stream crossings, limit redundant crossings, and withdraw permitted crossings that do not provide access to public lands.

Strategic Action 2.2.5: Promote Best Management Practices
Through education and outreach promote voluntary stewardship and Best Management Practices for development near riparian habitat that can be applied to all ownerships.

Strategic Action 2.2.6: Protect Riparian Areas with Easements
Conserve 10% or more of the priority 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 2018, 5% of priority riparian habitats that have been altered are restored.

Strategic Action 2.3.1: Promote Collaborative Approach to Riparian Restoration
On an annual basis, identify funding sources, partners and technical expertise to conduct restoration projects on priority riparian habitats. Encourage partners who conduct projects to apply for funding through National Fish Habitat Partnership (NFHP), 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.

Strategic Action 2.3.2: Restore Important Riparian Habitat
Projects 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 establishing a monitoring program. Methods should come from those identified in the ADF&G Streambank Revegetation and Protection Manual (2007).

Strategic Action 2.3.3: Research and Demonstrate Effective Restoration Techniques
Improve ongoing shoreline restoration activities by using the most up-to-date and effective restoration techniques based on the latest research and onsite evaluation of past projects.

3. Climate Change

During the 2013 Plan update, the climate change working group concluded that the Mat-Su Basin is vulnerable to climate change, but uncertainty remains as to how such changes will impact land cover, salmon species and ecological processes. Climate change is expected to alter watersheds by affecting flooding frequencies, glacial variation, snow pack depths, precipitation, surface and groundwater volumes, stream temperature, and other hydrologic characteristics (CIK 2013, SNAP 2013).

The 2008 Strategic Action Plan did not define a clear role for the Partnership to address climate change directly but it did place a priority on protecting and restoring many of the factors that can maintain or increase the resiliency of salmon to current human impacts (e.g., loss of riparian cover, wetlands, connectivity, and reservation of water). These actions are also likely to increase resiliency of the Plan's salmon and ecosystem targets to predicted climate change impacts. The "no regrets" approach to climate change vulnerability identified in 2008 remains valid for the 2013 Plan update. It is important to fully implement objectives and strategic actions in this entire plan that sustain and increase habitat and hydrologic connectivity and protect and restore riparian habitat and functions and key spawning and rearing habitat. These actions will increase resiliency of conservation targets to future uncertain climate change impacts, while also addressing more immediate non-climate related stresses and threats.

Overall Climate Change Goal: To increase resiliency of salmon and their habitat to future climate change impacts

Objective 3.1: Comprehensive Baseline and Monitoring for Stream Temperatures
By 2015, comprehensive baseline and monitoring program for stream temperatures exists to track and manage changes in priority Mat-Su Basin waterbodies and impacts on salmon and salmon habitat.

Strategic Action 3.1.1: Develop and implement a monitoring program that builds on the regional assessment done from 2008-2012 on non-glacial streams.

Strategic Action 3.1.2: Map non-glacial cold water refugia in priority watersheds. Determine priority watersheds with Science and Data Committee to maximize coordination with other partnership activities.

Strategic Action 3.1.3: Monitor priority watersheds to track rate of warming in temperature-sensitive streams and confirm that cold water refugia remain cold.

Strategic Action 3.1.4: Measure and then model the relationship between air temperature and water temperature for southcentral Alaska.

Strategic Action 3.1.5: Maintain relations with Alaska Landscape Conservation Cooperatives[21] to share information and to advance shared goals including upgrading Alaska's National Hydrography Dataset and implementing a statewide stream and lake monitoring and data sharing system.

Objective 3.2: Integrate Climate Change into Priorities
By 2015, integrate climate change into habitat conservation strategies and prioritizations.

[21] Landscape Conservation Cooperatives (LCCs) are applied conservation science partnerships between the U.S. Fish and Wildlife Service and other federal agencies, states, tribes, non-governmental organizations, universities and stakeholders within an ecologically defined area. http://www.fws.gov/alaska/lcc.

Strategic Action 3.2.1: Conduct vulnerability assessment for the Mat-Su Basin based on forecast of biome shift and July mean temperature in 50 years under a range of emission scenarios to assess climate change exposure. Use this assessment to conduct scenario planning exercises to help the Partnership adapt its strategic actions to the uncertainties associated with climate change impacts on salmon habitat.

Strategic Action 3.2.2: Develop habitat conservation strategies or prioritization weights based on sub-watershed vulnerability and as mapping different "warm" and "cold" stream types (i.e. sensitivity and exposure to climate change). Such strategies could include protecting lands with non-glacial anadromous streams that provide shading; emphasizing conservation through conservation easements and land acquisitions of low resilience, high exposure lands; or focusing on connecting refugia habitats with high resilience and low exposure.

Strategic Action 3.2.3: Use the annual Mat-Su Salmon Science and Conservation Symposium to increase awareness of real and projected climate change impacts within the Mat-Su Basin and possible adaption measures that could be implemented by public and private landowners in order to sustain desired habitat conditions for salmon.

4. 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. Currently, the borough and the Alaska Department of Transportation and Public Facilities (ADOT&PF) have developed design standards for fish passage. The other infrastructure groups, including the Alaska Railroad, do not have design standards. 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[22]. Some culvert projects may also require permits from the Mat-Su Borough and Army Corps of Engineers. Efforts have been made to streamline understanding between permitting agencies and the four infrastructure landowners. For instance, ADF&G and the ADOT&PF signed a Memorandum of Agreement concerning fish passage and road projects[23], yet coordination can be ineffective with changing staff, administrations, and department authorities.

Assessment of culverts that provide for adequate fish passage, particularly for juveniles, is a priority for anadromous waters identified in the Anadromous Waters Catalog (ADF&G 2007). Alaska Department of Fish and Game (ADF&G) also maintains culverts locations.[24] ADF&G 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'

[22] 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.
[23] Available at www.sf.adfg.state.ak.us/SARR/Fishpassage/FP_regs.cfm.
[24] This inventory is publicly available at http://www.adfg.alaska.gov/index.cfm?adfg=fishpassage.mapping.

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, 587 culvert crossings have been assessed since 1999 and constitute most of the potential crossings. Of these, 53% (311) of culverts are inadequate for fish passage, and another 18% (109) are considered unlikely to allow for adequate fish passage, and require additional data and analysis to be assessed completely. Approximately one third of the culverts in the Borough adequately pass fish. It is currently estimated (2012) that there exists about 633 miles of upstream habitat above barrier culverts within the Borough.

For the past decade, 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, degree of impediment to fish passage and main stem vs. tributary streams in areas of high value to anadromous fish. As of June 2013, ADF&G had an additional prioritization in draft form under review that links degree of fish passage impediment to habitat value that will be incorporated into selection of future fish passage projects.

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.

Overall Fish Passage Goal: To maintain salmon passage at all anadromous stream crossings in the Mat-Su Basin

Objective 4.1: No New Barriers
By 2015, 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 4.1.1: Develop and Enforce Local Design Standards
Develop design standards to maximize fish passage in all new construction activities in the Mat-Su Basin with all transportation infrastructure entities, including private and public roads, in coordination with ADF&G, 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. Support agencies (MSB, ADF&G, NOAA, etc.) in enforcement of design standards.

Strategic Action 4.1.2: 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 and include improved indicators of juvenile migration barriers.

Strategic Action 4.1.3: Monitor Culverts
Develop and implement culvert monitoring plan to ensure fish passage is maintained or improved.

Strategic Action 4.1.4: Improve State Coordination
Recommend that the Memorandum of Agreements (MOA) between ADOT&PF and ADF&G for culverts be updated to address changes in state departments, advances in fish passage standards, and links to habitat permitting. Evaluate need and potential development 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 4.1.5: Improve State-Local Coordination
Hold annual meetings between agencies (e.g., ADF&G, 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 4.1.6: 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.

Objective 4.2: Fish Passage Restoration
By 2015, fish passage will be restored in 65 priority culverts that currently block passage of juvenile or adult fish.

Strategic Action 4.2.1: 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 2016.

Strategic Action 4.2.2: Develop and Implement Fish Passage Prioritization and Improvement Plan
Develop and implement a multi-agency fish passage prioritization plan. From the prioritization plan, revise the 2011 Mat-Su Salmon Passage Improvement Plan to include budget and priorities for culvert replacement and re-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 4.2.3: Educate Agencies and Private Developers about Fish Passage
Develop a fish passage educational and outreach program for 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.

5. 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. Prior to 2006, over 3,100 permits had been filed in the Mat-Su Basin, with a majority in the Lowland East Complex (1,582) 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 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. The National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) have authority under the Fish and Wildlife Coordination Act to review 404 permits. ADF&G's Division of Habitat 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 created the Su-Knik 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. As of 2013, the Bank only includes borough-owned lands.

There are two private wetlands mitigation banks in the Mat-Su, and the Great Land Trust has an in-lieu fee wetlands mitigation program for the Mat-Su Borough.

Surveys and assessments of Mat-Su Basin wetlands can aid in 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 borough, with funding assistance from Army Corps of Engineers, has mapped wetlands in the central region of the MSB totaling over 400,000 acres. This wetlands mapping initiative is the most accurate wetlands mapping for the region and is available on the MSB website.

The functional quality of most wetlands in the Mat-Su Basin has not been assessed, though there is an interagency team that is developing a functional assessment tool to assess wetlands that have been mapped. 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 though preliminary studies are in process.

The current situation leaves many important wetlands at risk 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[25], comparisons of wetlands to be developed versus wetlands to be protected as mitigation are difficult.

Overall Wetlands Goal: To protect wetlands that provide important salmon habitat in the Mat-Su Basin

Objective 5.1 Identify, Map and Assess Functions of Wetlands for Salmon
By 2018, wetlands that are important for salmon will be identified, mapped and assessed for their functional importance for salmon.

Strategic Action 5.1.1: Map Priority Wetlands for Salmon
Map wetlands within priority watersheds for salmon and rank watershed for impact vulnerability to salmon populations.

Strategic Action 5.1.2: Wetlands Functional Assessment
Complete and implement the wetlands functional assessment to understand wetland type and function, susceptibility to climate change, and wetland drying.

[25] 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.

Strategic Action 5.1.3: Cumulative Impact Study of Wetland Loss
Conduct a study of cumulative impacts to wetlands in the MSB from 2000 to 2010.

Objective 5.2: Conserve Wetlands for Salmon
By 2020, 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 5.2.1: Implement MSB Wetlands Management Plan
The Mat-Su Borough wetlands management plan was completed in 2012 complete with goals and objectives.

Strategic Action 5.2.2: Protect Wetlands with Easements
Protect wetlands important to salmon through voluntary conservation easements and/or fee acquisition from willing sellers.

Strategic Action 5.2.3: Enhance Degraded Wetlands
Enhance degraded wetlands through activities such as reconnection of fragmented wetlands, revegetation of impacted areas, and improvement of salmon habitat and water quality.

Strategic Action 5.2.4: Strengthen Agency Review Process
Strengthen and maintain review of 404 permits by ensuring that federal agencies (USFWS, EPA, NOAA, ACOE) have sufficient resources available in the Mat-Su Basin. Permit review process will consider cumulative impacts at the watershed level.

Strategic Action 5.2.5: Educate Public about Wetland Mitigation Options
Expand public awareness of mitigation options including mitigation banks, on site mitigation, and in-lieu fee programs available for the Mat-Su.

Strategic Action 5.2.6: 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, tax incentives, development setbacks, public education, use of Green Infrastructure methods with communities, and land swaps.

6. Impervious Surfaces and Stormwater Pollution

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 (14.1% Lucille Creek, 10.3% Meadow Creek) (TNC 2011). 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 ADEC's 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; however, portions of the Knik-Palmer-Wasilla core area are being considered by the Environmental Protection Agency (EPA) and ADEC for an MS4 permit in the near future.

Stormwater runoff from construction activities are regulated by various agencies. The ADEC's Alaska Pollutant Discharge Elimination System (APDES) 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. The developer must also submit a Stormwater Pollution Prevention Plan (SWPPP) to ADEC to manage materials, equipment, and runoff from the construction site. The ADEC also has a Multi-Sector General Permit that regulates runoff and discharges from industrial sites, such as waste water treatment facilities and large gravel pits.

The Ma-Su Borough has developed a Stormwater Management Plan in collaboration with the Cities of Palmer and Wasilla designed to meet the requirements of a future permit that the federal government requires of communities of a certain size. The borough has also developed Low Impact Development Manuals for Homeowners and Contractors and has ongoing rain garden grant program with USFWS funding.

Overall Stormwater Goal: To minimize the impacts of stormwater pollution to water quality in Mat-Su waters.

Objective 6.1: Minimization of Impacts on Water Quality
By 2018, 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 6.1.1: 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 with native vegetation; and 3) prohibit direct discharges of 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 6.1.2: Promote Best Stormwater Management Practices
Promote Best Management Practices (BMP) for stormwater management in new developments on municipal, state and private lands. BMPs should include methods to reduce impervious surfaces and eliminate stormwater runoff leaving the site (e.g., buffers, rain gardens, detention, and retention).

Strategic Action 6.1.3: Educate about Low Impact Development Techniques
Create a public outreach program about the need and methods for reducing stormwater runoff and impervious surfaces. Promote demonstration projects with local developers to show methods and benefits.

Strategic Action 6.1.4: Conserve Lands Important to the Health of Water bodies
Work with willing landowners to conserve important lands that maintain water quality through conservation easements or fee acquisitions.

Objective 6.2: Minimize Road Runoff
By 2018, the extent and potential of road runoff as a contributor to water quality issues at salmon streams will be known and BMPs developed to minimize impacts.

Strategic Action 6.2.1: Perform Road Runoff Evaluation
Assess and inventory road runoff flow paths along salmon streams within the Borough. Based on standard criteria, estimate the potential contribution of sediment and contaminants to area streams, stratifying by impervious or curbed vs. non-impervious or ditched roadways.

Strategic Action 6.2.2: Create BMPs for Mitigating Road Runoff
Standard BMP's exist for mitigating road runoff. Working with the Borough Storm Water Management Planning team, identify and create a manual to mitigate road runoff for new construction and maintenance of old construction.

Objective 6.3: Imperviousness Impact Assessment
By 2018, understand the magnitude of impact of impervious surfaces and stormwater runoff in the most developed watersheds.

Strategic Action 6.3.1: Map Impervious Surfaces & Stormwater Network
Map current data on impervious surfaces and relationships with water bodies. By 2015, replace existing impervious surface data with available updates and apply to ongoing prioritization models.

Strategic Action 6.3.2: Map Stormwater Drainage Network
Map and identify stormwater drainage network that includes pipes and ditches. Map accumulations of stormwater runoff in streams.

Strategic Action 6.3.3: 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 6.3.4: Assess and Improve Current Regulatory Effectiveness
Assess adequacy of current APDES permitting under ADEC and adequacy of ADEC permit enforcement and water quality monitoring. If inadequate, seek funds to assist ADEC with monitoring of water quality.

Strategic Action 6.3.5: 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.

7. Aquatic Invasive Species

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 (ADF&G 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 (ADF&G 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 (ADF&G 2006b).

In 2006 the Alaska Department of Fish and Game (ADF&G) released a *Management Plan for Invasive Northern Pike in Alaska* (ADF&G 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. ADF&G has identified outreach and education, building partnerships, interagency coordination, research investigations, and pathway analyses as methods to achieve these objectives. Since the completion of the Partnership's 2008 plan, a range of projects have been implemented including public outreach, detection surveys and suppression projects[26].

In addition to northern pike, invasive reed canarygrass (*Phalaris arundinacea*) is found in an increasing number of riparian wetlands habitats in the Mat-Su Basin. While the invasive submerged aquatic plant *Elodea* has not been documented in the Mat-Su Basin, it is expected that it could arrive here easily with floatplanes and motor boats.

In an effort to reduce the potential introduction and spread of invasive organisms throughout Alaska, the Alaska Board of Fisheries implemented a ban on wadding footgear with absorbent felt soles that went into effect January 1, 2012. Subsequently, the Board of Game adopted a similar regulation for waterfowl hunters.

The overall goal is that no new Aquatic Invasive Species (AIS) will be introduced or become established in the Mat-Su Basin. Existing populations of northern pike and reed canarygrass will be contained to their current distributions, and impacts of these infestations on salmon and salmon habitat will be minimized.

Overall Aquatic Invasives Goal: To prevent the introduction or establishment of any new Aquatic Invasive Species

Objective7.1: Prevention
By 2016, identify potential vectors for introducing or spreading AIS in the Mat-Su and conduct outreach to inform and influence target audiences so that their activities do not introduce or spread AIS.

Strategic Action 7.1.1 Pathways Analysis
Work with state, federal, and local partners and user groups to develop a comprehensive analysis of current and potential invasion pathways for invasive species.

Strategic Action 7.1.2 In-reach to Agencies
Develop a collaborative program for implementation of BMPs for agency field staff; Distribute identification/informational materials to agencies and conduct training on AIS identification and prevention measures.

Strategic Action 7.1.3 Outreach to Public
Identify target audiences for priority species; Develop and implement outreach plan for all target audiences. This should include education and outreach efforts to increase public awareness of the problems and impacts of AIS and what can be done to limit their spread.

---

[26] A summary of the ongoing northern pike suppression efforts in the Alexander Creek drainage is available at http://www.adfg.alaska.gov/index.cfm?adfg=invasivepike.main.

Strategic Action 7.1.4 Prohibit Sales and Transport
Support regulatory efforts to prohibit the sale and transport of AIS.

Objective 7.2: Early Detection and Surveillance
By 2015, periodic surveillance surveys designed to have a high likelihood of detecting AIS at an incipient stage of infestation will be completed at priority waterbodies. Priorities are determined based on level of risk for introduction of AIS.

Strategic Action 7.2.1 Priorities
Prioritize water bodies for AIS surveillance based on risk of introduction of AIS.

Strategic Action 7.2.2 Cooperative Survey Program
Develop and implement survey program between ADF&G, ADNR, and other partners in high risk water bodies identified in 7.2.1

Strategic Action 7.2.3 Watch List for the Mat-Su
Compile a watch list of potential new invasive species and those currently infesting the Mat-Su Basin.

Strategic Action 7.2.4 Technology for Detection
Support the development of new technologies for the rapid detection of invasive species (e.g., eDNA methods).

Objective 7.3: Rapid Response
By 2015, procedures are in place to respond rapidly to any newly discovered introductions or to newly detected expansion of existing AIS.

Strategic Action 7.3.1 Rapid Response Plan
Develop a rapid response plan that specifies roles and responsibilities for addressing new detections of AIS. This will include critical interim measures to achieve containment while a longer-term eradication strategy is developed.

Strategic Action 7.3.2 Rapid Reporting
Support the establishment of a system for rapid reporting and species confirmation of AIS.

Objective 7.4: Control
By 2015, an effective program of integrated pest management for invasive species is developed and implemented, including elements of containment, eradication, control, and restoration.

Strategic Action 7.4.1 Implement Control Actions
Implement control actions on high priority invasive species using the best available technology and practices.

Strategic Action 7.4.2 Control Methods and BMPs
Support research on most effective and efficient control methods and best management practices and encourage sharing of successes and failures.

Strategic Action 7.4.3 Rapid Response Funding
Support the establishment of a statewide rapid response fund to ensure adequate resources are available to quickly respond to new infestations of AIS.

8. Large-scale Resource Development

Proposed large-sale resource development projects have the potential to change the hydrologic regime, including flow, sediment transport, and water quality, which can cause many direct and indirect effects to salmon and their habitats. The proposed coal mines and hydroelectric project differ in many ways, including permitting and licensing processes, yet have this flow regime change in common. The Partnership sees its roles in these processes as three-fold: 1) helping the public to understand the potential impacts to salmon habitats; 2) aiding the agencies in analyzing and understanding the data available; and 3) filling in data gaps and providing analytical tools related to these projects.

Three coal mines are proposed in the Matanuska River watershed -- the Wishbone Hill, Jonesville and Chickaloon coal mines. These mines have the potential to alter the surface and groundwaters of some anadromous rivers in the watershed, including the Matanuska River. The Wishbone Hill Coal Mine is near Buffalo Creek and Moose Creek, the Jonesville Coal Mine is near Eska Creek, and the Chickaloon Coal Mine is near Kings River and Chickaloon River. The combined lease area of these three coal mines encompasses approximately 20,000 acres of mostly undeveloped forest lands, including riparian habitats and wetlands.

The state of Alaska is proposing a large hydropower project on the upper Susitna River. This is not the first time that a large hydropower project has been proposed for the Susitna River. In the 1950s the U.S. Bureau of Reclamation studied the hydroelectric potential of the Susitna River; these investigations were revived in the late 1970s by the U.S. Army Corp of Engineers. In the 1980s the state pursued a license for a two-dam project on the Susitna River; the state withdrew their Federal Energy Regulatory Commission (FERC) licensing application when oil prices declined in the 1980s. In 2008 the Alaska Energy Authority (AEA) was authorized to reevaluate a project on the Susitna River and began the licensing process in early 2012 for the proposed Susitna-Watana Hydroelectric Project (AEA 2013). The proposed project consists of a 735 foot tall dam located approximately 184 river miles upstream of Cook Inlet and would create a 42 mile long reservoir. The proposed operation of this project (i.e. load-following operation) would result in river flows that are different seasonally than the natural flows.

Currently AEA is in the study phase of the licensing process, working with stakeholders to study the baseline conditions of the Susitna River and to develop frameworks to assess the potential project changes to the flow and sediment regimes and how those changes will affect salmon and their habitats. The studies will be used by FERC to make a license determination, and by stakeholders to influence the project through protection, mitigation, and enhancement recommendations. Both NMFS and USFWS have mandatory conditioning authority under the Federal Power Act to prescribe fish passage at the dam.

Large projects are often the impetus for large data collection efforts in Alaska. Like much of Alaska, data about fish and wildlife and their habitats, and how people rely upon those resources, is non-existent or decades old in the Mat-Su. The coal mining projects and the hydropower project are including data collected in the 1980s to develop their permits and license applications for similar projects. The relevancy and appropriateness of these decades-old data may be compromised by changes in existing conditions due to other development, settlement, or climate change, or data collection methods may be outdated and newer methods and technology would provide better information for project design, permitting, and operation.

Overall Large-scale Resource Development Goal: To provide information and analysis to aid in understanding the potential impacts to salmon habitat from large-scale resource development projects.

Objective 8.1: Education and Outreach about Large-scale Resource Projects
By 2017, the public will have access to information about proposed large-scale resource development projects and their potential to affect salmon and their habitats.

Strategic Action 8.1.1: Large Project Workshops
Provide public workshops and meetings to present information about large projects, permitting processes, and ongoing studies. These workshops would address what is being proposed, how it is being studied, and what are the potential threats to salmon and their habitats. Meetings could be oriented around particular user groups (e.g. fishermen) or scientific information (e.g. basic hydrologic and ecological processes).

Strategic Action 8.1.2: Participation in Licensing/Permitting Process
Provide information about public participation in the licensing and permitting processes through workshops and online resources.

Objective 8.2: Agency Assistance for Large-scale Resource Projects
By 2017, state and federal agencies and stakeholders involved in permitting processes for large-scale resource development projects have the data, analytical tools, and expertise that they need to understand the potential to affect salmon and their habitat.

Strategic Action 8.2.1: Large-scale Resource Specific Sessions at the Mat-Su Salmon Symposium
The symposium is an ideal platform to discuss the ongoing study of large-scale resource development projects and what they mean to fish and their habitats. The project specific sessions would provide the partners, public, and project proponents an opportunity to discuss the project and salmon-related concerns.

Strategic Action 8.2.2: Tools to Understand Potential Impacts
Provide training on decision support tools and methods for assessing potential impacts from large resource development projects to salmon and their habitat.

Objective 8.3: Address Data Gaps
By 2017, data gaps for large-scale resource development projects will be identified and filled as feasible for the licensing and permitting processes.

Strategic Action 8.3.1: Hydrologic Data Collection
For large-scale resource development projects that will alter the hydrologic regime, support partners in filling data gaps by collecting stream flow, water level, or water quality measurements.

9. 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 either a water right or a temporary authorization.[27] A water right allows a specific amount of water from a specific water source to be diverted, impounded, or withdrawn for a beneficial use. A reservation of water, also a water right, may be obtained for water to remain instream, that is, not to be removed for consumptive or non-consumptive use. A reservation of water can be obtained 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. Seniority of water rights, including reservations of water, is based on the prior appropriation doctrine, whereby rights acquired first in time have priority use.

Water rights are administered by the Alaska Department of Natural Resources (ADNR). In most cases, water withdrawals in streams designated as anadromous will also require a fish habitat permit from ADF&G and may be subject to other permits depending on land status. ADNR encourages but does not require the application of permits or water rights for all other groundwater and surface withdrawals including residential wells. ADNR maintains a well log database called the Well Log Tracking System (WELTS)[28]. Logs typically include well construction (including pumping capacity) and borehole lithology data. Well logs are required in water rights applications, but not all well logs are associated with a water rights application and submittal of well logs may not be complete.

Water rights associated with wells include well depth or waterbody, type of water use, water quantity, period of water use, water right priority date, and location. 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

[27] A temporary water use permit can be obtained, which is not a water right but an authorization to use the specified amount of water for up to 5 years. Typically, ADNR issues a temporary permit first, then adjudicates it to a certified water right after five years.
[28] http://dnr.alaska.gov/mlw/welts

protection. Additionally, U.S. Geological Survey (USGS) has a well log database and maintains groundwater data (e.g. groundwater levels, groundwater quality, borehole lithology/well construction) in the National Water Information System (NWIS). In 2013, USGS and ADNR completed a four-year cooperative study of groundwater resources in the Mat-Su Basin (Kikuchi 2013). Further study of groundwater resources in the Mat-Su Basin could address issues not resolved by previous investigations; for example, quantifying groundwater discharge to Knik Arm.

ADNR also adjudicates[29] applications for reservations of water, which may be applied for by government agencies, other organizations, and private individuals. Water that is not reserved for instream flows first, is subject to allocation for other uses. The adjudication process involves public notice and public interest findings. In the Mat-Su Basin, reservations of water have been filed for twenty-two reaches in nineteen streams. These filings have been made by various entities, but the majority by ADF&G. Of these, seven of the reaches in six streams have been adjudicated. Since the inception of the Partnership, three applications have been submitted to ADNR on three priority waterbodies (Wasilla, Montana and Moose Creeks).

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. In the Mat-Su Basin, USGS maintains continuous gages on seven streams (compared to an average of 61 gages in a similar size area in the lower 48 states), collects continuous groundwater-level data at five wells, and operates lake stage monitoring stations on nine lakes. 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. This study (Moran and Solin 2006) developed a water-table map, similar to the previous work of Jokela and others (1991). This study also included groundwater quality sampling for major ion chemistry, nutrients, and stable isotopes of water. Previous to the 2006 study, groundwater quality data was collected throughout the Cook Inlet Basin as part of the National Water-Quality Assessment (NAWQA), including analysis for major ion chemistry, stable isotopes of water, groundwater age tracers, pesticides, and volatile organic compounds.

The relationship between groundwater and surface water, including wetlands, has not been extensively documented in the Mat-Su Basin. However, efforts are being made in that area. Recent and ongoing studies have investigated the relationship between groundwater and surface water in the Knik-Palmer-Wasilla core area; (Kikuchi, et al 2012, Kikuchi 2013). Ongoing USFWS studies have looked at salmon habitat use in relation to groundwater seeps and springs in the Big Lake watershed. The USGS investigated salmon use of clear side-channels in the glacial Matanuska River for spawning; the source water for these side-channels is often springs in the braid plain (Curran et al. 2011). An increased density of monitoring wells, especially in areas of population growth, near hydraulically connected surface water bodies or wetlands, would facilitate understanding ground-surface interaction.

[29] Administrative determination of the validity and amount of a water right includes the settlement of conflicting claims among competing appropriators of record under 11 AAC 93.970 (1).

Predictive simulation of how groundwater pumping might affect surface water resources will likely require some refinement and enhancement to the existing regional steady-state groundwater flow model. The recently published groundwater study (Kikuchi 2013) does not undertake any kind of scenario analysis. However, the groundwater flow model developed in that study could provide a basis for future scenario analysis (i.e. hydrologic effects of increased groundwater withdrawal to meet human demand) and options for well location to minimize impacts on surface water bodies while still supplying water to human communities (e.g. Barlow and Dickerman, 2001).

Overall Water Flow Goal: To protect the stream flows that support salmon at all life stages.

Objective 9.1: Instream Flow on Anadromous Waters
By 2020, partner organizations have filed applications for reservations of water with ADNR to preserve the flow regimes of priority anadromous lakes and streams.

Strategic Action 9.1.1: Prioritize Anadromous Streams and Lakes
Prioritize anadromous streams and lakes for reservations of water based on importance to salmon and vulnerability by 2016 and create a report documenting existing reservations, applications and remaining waters to be evaluated and applied for.

Strategic Action 9.1.2: Mat-Su Basin Water Reservation Protection Program
Continue to develop a cooperative program to implement a cost-effective water reservation protection program.

Strategic Action 9.1.3: File for Reservations of Water
File for reservations of water on priority anadromous lakes and stream reaches.

Strategic Action 9.1.4: 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).

Strategic Action 9.1.5: Conserve Lands that Maintain Stream Flow
Work with willing landowners to conserve lands along headwater streams, aquifer recharge areas and other hydrologically important areas through conservation easements and fee acquisition.

Objective 9.2: Community Water Needs Study
By 2020, 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 9.2.1: 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.

10. 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 and a bridge to span Knik Arm. Additionally, the state is in the process of obtaining a license for a large hydropower project on the Susitna River, requiring study of dramatic changes to the flow regime and potentially the form and function of the Susitna River estuary.[30] Offshore gold mines near Anchor Point are proposed, as is an alternative energy project 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, Federal Power Act), the USFWS and NOAA Fisheries comment and consult on federal permits and licenses.

Prior to the elimination of the Alaska Coastal Management Program[31] coastal projects underwent a consistent review process by local, state and federal agencies. Although the Mat-Su Borough's Coastal Zone Management Program no longer exists, non-governmental organizations (e.g. Cook Inletkeeper and Cook Inlet Regional Citizens Advisory Council) continue to monitor coastal development.

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) included 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 had addressed the upper part of Cook Inlet.

On October 22, 2008, National Marine Fisheries Service (NMFS) listed the Cook Inlet beluga whale distinct population segment as an endangered species under the Endangered Species Act. The listing of Cook Inlet beluga whales as endangered required that critical habitat be

---

[30] For more information on the Susitna-Watana Hydroelectric Project, see Section *8 Large-scale Resource Development* in this chapter.
[31] The Alaska Coastal Management Program existed in 2008 when the plan was first written.

designated. In designating critical habitat, NMFS had to consider physical and biological features essential to the conservation of the species that may require special management. NMFS identified five essential features and designated two areas of Cook Inlet as critical habitat. The features identified as essential for the conservation of the beluga whales include:

1. intertidal and subtidal waters of Cook Inlet with depths less than 30 feet and within 5 miles of high and medium flow anadromous fish streams (which includes some of the Mat-Su Borough);
2. primary prey species consisting of four species of Pacific salmon (Chinook, sockeye, chum, and Coho), Pacific eulachon, Pacific cod, walleye pollock, saffron cod, and yellowfin sole;
3. waters free of toxins or other agents of a type and amount harmful to Cook Inlet beluga whales;
4. unrestricted passage within or between the critical habitat areas; and
5. waters with in-water noise below levels resulting in the abandonment of critical habitat areas by Cook Inlet beluga whales

Two areas were excluded from the critical habitat designation given their interest to national security: 1) all property and overlying waters of Joint Base Elmendorf-Richardson between Mean Higher High Water and Mean High Water, and 2) waters off the Port of Anchorage and Point MacKenzie. In addition to making it illegal to "take" (as defined by the ESA) a beluga whale without prior authorization, the ESA listing also requires all Federal agencies to consult with NMFS to ensure their actions do not jeopardize the continued existence of the beluga whales or adversely modify or destroy their designated critical habitat.

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 (ADF&G)[32].

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. Houghton et al. (2005) found that both juvenile Chinook and Coho salmon were caught more often in near shore

[32] www.coastalaska.net

environments of Knik Arm rather than in open water, suggesting that the juveniles remain along the shorelines (2005). Juvenile Chinook and Coho salmon that were relatively larger appear to remain in the Knik Arm longer and prefer the near shore environment. Houghton et al. (2005) also suggests that sockeye salmon may remain longer in the Knik Arm to feed. 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). Two bibliographies have been compiled on anadromous fish studies within Knik Arm (USFWS, 2010; ARRI, 2012). Additionally, an integrated research plan has been created to move research of salmon use and ecology forward (HDR, 2010). This plan identified key research questions, prioritized them and developed an integrated research framework of five separate studies that together would significantly improve the understanding of salmon ecology in Knik Arm.

The 2008 plan also identified conservation of estuaries for salmon as an objective, including identification of high priority estuaries. The Great Land Trust has worked with private and public landowners to conserve land at high priority estuaries along the Knik Arm, including Eklutna River; Knik/Matanuska River; Spring Creek, Wasilla Creek, Rabbit Slough, Cottonwood Creek, O'Brien Creek, and Goose Creek.

Also since the 2008 plan, the Kenai Peninsula Fish Habitat Partnership has formed and has conservation goals for Cook Inlet that complement those of the Mat-Su Salmon Partnership. The two partnerships will be most effective in working together on issues that affect fish habitat in Cook Inlet.

Overall Estuaries Goal: To ensure that all estuarine and nearshore habitats that provide priority salmon habitat are safeguarded during development in Cook Inlet.

Objective 10.1: Salmon Ecology of Cook Inlet
By 2018, implement the Knik Arm Salmon Ecology Integrated Research Plan (HDR, 2010) to significantly improve the understanding of salmon ecology in Knik Arm.

Strategic Action 10.1.1: Identify and Map Habitat Types
Identify habitat types in Cook Inlet and map with Shorezone, ESI or additional survey.

Strategic Action 10.1.2: Create a Comprehensive Classification and Map ofSsalmon Habitat Types in Knik Arm
An interagency committee will develop and a map a classification scheme, resulting in a geodatabase with fisheries information from Actions 10.1.3 and 10.1.4 linked to specific habitats, creating a spatial framework for further ecological studies.

Strategic Action 10.1.3: Investigate Salmon Habitat Use
Develop comprehensive investigation plans and implement them to collect fisheries relative abundance and life history data. This information would be collected through a

variety of techniques with broad field seasons, enabling stratification by species, habitat type and time.

Strategic Action 10.1.4: Analyze Juvenile Salmon in the Estuarine Environment
Laboratory techniques would be employed to investigate diet, energetics, otolith micro-structure and genetics to address life history questions about the utilization of the Knik Arm estuary.

Strategic Action 10.1.5: Analyze the Effects of Manmade Structures and Pollutants on Salmon
Identify current and potential future development of manmade structures in Knik Arm and what would be needed to analyze their effects to the nearshore environment, and their analysis. Water quality effects from storm water and waste water discharge would also be compiled and analyzed.

Objective 10.2: Conserve Estuaries for Salmon
By 2018, assure no long-term impairments of vulnerable coastal habitats from incompatible shoreline developments.

Strategic Action 10.2.1: Assess Conservation Status of Estuaries throughout Knik Arm
Identify and prioritize estuarine lands in Knik Arm for conservation.

Strategic Action 10.2.2: Protect Priority Estuarine Habitats
Protect priority estuarine habitat in Knik Arm through acquisition, conservation easement, or other mechanism.

Strategic Action 10.2.3: Cook Inlet Collaboration
Work with Kenai Peninsula Fish Habitat Partnership, governments, NGOs, communities, fishing interests, University of Alaska, and industry interests to address Cook Inlet marine and coastal issues, including transportation infrastructure and energy development.

Strategic Action 10.2.4: Minimize Disruption of Nearshore Habitats
Minimize disruption of natural sediment erosion, deposition and transport processes in all nearshore sediment habitats by beach armoring, jetties and other infrastructure through avoidance, minimizing and mitigating measures. 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 10.2.5: 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.

11. Motorized Off-Road Recreation

The Mat-Su Basin is a popular recreational destination for off-highway vehicle (OHV) users in the state's largest city, Anchorage, and due to its limited road system, some remote property owners must use OHVs to access their properties. The need and desire to access remote places with OHV has led to the development of an extensive system of sanctioned and unsanctioned trails. Since the 1970s, advancements in the design, versatility, reliability, and affordability of OHVs have resulted in a steadily expanding number and variety of users accessing increasingly remote areas. Trail construction has not kept pace with this use so users have blazed their own routes as needed or desired. Additionally, some recreational users seek more difficult or extreme routes and obstacles to enhance their enjoyment of the sport, and streams, wetlands, and damage-produced mud holes can provide that.

Currently no database is available that maps existing OHV trails across the Mat-Su Basin. Mapping existing trails, and specifically where they cross streams, can be difficult as preferred routes regularly change due in part to annual flows and paths of streams. The USFWS and Chickaloon Village surveyed OHV trail crossings of streams and wetlands in the Knik Public Use Area in 2013 and its report assessing impacts to fish habitat was pending as this plan update was completed. In 2001-2002, ADF&G conducted aerial surveys of OHV trail stream crossings in the upper Susitna River drainage. Each crossing site was evaluated based on five criteria and assigned a ranking of 1-5, with 1 indicating the least disturbance and 5 indicating the greatest. The criteria were based on the presence of one or more of the following conditions: exposed soil, denuded stream bank, increased width-to-depth ratio, standing water on the approaching trail, and deteriorating stream bank. Of 150 total stream crossing sites surveyed, 61% ranked 3 or higher and 44% ranked 4 or higher. The most commonly observed impacts were exposed soil at the crossing and bank alteration.

ADF&G has statutory responsibility for protecting freshwater anadromous fish habitat (AS 16.05. 871) and may require a fish habitat permit for activities conducted below the ordinary high water mark of an anadromous stream. ADF&G considers non-permitted anadromous stream crossings as closed but experiences difficulties and limitations enforcing this. State lands in general are open to OHV use, though certain State Park lands and Special Use Areas may have restrictions. For example, at Hatcher's Pass Recreational Area, certain areas are closed to motorized use seasonally.

Locally, regulations vary on OHV use. The Mat-Su Borough has no regulations related to OHV use on borough lands. City ordinances for OHV use differ. The city of Palmer does not allow OHV use within city limits. Conversely, the city of Wasilla does allow OHV use within city limits as long as the OHV is not driven on paved roads and must not exceed 10 mph on paths parallel to a paved road, the operator must be wearing a helmet, and the operator must be older than 15 years of age or accompanied by an adult.

Consequently, differing laws and regulations make enforcement difficult across the Mat-Su Borough. For an area the size of West Virginia, the state lacks sufficient manpower to monitor OHV activity and to enforce state laws across the borough. State regulations consider any violations in anadromous fish habitat to be criminal offenses. This severity can hamper law enforcement officers in dealing judiciously with the public and potential offenders.

Overall Off-road Recreation Goal: To minimize degradation of salmon habitat at trail intersections.

Objective 11.1: Impacts to Salmon and Salmon Habitat
By 2018, qualify the impacts to salmon and salmon habitat from OHV use regarding stream morphology and water quality to specifically determine physical damage to the stream and banks and hydrocarbon and sedimentation inputs to streams.

Strategic Action 11.1.1: Assess, inventory, and identify a minimum of 50% of the OHV trails within the Mat-Su Basin and identify intersections with critical fish habitat by winter of 2018.

Strategic Action 11.1.2: Assess current level of science for OHV trail impacts and fish habitat.

Strategic Action 11.1.3: Develop and implement a collaborative research plan.

Objective 11.2: Mitigate OHV Use at Streams
By 2018, establish effective and publicly acceptable mechanisms to support stream health near OHV trails and at stream crossings.

Strategic Action 11.2.1: Collaborate with OHV user groups to determine effective and publicly-acceptable mechanisms to mitigate or prevent damage to fish habitat from OHV use while providing attractive trail-riding opportunities.

Strategic Action 11.2.2: Identify and prioritize the most impacted crossings and work toward mitigation on 50% of those locations by 2018, including relocating those that can be moved to more appropriate areas or installing hardened or hard-wet crossings or bridges.

Strategic Action 11.2.3: Develop an OHV educational and outreach program in collaboration with OHV user groups. Messaging should include information about where to ride that has the least impact on salmon.

Strategic Action 11.2.3: Work with borough and land managers to coordinate trail management, signage, enforcement, and maintenance.

Strategic Action 11.2.4: Work with other trail managers and OHV user groups to re-route or re-build trails to avoid salmon habitat.

Strategic Action 11.2.5: Work with the Wildlife Troopers to patrol accessible unpermitted crossings and problem areas to issue citations to users who are crossing anadromous streams without a permit.

Strategic Action 11.2.6: Work to build support for a dedicated ADF&G "urban sprawl team" that focuses on educating user groups about salmon, habitat needs and lifecycle with a focus on regulations, mapping trails and appropriate stream crossings.

12. Wastewater Management

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-foot 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.

Within the Mat-Su Basin, only the cities of Palmer and Wasilla and the community of Talkeetna operate limited wastewater collection networks. All houses, commercial, and industrial buildings outside these city limits use on-site 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 were 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 Cook Inlet. 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 Mat-Su Borough created a Wastewater and Septage Advisory Board in 2012 to address the concept and citing of a regional septage facility.

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.

There are three permitted publically owned wastewater treatment facilities in the Mat-Su located in Palmer, Wasilla and Talkeetna. The Talkeetna facility was originally built in 1989 but underwent major improvements in 2003. The current treatment utilizes a series of settling ponds and a constructed wetlands for final polishing of the effluent before discharging to a slough of the Talkeetna River. This permitted facility is owned and operated by the Mat-Su Borough.

The wastewater treatment plant (WWTP) in Palmer began operation in 1972 as a single lagoon system. The facility's original NPDES permit was issued by EPA in 1976 and included secondary treatment requirements. In 1985 the lagoon system was expanded to two alternately operated lagoon systems ("ponds"). There have been several upgrades to the system over the years and in 2002 chlorine disinfection was replaced with an ultraviolet (UV) disinfection system. Sludge is periodically excavated from each of the ponds, amended with lime to raise the pH then mixed with top soil (EPA NPDES permit #AK-002249-7). The effluent discharges to the Matanuska River currently under an administratively extended NPDES permit from the EPA. The next permit cycle for the facility will be administered by the DEC through the APDES program currently scheduled for 2014.

The City of Wasilla wastewater treatment plant services a portion of the residential and business properties within city limits. The City of Wasilla's wastewater service uses a force-main collection system. Each service uses a septic tank and pump vault that are connected to the force-main system. The septic tank and pump vault are maintained by the City and used by approximately 800 service connections. The wastewater treatment plant consists of two aerated lagoons that receive wastewater from the force-main system, and an aerated digester to treat septage from each septic tank. The City pumps these septic tanks with a pumper truck on a regular basis and hauls the septage to the WW treatment plant. Pre-treatment equipment is provided that removes grit and debris from the septage prior to treatment in the aerated digester. The City maintains 9 acres of drainfield area to discharge of up to 400,000 gallons per day of treatment wastewater (City of Wasilla webpage). The WWTP has secondary treatment for septage and the discharge is subsurface at the facility. This facility currently operates under an administratively extended 1996 permit from the ADEC. Because of the subsurface discharge, high groundwater nitrates are of great concern.

Overall Wastewater Goal: To ensure that wastewater in the Mat-Su does not impact water quality of salmon habitat.

Objective 12.1: Improved Wastewater Disposal
By 2018, 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 12.1.1: 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 12.1.2: Map Septic Suitability
NRCS has identified areas that are poorly-suited to onsite systems and/or that are subject to existing ADEC regulations. Make NRCS soils information readily available to developers, realtors, the general public, and the Mat-Su Borough. Ideally this information will be available on a website with other information important for developing parcels.

Strategic Action 12.1.3: Educate the Public about Effective Septic Systems
Create a public outreach program about the proper installation and ongoing maintenance required for properly functioning on-site septic systems.

Objective 12.2: Expanded Wastewater Infrastructure
By 2018, Mat-Su Borough and its communities have a wastewater infrastructure and treatment facilities that can handle sewage discharges in the Mat-Su Borough.

Strategic Action 12.2.1: Support Improved Treatment of Wastewater Discharges
Provide technical assistance and other support to help local governments to develop improved sewage and wastewater treatment.

Objective 12.3 Wastewater Pollution Prevention
By 2018, quantify the extent and sources of possible wastewater pollution to surface and ground waters from on-site septic systems and wastewater discharge.

Strategic Action 12.3.1: Assess Human Sewage Pollution Impacts to Water Quality in the Core Area
Conduct a study to determine the number, age and location of on-site septic systems within the Knik-Palmer-Wasilla Core Area. Develop GIS map layers of results.

IX. Measures of Conservation Success

The overall success of the Mat-Su Salmon Partnership will be evaluated on the status of salmon and their habitat, accomplishment of objectives in this plan, and organizational development. The status of salmon stocks will rely somewhat upon the work of the Partnership, but will also be strongly related to factors beyond the Partnership's control, such as harvest and marine conditions. Some objectives will take many years to achieve, yet progress may be measurable on an annual basis. Progress on conservation objectives should be regularly monitored to assess the validity and effectiveness of the action. The Partnership should also be evolving into a more diverse, effective, and stable organization that people and decision makers in the Mat-Su seek out for conservation of salmon habitat. Annually, the Partnership will focus on a short list of measurements to track the status of salmon and the Partnership's success (Table 8). Tables 9 to 11 include additional measurements of salmon and habitat status, accomplishment of objectives, and organizational development.

Table 8. Annual Partnership Measurements
of stocks of concern
% of waters in Anadromous Waters Catalog
% of native vegetation within riparian corridors
acres of land with long-term protective status
of waterbodies not meeting ADEC water quality standards
% of impervious surfaces in developed areas
% of riparian habitats with long-term protective status
% of riparian habitats restored
% of wetlands with long-term protective status
of gages on waterbodies
of reservations of water
miles of habitat restored for fish movement
of waterbodies with Northern pike
of waterbodies with invasive aquatic plants
of active, engaged partners
of Partnership supported projects
of people at annual Mat-Su Salmon Symposium

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. The partnership will monitor effectiveness of strategy implementation by monitoring indicators for target viability (Table 9) and the mitigation of potential threats (Table 10). Index watersheds will provide an opportunity for finer scale monitoring at some locations, and the annual indicators may be revised based on studies within index watersheds.

Table 9. Viability Monitoring

Ecological Attribute	Indicator
Status of Pacific salmon stocks	• Maintenance of Alaska Department of Fish and Game (ADF&G) escapement goals & sustainable yield of wild salmon • Number of stocks of concern in the Mat-Su Basin
Salmon Habitat	• Percent of streams, lakes, and wetlands included in the state's Anadromous Waters Catalog with lifestage information • Map of salmon habitat by species and lifestage based on model of known habitat associations • Map of salmon use in Knik Arm
Connectivity between habitats for different life stages of Pacific salmon	• Percent of spawning & rearing habitat accessible
Hydrological regime	• Magnitude and timing of annual peak flows • Seasonal and long-term flow characteristics • Freshwater input to Cook Inlet
Riparian integrity	• Percent of native vegetation within riparian corridors along stream and lake shorelines
Size & extent of native communities	• Acres of land protected through conservation easements or transfer to state conservation unit • 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 10. Threat Monitoring

Ecological Attribute or Potential Threat	Indicator
Water Quality	• Number of waterbodies not meeting ADEC water quality standards, including water temperature, for freshwater aquatic life • 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, including water temperature
Stormwater Pollution and Impervious Surfaces	• Percent of impervious surfaces in Lowland East and Lake Complexes • Institution of local mechanisms to protect water quality from stormwater runoff
Priority riparian habitats	• Map of riparian areas important for salmon • Percent of priority riparian habitats with long-term protective status • Percent of priority riparian habitats restored • Existence of effective local ordinances that protect riparian habitats on public and private lands
Wetlands important for salmon	• Map of wetlands with functional importance to salmon • Percent of wetlands important to salmon with long-term protective status
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 • Number of TWUP/Water Rights or Title 16 Fish Habitat applications for surface and ground water withdrawals • Assessment of community water needs

Table 10. Threat Monitoring	
Ecological Attribute or Potential Threat	**Indicator**
Fish Passage	• Miles of habitat restored for instream fish movement • Percent of stream crossings surveyed and assessed for fish passage database • Percent of 'Red' and 'Gray' culverts replaced • Agreements and plans between local, state, and federal agencies for transportation and fish passage
Aquatic Invasive Species	• Number of waterbodies with Northern pike • Number of waterbodies with invasive aquatic plants
Estuaries	• Percent of priority estuarine habitats with long-term protective status
Wastewater Management	• Percent of Mat-Su Basin residences and businesses on community septic systems or municipal wastewater systems
Climate Change	• Existence of a stream temperature monitoring program
Large-scale Resource Development	• Number of workshops and trainings to educate stakeholders in permitting processes
Motorized Off-road Recreation	• Effective mechanisms to minimize degradation of salmon habitat from OHV use

In addition to tracking overall Partnership success, individual partner projects will be monitored to ensure that limited funds are being put to the best use. The partnership requests project proposals annually for NFHP funds that it receives. Funded projects must address the objectives of this plan and demonstrate a measurable and effective benefit to salmon habitat. The Partnership seeks projects that can be completed as designed, have measureable results that can be used to inform other actions, and increase social awareness about the conservation of salmon habitat. Leveraging of NFHP funds with other funding is also desirable. While the monitoring and evaluation component will vary by project type, standard project measures are identified in Appendix 12.

The Partnership also needs to measure progress toward its organizational goals to ensure that it continues to develop into an organizational with the capacity to implement this strategic action plan. Those indicators are listed in Table 11.

Table 11. Partnership Success

Partnership Attributes	Indicator
Governance	• Active committees with clear roles and responsibilities
Membership	• Number of active, engaged partners • Number of partners from non-profit, fishing, and business communities
Staff	• Full-time Partnership coordinator
Financial Management	• Annual budget approved by Steering Committee • Sustainable funding for staff and activities • Number of Partnership supported projects • Leveraging of project funds with non-NFHP sources
Outreach and Communications	• Number of government staff and elected officials contacted • Number of public presentations and news media coverage • Number of people at annual symposium

X. The Future for the Mat-Su Salmon Partnership

The Mat-Su Salmon Partnership developed its first Strategic Action Plan in 2008 and updated the plan in 2013 in an effort 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 addresses 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 V).
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 VI) 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 VII) 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 VIII) are identified for these threats and stresses. Throughout the planning process, lack of information and data led to priorities for research and monitoring, and the plan makes includes these needs in the overarching Science Strategies.
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 Partnership (NFHP). A major function of the Mat-Su Salmon Partnership has been to provide a forum to present and evaluate conservation actions, as well as to make recommendations for future funding under NFHP.

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

ADF&G

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, smelts, lampreys, and whitefishes. 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 infrastructure 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; now known as the National Fish Habitat Partnership

NFHB

National Fish Habitat Board

NFHP

National Fish Habitat Partnership

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.

Personal Use
In Alaska, "Personal use" is a legally defined regulatory category of fishery. It is defined as "the taking, fishing for, or possession of finfish, shellfish, or other fishery resources, by Alaska residents for personal use and not for sale or barter, with gill or dip net, seine, fish wheel, long line, or other means defined by the Board of Fisheries". From http://www.adfg.alaska.gov/index.cfm?adfg=fishingPersonalUse.main.

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.

Stocks of Concern
The Policy for the Management of Sustainable Salmon Fisheries (SSFP; 5 AAC 39.222) directs the Alaska Department of Fish and Game (ADF&G) to provide the Alaska Board of Fisheries with reports on the status of salmon stocks and identify any salmon stock that present a concern. The SSFP defines three levels of concern (Yield, Management, and Conservation) with yield being the lowest level of concern and conservation the highest level of concern.

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.

Subsistence
Subsistence uses of wild resources are defined as 'noncommercial, customary and traditional uses' for a variety of purposes. Under Alaska’s subsistence statute, the Alaska Board of Fisheries must identify fish stocks that support subsistence fisheries and, if there is a harvestable surplus of these stocks, adopt regulations that provide reasonable opportunities for these subsistence uses to take place. Whenever it is necessary to restrict harvests, subsistence fisheries have a preference over other uses of the stock.

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.

References and Cited Literature

Abookire, A.A., Piatt, J.F., 2005. Oceanic conditions structure forage fishes into lipid-rich and lipid-poor communities in Lower Cook Inlet, Alaska. Marine Ecology Progress Series Vol. 287, p. 229-240.

Ahlstrand, G.M. & C.H. Racine, 1990. Response of an Alaskan shrub-tussock community to selected all-terrain vehicle use. Natural Resources Management Report AR-19. National Park Service, Alaska Region.

Alaska Department of Environmental Conservation (ADEC). 2007. Alaska Clean Water Actions. Available: http://www.dec.state.ak.us/water/acwa/acwa_index.htm.

Alaska Department of Environmental Conservation (ADEC). 2012. Alaska's DRAFT 2012 Integrated Water Quality Monitoring and Assessment Report. Available: http://www.dec.state.ak.us/water/wqsar/waterbody/docs/2012finalIntegratedReport.pdf.

Alaska Department of Environmental Conservation. 2010. Integrated Water Quality and Assessment Report. Juneau, AK.

Alaska Department of Fish and Game. 1996. Off road vehicle and snowmachine use in Alaska: a report to the Alaska Board of Game. Alaska Department of Fish and Game, Division of Wildlife Conservation.

Alaska Department of Fish and Game (ADF&G). 2006. Matanuska-Susitna Valley & West Cook Inlet King Salmon. Northern Cook Inlet Recreational Fishing Series, Anchorage, Alaska. Available: http://www.sf.adfg.state.ak.us/region2/pdfpubs/matsu_king_salmon.pdf.

Alaska Department of Fish and Game (ADF&G). 2006b. Management Plan for Invasive Northern Pike in Alaska. Alaska Department of Fish and Game, Division of Sport Fish, Anchorage. 58 pp.

Alaska Department of Fish and Game (ADF&G). 2008. Susitna Sockeye Salmon Action Plan. Alaska Department of Fish and Game, Division of Sport Fish, Anchorage. 8 pp.

Alaska Department of Fish and Game (ADF&G) Chinook Salmon Research Team. 2013. Chinook salmon stock assessment and research plan, 2013.. Alaska Department of Fish and Game, Special Publication No. 13-01, Anchorage. 56 pp.

Alaska Department of Natural Resources (ADNR). 2008. Southeast Susitna Area Plan (Revising the entire Willow Sub-Basin Area Plan and a portion of the South Parks Highway Subregion of the Susitna Area Plan) Public Review Draft. January 2008. Alaska Department of Natural Resources, Anchorage, Alaska. Available: http://www.dnr.state.ak.us/mlw/planning/

Alaska Department of Natural Resources (ADNR). 1999. Cook Inlet Area wide Oil and Gas Lease Sale: Final Finding of Director. Alaska Department of Natural Resources, Division of Oil and Gas, Anchorage, Alaska. Available: http://www.dog.dnr.state.ak.us/oil/products/publications/cookinlet/cookinlet.htm#

Alaska Department of Natural Resources (ADNR). 1991. Report of Investigations 90-4: Ground-Water Resources of the Palmer-Big Lake Area, Alaska: A Conceptual Model. Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys, Anchorage, Alaska.

Alaska Energy Authority (AEA). 2013. Susitna-Watana Hydro Project Website. Retrieved April 20, 2013, from http://www.susitna-watanahydro.org

Alaska Regional Assessment Group (ARAG). 1999. The potential consequences of climate variability and change. The Center for Global Change and Arctic System Research: University of Alaska, Fairbanks, 42p.

Allen, B.M. and R.P. Angliss. 2013. Alaska marine mammal stock assessments, 2012. U.S. Dep. Commer., NOAA Tech. Memo. NMFSAFSC-245, 282 p. Available: http://www.nmfs.noaa.gov/pr/sars/pdf/ak2012.pdf

Angliss, R. P., and R. B. Outlaw. 2007. Alaska marine mammal stock assessments, 2006. U.S. Dep. Commer., NOAA Tech. Memo. NMFSAFSC-168, 244 p.

Assani, A. 2007. The Natural Flow Regime concept and the development of Potamology. Research Note No. 01/07. Laboratoire d'Hydro-climatologie et Geomorphologie Fluvial, UQTR, Trois-Rivieres. 25.

Barlow, P.M., and Dickerman, D.C. 2001. Numerical-simulation and conjunctive-management models of the Hunt-Annaquatucket-Pettaquamscutt stream-aquifer system, Rhode Island: U.S. Geological Survey Professional Paper 1636, 88 p.

Barlow, P.M., and Leake, S.A., 2012, Streamflow depletion by wells -- Understanding and managing the effects of groundwater pumping on streamflow: U.S. Geological Survey Circular 1376, 84 p.

Barrett, B. M., F. M. Thompson, and S. N. Wick. 1985. Adult Salmon Investigations: May-October 1984. Report No. 6, Alaska Department of Fish and Game, Commercial Fisheries Division, Anchorage, Alaska.

Bartholow, J.M. and J.A. Henriksen. 2006. Assessment of Factors limiting Klamatch River fall Chinook salmon production potential using historical flows and temperatures. US Geological Survey, Reston, VA. 111 p.

Beamish, R. J., and C. Mahnken. 2001. A critical size and period hypothesis to explain natural regulation of salmon abundance and the linkage to climate and climate change. Prog. Oceanogr. 49:423−437.

Beamish, R. J., C. Mahnken, and C. M. Neville. 2004. Evidence that reduced early marine growth is associated with lower marine survival of Coho salmon. Trans. Am. Fish. Soc. 133:26−33.

Brabets, T.P., G.L. Nelson, J.M. Dorava, and A.M. Milner. 1999. Water-quality assessment of the Cook Inlet Basin, Alaska – environmental setting. U.S. Geological Survey. Water-resources investigations report 99-4025. 66 p.

Broadhurst, G. 1998. Puget Sound Nearshore Habitat: A Summary of Current Threats and Obstacles: Puget Sound/Georgia Basin Environmental Report Series Number 7.

Cedarholm, C.J., D.B. Houston, D.L. Cole, and W.J. Scarlett. 1989. Fate of Coho salmon (Oncorhynchus kisutch) carcasses in spawning streams. Canadian Journal of Fisheries and Aquatic Science 46: 1347-1355.

Center for Watershed Protection (CWP). 2000. The Importance of Imperviousness. Watershed Protection Techniques 1(3): 100-111 in The Practice of Watershed Protection. Article 1. Center for Watershed Protection. 700 pp.

Cleary, P. M., R. A. Merizon, R. J. Yanusz, and D. J. Reed. 2013. Abundance and spawning distribution of Susitna River chum Oncorhynchus keta and Coho O. kisutch salmon, 2010. Alaska Department of Fish and Game, Fishery Data Series No. 13-05, Anchorage.

Cleary, P.M., R.J. Yanusz , N.J. Szarzi, J.E. Erickson, D. J. Reed, J.P. Bullock, and R.A. Neustal. *In prep.* Abundance and spawning distribution of Susitna River chum Onchorynchus keta and Coho O. kisutch, 2011. Alaska Department of Fish and Game, Fisheries Data Series, Anchorage.

Cleary, P.M., R.J. Yanusz , N.J. Szarzi, J.E. Erickson, D. J. Reed, and R.A. Neustal. *In Prep.* Abundance and spawning distribution of Susitna River chum Onchorynchus keta and Coho O. kisutch, 2012. Alaska Department of Fish and Game, Fisheries Data Series , Anchorage**.**

Cook Inlet Regional Planning Team (CIRPT). 2007. Cook Inlet Regional Salmon Enhancement Plan, Phase II 2006-2025. 504 pp.

Cook Inletkeeper. 2013. Stream Temperature Monitoring Network for Mat-Su Salmon Streams 2008 – 2012, Synthesis Report. Final project report for U.S. Fish and Wildlife Service (F12AC00712) and the Mat-Su Basin Salmon Habitat Partnership.

Curran, J.H., McTeague, M.L., Burril, S.E., and Zimmerman, C.E., 2011. Distribution, persistence, and hydrologic characteristics of salmon spawning habitats in Clearwater side channels of the Matanuska River, southcentral Alaska: U.S. Geological Survey Scientific Investigations Report 2011-5102, 38 p.

Davis, Jeffrey C., Gay A, Davis, and Laura Eldred. 2006. Montana Creek Ecological and Water Quality Assessment. Aquatic Restoration and Research Institute, Talkeetna, Alaska. 56 pp.

Davis, Jeffrey C. and Gay A, Davis. 2007. The Little Susitna River - An Ecological Assessment. Aquatic Restoration and Research Institute, Talkeetna, Alaska. 86 pp.

Davis, J.C., G.A. Davis, and L.R. Jensen. 2013. Matanuska-Susitna Stormwater Assessment: 2011-2012. Final Report for the Alaska Department of Environmental Conservation. Aquatic Restoration and Research Institute, Talkeetna, Alaska.

Day, J.W., Hall, C.A.S., Kemp, M.W., and Yanez-Arancibia, A. 1989. Estuarine Ecology. John Wiley and Sons, Inc.: Toronto, Canada.

Fair, L. F., T. M. Willette and J. W. Erickson. 2013. Review of salmon escapement goals in Upper Cook Inlet, Alaska, 2013. Alaska Department of Fish and Game, Fishery Manuscript Series No. 13-13, Anchorage.

Farley, E. V. Jr., J. H. Moss, and R. J. Beamish. 2007. A review of the critical size, critical period hypothesis for juvenile Pacific salmon. North Pacific Anadromous Fish Commission Bulletin 4:311–317.

Farley, E.V., A. Starovoytov, S. Naydenko, R. Heintz, C. Guthrie, L. Eisner, and J.R. Guyon. 2011. Implications of a warming eastern Bering Sea for Bristol Bay sockeye salmon. ICES J. Mar. Sci. (2011) first published online April 13, 2011.

Fox, J., and P. Shields. 2005. Upper Cook Inlet commercial fisheries annual management report, 2004. Alaska Department of Fish and Game, Report to the Board of Fisheries, 2005, Anchorage. Available: http://www.cf.adfg.state.ak.us/region2/pubs/bof/uci_2004_amr_bof.pdf

Freeman, M.W. and J Durst, Ed. 2004. Region II Forest Resources and Practices Riparian Management Annotated Bibliography. Report to the Alaska Board of Forestry. Alaska Department of Natural Resources, Division of Forestry and Office of Habitat Management and Permitting, Anchorage, Alaska.

Fried, Neal. 2007. Economic and Demographic Changes in the Fastest Growing Place in Alaska – The Mat-Su Borough. Unpublished presentation. Alaska Dept. of Labor and Workforce Development, Anchorage, AK.

Fried, Neal. 2013. Some Alaska and MatSu Labor Market and Economic Indicators. Unpublished presentation to the Mat-Su Borough Assembly, March 19, 2013. Alaska Dept. of Labor and Workforce Development, Anchorage, AK.

Gelfenbaum, G., T. Mumford, J. Brennan, H. Case, M. Dethier, K. Fresh, F. Goetz, M. van Heeswijk, T.M., Leschine, M. Logsdon, D. Myers, J. Newton, H. Shipman, C.A. Simenstad, C. Tanner, and D. Woodson, 2006. Coastal Habitats in Puget Sound: A research plan in support of the Puget Sound Nearshore Partnership. Puget Sound Nearshore Partnership Report No. 2006-1. Published by the U.S. Geological Survey, Seattle, Washington. Available: http://pugetsoundnearshore.org.

Gerken J. and S. Sethi. 2013. Juvenile Coho Salmon Migration and Habitat Use in Meadow Creek, Southcentral Alaska, 2011. Alaska Fisheries Data Series Number 2013-1. Published by US Fish and Wildlife Service, Anchorage, Alaska. Available: http://www.fws.gov/alaska/fisheries/fish/Data_Series/d_2013_1.pdf

Glass, R.L. 2001. Ground-water quality in the Cook Inlet Basin, Alaska, 1999: U.S. Geological Survey Water-Resources Investigations Report 01-4208, 58 p.

Glass, R.L, T.P. Brabets, S.A. Frenzel, M.S. Whitman, and R.T. Ourso. 2004. Water Quality in the Cook Inlet Basin Alaska, 1998 – 2001. U.S. Geological Survey, Reston, Virginia.

Gomi, T., R. C. Sidle, and J. S. Richardson. 2002. Understanding processes and downstream linkages of headwater streams. BioScience 52:905-916.

Gracz, M. 2013. Cook Inlet Wetlands. Kenai Watershed Forum, Kenai, Alaska. Available: http://cookinletwetlands.info.

Groot, C. and Margolis, L. 1991. Pacific Salmon Life Histories. University of British Columbia Press, Vancouver, Canada.

Hall, Jonathan V. 2001. Status and Trends of Wetlands in the Palmer/Wasilla Area, Alaska (1978 to 1996). U.S Fish and Wildlife Service, Ecological Services Office, Anchorage, AK.

Happe, P.J., K.E. Shea & W.M. Loya, 1998. Assessment of all-terrain vehicle (ATV) impacts: within Wrangell-St. Elias National Park and Preserve, Alaska. Unpublished Wrangell-St. Elias National Park and Preserve Research and Resource Management Report No. 98-1. Copper Center, AK: U.S. Department of the Interior, Wrangell-St. Elias National Park and Preserve.

Hasbrouck, J. J., and J. A. Edmundson. 2007. Escapement goals for salmon stocks in Upper Cook Inlet, Alaska: report to the Alaska Board of Fisheries, January 2005. Alaska Department of Fish and Game, Special Publication No. 07-10, Anchorage. Available: http://www.sf.adfg.state.ak.us/FedAidPDFs/sp07-10.pdf

HDR, 2010. Knik Arm Salmon Ecology Integrated Research Plan, prepared for U.S. Fish and Wildlife Service, Conservation Planning Assistance.

Healy, M. C. 1991. Life history of chinook salmon. Pages 311-393 *in* C. Groot and L. Margolis, editors. Pacific salmon life histories. University of British Columbia Press, Vancouver, British Columbia.

Henriksen, J.A, J. Heasley, J.G. Kennen, and S. Nieswand. 2006. Users' manual for the Hydro-ecological Integrity Assessment Process software (including the New Jersey Assessment Tools): U.S. Geological Survey Open-File Report 2006-1093. 72 pp.

Houghton, J., Starkes, M. Chambers, and D. Ormerod. 2005. 2004-2005 marine fish and benthos studies-Port of Anchorage, Anchorage, Alaska. Report prepared by Pentec Environmental, Edmonds, WA, for Integrated Concepts and Research Corporation.

Inskip, P. D. 1982. Habitat suitability index model: northern pike. U.S. Dept. Int., Fish and Wildlife Service, FWS/OBS-82/10.17. 40 pp.

Johannessen, J. W. 2001. Soft Shore Protection as an Alternative to Bulkheads, Projects and Monitoring. Proceedings of Puget Sound Research.

Johnson, J. and E. Weiss. 2007. Catalog of waters important for spawning, rearing, or migration of anadromous fishes – Southcentral Region, Effective June 1, 2007. Alaska Department of Fish and Game, Special Publication No. 07-05, Anchorage. Available: http://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?ADFG=data.AWCData.

Johnson, J. and M. Daigneault. 2013. Catalog of waters important for spawning, rearing, or migration of anadromous fishes – Southcentral Region, Effective July 1, 2013. Alaska Department of Fish and Game, Special Publication No. 13-08, Anchorage. Available: http://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?ADFG=data.AWCData.

Kennish, M.K., 1986. Ecology of Estuaries, Volume I, Physical and Chemical Aspects. CRC Press, Inc. Boca Raton, Florida.

Kikuchi, C.P., Ferre, T.P.A., and Welker, J.M. 2012. Spatially telescoping measurements for improved characterization of groundwater-surface water interactions: Journal of Hydrology, v. 446-447, p. 1-12.

Kikuchi, C.P. 2013. Shallow groundwater in the Matanuska-Susitna Valley, Alaska -- Conceptualization and simulation of flow: U.S. Geological Survey Scientific Investigations Report 2013-5049, 84 p.

Kyle, R.E. and T.B. Brabets. 2001. Water temperatures in streams in the Cook Inlet Basin, Alaska, and implications of climate change. US Geological Survey-Resources Investigation Report 01-4109.

Lafferty, R. R. Massengill, D. Bosch, and J. J. Hasbrouck. 2007. Stock status of Coho salmon in Upper Cook Inlet: Report to the Alaska Board of Fisheries, January 2005. Alaska Department of Fish and Game, Fishery Manuscript No. 07-01, Anchorage. Available: http://www.sf.adfg.state.ak.us/FedAidPDFs/fms07-01.pdf

Lamke, R.D., 1986, Alaska surface-water resources, in U.S. Geological Survey, National water summary 1985---Hydrologic events and surface-water resources: U.S. Geological Survey Water-Supply Paper 2300, p. 137-144.

Leask L, M. Killorin, and S. Martin. 2001. Trends in Alaska's People and Economy: Prepared for the Alaska 20/20 Partnership, Bringing Alaskans Together to Chart Our Future. Institute of Social and Economic Research, University of Alaska Anchorage. Available: http://www.iser.uaa.alaska.edu.

Linley, T., 2001. Influence of Short-Term Rearing on the Ocean Survival and Size at Return of Coho Salmon in Southeastern Alaska. North American Journal of Aquaculture, Vol 63, Issue 4, p. 306-311

Low, Greg. 2003. Landscape-Scale Conservation: A Practitioner's Guide. The Nature Conservancy, Arlington, VA.

Mahnken, C., E. Prentice, W. Waknitz, G. Monan, C. Sims, and J. Williams. 1982. The application of recent smoltification research to public hatchery releases: an assessment of size/time requirements for Columbia River hatchery Coho salmon (Oncorhynchus kisutch). Aquaculture 28:251–268.

Matanuska-Susitna Borough (MSB). 2006. Big Lake Watershed Atlas: Wetlands and Waterbodies within the Big Lake Watershed, 2006 edition. Matanuska-Susitna Borough : Palmer, AK. 134 pp.

McNab, W.H. and P.E. Avers. 1994. Ecological subregions of the United States: Section Description. Administrative Publication WO-WSA-5. US Department of Agriculture, Forest Service, Washington, D.C. 267 p.

Merizon, R. A., R. J. Yanusz, D. J. Reed, and T. R. Spencer. 2010. Distribution of spawning Susitna River chum Oncorhynchus keta and Coho O. kisutch salmon, 2009. Alaska Department of Fish and Game, Fishery Data Series No. 10-72, Anchorage.

Moran, E.H., and Solin, G.L. 2006. Preliminary water-table map and water-quality data for part of the Matanuska-Susitna Valley, Alaska, 2005; U.S. Geological Survey Open-File Report 2006-1209, 43 p.

Moulton, L.L. 1997. Early marine residence, growth, and feeding by juvenile salmon in northern Cook Inlet. Alaska Fisheries Research Bulletin 4(2):154-177.

Mouw, J. 2003. Overwintering and Spawning Ecology of Fishes in Cold Climates, an Annotated Bibliography. In Freeman, M.W. and J Durst, Ed. 2004. Region II Forest Resources and Practices Riparian Management Annotated Bibliography. Report to the Alaska Board of Forestry. Alaska Department of Natural Resources, Division of Forestry and Office of Habitat Management and Permitting, Anchorage, Alaska.

Murphy, M. L., and W. R. Meehan. 1991. Stream ecosystems. Pages 17-46 *in* W. R. Meehan, editor. Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19, Bethesda, Maryland.

National Fish Habitat Partnership. 2012. National Fish Habitat Action Plan, 2nd Edition. Available: http://www.fishhabitat.org/sites/default/files/www/NFHP_AP_Final_0.pdf.

National Marine Mammal Laboratories, Alaska Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration (NMML). 1999. Synthesis of available information on the Cook Inlet stock of Beluga whales. Edited by: Moore, S. and D. Rugh, K. Sheldon, B. Mahoney and R. Hobbs. AFSC Processed Report 99-06. 22p.

Nemeth, M. J., C. C. Kaplan, A. P. Ramos, G. D. Wade, D. M. Savarese, and C. D. Lyons. 2007. Baseline studies of marine fish and mammals in Upper Cook Inlet, April through October 2006. Final report prepared by LGL Alaska Research Associates, Inc., Anchorage, Alaska for DRven Corporation, Anchorage, Alaska.

National Fish Habitat Board (NFHB). 2005. National Fish Habitat Action Plan. Available: www.fishhabitat.org.

Olden, J.D., and N.L. Poff. 2003. Redundancy and the choice of hydrologic indices for characterizing streamflow regimes. *River Research and Applications* 19:101-121.

Oslund, S. and S. Ivey. 2010. Recreational Fisheries of Northern Cook Inlet, 2009-2010: Report to the Alaska Board of Fisheries, February 2011. Alaska Department of Fish and Game, Fishery Management Report No. 10-50, Anchorage

Ourso, R. T., and S. A. Frenzel. 2003. Identification of linear and threshold responses in streams along a gradient of urbanization in Anchorage, Alaska. Hydrobiologia 501:117-131.

Parker, R. R. 1968. Marine mortality schedules of pink salmon of the Bella Coola River, Central British Columbia. Journal of the Fisheries Research Board of Canada 25:757–794.

Phillips, MJ, LW Swift, and CR Blinn. 2000. Best management practices for riparian areas. In Riparian Management in forests of the continental eastern united states. ES Verry, JW Hornbeck, and CA Dollof (eds) Boca Raton, FL, Lewis Publishers.

Poff, N.L., J.D. Allen, M.B. Bain, J.R. Karr, K.L. Prestegaard, B.D. Richter, R.E. Sparks, and J.C. Stromberg. 1997. The Natural Flow Regime. *BioScience*, V.47, No. 11, 769-784.

Poff, N.L. and J.K. H, Zimmerman. 2010. Ecological responses to altered flow regimes: a literature review to inform environmental flows science and management. *Freshwater Biology*, 55:194-20.

Poole, G. C. 2002. Fluvial landscape ecology: addressing uniqueness within the river discontinuum. *Freshwater Biology*, 47:641-660.

Quinn, Thomas P. 2005. The Behavior and Ecology of Pacific Salmon and Trout. American Fisheries Society and University of Washington Press, Seattle Washington.

Pickett, S.T.A and J.N. Thompson. 1978. Patch dynamics and the design of nature reserves. Biological conservation 13:27-37.

Richter, B.D, J.V. Baumgartner, R. Wigington, and D.P. Braun. 1997. How Much Water Does a River Need? *Freshwater Biology,* 37, 231-249.

Ricketts, T., H.E., Dinerstein, D.M. Olson, C.J. Louckes et al. 1999. Terrestrial ecoregions of North America: a conservation assessment. Washington DC: Island Press.

Rodrigues, R., M. Nemeth, T. Markowitz, and D. Funk. 2006. Review of literature on fish species and beluga whales in Cook Inlet, Alaska. Final report prepared by LGL Alaska Research Associates, Inc., Anchorage, AK, for DRven Corporation, Anchorage, AK.

Rinella, D. J. and D. L. Bogan. 2003. Ecological impacts of three lower Kenai Peninsula, Alaska, ATV stream fords. Environment and Natural Resources Institute. University of Alaska Anchorage.

Sandercock, F. K. 1991. Life history of Coho salmon. Pages 395-446 in C. Groot and L. Margolis, editors. Pacific salmon life histories. University of British Columbia Press, Vancouver, British Columbia.

Schick, Jonathon W. 2006. Land Cover Dynamics of the Matanuska-Susitna Valley, Alaska: Past Trends and Future Possibilities. Master's Thesis. Alaska Pacific University. Anchorage, Alaska. 44 pp.

Schueler, TR & HK Holland, eds. 2000. The Practice of Watershed Protection. Center for Watershed Protection: Elliot City, Maryland. 2000.

Shields, P., and A. Dupuis. 2013. Upper Cook Inlet commercial fisheries annual management report, 2013. Alaska Department of Fish and Game, Fishery Management Report No. 13-49, Anchorage.

Silk N. and K. Ciruna, eds. 2004. A Practitioner's Guide to Freshwater Biodiversity Conservation. Washington, D.C.: Island Press.

Simenstad, C. A., Nightingale, B.J., Thom, R.M., and Shreffler, D.K., 1998. Impacts of Ferry Terminals on Juvenile Salmon Migrating Along Puget Sound Shorelines. Research Report Research Project T9903. Washington State Transportation Commission, Department of Transportation and in cooperation with U.S. Department of Transportation Federal Highway Administration.

Simenstad, C.A., Wissmar, R.C. 1985. Evidence of the Origins and Fates of Organic Carbon in Estuarine and Nearshore Food Webs. Marine Ecology Progress Series Vol.22: p. 141-152

Small, D. and Carmen, R. 2005. Marine Shoreline Armoring in Puget Sound and the Washington State Hydraulic Code. Proceedings from the 2005 Puget sound and Georgia Basin Research Conference.

Scenarios Network for Alaska & Arctic Planning (SNAP). 2013. Regional Climate Projections - SouthCentral Alaska. Available: http://www.snap.uaf.edu/attachments/Alaska_Regional_Climate_Projections_SouthCentral.pdf

Speckman, S.G., 2004. Characterizing Fish Schools in Relation to the Marine Environment and their use by Seabirds in Lower Cook Inlet. Doctoral Dissertation. University of Washington.

Speckman, S.G., Piatt, J,F., Minta-Vera, C.V., Parrish, J.K. 2005. Parallel structure among environmental gradients and three trophic levels in a subarctic estuary. Oceanography 66:26-65.

Stevenson, H.L., and Colwell, R.R. 1973. Estuarine Microbial Ecology. Belle W. Baruch Coastal Research Institute. University of South Carolina Press: Columbia, South Carolina.

Sweet, D., S. Ivey, and D. Rutz. 2003. Area management report for the recreational fisheries of Northern Cook Inlet, 2001 and 2002. Alaska Department of Fish and Game, Fishery Management Report No. 03-10, Anchorage. Available: http://www.sf.adfg.state.ak.us/FedAidPDFs/fmr03-10.pdf

The Nature Conservancy (TNC). 2011. Mapping Impervious Surfaces in the Mat-Su: Measuring Development at the Subwatershed Scale. The Nature Conservancy: Anchorage, Alaska.

The Nature Conservancy (TNC). 2007. Priority Waterbodies in the Mat-Su Borough: Map Atlas and Spatial Data Library for Fish Creek, Meadow Creek, Wasilla Creek and Little Susitna River. The Nature Conservancy: Anchorage, Alaska. CD.

University of Alaska Fairbanks, Sea Grant College Program (UAF Sea Grant). 2002. Available: www.uaf.edu/seagrant/earthquake/reduce11.html.

United States Geological Survey (USGS). 2001. Water Temperature of Streams in the Cook Inlet Basin, Alaska, and Implications for Climate Change. Water Resources Investigations Report 01-4109. 24p.

U.S. Fish and Wildlife Service. Conservation Planning Assistance. 2009. Studies of Anadromous Fish in Knik Arm. A Literature Review. Prepared by, Prevel-Ramos, A.,Brady, J.A., Houghton, J., Dec. 2009.

US Geological Survey (USGS). 2004. Water Quality in the Cook Inlet Basin, Alaska, 1998-2001.US Geological Survey, Circular 1240: Reston, Virginia.

Vannote, R.L., G. W. Minshall, K. W. Cummins, J. R. Sedell, and C. E. Cushing. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences 37:130-137.

Vincent-Lang, D., and D. McBride. 1989. Stock origins of Coho salmon in the commercial harvests from Upper Cook Inlet, Alaska. Alaska Department of Fish and Game, Fishery Data Series Number 93, Anchorage. Available: http://www.sf.adfg.state.ak.us/FedAidPDFs/fds-093.pdf.

Wilkinson, T., 2001. On the beaten path. National Parks, 75(3-4): 34-38.

Willette, T. M., R. T. Cooney, and K. Hyer. 1999. Predator foraging mode shifts affecting mortality of juvenile fishes during the subartic spring bloom. Canadian Journal of Fisheries and Aquatic Sciences 56:364-376.

Willette, T.M., R.. DeCino, C. Habicht, A.W. Barclay and X. Zhang. In press. An evaluation of the selectivity of fish wheels used to apportion sonar counts to species on the Yentna River, Alaska. Alaska Department of Fish and Game, Fishery Data Series, Anchorage.

Williams, G. and R. Thom. 2001. Marine and Estuarine Shoreline Modifications Issues. White Paper prepared for Wash. Dept. of Fish and Wildlife, Ecology and Transportion. Battelle NW.

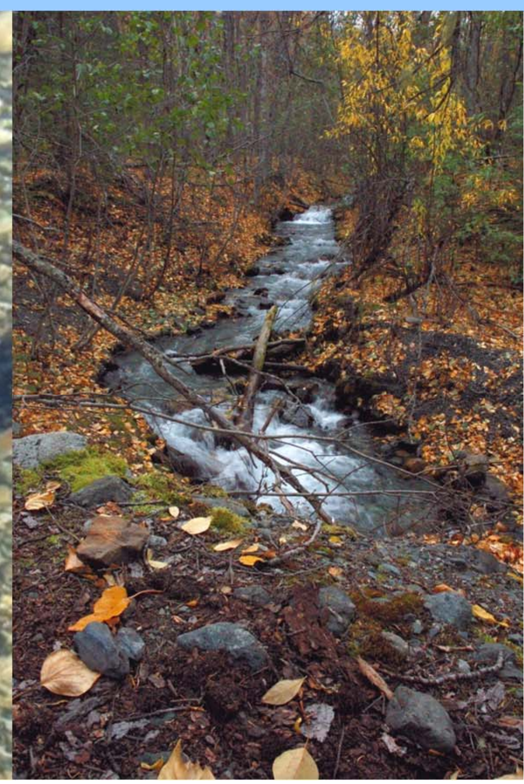
Wipfli, M. S., and D. P. Gregovich. 2002. Export of invertebrates and detritus from fishless headwater streams in southeastern Alaska: implicatioins for downstream salmonid production. Freshwater Biology 47:957-969.

Yanusz, R., R. Merizon, D. Evans, M. Willette, T. Spencer, and S. Raborn. 2007. Inriver abundance and distribution of spawning Susitna River sockeye salmon Oncorhynchus nerka, 2006. Alaska Department of Fish and Game, Fishery Data Series No. 07-83, Anchorage.

Yanusz, R. J., R. A. Merizon, T. M. Willette, D. G. Evans and T. R. Spencer. 2011. Inriver abundance and distribution of spawning Susitna River sockeye salmon Oncorhynchus nerka, 2007. Alaska Department of Fish and Game, Fishery Data Series No. 11-19 Anchorage.

Yanusz, R. J., R. A. Merizon, T. M. Willette, D. G. Evans and T. R. Spencer. 2011. Inriver abundance and distribution of spawning Susitna River sockeye salmon Oncorhynchus nerka, 2008. Alaska Department of Fish and Game, Fishery Data Series No. 11-12 Anchorage.





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

Mat-Su Basin Salmon Habitat Partnership
2013