A Comprehensive Inventory of Impaired Anadromous Fish Habitats in the Matanuska-Susitna Basin, with Recommendations for Restoration, 2013

Prepared by

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Abstract

This document was written to identify the factors or activities that are likely to negatively impact the production of salmonids in the Matanuska-Susitna (Mat-Su) basin and to offer mitigation measures to lessen those impacts. Potential impacts can be characterized in two different catagories; natural and anthropogenic. Natural threats to salmon habitat in the Mat-Su basin include natural loss or alteration of wetland and riparian habitats, alteration of water quality and quantity, and beaver dams blocking fish migration. Anthropogenic impacts include urbanization that increases loss or alteration of wetlands and riparian habitats and decreases water quantity and quality; culverts that block or impair fish passage; ATV impacts to spawning habitats, stream channels, wetlands and riparian habitats; "coffee can" introduction of pike in salmon waters; and, beaver dams at or in culverts. What resulted is an amalgamation of existing research and expertise delivered in a brief narrative describing those limiting factors and activities, as well as an appendix listing possible studies to better understand those impacts and potential projects to limit or repair damage to important salmon habitats (Appendix A).

Introduction

The Matanuska-Susitna (Mat-Su) Basin is drained primarily by two major rivers, the Matanuska and Susitna. The Susitna River watershed encompasses 19,300 square miles, flowing over 300 miles from the Susitna Glacier in the Alaska Range, through the Talkeetna Mountains, to upper Cook Inlet. The Susitna basin is bordered on the south by Cook Inlet and the Talkeetna Mountains, on the east by the Talkeetna Mountains and on the north and west by the Alaska Range. The west side of the Susitna River has several major tributaries including Alexander Creek, Yentna River (including the Talachulitna River, Swentna River, Lake Creek and Kahiltna River drainages), and the Deshka River (including Kroto and Moose Creeks). From the east, Willow Creek, Little Willow Creek, Kashwitna River, Sheep and Montana Creeks and the Talkeetna River (including Clear Creek and Sheep River) flow into the Susitna River. The Little Susitna River is a separate drainage in the basin that drains directly into Cook Inlet and supports one of the state's largest coho salmon sport fisheries. Willow Creek, Cottonwood Creek and Meadow Creek flow through the more urban, populated areas on the east side of the Susitna River Drainage. The Susitna River drainage supports significant recreational fisheries for native runs of Chinook and coho salmon, along with resident populations of rainbow trout and grayling. Much of the sport fishing occurs along the road system, however, the west side of the Susitna River is roadless, with access provided by either power boat or float plane.

The Matanuska River watershed encompasses over 2,070 square miles, stretching approximately 75 miles from the headwaters at the Matanuska Glacier in the Chugach Mountains to its terminus

in the Knik Arm of Cook Inlet. It drains the broad Matanuska Valley that is bordered on the north by the Talkeetna Mountains and by the Chugach Range to the south. Several tributaries contribute to the glacial melt water including Caribou, Coal, Wolverine, Moose, Eska, Granite and Boulder Creeks, Kings River and the Chickaloon River, the largest tributary of the Matanuska. The Matanuska River is a popular destination for whitewater rafting.

Fisheries Resources

All five species of Pacific salmon return to the waters of the Mat-Su Basin, although Chinook, coho, and sockeye salmon comprise the majority of sport and commercial fishing interest.

Chinook Salmon

There are seventeen stocks of Chinook salmon in the Northern Cook Inlet Management Area (NCIMA). Collectively Chinook salmon make up the largest proportion of Cook Inlet drainage stocks. Chinook salmon have been documented in over 2,800 river miles of the Mat-Su Basin. The Chinook salmon runs to the Susitna River are the most numerous in the management area, and the fourth most abundant runs in Alaska. Collective annual run to the Susitna River drainage likely ranges from 100,000-200,000 fish (Delaney and Vincent-Lang *Unpublished*). Based on Statewide Harvest Survey estimates (SWHS), sport harvest of NCIMA Chinook salmon varied from 8,894 to 2,785 during 2009-2012. Poor runs in 2011 and 2012 prompted in-season restrictions to both sport and commercial fisheries. In response to poor runs of Chinook salmon, emergency orders have also been issued to close sport fisheries. Of the eleven Chinook salmon stocks listed as stocks of concern by the Alaska Board of Fisheries, seven are located in the NCIMA. Harvest of Chinook salmon in the Northern District 247-41 Susitna Flats commercial fishery ranged from about 92 to 165 fish from 2009 – 2012.

Coho Salmon

Coho salmon have been documented spawning in 3,218 river miles of the Mat-Su Basin. The Susitna River drainage supports the largest coho salmon stock within the NCIMA and the entire Upper Cook Inlet area. Total coho salmon abundance in the Susitna River drainage was estimated at 663,000 fish in 2002 (Willette et al. 2003). More recent information indicates that drainage-wide abundance has been approximately 200,000 fish during 2010-2012 (Cleary et al. 2013 and Unpublished). Sport harvest of coho salmon in the NCIMA ranged from 31,193 to 17,063 fish (SWHS) during 2009-2012. Total commercial harvest in the Northern District, Subdistrict 247-41 Susitna Flats fishery for coho salmon ranged from 1,990 to 3,115 during 2009–2012.

Sockeye Salmon

Sockeye salmon have been documented spawning in over 1,845 river miles in the Mat-Su Basin. The Yentna River is thought to support about 77% of the Susitna River sockeye escapement (Fair et al. 2009). The sport fishery for sockeye salmon in NCIMA drainages is mostly incidental to harvest of other salmon. Sport harvest of sockeye salmon in the NCIMA ranged from 9,783 to 5,395 fish from 2009-2012 (SWHS). Angler effort in the Susitna River drainage for all users varied from about 140,200 to 96,901 days fished for all species during 2009-2012 (SWHS).

While the Susitna River drainage is the third most productive sockeye salmon drainage in Upper Cook Inlet, the Board of Fish has listed the Susitna River sockeye as a stock of yield concern in

2008. Total commercial harvest in the Northern District, Subdistrict 247-41 Susitna Flats fishery for sockeye salmon ranged from 778 to 3,208 fish during 2009 – 2012.

Purpose and Need for this Inventory

During the 2013 legislative session a $2.5 million capital improvement project (CIP) for "Salmon Research, Restoration, and Enhancement Initiatives for the Susitna River Drainage System" was appropriated to the Alaska Department of Fish and Game (ADF&G). ADF&G engaged with the Mat-Su Fish and Wildlife Commission (Mat-Su Commission) in a collaborative process to determine the best way in which to use those funds. The purpose of this document is to create an inventory list of habitat projects that can be used when money comes available to the state, local governments and local groups. This CIP funding can be used to address documented impairments that have been identified as affecting salmon habitat and to fund surveys to identify undocumented impairments to salmon habitat. These surveys should seek to identify diverse habitat type impacts that impair salmon production such as fish passage problems at culverts, bank erosion, beaver dams and invasive northern pike. Although the CIP is identified for the Susitna River drainage, in discussions during the collaborative process the Mat-Su Commission has expressed a desire to assist ADF&G in any habitat surveys that would be needed to be done outside of the Susitna River drainage. Once these potential projects with costs are identified, they would be brought to the Mat-Su Commission for their consideration.

In the Mat-Su Basin there are many agencies and organizations currently conducting field surveys, habitat assessments and restoration work. Agencies such as the ADF&G, the United States Fish and Wildlife Service, the Mat-Su Borough, Palmer and Wasilla Soil and Water Conservation Districts, non-profit organizations and private consultants are a few of the groups working on salmon and development related studies. This inventory draws from a considerable body of work and experience from both within and outside of ADF&G. Using strategies and identified data gaps identified in the Mat-Su Salmon Habitat Strategic Action Plan, this inventory attempts to utilize and build upon information from other inventories and prioritization projects to identify and better understand factors that limit salmon production in the Mat-Su Basin. Prior work includes the culvert inventory and prioritization, Anadromous Waters Catalog (AWC) inventory, Alaska Freshwater Fish Inventory database and site selection processes, Alaska Clean Water Actions (ACWA) database, historic habitat inventories from the Fisheries Restoration and Enhancement Division (FRED), and the Habitat Division's Alaska Habitat Management Guides. Through this inventory, it is ADF&G's desire to limit duplication of efforts due to a lack of communication and minimize funding duplicative studies. Through an organized, prioritized and collaborative process, identified threats to salmon production can be systematically identified and addressed effectively and efficiently.

Threats to Anadromous Fish Habitat and Recommended Actions

A summary of threats, recommended actions, priorities and approximate costs are listed in Appendix A.

Loss or alteration of wetlands

Wetlands - "Alaska contains approximately 63 percent of the nation's wetlands. Most of the state's freshwater wetlands (around 100 million acres) are peat lands; however, the state also has marshes, bogs, fens, tundra, and meadows. Another 75 million acres are tidal wetlands and coastal estuaries. Alaska has lost approximately 200,000 acres of wetlands to development activities." (http://www.matsugov.us/wetlands/

Under authority of the Clean Water Act, the Army Corp of Engineers (ACE) has regulatory oversight of filling navigable waterways or "waters of the United States". This includes water bodies and wetlands that have "more than a speculative or insubstantial effect on the chemical, physical and biological integrity of traditional navigable waters." However, not all wetlands come under ACE authority and throughout the Mat-Su borough filling of wetlands occurs for a variety of developmental activities. Examples of wetlands loss include filling for residential development on Big Lake; construction of roads, railroads, and bridges; and material extractions and sales (gravel, peat and top soil).

Environmental impacts incurred from unavoidable wetland losses permitted by the ACE must be mitigated in accordance with the Clean Water Act and the 2008 Mitigation Rule. Compensatory wetland mitigation options include Mitigation Bank Credit Purchase, In-Lieu-Fee (ILF) Program Payment and Permittee-Responsible or Project-Specific Mitigation. Mitigation banks are established by private or public third party entities that restore, enhance, or otherwise permanently preserve wetlands in perpetuity and generate credits which may be used to offset unavoidable wetland impacts. In the Mat-Su, there are two resources from which established mitigation credits may be purchased, the Su-Knik Bank and Pioneer Reserve and the Conservation Fund sponsors an ILF program in the Mat-Su Area. Proactively, the Great Land Trust seeks to protect (prevent from filling) estuaries and wetlands through land purchases and conservation easement agreements. http://www.greatlandtrust.org/ourland/projects.html

The Mat-Su Borough recognizes the importance of wetlands and addresses special considerations in their wetlands management plan. This plan does not propose or include any new regulations or permitting requirements. It encourages voluntary practices to conserve and protect wetland resources within the Mat-Su.

Assess and mitigate for wetland alteration or loss

1. Survey and prioritize wetland habitats – This project will synthesize and augment work conducted by agencies and organizations (The Nature Conservancy, Great Land Trust, Conservation Fund, and National Fish Habitat Partnership) that currently are surveying, delineating and mapping wetland habitats. Products from this project would include; a) a protocol with criteria that will be used to prioritize wetlands for their importance for juvenile salmon habitat and water quantity and quality, and b) the prioritized list of wetlands. The prioritized list will be used for selecting properties for acquisition or

conservation easements that provide long term protection for salmon rearing and overwintering habitats, and water quantity and water quality. Estimated cost: $100,000

2. Conservation easements to preserve wetland habitats – This project will use the prioritized wetland list to identify and negotiate with willing private landowners and land managers to acquire conservation easements on high value wetlands that provide important salmon rearing and overwintering habitats, and water quantity and quality. Estimated cost: to be determined.

3. Acquiring land to preserve wetland habitats – This project will use the prioritized wetland list to identify and negotiate with willing private landowners and land managers to purchase lands with high value wetlands that provide important salmon rearing and overwintering habitats, and water quantity and quality. Estimated cost: to be determined.

Loss or alteration of riparian habitats

Many of the waters, including anadromous streams, within the Mat-Su Borough are adjacent to private land. Few restrictions are in place that protect riparian habitat above the ordinary high water (OHW) mark. The Mat-Su Borough has a 75' structural setback restriction in place adjacent to water bodies, however, no laws restrict vegetation clearing. Salmon habitat depends on a shifting habitat mosaic, that is, streams changing shape and form. When floods occur and streams change course and banks scour, essential features of good fish habitat, such as large woody debris, spawning gravels, and pool riffle sequences are created and maintained. Riparian habitat also provides shade that helps ameliorate high summer temperatures and provide cover and food for rearing fish. As riparian habitats are cleared or built upon without restriction or voluntary "Best Management Practices", salmon habitat is negatively impacted because these natural processes and functions are diminished or eliminated.

Assess and mitigate riparian habitats

Damage to stream banks in the Mat-Su Basin occur both on public and private lands and usually involve habitat damage due to stream stabilization using rip rap, riparian vegetation removal (lawns) and culvert/ATV crossings. The following projects represent a prioritized list of habitat improvement projects on various streams in the Mat-Su Basin:

1. Private land project on Wasilla Creek - During last fall's flooding, approximately 150 feet of river bank along this private property was damaged. This project involves installing approximately 150 feet of toe wood and planting a 150-foot by 10 foot area of vegetative mat immediately on top of and landward of the toe wood bank stabilization. Estimated cost: $35,000 for design and construction.

2. Wasilla Creek at Palmer-Fishhook and Carnegie Road - Immediately downstream of this culvert, rip rap was placed approximately 100 feet along both sides of the creek to stabilize the bank and ATV access was relocated along the roadway to stop them from driving through the creek. This project would remove or reposition the rip rap, install approximately 200 feet of brush layering and replant the 200-foot by 10-foot upland area using vegetated mat immediately landward of OHW. Estimated cost: $40,000 for design and construction.

3. Montana Creek off Kalispell Road - During last year's fall flooding, approximately 600 feet of river bank eroded along two private properties, washing out a portion of the borough road. This project involves installing 600 feet of rootwad bank stabilization and re-vegetating the 600-foot by 10-foot area on top of and landward of the rip rap with native vegetated mat. Estimated cost: $375,000 for surveying, design, CAD drawings and construction.

4. Montana Creek off of Old Montana Creek Road - Several years ago this Mat-Su Borough owned river bank was stabilized using rip rap along approximately 900 feet of Montana Creek, from below OHW to the top of the stabilized bank. This proposed project involves removing and re-locating the rip rap, installing approximately 900 feet of rootwad bank stabilization and re-vegetating the 900-foot by 20-foot area on top of and landward of the rip rap with vegetative mat. Estimated cost: $555,000 for surveying, design, CAD drawings and construction.

Loss or alteration of estuaries and nearshore habitats

Several Mat-Su Basin waterways converge in upper Cook Inlet to form an important estuary utilized by five species of Pacific salmon and resident fish. The Knik and Matanuska rivers, Cottonwood Creek, and Palmer Slough with its tributaries including Rabbit Slough, Wasilla Creek and Spring Creek lie within some of the most densely developed and populated areas within the region and contribute their flows to this estuary. Much of the estuary is protected within the Palmer Hay Flats State Game Refuge. The refuge and adjoining conservation properties protect approximately 45,000 acres of rivers, streams, lakes, freshwater and brackish wetlands, sedge flats, mudflats, tidal sloughs and tidally influenced waters of upper Cook Inlet.

The Palmer Hay Flats refuge and adjoining areas are heavily used by recreationists engaged in fish, wildlife and other outdoor oriented activities. While the off-road use of vehicles is generally prohibited on these lands, small all-terrain-vehicles (ATVs) are allowed on some adjoining lands and are allowed within the refuge under specific conditions. Refuge managers have concerns regarding two trails within the refuge where habitat damage is or may be occurring because of ATV use. One example is the illegal use of ATVs in salmon streams along the Matanuska River floodplain.

Cottonwood Creek estuary and wetland complex

Refuge managers currently manage the 7-mile long ATV trail and its uses at Cottonwood Creek to minimize impacts to fragile wetland habitat. However, with increasing use of ATVs at Cottonwood Creek, these impacts have also increased and refuge managers are considering if additional measures to protect these habitats are warranted while still attempting to maintain public access. Use of the trail by ATVs has resulted in two potentially detrimental effects including damage to wetland vegetation and likely potential changes in wetland drainage patterns.

Actions to identify and restore estuaries and nearshore habitats on Cottonwood Creek

1. Survey the Cottonwood Creek trail and wetlands to assess and identify mitigation measures that would include trail rerouting and hardening options. Estimated cost: $70,000.

Matanuska River Floodplain and wetland complexes

While generally allowed on uplands outside the refuge boundary, ATV use inside the refuge and along parts of the Matanuska River floodplain is prohibited, as is their use within salmon streams throughout the region unless otherwise authorized. This area of the Matanuska River floodplain (within and outside the refuge) supports many acres of wetland habitat as well as backwater sloughs, streams, springs and other waterways that support migrating, spawning and rearing salmon, and other fish and wildlife. Unfortunately, illegal ATV use in areas important to spawning salmon have contributed to the degradation of riparian habitat and adjoining wetlands.

Actions to identify and sustain estuaries and nearshore habitats on the Matanuska River Floodplain

1. Matanuska River floodplain anadromous fish sampling - Assess streams in the Matanuska River floodplain impacted by ATV uses for the presence of anadromous salmon species for including the stream into the Anadromous Waters Catalog. Estimated cost: $15,000.

2. Matanuska River Floodplain access management - This project seeks to educate ATV operators about and control ATV use adjacent to sensitive fish and wildlife habitats inside and outside the refuge along the river's floodplain. An intensive educational effort on proper use and access with ATVs adjacent to sensitive habitats will be conducted to include signs, interpretive panels, brochures and educational materials. In addition, signage and physical barriers will be placed to control access near sensitive habitats. Estimated cost: $25,000

Culverts that block or impair fish passage

Juvenile fish need to disperse from spawning areas to find food, escape predators and find suitable rearing and overwintering habitats. Juvenile fish may move far upstream into small headwater tributaries or lakes or may move downstream into wetlands and coastal areas. When their movement is restricted they become vulnerable to predators, over-crowding, reduced ability to feed, stranding and water temperature fluctuations.

The ADF&G has inventoried and assessed 97% of the road crossings and all but 20 of the Alaska Railroad crossings of fish bearing waters in the Mat-Su Borough. This is accomplished using a rapid assessment method that primarily focuses on impacts to juvenile fish movement, but, also identifies potential adult barriers. Of the 567 crossings assessed during 2004-2011 on fish-bearing waters, 295 sites, or 52% were rated as "Red" or a barrier to the movement of juvenile fish. An additional 107, or 19%, were rated as "Gray" or a potential barrier to the movement of juvenile fish. Fifty-five (55) culverts were identified as potential barriers to spawning adult salmon as they are located in streams known or believed to be suitable for spawning and are perched one foot or more at the outlet. Conditions affecting fish passage at each of the 567 sites include culverts that are too steep for fish to swim through (32%), damaged culverts (20%),

perched culverts (18%) and undersized culverts (27%). Undersized culverts tend to become perched overtime and are also vulnerable to flood damage.

Known barriers have been provisionally prioritized by ADF&G relative to the amount of upstream habitat potentially available, the number of salmon species that use the system and the severity of the barrier. Many sources were used to determine the upstream extent of habitat above barriers including existing National Hydrology Database maps, topographic maps, the Anadromous Waters Catalog, aerial photography, satellite photography and local sources of data. It should be emphasized these are coarse estimates of upstream habitat and could change as more and better data are acquired. Also, one hundred twenty-two (122) barriers are located on streams that are unmapped at this time and ADF&G was unable to make any estimate of the extent of upstream habitat for 106 barriers. These factors should be considered when using the existing prioritization. It is anticipated that the prioritization will be updated and improved as better stream data become available. All of the data collected by the ADF&G Fish Passage Improvement Program is available online in an interactive mapping format at: http://extra.sf.adfg.state.ak.us/FishResourceMonitor/?mode=culv

Prioritization and replacement of culverts to restore fish passage

1. Fish Prioritization Optimization Model – This project seeks to improve the existing culvert prioritization process using an optimization model. An optimization model uses business optimization software to optimize the number of stream miles re-connected in a defined area for a given cost. Once all the data are collected and entered into the model it can be used to look at numerous scenarios involving priority watersheds, available funds, road ownership and species of interest. As barriers are removed or replaced, the model can be updated to reflect new conditions with minimal effort. Currently, ADF&G has access to optimization software and the existing culvert assessment provides the majority of the data needed to run the model. Approximately two months of staff time would be needed to collect additional data, including cost estimates for replacement and desk-based mapping work to determine stream miles above existing barriers. This model would be a powerful tool to optimize benefit from fish passage dollars as they become available for many years into the future. Estimated cost: $25,000.

2. Culvert inventory on the Alaska Railroad in the Mat-Su Borough core areas - During a 2009-2011 study, ADF&G worked with the Alaska Railroad to assess culverts on the tracks. However due to rail schedules, ADF&G was unable to complete this inventory between Houston and Talkeetna. There are an estimated 27 culverts on this stretch of the railroad and they are the only culverts on public right of ways in the Mat-Su Borough that have not been assessed. This project would pay for two weeks of staff time for two ADF&G staff to carry out the fieldwork, use of a high rail, and staff time for Alaska Railroad personnel to accompany ADF&G staff while working on the tracks. The project includes funds for data entry and production of a summary report. Data would be available online and incorporated into future prioritizations. Estimated cost: $20,000.

3. Poddle Creek culvert replacement - This project would replace a perched culvert on private land upstream of a public road. This site is not included in the existing ADF&G assessment and was identified when the landowner approached agency staff. Poddle

Creek, a tributary of the Little Susitna River, is used by coho and Chinook salmon for spawning and rearing. Removing the existing perched culvert and replacing it with a 10-foot diameter box culvert would restore access to approximately one mile of habitat. The project may need coordination through a non-profit organization to work on private land. Estimated cost: $200,000 including design and construction.

4. Nurses Creek culvert replacement - A culvert on Nurses Creek, a tributary of the Little Susitna River, will be replaced with an approximate 8-foot diameter culvert on a borough road. The project may need coordination through a non-profit organization to work on this passage issue on private land. Once replaced, approximately one-half mile of spawning and rearing habitat will be open to coho and Chinook salmon. Estimated cost: $120,000 including design and construction.

5. Lucille Creek at Big Lake Road culvert replacement - The Alaska Department of Transportation (ADOT) culvert under Big Lake Road in Lucille Creek, a tributary of Fish Creek, is a near total barrier to the upstream movement of juvenile fish and is a partial barrier to the movement of spawning adult salmon at lower flows. Spawning coho and sockeye salmon and rainbow trout use Lucille Creek which also provides excellent rearing habitat for juvenile fish. There are approximately 14 miles of stream habitat above this culvert, of which 8.13 miles are included in the Anadromous Waters Catalog. In addition to blocking fish passage, the existing crossing has no way for ATVs to cross the stream except to drive through an area where ADF&G Fish Passage Program staff observed numerous adult fish holding and spawning. An improved crossing would provide unimpeded fish passage to extensive spawning and rearing habitat and would reduce direct impacts to the stream including the potential for destruction of salmon spawning redds by ATV use. Estimated cost: $1.5 million including design and construction.
   Photographs and assessment data for this site are available online: http://www.adfg.alaska.gov/sf/reports/FishPassage/rptSite.cfm?site=20501434

6. Trapper Creek at Susitna River Road culvert replacement - Trapper Creek is a tributary to the Susitna River and one of the largest culverted systems in the Mat-Su Borough with over 30 miles of habitat. It supports coho and Chinook salmon and rainbow trout. There are two crossings on Trapper Creek located at Susitna River Road (Borough owned) and the Parks Highway (ADOT owned). The Susitna River Road crossing consists of three culverts that are undersized relative to the creek, are frequently blocked by beaver activity and are in poor condition. The road is at danger of failure during high flows. The proposed solution is to replace the existing culverts with a bridge. Estimated cost: $500,000 including design and construction.
   Photographs and assessment data for this site are available online: http://www.adfg.alaska.gov/sf/reports/FishPassage/rptSite.cfm?site=20501409

7. Caswell Creek at Caswell Lakes Road culvert replacement - Caswell Creek supports spawning and rearing coho salmon. Multiple borough-owned culverts at this site are located below Caswell Lake and provide access to in-stream habitat and the lake. They are undersized and damaged; one is frequently clogged with debris and sediment, as well

as ice as late as May. The proposed solution is to replace them with a single correctly sized culvert. Estimated cost: $300,000 including design and construction.
Photographs and assessment data for this site are available online: http://www.adfg.alaska.gov/sf/reports/FishPassage/rptSite.cfm?site=20501462

8. Twin Lake at Birch Road culvert replacement - This culvert is located on a borough road at the outlet of Twin Lake. It is located on a tributary to Meadow Creek and supports coho salmon. There is approximately 1.91 miles of catalogued anadromous in-stream habitat above the culvert and below the Alaska Railroad. The culverts are severely undersized and prone to blockage and the road is vulnerable to failure at higher flows. The project may need coordination through a non-profit organization to work on this fish passage issue on private land. Estimated cost: $150,000
   Photographs and assessment data for this site are available online: http://www.adfg.alaska.gov/sf/reports/FishPassage/rptSite.cfm?site=20501092

9. Meadow Creek Tributary at the Alaska Railroad culvert replacement - This State owned culvert is on a tributary to Meadow Creek where it crosses the Alaska Railroad, south of the Meadow Lakes area. Coho and sockeye salmon use this tributary, but no fish have been observed above this culvert. It is perched 1.06 feet and is likely a complete barrier to fish passage. There is approximately three miles of in-stream habitat and 72 acres of lake habitat available above this culvert. Estimated cost: $700,000.
   Photographs and assessment data for this site are available online: http://www.adfg.alaska.gov/sf/reports/FishPassage/rptSite.cfm?site=20501081

10. Coal Creek culvert replacement - This project would replace a borough owned culvert that is perched approximately four feet and is a total barrier to adult and juvenile fish of all species. The culvert would be replaced with an approximately 90 foot long bridge. This project will require the permission of the private landowner and will open approximately one mile of spawning and rearing habitat for coho and Chinook salmon and Dolly Varden trout. Estimated cost: $400,000 for design and construction cost for the bridge.
    Photographs and assessment data for this site are available online: http://www.adfg.alaska.gov/sf/reports/FishPassage/rptSite.cfm?site=20501232

Beaver dams that block or impair fish passage

Beaver dams in a natural stream generally improve habitat for rearing salmonids and typically can be easily navigated by migratory fish at higher water or via overflow channels. Beaver dams store up water that can be used by juvenile salmon for overwintering ponds, particularly coho salmon, and assist in wetland formation and maintenance upstream of the structure. Generally, the practice of removing beaver dams are negative to the watershed and salmon rearing, causing draining of wetlands, changes to vegetation types in riparian areas, less overwintering salmon habitat, shorter water retention time in the watershed, increased flooding and stream channel down-cutting. Because of these potential secondary negative effects, a prudent approach should be used to assure that only beaver dams that substantially block upstream migration of juvenile and adult salmon are removed or altered.

One notable problem is when beaver dams are constructed inside or at the entrance to culverts. These dams are much more difficult for fish to navigate as there is no opportunity to move around the dam in side channels and the fish's ability to leap over the dam is much reduced or eliminated by the culvert. Beavers are attracted to the sound of running water and to pre-existing channel constrictions when choosing a dam site and therefore many undersized culverts are attractive dam locations. ADF&G has identified 49 crossings in the Mat-Su Borough that have beaver activity in or near the culvert. Some of these dams are six to eight feet tall; completely blocking fish passage through the culvert at all flow regimes and impounds a significant amount of water upstream of the roadbed. Failure of the dam during a high flow event also has the potential to damage or wash out the road. An example of a site where a beaver dam blocks upstream movement of fish can be seen at: http://www.adfg.alaska.gov/sf/reports/FishPassage/rptSite.cfm?site=20502150

Sites known to have nearby beaver activity can be reviewed using existing data and photographs to identify sites where beaver activity is substantially blocking the upstream movement of spawning or juvenile fish. Identified dams should be removed to restore fish passage through the site and possibly measures taken to remove problem beavers in the area. These efforts will require ongoing maintenance as, for the reasons noted above, beavers are likely to return to the site and construct a new dam.

Assess and remove beaver dams that block and impair fish passage

1. Assessment of anadromous streams for undocumented beaver dams that block or impair fish passage - Many streams in the Mat-Su Basin have undocumented beaver dams that block or impair fish passage. This effort would survey anadromous streams using aerial photographs, GIS, helicopter and on-the-ground surveys to identify beaver dams that actually block or significantly impair fish passage. Much of this work could occur during the anadromous fish sampling and verified on the ground with a limited field effort. This task could be completed as a component of the Mat-Su fish inventory efforts. Cost estimate: $75,000.

2. Removal of known beaver dams at culvert road crossings - Sites known to have nearby beaver activity can be reviewed using existing data and photographs to identify sites where beaver activity is substantially blocking the upstream movement of spawning or juvenile fish. Identified dams, and possibly beavers, should be removed to restore fish passage through the site. This effort will require ongoing maintenance as, for the reasons noted above, beavers are likely to return to the site and construct a new dam. Cost estimate: $500 to $10,000 per site depending on the site.

3. Research improved beaver exclusion devices and culverts - Beavers are attracted to the sound of running water and to existing stream constrictions so undersized culverts require maintenance to remove beaver dams. Beaver exclusion devices are used by ADOT to keep beavers from entering culverts and to prevent dam building inside, where removal is more difficult than at the inlet or outlet of the culvert. Generally exclusion devices consist of metal grates placed across the inlet of the culvert and, unfortunately, often completely blocking fish passage. There is limited research into improved beaver exclusion devices, inside and outside of Alaska, and to date no design has provided all of the desired

outcomes. A joint project between ADF&G and ADOT could examine existing designs, develop new options and test them for effectiveness. Cost estimate: $50,000.

Loss or alteration of water flow or volume

As the population and economic activity grows in the Mat-Su Basin, so grows the demand for water. Surface and groundwater is used for public drinking supply, agriculture, hydropower, snow making, road maintenance, fire suppression among many other uses. Water use and water right applications include, for example: Hatcher's Pass Downhill Ski Area (surface water right applied for snow making); ADOT has numerous water rights and temporary water use permits throughout the Borough for road maintenance roads; existing hydropower (e.g., McRobert's Creek); planned hydropower (e.g.'s, Fish Hook Creek - Hatcher's Pass and Susitna-Watana Dam); public drinking water withdrawals (e.g., Creekside Apartments from Wasilla Creek); and, cattle grazing (e.g., surface water right held by a farmer on Wasilla Creek).

The Mat-Su Basin Salmon Conservation Partnership strategic plan identified instream flow protection as one of the priority actions. Instream flow protection is needed to support salmon habitat and the fluvial processes that maintain that habitat. A reservation of water is one way to ensure sufficient flows long-term, although ADF&G also has the authority to review and permit proposed withdrawals from fish-bearing waters on a case by case basis to ensure habitat protection. Salmon life history stages such as migration, spawning, egg incubation, and rearing have adapted to natural and seasonal water quantities and patterns in rivers and lakes. Under Alaska's Water Use Act, a reservation of water is a water right to maintain or leave sufficient amounts of water in a river or lake for one or more of the following four purposes: protecting fish & wildlife habitat, migration, and propagation; protecting navigation & transportation; recreation & park purposes; water quality and sanitation. The Alaska Department of Natural Resources (ADNR) administers these water rights and requires 5 years of data to establish reserved water amounts. These data are also useful to scientists and natural resource managers for making informed decisions regarding sustainable water developments and land-use practices.

Assess and reserve instream flows for fish habitat

1. Fish Creek (Nancy Lake drainage) - Fish Creek flows out of Red Shirt Lake (in the Nancy Lake drainage) then into Flathorn Lake before emptying into the lower Susitna River. This stream produces sockeye, coho, chum, and pink salmon and flows through the Lowlands-East conservation target identified in the 2008 Matanuska-Susitna Basin Salmon Habitat Partnership Strategic Action Plan (SAP). Fish Creek is located in oil and gas leasing area, and future state agricultural lands disposal area which could have an impact on instream flows. Protection of instream flow on these streams meets objective 7.1 "Instream Flow on Anadromous Waters" of the SAP. Estimated cost: $70,000.

2. McRoberts Creek - McRobert's Creek is a tributary to Jim Creek which flows into the Knik. In the past few years, the Jim Creek coho sport fishery has had the highest catches of coho salmon in the NCIMA. McRobert's Creek is an important coho salmon spawning stream and used as an escapement index stream by ADF&G. McRobert's and Jim Creek flow through the Lowlands-East conservation target identified in the SAP and are highly vulnerable to pending residential development and groundwater extraction. Surrounding landownership is Mat-Su Borough, private, Eklutna Native Corp. and some state. A small

residential hydropower project exists in the upper reaches of McRobert's Creek. Protection of instream flow on this stream meets objective 7.1 "Instream Flow on Anadromous Waters" of the SAP. Estimated cost: $60,000.

3. Kings River - Kings River is a clear-water tributary to the Matanuska River and supports Chinook, chum and coho salmon. The river is located in the Upland Complex conservation target identified in the SAP. Protection of instream flow on these streams meets objective 7.1 "Instream Flow on Anadromous Waters" of the SAP. Estimated cost: $60,000.

Alteration of water quality

The Alaska Clean Water Actions (ACWA) was initiated as a way to direct multiple funding sources toward the recovery and stewardship of Alaska's water bodies. In 2002, Administrative Order 200 established ACWA as a collaboration of the three natural resource agencies the Departments of Environmental Conservation (ADEC), ADNR, and ADF&G and the Division of Governmental Coordination to coordinate the State's water resource management at the policy and technical levels. The goal of ACWA is to use a collaborative method to collect information, identify problems and areas needing protection, and direct resources toward the highest priority water body issues. The overall objective is to protect waters so they are drinkable, fishable, swimmable, and workable across the State. ACWA tracks information on all nominated water bodies through an interagency database. The database contains nominations, sufficient and credible information scores, priority rankings, and water body track. To date, there are 384 waters nominated into the ACWA program and 139 of these rank as high priority, with 20 of those being in the Mat Su Borough.

The 2010 U.S. census revealed that the Mat-Su Valley population growth was up from 59,322 in 2000 to 88,995 for 2010. Increases to population generally lead to increased development in and near riparian areas, potentially causing problems to water quality in area streams. Threats to water quality in the Mat-Su Basin include runoff from roads and other impermeable surfaces, failing septic systems, household/agricultural fertilizers, chemicals and pesticides, oil and gas tank leaks, and recreational activity. Stormwater runoff in the urban areas is another concern that is being assessed and the Mat-Su Borough is developing a Stormwater Management Plan. There are a number of streams in the Mat-Su Basin that are classified as "impaired" under the Clean Water Act. These water bodies include Big Lake, Cottonwood Creek, Matanuska River, and Lake Lucille. Big Lake is impaired due to petroleum contamination from boat motors and the Little Susitna River, a popular Chinook and coho salmon fishery is being monitored for petroleum contamination and turbidity from recreational boaters. There are also concerns about excessive nutrients, (which lead to algal blooms and oxygen depletion) in Wasilla Lake, however, neither the ADEC nor the EPA have established standards for nutrients.

Assess and mitigate water quality issues

1. Two stroke engine buyback program – Increased hydrocarbon levels due to two stroke outboard use have been documented in several water bodies in Southcentral Alaska. On the Kenai River, a two stroke engine buyback program was funded and initiated that was effective in reducing hydrocarbon levels in the river, within the standard set by ADEC. This project would use the same rationale in the Mat-Su basin to purchase two stroke

engines from public, decommission those engines so they could no longer be used, and give a credit towards the purchase of cleaner running four stroke engines. Estimated cost: $300,000.

2. Big Lake and Little Susitna River hydrocarbon monitoring – This project would continue monitoring of hydrocarbons in these two systems. With reduction of boat traffic in the Little Susitna due to fisheries closure in recent years, sampling would serve as baseline data for when fishing activity increases. If conducted concurrently with the two stroke engine buyback program, this information would serve as baseline data and a measure of the success of the buyback program. Estimated cost: $50,000 per year.

3. Stormwater runoff abatement – In the 2010 U.S. census, the Mat-Su Borough passed EPA's population threshold of 50,000. Under the Clean Water Act, once a community meets a population threshold, an Municipal Separate Stormwater Sewer System (MS4) permit is required to outline how a community must work together to keep pollutants out of their stormwater and environment. The need to enhance and regulate stormwater in the Mat-Su Valley's core area is an issue on the immediate horizon. Anticipating this need, the Borough sought EPA funds to develop a Stormwater Management Plan (SMP) which has been out for public review and is near completion. In Objective 4.1 of their SAP, the Mat-Su Basin Salmon Habitat Partnership recognizes the need to reduce the impacts of stormwater runoff on water quality and salmon habitat. This project would assist the Borough or other entities in close coordination with the Borough (and the municipalities of Palmer and Wasilla) to implement the guidelines set forth in the plan. This would include, but, not be limited to: a) building upon existing knowledge, identify and prioritize stormwater runoff sources with most potential harm to salmon habitat; b) identify techniques and build structures, such as sediment traps, grassed swales, rain gardens, green parking, sand and organic filters or bioengineer wetlands, in conjunction with known stormwater runoff pathways to reduce impacts to salmon habitat; and c) public education and outreach on the issue and what citizens can do to reduce stormwater runoff and pollutants. Estimated cost: $500,000.

Increased predation from northern pike

Invasive northern pike *Esox lucius* are a significant threat to anadromous fish habitat in the Mat-Su Basin. Northern pike are not native to this area of Alaska. ADF&G believes northern pike were first illegally introduced to the Yentna River drainage sometime in the late 1950s. Over the decades, continued illegal introductions as well as their dispersal into connected river systems, had led to their current known distribution in over 100 water bodies in the Mat-Su Basin alone. Northern pike are also established in waters in the Anchorage area and the Kenai Peninsula.

Northern pike are opportunistic ambush predators, but they tend to target juvenile salmonids when they are available. Northern pike typically occupy shallow, vegetated, slow-moving rivers, sloughs, and littoral zones of lakes. These habitats are also utilized by rearing salmonids, and northern pike predation is a significant cause of juvenile salmonid mortality where such habitat overlap occurs. The most extreme example of this is the Alexander Creek system, which was once a very productive Chinook salmon fishery. Northern pike established throughout the entirety of Alexander Creek in the late 1990s, and Chinook salmon abundance in the river

consequently declined. Today, all salmon fisheries in Alexander Creek are closed to harvest. For the last three years, ADF&G has been annually suppressing the northern pike population in Alexander Creek with gillnets to increase the survival and productivity of salmonids in the system. The goal is to restore sustained yields to salmon fisheries, particularly for Chinook salmon. In Anchorage and the Kenai Peninsula, ADF&G has had success eradicating entire northern pike populations with a piscicide called 'rotenone' to restore recreational fisheries and prevent northern pike from spreading to other waters. In the Mat-Su Basin, there are many locations where northern pike are negatively affecting salmon populations and decreasing the quality of anadromous rearing habitats. ADF&G is making progress in Alexander Creek, but there is substantial need to expand northern pike control, eradication and education efforts to other locations in the Mat-Su Basin.

Remove or reduce invasive northern pike populations

High priority areas for northern pike control and eradication in the Mat-Su Basin, outside of Alexander Creek include: Cabin Lake in the Yentna River Drainage, Nancy Lake in the Little Susitna River Drainage, Anderson and Kings Lakes in the Cottonwood Drainage, and a series of road system lakes that once provided popular sport fisheries for local anglers (Knik, Prator, and Memory). The following projects identify methods and approximate budgets to control northern pike populations in these locations and restore and protect sustained yields. The projects are listed in order of their priority.

1. Cabin and Nancy Lakes Northern Pike Suppression and Beaver Dam Removal - Cabin Lake in the Yentna Drainage and Nancy Lake in the Little Susitna Drainage share common challenges. They both have invasive northern pike populations that decrease the quality of rearing habitat for anadromous fish, and they both have small, low-flow outlet streams that are blocked by multi-generational beaver dams that entirely impede anadromous fish passage. ADF&G proposes to begin annual northern pike suppression in both lakes with fyke nets to suppress the northern pike populations. Fyke nets will be used in these lakes rather than gillnets so that adult salmon captured in them can be released alive. All northern pike will be dispatched. Netting will take place during the spring spawning period (ice-out through mid-June). At this same time, field crews will manually remove beaver dams with chain saws and axes to reopen the lake outlets and reestablish anadromy to both lakes. As with the netting, the beaver dam removal will have to be maintained on an annual basis. To evaluate the success of the projects, three aerial surveys will be conducted over Cabin Lake in August to index adult sockeye salmon abundance and look for changes over time. In Nancy Lake, a smolt/weir trap (provided by the Cook Inlet Aquaculture Association) will be installed and operated from early May-July to quantify the entire sockeye smolt out-migration. Estimated cost: $200,000 annually, including a fishery biologist project leader, six technicians, charter flights, and all of the nets and equipment.

2. Anderson and Kings Lakes Northern Pike Eradication - There are nine lakes in the 200 square mile Cottonwood Creek drainage, and two of them, Anderson and Kings Lakes, currently have invasive northern pike populations. In both of these lakes, populations of native rainbow trout, coho salmon, and sockeye salmon have been declining, presumably because of the growing northern pike populations. The Cottonwood Creek

drainage is highly productive and supports native populations of rainbow trout, Dolly Varden, longnose suckers, and all five Pacific salmon species. The entire system is vulnerable to northern pike establishment and needs to be surveyed to ensure that northern pike distribution is entirely restricted to Anderson and Kings Lakes. In an effort to prevent northern pike from spreading throughout the Cottonwood Creek drainage as well as other neighboring systems, ADF&G proposes to eradicate the northern pike populations in Anderson and Kings Lakes using rotenone. This project will span four years, and will involve working with a planner to conduct a public scoping process, conducting surveys of all lakes in the Cottonwood Creek drainage, collecting pre-treatment data from the lakes, permitting the projects (ADEC, ADF&G, EPA, NEPA), conducting the rotenone applications, evaluating the projects post-treatment to ensure they were successful, and restoring the fisheries to the lakes. Estimated cost: $735,000, including a fishery biologist project leader, 24 months of technician time, planner/ lab services, rotenone and supplies.

3. Knik, Prator, and Memory Lakes – Northern Pike Eradication
   These three lakes were once very popular rainbow trout sport fisheries prior to invasive northern pike establishment. Knik, Prator, and Memory Lakes are all on the road system and were formerly stocked by ADF&G. ADF&G proposes to eradicate the northern pike populations in all three of these lakes to restore recreational fishing opportunities for residents of the Matanuska-Susitna Valley and prevent northern pike from spreading or being transplanted from these accessible lakes. This project will span three years, and will involve working with a planner to conduct a public scoping process, collecting pre-treatment data from the lakes, permitting the projects (ADEC, ADF&G, EPA, and NEPA), conducting the rotenone applications, evaluating the projects post-treatment to ensure they were successful, and restoring the lakes with rainbow trout. Estimated cost: $560,000, including a fishery biologist project leader, 12 months of technician time, planner/ lab services, rotenone and supplies.

Inadequate identification of anadromous fish-bearing waters

The *Catalog of Waters Important for Spawning, Rearing or Migration of Anadromous Fishes* (AWC) and the *Atlas to the Catalog of Waters Important for Spawning, Rearing or Migration of Anadromous Fishes* (Atlas) currently documents the occurrence of nine different species of anadromous fishes within the Mat-Su watershed. AWC listed fishes for the area include all five species of Pacific salmon, Arctic lamprey, eulachon, Dolly Varden, and Humpback whitefish. Anadromous fishes occur in 773 Mat-Su Basin rivers, streams, and creeks totaling 4,426 river miles. Comparison of AWC water body hydrography and fish elevation data with the United States Geological Survey National Hydrography Dataset and National Elevation Data indicate that undocumented portions of area streams could equal and possibly exceed the total river miles currently listed for the Mat-Su Basin in the AWC.

Since Alaska laws form the basis for the department's permitting program and role in regulating activities in specified anadromous fish-bearing water bodies, it is critical that fish species and water body hydrography data included in the AWC is as accurate as possible. Because the occurrence of various fish species in any given water body are subject to change over time and water bodies are dynamic with hydrography subject to change, it is important to update AWC

information, especially in locales utilized as recreation areas and frequented by hikers, fishers, and hunters or subject to frequent ATV use.

Assess and document anadromous fish streams

1. Documentation of unsubstantiated water bodies – In the Mat-Su Basin there are ninety-four AWC water bodies that lack adequate documentation. Most these "unsubstantiated" water bodies are second level or higher tributary streams or lakes listed in the AWC since the early 1980s. Unsubstantiated AWC water bodies are pervasive throughout the Mat-Su basin, although most (75) are tributaries of the Susitna River. Initial sampling effort could involve aerial surveys using fixed-wing aircraft to determine presence of adult anadromous fishes, primarily salmonids, with following up, on-the-ground sampling to establish occurrence of juvenile fishes or other anadromous fishes not readily observed from the air. The Little Susitna River watershed, Upper Deshka River and Skwentna River, Talachulitna River, Beluga River and Peters Hills areas need more intense sampling (trapping, seining and electro-fishing) of AWC listed bodies to ensure all species and/or life stages currently found in these water bodies are in the AWC. This endeavor would also serve ongoing efforts by the department to revise water body hydrography as represented on AWC Atlas maps. Prioritization of this effort is based on the level of development and extent of fisheries, with a focus on areas of continued growth and current or potential resource development where major fisheries or anadromous fish production occurs. Estimated cost: $500,000.

2. Matanuska River watershed between the old Glenn Highway Bridge and the Glenn Highway - The department recently received an AWC nomination from a Mat-Su resident and the local Habitat Division staff expressing concern regarding AWC mapping inaccuracies in the area. This area was previously beneath the bed of the Matanuska River and, since the 1980s, the river has migrated east and abandoned this floodplain. The area has become relatively stable since then with numerous streams evolving from natural springs in the old floodplain with many being used by various anadromous fish species. Increased ATV use in the area has resulted in ATVs riding in and across anadromous streams and springs, potentially disturbing salmon redds and increasing turbidity in spawning areas. A two-part coordinated on-the-ground sampling effort could accurately map new and existing water bodies, and ascertain and document anadromous fish life-stage information for area water bodies, thereby providing a means for protection to the stream. Estimated cost: $50,000.

Loss or alteration of wetlands and riparian habitats due to ATVs

Poorly sited or constructed ATV trails can have negative effects on fish and wildlife habitat and surface water quality and quantity. Stream banks are important transition zones between aquatic and terrestrial systems and shoreline habitats are important for many fish species and life stages. Surface vegetation along stream banks and in riparian zones stabilizes soil and slows water velocity during high water events. Human impacts such as fording streams with ATVs can reduce bank vegetation, erosion resistance, structural stability, and destroy fish cover. Inputs of sediment and silt from bank erosion or adjacent uplands reduce water transparency, smother fish eggs and benthos, and fill pools and shallow water habitats.

Typical effects of ATV use in wetlands are physical damage including rutting, soil compaction, and the destruction of vegetation. These physical changes may result in the alteration of hydrogeologic pathways and biogeochemical processes that are essential to the immediate environment within the wetland and to the surrounding ecosystem. For example, deeply rutted ATV trails in wetlands can lower water tables and circumvent chemical processes by shortening the residence time of water.

Assess and mitigate ATV impacts to wetlands and riparian habitats

1. Upper Susitna River ATV stream crossing study – During fall 2001 and spring 2002, ADF&G conducted aerial surveys of ATV trail stream crossings in the Susitna River drainage. East of the Susitna River, the survey covered drainages from Willow Creek north to the Talkeetna River. West of the Susitna River, the survey covered drainages from the mouth of Montana Creek north to approximately 9 miles north of the Petersville Road. Each 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 disturbance. The ranking of each crossing represents 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. For example, a crossing where there was an increase in the width to depth ratio, exposed soil, and the banks were denuded would receive a rank of 3.

   ADF&G collected data for a total of 150 stream crossing sites. Preliminary analysis indicated that approximately 61% of the sites surveyed ranked 3 or above and 44% of the sites ranked 4 or above. Detailed site condition data are available for the sites surveyed in 2001. Exposed soil at the crossing and bank alteration were the most commonly observed impacts during the 2001 survey. Eighty percent of the stream crossings sites showed exposed soil adjacent to the creek and 66 percent showed stream bank alteration from ATVs crossing the stream. This project would revisit and update this decade old survey information and provide possible solutions to ATV impacts at those sites. Solutions could range from stream bank stabilization and re-vegetation, hardening trail access, construct ATV bridges over salmon streams, closing portions of trail and relocating access to avoiding sensitive habitats, and construction of educational and interpretive signage. Estimated cost: $75,000 to $180,000.

Appendix A. Summary of threats and prioritized actions for restoration of anadromous fish habitats in the Matanuska-Susitna Basin, 2013.

Threat	Location of Action or Project	Restoration Action or Project	Priority	Approximate Cost ($K)
Loss or alteration of wetlands	Mat-Su Basin	Survey and prioritize wetland habitats	1	$100
	Mat-Su Basin	Acquire conservation easements to preserve wetland habitats	2	To be determined
	Mat-Su Basin	Acquire land to preserve wetland habitats	3	To be determined
Loss or alteration of riparian habitats	Wasilla Creek	Mitigate riparian habitat on specified private land	1	$35
	Wasilla Creek	Mitigate riparian habitat off of Fishhook and Carnegie Rd	2	$40
	Montana Creek	Mitigate riparian habitat off of Kalispell Rd	3	$375
	Montana Creek	Mitigate riparian habitat off of Old Montana Creek Rd	4	$555
Loss or alteration of estuaries and nearshore habitats	Cottonwood Creek	Survey ATV trails and wetlands to assess mitigation measures	1	$70
	Matanuska River	Anadromous fish sampling near ATV crossings	1	$15
	Matanuska River	Floodplain ATV access management	2	$25
Culverts that block or impair fish passage	Mat-Su Basin	Fish Prioritization and Optimization Model	1	$25
	Mat-Su Basin	Alaska Railroad culvert inventory	2	$20
	Poddle Creek	Culvert replacement	3	$200
	Nurses Creek	Culvert replacement	4	$120
	Lucille Creek	Big Lake Road culvert replacement	5	$1,500
	Trapper Creek	Susitna River Road culvert replacement	6	$500
	Caswell Creek	Caswell Lakes Road culvert replacement	7	$300
	Twin Lake	Birch Road culvert replacement	8	$150
	Meadow Creek trib.	Alaska Railroad culvert replacement	9	$700
	Coal Creek	Culvert replacement	10	$400

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Threat	Location of Action or Project	Restoration Action or Project	Priority	Approximate Cost ($K)
Beaver dams that block or impair fish passage	Mat-Su Basin	Identify and assess beaver dams that block or impair fish passage	1	$75
	Mat-Su Basin	Remove problematic beaver dams	2	$0.5 to $10 per incidence
	Mat-Su Basin	Research improved beaver exclusion devices	3	$50
Loss or alteration of water flow or volume	Fish Creek (Nancy Lake)	Assess and reserve instream flows	1	$70
	McRoberts Creek	Assess and reserve instream flows	2	$60
	Kings River	Assess and reserve instream flows	3	$60
Alteration of water quality	Mat-Su Basin	2-stroke engine buyback program	1	$300
	Big Lake/Little Susitna River	Hydrocarbon monitoring	2	$50
	Mat-Su Basin	Storm water runoff abatement	3	$500
Increased predation from northern pike	Cabin and Nancy Lakes	Northern pike suppression and beaver dam removal	1	$200
	Anderson and Kings Lakes	Northern pike eradication	2	$735
	Knik, Prator, and Memory Lakes	Northern pike eradication	3	$560
Inadequate identification of anadromous fish-bearing waters	Mat-Su Basin	Document unsubstantiated water bodies	1	$500
	Matanuska River	Map and conduct sampling from Old Glenn Highway bridge to Glenn Highway	2	$50
Loss or alteration of wetlands and riparian habitats due to ATV use	Upper Susitna River	Update ATV crossing study and provide recommendations	1	$180