Mat-Su Salmon Passage Improvement Plan

Mat-Su Basin Salmon Habitat Partnership

2011

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Photos on cover: Sunrise Road crossing Poddle Creek; before restoration (left) and immediately after (right)

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Introduction

The Matanuska-Susitna (Mat-Su) Borough in south-central Alaska is the fastest growing region of Alaska. Located just north of Alaska's largest city, Anchorage, the Mat-Su Borough provides not only affordable housing options, but also a rural setting and diverse areas to recreate. One unfortunate consequence of those factors plus the young age of the state and the borough is that many road crossings of streams were not adequately designed or constructed prior to statehood. Rapid growth has also brought with it rapid development and some problem culverts have been installed on private property. Inadequate culverts can block salmon migration for both adults and rearing juveniles and alter spawning, rearing, and over-wintering habitat for salmon.

How Culverts Impact Salmon

The rivers and lakes of south-central Alaska support some of North America's most viable and productive salmon fisheries. Salmon migration, spawning, rearing and ultimately production in these waterbodies are dependent on connectivity of habitat. Stream crossing structures affect the movement of fish and other aquatic organisms by altering the stream physical characteristics. Migration barriers can have significant effects to fish production as access to large areas of spawning or rearing habitat can be eliminated or reduced (Gibson et al 2005; Sheer and Steel 2006). Anadromous juvenile and adult fish are highly mobile, and it's common for these fish to use different parts of a stream or watershed at different times of the year (Kahler & Quinn 1998). Adult salmon may have reduced access to spawning habitat, while young salmon have reduced access to rearing and over-wintering. Juvenile salmon can be affected in their need to move upstream and downstream to reach habitat (Davis & Davis 2012) or lower velocity flows (Cedarholm & Scarlett 82). Impeded movement of fish between habitats essential for rearing and spawning can negatively impact population status.

Stream crossing structures can impede fish migration in various ways. Undersized culverts increase stream velocity, which can be a total or partial barrier to weaker or smaller fish. Velocity can also be increased by culverts that are steeper than the natural gradient of the stream. Culverts installed improperly may have a perch at their outlet which fish cannot jump or these culverts may have too little water for fish to swim through.

Not only can inadequate culverts impede fish movement, they can potentially alter stream channel characteristics and modify habitat if they change stream flow. These changes may occur upstream or downstream of the crossing and may lead to loss of habitat or other barriers to reaching habitat.

Removing fish migration barriers and restoring connectivity has been ranked as the most important restoration activity in some prioritizations due to high cost-effectiveness and short time frame for improvement in fish populations (Roni et al 2002). Evaluation of habitat restoration techniques show that the removal or mitigation of barriers to fish movement can lead to some of the largest increases in fish production (Roni et al 2002; Scully et al 1990).

With salmon and resident fish providing the basis for a vibrant sportfishing economy in the Mat-Su Basin (Colt and Schwoerer 2009) and providing an important food source for Alaskans, the replacement of inadequate culverts can provide tangible benefits to fish and people.

The Goal of this Plan

The Matanuska-Susitna Basin Salmon Habitat Partnership formed in 2005 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. In 2008 the Mat-Su Salmon Partnership completed a Strategic Action Plan that identified road crossings, in particular culverts, as a potential threat to salmon habitat. That plan identified two main goals: preventing new barriers to migration and restoring migration at existing barriers at priority sites. This Mat-Su Salmon Passage Improvement Plan addresses the second goal by identifying priorities for restoration. This plan is intended to guide partners to areas where fish passage restoration should be focused and to provide information to help them to select projects.

The Partnership's Fish Passage Working Group (FPWG) developed the prioritization framework to identify priority culverts through a series of workshops. After draft prioritization criteria were agreed upon, The Nature Conservancy used Alaska Department of Fish and Game (ADF&G) culvert survey data to prioritize the crossings. After the FPWG agreed upon the criteria to be used, TNC completed the prioritization. The prioritization was augmented in January 2011 after ADF&G completed their database with 2010 field surveys.

This Salmon Passage Improvement Plan only includes culverts. Other structures that might impair salmon migration or habitat, like bridges and dams, have not been assessed for several reasons. First, culverts are by far the greatest impediments to fish passage in the Mat-Su. Second, no inventory exists for these other blockages with the consistency and thoroughness of the culvert inventory maintained by ADF&G. Third, natural blockages such as beaver dams can be temporary and may be providing habitat for some aquatic species while impeding movement of others.

This plan prioritizes culverts for replacement by building on the Level 1 Assessment that ADF&G uses. The prioritization framework allows additional culverts to be included as they are surveyed and is flexible so that individual partners can include additional factors to prioritize their organization's restoration work.

The plan also looks at ways for the partnership to work collaboratively to address the highest priority fish passage needs. As has been proven already, much more can be accomplished when partners combine their strengths to tackle fish passage.

Culverts in the Mat-Su

There are hundreds of stream crossings in the Mat-Su Basin. Some convey streams under roads and railroads, while others were installed for intermittent water in roadside ditches. As of Fall 2010, the Alaska Department of Fish and Game (ADF&G) had surveyed over 660 culverts in the Mat-Su Basin that they thought might convey waters where anadromous or resident fish reside or migrate. These culverts were under private driveways, borough roads, state highways, the Alaska Railroad, and trails, at a total of 518 stream crossing sites (Table 1). After the summer of 2011, ADF&G estimated that they had surveyed all borough and state roads and most of the railroad. Progress on private roads, driveways, and trails is much harder to estimate.

Table 1. Ownership of crossing sites

Owner	Count	Percent
Mat-Su Borough	339	65%
State of Alaska	94	18%
Private	45	9%
Alaska Railroad	33	6%
Trail (owner unclear)	7	2%
Total	518	100%

ADF&G assesses culverts for fish passage based on the swimming ability of juvenile Coho salmon (55mm). In the field, ADF&G measures the culvert length, width, perch, and slope and notes culvert shape, type, and condition and presence of bed material within the culvert. These criteria are then compared to a matrix to determine the likelihood that the culvert passes juvenile fish (Appendix 1). The matrix categorizes the culvert based on pipe type, gradient, constriction, perch, and backwatering. In this Level 1 assessment, the culverts are categorized as follows:

- Green – conditions may be adequate to pass juvenile fish
- Gray – conditions unlikely to pass juvenile fish, additional analysis required
- Red – conditions assumed inadequate to pass juvenile fish, additional analysis required

In the Mat-Su Basin, more than half the culverts were assumed to be inadequate to pass fish, and almost another quarter were unlikely to pass juvenile fish (Table 2). As many as 500 culverts could be impeding juvenile fish passage, thus affecting salmon populations and altering habitat. Ownership of these crossings occurs across the agencies (Table 3).

The Level 1 assessment tells us the scope of the fish passage problem but not where to focus or which culverts are likely having the greatest impact on salmon. The Mat-Su Salmon Partnership wanted to determine which inadequate culverts are priorities for replacement, so the information from the ADF&G surveys was used to examine the crossings more closely and to prioritize crossings for replacement.

Table 2. Level 1 Assessment of crossing sites

Category	Count	Percent
Green	107	21%
Gray	125	24%
Red	286	55%
Total	518	100%

Table 3. Level 1 Assessment and ownership of crossing sites

Owner	Green	Gray	Red	Count	Percent
Mat-Su Borough	94	59	186	339	65%
State of Alaska	9	23	62	94	18%
Private	12	12	21	45	9%
Alaska Railroad	7	10	16	33	6%
Trail (owner unclear)	3	2	2	7	2%
Total	104	127	287	518	100%

Culvert Prioritization

Other prioritizations of culverts for replacement have included scoring and ranking schemes that assign scores to each barrier for a set of physical, ecological, and economic attributes. Factors typically include habitat quantity and quality, degree of barrierity, condition, and cost. Some include a benefit-cost ratio of habitat quantity or quality gained. Often these prioritizations are independent of spatial arrangement, which is a disadvantage along with their static nature (O' Hanley & Tomberlin 2005). The actual order of replacement is often influenced by social and economic factors. Culverts are also prioritized with optimization models that look for maximum possible benefit (or minimum cost) given one or more operational and resource constraints (O' Hanley & Tomberlin). Their disadvantage is technical complexity and need for mathematical and computer power.

For the Mat-Su Basin, we opted for a scoring and ranking scheme that utilizes the data already gathered by ADF&G. The goal of this prioritization is to identify the "worst of the worst" impediments to fish passage in the Mat-Su Basin. Using measurements from the ADF&G surveys, relative degree of impediment of red and gray culverts was assessed. Many of the other typical factors, such as habitat quantity and quality, do not exist for a basin-wide analysis.

Prioritization Criteria

The Mat-Su prioritization puts an emphasis on biological value at the crossing. Other factors, like cost, opportunity, and risk, were determined to be best used as secondary information after the initial prioritization. Four criteria were used to prioritize fish passage restoration. Culverts on non-anadromous streams and culverts assessed by ADF&G as adequate (i.e. Green) would receive low scores and not be included in the final list of culverts for replacement. Because the ADF&G Level 1 assessment is designed to identify impediments to passage of juvenile fish, extreme scores for the constriction and gradient criteria were added to highlight those culverts which may be adult impediments, too.

1. Anadromy

The prioritization was only applied to culverts on documented anadromous streams and those that are potentially anadromous. For undocumented streams, any stream segment below 1000' was assumed to be potentially anadromous. The 1000 foot contour was used in developing the Strategic Action Plan because this elevation generally corresponds with a rough geomorphic break along the Talkeetna Mountains where stream gradient increases 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 above this elevation with only 15% of total documented anadromous waters in the Mat-Su Basin occurring above 1000 feet. Stream segments were based on the National Hydrography Dataset and streams digitized by USFWS and TNC. Culverts on resident fish streams, as documented in the Anadromous Waters Catalog (AWC), were not prioritized.

Anadromy	Score
Not anadromous: stream segment > 1000' & not in AWC	0
Potentially anadromous: stream segment below 1000', not in AWC or within 50 m of AWC, on or near (33 m) of an NHD stream segment	8
Documented Anadromous: AWC # in culvert data, or on or near (50 m) an AWC stream segment as anadromous	10

2. Level of blockage

ADF&G's Level 1 assessment is based on the swimming ability of a juvenile Coho (55 mm). Red culverts block juvenile fish, and gray culverts are likely to be partial or complete barriers, but more information is required to determine the level of blockage. Blockages to adult fish are not flagged in the culvert inventory though some data, like perch and pool depth, might indicate a total blockage to adults. Perch alone would not indicate if adults would travel further upstream if they could (i.e. lack of spawning habitat) or if water levels affect access, too.

Level 1 assessment category	Score
Assumed not a barrier: Green	0
Assumed partial barrier: Gray	5
Assumed barrier: Red	7

3. Constriction

Constriction ratio is based on the width of the culvert compared to the width of the stream as measured at ordinary high water (OHW)[1]. The break points for the score were derived from stream simulation guidelines (USFS 2008) and the Level 1 assessment matrix. Culverts connected to wetland systems or lakes may have minimal or no flow and are continually backwatered. In these cases, the constriction of the culvert does not affect fish passage.

Ratio of Culvert span to OHW	Score
> 1.0 or continually backwatered	0
0.9 – 1.0	1
0.75 – 0.9	2
0.5 - 0.75	5
0.5 – 0.4	7
< 0.4	10

4. Gradient

Gradient was measured in the culvert. Culverts that are embedded in the creek substrate and are retaining substrate within the pipe are likely providing resting places for juvenile salmon, so higher gradients are not necessarily an impediment to fish passage. Culverts that are not embedded retain no substrate and thus no variable flows with resting places. The break points for the score were based on the Level 1 assessment matrix.

Gradient within culvert	Score
If culvert embedded < 1.0%	0
>1.0%	2
If culvert not embedded < 0.5%	0
0.5 – 1.0%	1
1.0 – 2.0%	2
2.0 – 3.5%	3
3.5 – 5%	7
>5%	10

Tiers for Restoration Priority

We grouped crossings into priority tiers based on scores (criteria and total scores in Appendix 2). Using tiers instead of a prioritized list based on scores has several advantages. First, this approach also allows us to more easily add additional culverts to the prioritization as they are surveyed by ADF&G. Second, within the high priority tiers we can look at the geographic distribution of inadequate culverts to consider how best to address impacts on entire systems. Third, partners and organizations with different missions can select crossings within a tier that

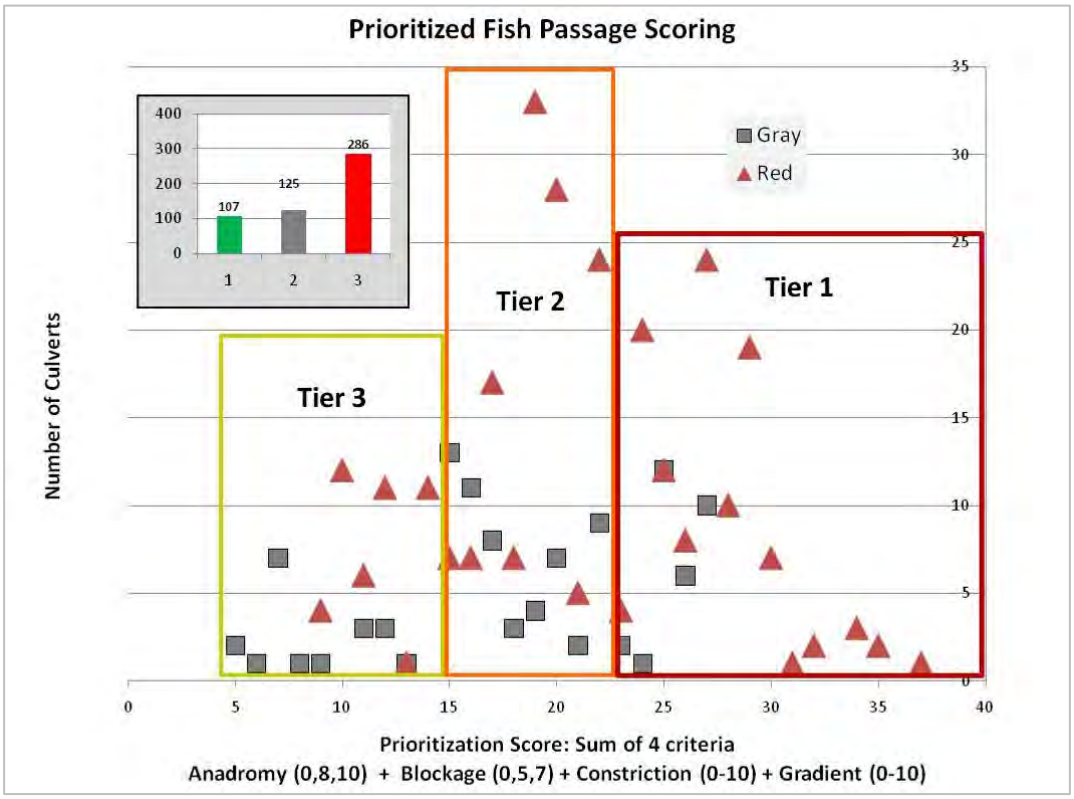
[1] Ordinary high water is defined by Alaska law as "in the non-tidal portion of a river lake, or stream: the portion of the bed(s) and banks up to which the presence and action of the non-tidal water is so common as to leave a natural line or "mark" impressed on the bank." The full definition and a graphic are available on the state website: www.adfg.alaska.gov/index.cfm?adfg=uselicense.faqs.

meet their requirements for restoration. Break points between tiers were calculated with a Natural Breaks analysis[2]. Tier 4 includes all green culverts or those on assumed non-anadromous streams. The four tiers are as follows:

Tier	Score Range	Count	Percent
Tier 1 – Highest Priority for Restoration	23 - 37	144	28%
Tier 2 – High Priority for Restoration	15 - 22	165	32%
Tier 3 – Medium Priority for Restoration	5 - 14	84	16%
Tier 4 – Assumed Adequate for Fish Passage	Not scored	125	24%

This approach illustrates that some culverts categorized as Gray with the Level 1 assessment may be a high priority for restoration compared to some Red culverts (Figure 1). For some Gray culverts, the combination of factors that impede fish passage indicate a greater likelihood that juvenile fish are not able to pass. For some Red culverts, this prioritization indicates that one factor may have automatically categorized them as Red, yet other culverts may pose much greater problems. Whereas the Level 1 assessment indicated that 76% of culverts were inadequate or assumed inadequate, the Tiered Prioritization narrows the scope to just over half the culverts (60%) as high priorities (Tiers 1 and 2) for restoration and illustrates that some inadequate culverts may be lower priority when their characteristics are compared to other inadequate culverts (Tier 3).

Figure 1. Comparison of Level 1 Assessment and Tiered Prioritization



[2] Natural breaks is a data classification method that partitions data into classes based on natural groups in the data distribution. This classification assigns data to classes so that the variances within classes are minimized, while the variances among classes are maximized. For more, see http://www.cdc.gov/BRfss/maps/faqs.htm#13.

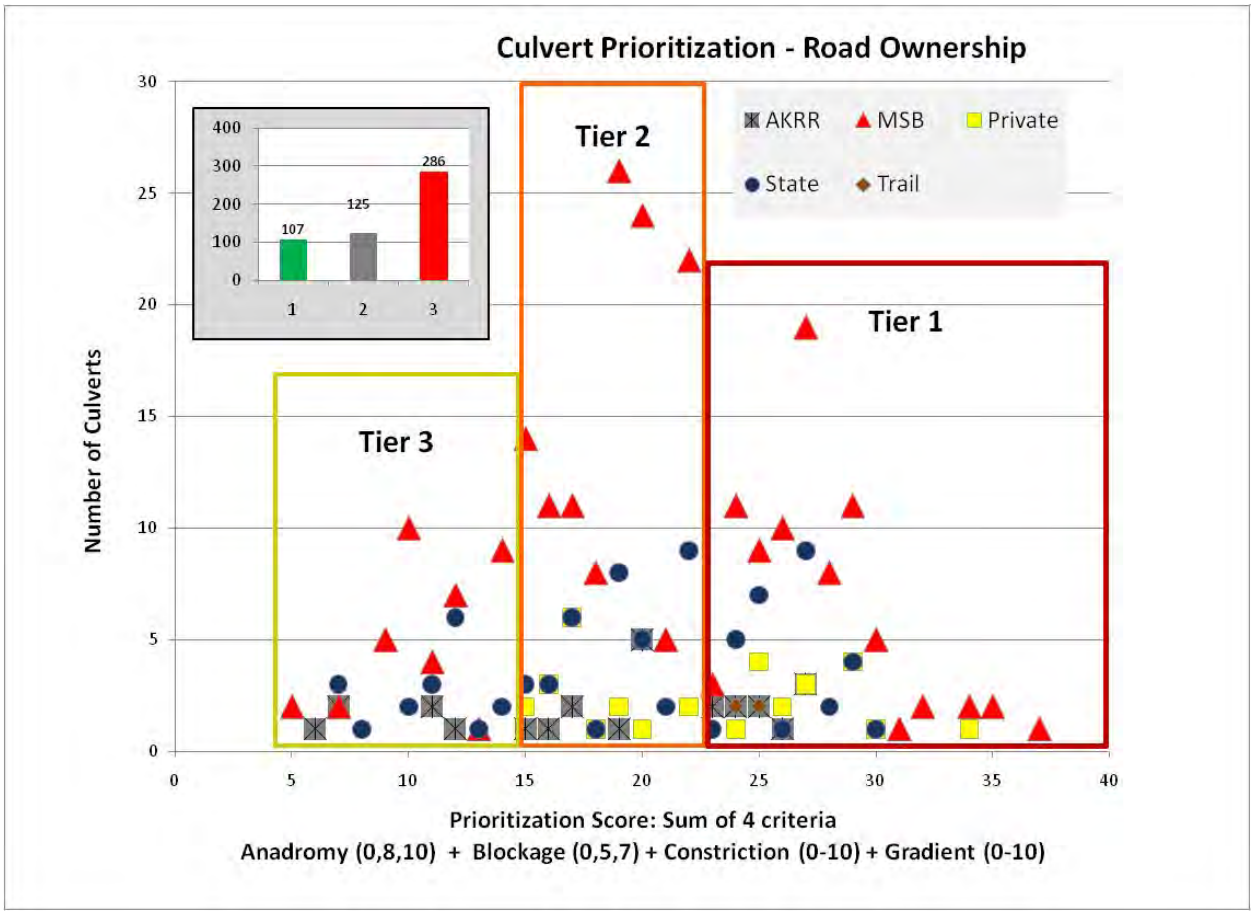
Ownership of Inadequate Culverts

The majority of crossings in Tiers 1 to 3 are on roads owned or maintained by the Mat-Su Borough (Table 4). The state has the more than a fifth, private owners own 8%, and 7% are under the Alaska Railroad. A visual representation of the distribution of ownership shows that publicly-owned culverts are distributed fairly evenly across the Tiers 1 – 3 (Figure 2). Private culverts, however, fall into Tiers 1 and 2.

Table 4. Ownership of Tiers 1 - 3

Owner	Count	Percent
Mat-Su Borough	245	62%
State of Alaska	85	22%
Private	33	8%
Alaska Railroad	26	7%
Trail (owner unclear)	4	1%
Total	393	100%

Figure 2. Ownership of Tiered Prioritization



Location of Inadequate Culverts

As expected, the majority of Tier 1 – 3 crossings occur in the core area of Palmer and Wasilla (Figure 3a, b, c). Tier 1 – 3 crossings are also concentrated in four other areas -- the subwatersheds in the upper Susitna Valley from Willow to the north of Trapper Creek and Talkeetna; subwatersheds along the Parks Highway corridor along the upper Chuiltna River; at tributaries to the Susitna River on the Denali Highway, and the upper part of the Matanuska River watershed. There are also Tier 3 crossings in the Lake Louise area.

Figure 3a. Watersheds with Tier 1 (red) culverts

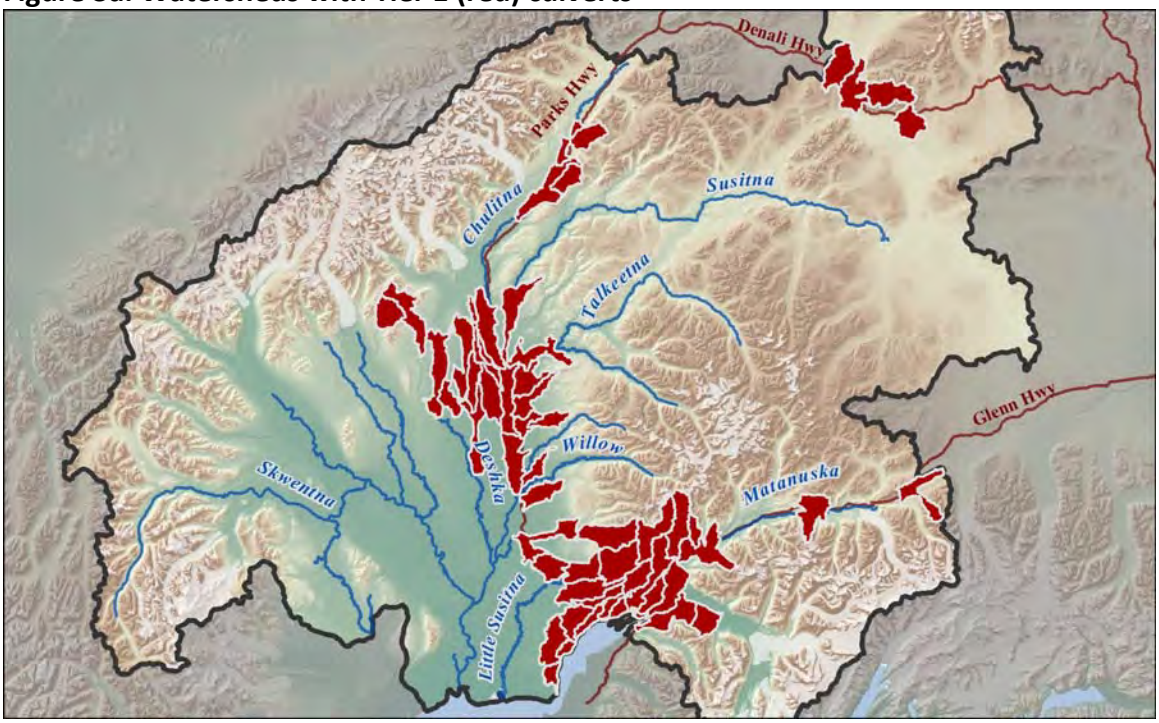


Figure 3b. Watersheds with Tier 2 (orange) culverts

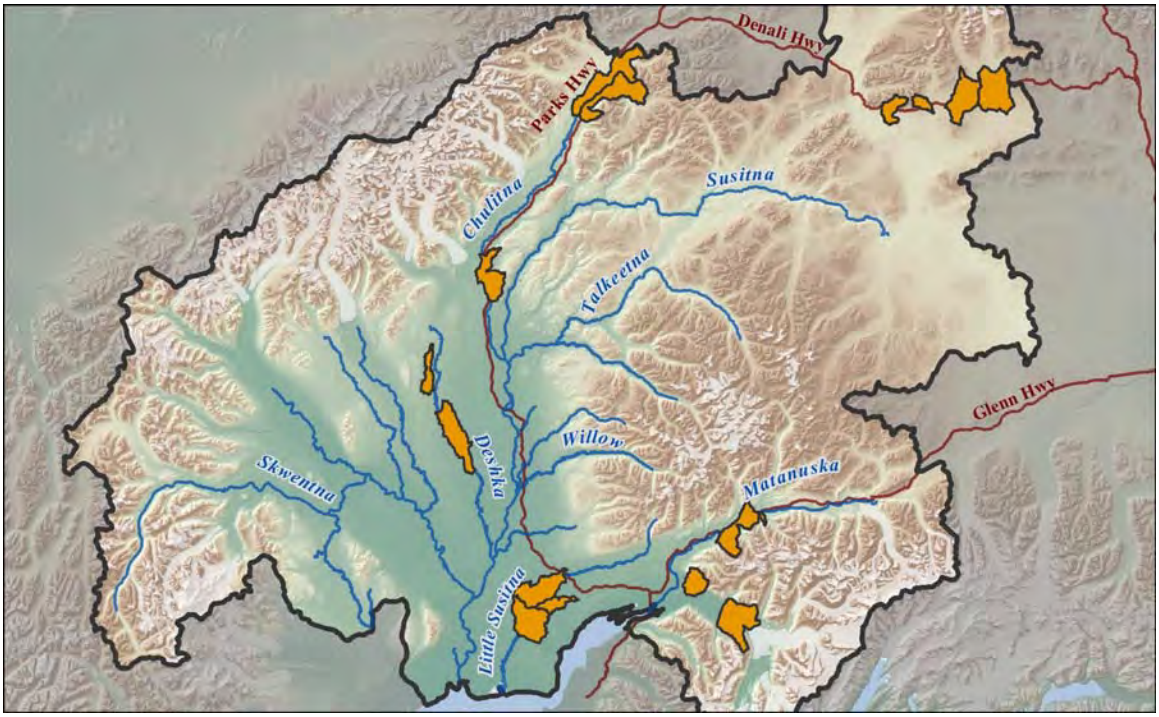
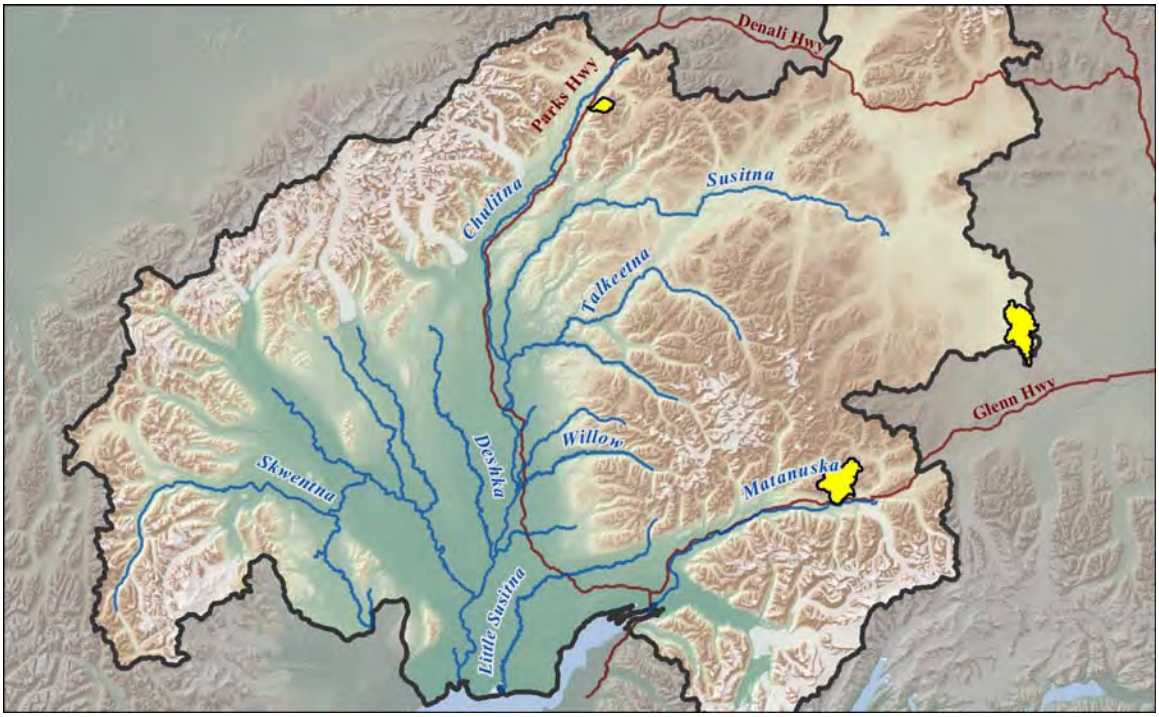


Figure 3c. Watersheds with Tier 3 (yellow) culverts



Additional Criteria for Further Prioritization

There were several criteria that we wanted to include and could not due to lack of data or inconsistency in the data. Other information could be useful to the transportation agencies and for project selection at a finer scale than this prioritization will achieve. As this prioritization developed, we noted what else we'd like to know about the stream or culvert to help inform information and science needs and for possible inclusion in a more comprehensive prioritization methodology.

Habitat Quantity and Quality

Habitat quantity and quality are included in other prioritizations and indicate the relative amount of habitat that fish cannot reach.

Habitat quantity is a typical criterion in culvert prioritizations, but its use varies. Some prioritizations look at upstream habitat, others at downstream, and others add the lengths or take the greater (Taylor and Love) or lesser of the two. Looking at habitat upstream is most important when adult salmon migration to spawning areas maybe blocked. For juvenile salmon, access to habitat upstream or downstream may be an issue at some culverts. Juvenile salmon may be absent from rearing habitat if there's a lack of adult spawning.

In addition to deciding how to include habitat quantity, we also faced a challenge with applying the criteria across the basin with the data available. In Alaska, the Anadromous Waters Catalog (AWC) delineates waters with anadromous fish, and the National Hydrographic Dataset (NHD) maps freshwater streams. In some places in the Mat-Su, the AWC and NHD are not coincident or existent, or we know from on-the-ground observation that the available dataset is incorrect. In addition, culvert point locations seldom occur on a stream segment, which makes it difficult to automate the calculation of habitat on either side of the culvert. These discrepancies made it difficult to automate a mapping calculation. Manual calculation is possible for smaller areas of interest, where there is other information to clarify stream location, but was not feasible for the entire basin. On individual streams, qualitative habitat surveys would provide the best measure.

To investigate how habitat quantity might impact the prioritization scores, we did manually calculate habitat quantity upstream in the Little Susitna River and Wasilla Creek watersheds. Little Su tributaries are not very long, so calculating habitat quantity did not change relative scores. On Wasilla Creek, we scored the culverts both as distance to the next blockage and as total distance upstream. The former calculation did not change relative scores for most culverts, as was seen with the Little Su tributary culverts, because there are several culverts along the creek that impede fish passage. When the total distance was used, then culverts lower in the creek were favored. Because so many of the culverts in the Mat-Su are barriers to juvenile salmon, not adults, total habitat may not best indicate how an inadequate culvert affects a juvenile fish's access to the habitat they need.

As with habitat quantity, data for habitat quality is not available for the entire basin. AWC does document some stream segments with lifestage information, but that type of information is not available for all streams in the catalog and the quality of that habitat is not noted. We decided that at this time, habitat quality is best collected in the field and used to prioritize a subset of crossing replacements within or between smaller watersheds.

Culvert Perch

Due to a change in how ADF&G collected perch height in 2005, we could not include perch in the prioritization for the entire basin. Perch height could help highlight Red culverts that might be adult barriers and would provide more detail to compare blockages. For all culverts surveyed from 2005 and after, perch could be included as an additional criterion for prioritizing, if it were available for culverts of interest. Of the 518 crossings, 336 were surveyed after 2005.

To see how perch might affect the prioritized scores and the overlap of gray and red culverts, we applied perch to those 336 crossings (Table 4). The break points for the score were based on the Level 1 assessment matrix with an extra point for perches (recorded as outfall height by ADF&G) that might impede adult salmon (>12"). The Fish Passage Working Group selected 12" as a minimum threshold for adult salmon barriers; additional research is required to determine what perch will block adult salmon.

Including perch increased the score of 107 (32%) of those 336 crossings (Table 4). Forty-three crossings may be impediments to adult salmon migration, and 29 others were also categorized Red by ADF&G for outfall heights greater than 4".

Not all of the perched crossings are on documented anadromous streams. Twenty-nine perched culverts are on anadromous streams (Table 5; Appendix 3) and all fall into Tier 1 or Tier 2 as priorities for restoration.

Table 4. Perch at all crossings

Outfall height	Score	Count
= 0	0	229
0.1 – 4"	1	35
4.1" – 12"	2	29
> 12"	3	43

Table 5. Perch at anadromous crossings

Outfall height	Tier 1	Tier 2
0.1 – 4"	7	2
4.1" – 12"	8	3
> 12"	7	2

Additional Biological and Opportunity Factors

A complete fish passage database should have three kinds of information: ranking criteria and scores (see above); secondary biological factors that partners may use to prioritize further; and opportunity factors that partners may use to prioritize further or to plan projects. Secondary Biological and Opportunity factors are listed below; those in italics are in the current prioritization database. Other factors may be gathered on a smaller scale to prioritize crossings within a watershed or to design the restoration project.

Secondary Biological factors:

- Barriers upstream and downstream
- Presence of adults and/or juveniles upstream
- Species diversity or richness; may include trout
- Fish Abundance and/or status of population
- Proximity to spawning areas
- Proximity to rearing areas
- Upstream and/or downstream habitat quality or type (e.g. wetland, lake)
- Upstream and/or downstream habitat quantity
- Priority watersheds based on Salmon Watersheds Atlas (Mat-Su Salmon Partnership 2009)
- Invasive species (i.e. pike) in the watershed

Opportunity Factors:

- *Owner of road/culvert*
- *Additional culvert survey information*
    - *Perch*
    - *culvert type*
    - *culvert condition*
    - *inlet width and height*
    - *culvert length*
- Road scheduled for work in future
- Potential design and construction costs

Collaborative Approaches to Improving Fish Passage

Organizations in the Mat-Su Salmon Partnership have been working together for over 15 years to improve fish passage in the basin. One goal of this plan is to find additional ways that these existing collaborations can be enhanced to effect greater overall improvement in fish passage in the Mat-Su. The prioritization suggests partners might be effective working together in watersheds or concentrating their efforts to assist transportation agencies with repairing their culverts.

Ecosystem Approach

An ecosystem approach attempts to remove all barriers to fish passage within a watershed or adjacent watersheds and to restore more normal functioning to the streams. This opens up an entire ecosystem, ensuring that returning salmon have access to spawning areas and that juvenile fish can move throughout the ecosystem to reach unfrozen overwintering areas and productive rearing. Studies elsewhere have indicated that reducing the environmental impacts of river infrastructure networks at a watershed level provide the most effective and cost-efficient means by which to enhance fish populations and overall ecological status of river systems (Kemp & O' Hanley 2010). Partners including the Mat-Su Borough, US Fish and Wildlife Service, and The Nature Conservancy have used a watershed approach in the last four years to open up fish passage on tributaries to the Little Susitna River.

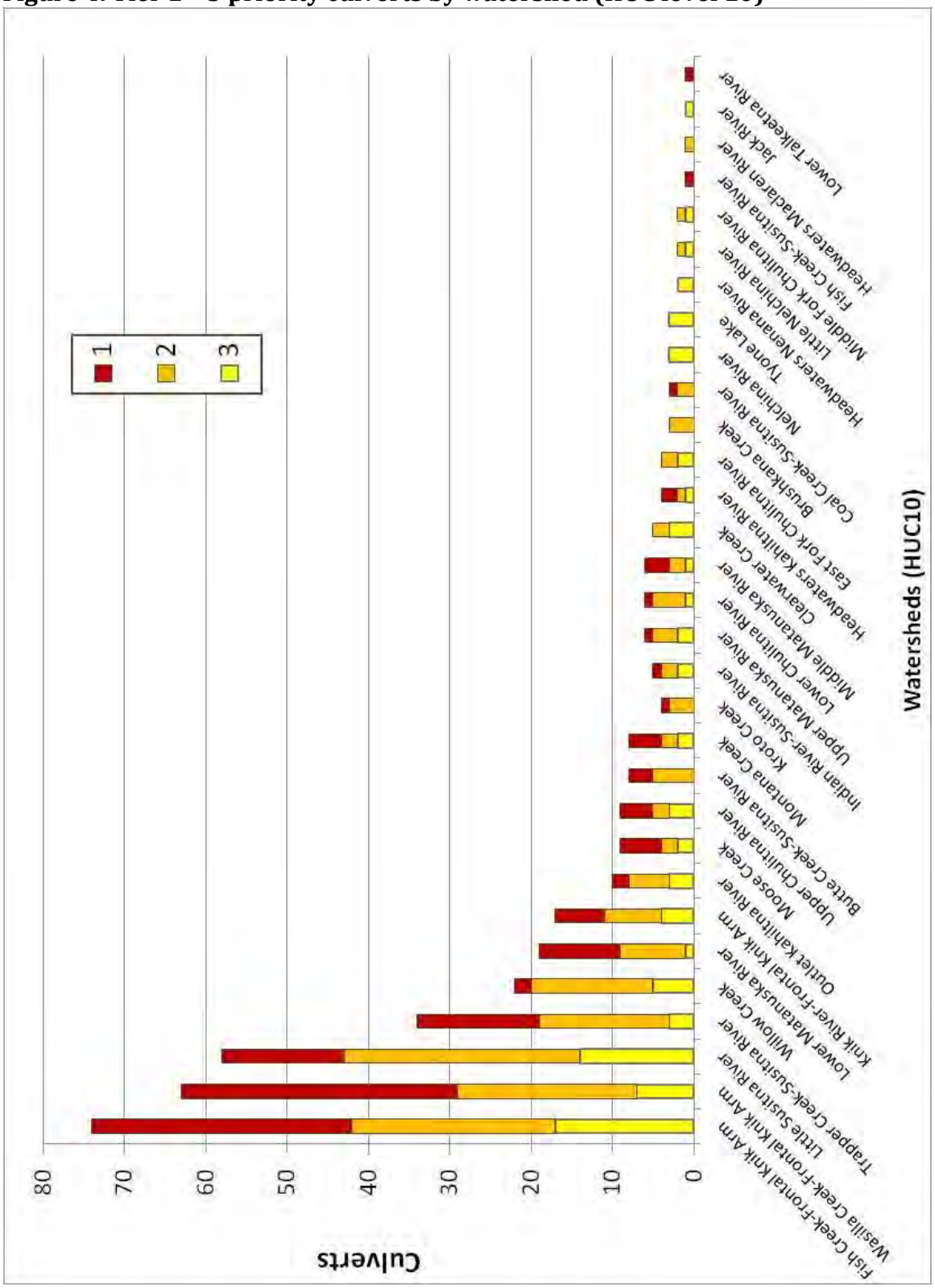
The summary of Tier 1 - 3 crossings by watershed indicates several areas where a watershed approach to improving fish passage might provide a large benefit (Figure 3; Figure 4; Table 5).

To select one or two watersheds for greater focus, we could include additional criteria that were not possible across the basin, including habitat quantity, perch, species, and opportunities. Partners can also do on-the-ground assessment of conditions, including habitat quality. Costs and landowner/culvert owner willingness will be important factors to determine where to focus.

Table 5. Potential Grouped watersheds for restoration focus

	Watersheds (HUC 10)	Tier 1	Tier 2	Tier 3	Total Tiers 1-3
Little Susitna-Big Lake	Goose Bay	32	25	17	74
	Little Susitna River	15	29	14	58
	Willow Creek	2	15	5	22
	Fish Creek-Big Lake	1			1
Matanuska-Knik	Matanuska-Knik Delta	34	22	7	63
	Lower Matanuska River	10	8	1	19
	Knik River-Frontal Knik Arm	6	7	4	17
	Upper Matanuska River	1	3	2	6
	Middle Matanuska River	3	2	1	6
Middle Susitna	Trapper Creek-Susitna River	15	16	3	34
	Montana Creek	4	2	2	8
	Indian River-Susitna River	1	2	2	5
	Lower Talkeetna River	1			1
Petersville	Outlet Kahiltna River	2	5	3	10
	Moose Creek	5	2	2	9
	Kroto Creek	1	3		4
	Headwaters Kahiltna River	2	1	1	4
Chulitna	Upper Chulitna River	4	2	3	9
	Lower Chulitna River	1	4	1	6
	East Fork Chulitna River		2	2	4
	Middle Fork Chulitna River		1	1	2
Susitna Headwaters	Butte Creek-Susitna River	3	5		8
	Clearwater Creek		2	3	5
	Coal Creek-Susitna River	1	2		3
	Headwaters Maclaren River		1		1

Figure 4. Tier 1 – 3 priority culverts by watershed (HUC level 10)



Adult Barrier

Inadequate culverts may impede movement of juvenile fish within a stream system or block adult salmon from spawning, thus removing a stream as productive habitat. Forty-three crossings in the basin have perches greater than 12" and may pose a barrier to adult salmon. Restoration of passage at these crossings could increase the amount of available spawning habitat, which in turn could introduce juveniles to more rearing habitat in the basin. These crossings occur in watersheds with Tier 1 and Tier 2 culverts and in many cases, these culverts scored highly based on their gradient and constriction scores (Appendix 3).

To determine if these culverts are blocking significant spawning habitat, the length of habitat upstream of the crossing can be calculated with available GIS stream layers or assessed with field surveys. Where the length appears to be significant, habitat quality can be assessed in the field. With this information, partners can determine restoration needs, estimate construction costs, and determine which agencies need to be involved to restore fish passage at these crossings.

Agency Focus

The Mat-Su Salmon Partnership could focus on helping its government partners with replacing their inadequate culverts. The Mat-Su Borough owns 64% of the Tier 1 – 3 crossings and the State of Alaska owns 21%.The partnership can help these agencies in several ways.

First, they can raise funds to assist with design and construction costs. US Fish and Wildlife Service has worked with the Mat-Su Borough to provide technical expertise and construction funding for over 60 culverts in the last 15 years. The Nature Conservancy (TNC) has applied for federal grants to replace culverts on borough roads and right-of-ways. In some cases, TNC transferred the funds to the borough for the work to be contracted through the borough and in others, TNC acquired permits to replace culverts on right-of-ways. The Alaska Department of Fish and Game, Chickaloon Traditional Native Council and Natural Resource Conservation Service have all contributed to replacements on state and borough roads in the past.

Second, partners can work with the transportation agencies during their project scoping and planning phases to help identify culverts that need to be replaced. This prioritization will aid these agencies in understanding which culverts are priorities. The FPWG could work with the agencies to look at their current transportation project plans (i.e. DOT STIP, MSB CIP) for inadequate culverts that could be replaced during other road construction.

Third, partners can advocate for these agencies to have greater support from their administrations to undertake fish passage restoration projects. One strategic action of the Partnership's plan identified education within agencies as a means to maintaining fish passage at roadways[3].

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

Recommendations

This prioritization aids in reducing the number of crossings that appear to require replacement to ensure fish passage, yet many barriers remain. Recent monitoring of fish passage culvert replacements suggest that we could be more effective in selecting projects if we understood juvenile salmon distribution and habitat use better. Additional analyses and field investigations are needed to select those culverts whose replacement will have the biggest benefit to salmon populations. We will also need to seek funding to implement these fish passage priorities. The following recommendations includes the possible approaches to selecting those highest priority projects and are intended to guide the Mat-Su Salmon Partnership in next steps to improving fish passage in the Mat-Su Basin. These approaches are not mutually exclusive and multiple approaches could be taken to provide greater understanding about fish passage and bring greater efficiency and effectiveness to restoration activities.

- **Perched Culverts:** Do additional analyses and field investigations to determine which perched crossings have cut off important anadromous fish habitat, either adult spawning or juvenile rearing. For culverts surveyed after 2005, take the prioritization to the next phase by including perch. This could change the prioritization significantly for those culverts categorized as Red because of perch alone yet falling into Tier 2 or 3 in this prioritization.
    a. Re-survey culverts surveyed prior to 2005 and identified as Red due to perch. Reassess how the inclusion of perch affects culvert prioritization scores.
    b. As possible, use GIS to delineate potential habitat above these perched culverts and use expert opinion to identify potential replacement projects. LiDAR data for the Mat-Su should make this task more feasible than existing datasets do.
    c. Field investigate to confirm quantity and determine quality of habitat and relative abundance of juvenile salmon upstream of perched culverts to indicate if an adult barrier exists.

- **Ecosystem Approach:** Based on this prioritization, pick watershed(s) to start planning an ecosystem-scale fish passage program for the next 4 – 5 years.
    a. Choose watersheds based on stream types, habitat quality, species affected, potential benefits, and opportunities. Also look for small streams where a series of inadequate culverts may trap juvenile fish in small sections of streams, creating greater densities and blocking access to additional habitat, possibly of higher quality for rearing and overwintering.
    b. Field investigate to determine quantity and quality of habitat inaccessible due to inadequate culverts, including perched culverts that block adult migration and all culverts that impede juvenile movement upstream and downstream.

- **Agency Focus:**
    a. Add generalized cost estimates to prioritization based on stream size, ownership and road surface
    b. Review borough and state transportation plans for overlap with watersheds with higher number of Tier 1 – 2 crossings
    c. Work with agencies to determine which projects are feasible

- **Watershed Study:** Pick a watershed to study how culverts affect juvenile distribution and ecosystem functioning within a watershed. Choose based on stream types, habitat quality, species affected, and opportunities.
    a. FWS completed a spawning distribution study and is currently undertaking a juvenile coho salmon tagging study in the Big Lake watershed to investigate their migration and habitat use, including overwintering areas. These data will provide input into an optimization model to better prioritize culvert replacement in this area.
    b. Field investigate habitat variables to better understand how culverts affect juvenile and adult fish movement and juvenile distribution and ecosystem functions, such as sediment transport and flood control. Additional analyses should incorporate some type of biotic measure (e.g. PIT tags, catch-per-unit-trap, mark recapture, etc,)

- **Funding:** Develop a long-term funding plan for fish passage restoration in the Mat-Su.
    a. This might include agreements between the various organizations on roles and responsibilities.
    b. Identify potential funding, both private and public, for fish passage restoration from 2013- 2018 (including grants, STIPs, foundations, etc.). Create a calendar and partner responsibility list for applying for funds.
    c. Prepare an overall fish passage restoration project description that can be used as a basis for preparing proposals.

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Appendices

1. Alaska Department of Fish and Game Level 1 Assessment of Fish Passage
2. Prioritized Crossing Sites in the Mat-Su with Criteria Scores
3. Perched Crossing Sites in the Mat-Su with Criteria Scores

Appendix 1: Alaska Department of Fish and Game Level 1 Assessment of Fish Passage

ADFG Juvenile Salmonid Fish Passage Assessment Criteria

	Structure Type	Green *Conditions may be adequate to pass juvenile fish*	Gray *Conditions unlikely to pass juvenile fish, additional analysis required*	Red *Conditions assumed inadequate to pass juvenile fish, additional analysis required*
1	Bottomless pipe arch, embedded pipe arch, or embedded circular CMP (all span widths and corrugations)	Installed at channel gradient (+/- 1% slope), AND culvert span to OHW width ratio greater than or equal to 0.75 OR fully backwatered	Structure not installed at channel gradient (+/- 1%), OR culvert span to OHW width ratio of 0.5 to 0.75	Culvert span to OHW width ratio less than 0.5
2	Culverts (all span widths) with 2 X 6 inch corrugations or greater, not embedded.	Culvert gradient less than 1.0%, AND outfall hgt.= 0, AND culvert span to OHW width ratio greater than 0.75 OR fully backwatered	Culvert gradient 1.0 to 2.0%, OR less than or equal to 4-inch outfall hgt., OR culvert span to OHW width ratio of 0.5 to 0.75	Culvert gradient greater than 2.0%, OR outfall hgt. greater than 4 inches, OR span to OHW width ratio less than 0.5
3	Pipe arch or circular CMP (span width greater than 4 feet), less than 2 X 6 inch corrugations, not embedded	Culvert gradient less than 0.5%, AND outfall hgt. = 0, AND culvert span to OHW width ratio greater than 0.75 OR fully backwatered	Culvert gradient 0.5 to 2.0%, OR less than or equal to 4-inch outfall hgt., OR culvert span to OHW width ratio of 0.5 to 0.75	Culvert gradient greater than 2.0%, OR outfall hgt. greater than 4 inches, OR culvert span to OHW width ratio less than 0.5
4	Circular CMP (span width less than or equal to 4 feet), less than 2 X 6 inch corrugations, not embedded	Culvert gradient less than 0.5%, AND outfall hgt.= 0, AND culvert span to OHW width ratio greater than 0.75 OR fully backwatered	Culvert gradient 0.5 to 1.0%, OR less than or equal to 4-inch outfall hgt., OR culvert span to OHW width ratio of 0.5 to 0.75	Culvert gradient greater than 1.0%, OR outfall hgt. greater than 4 inches, OR span to OHW width ratio less than 0.5.
5	Box culverts, culverts with non-standard configurations or materials, baffled, or multiple structure installations		All	

1: These criteria are not design standards, but rather indicate whether the structure is likely to provide fish passage for juvenile salmonids based on a one-time evaluation.

2: Ordinary high water (OHW) is the mean stream width measured either upstream or downstream of the culvert beyond the hydraulic influence of the culvert. The OHW mark is the elevation on the bank where the ordinary action of stream flows leaves a natural line on the bank as indicated by erosion, changes in soil characteristics, destruction of terrestrial vegetation, or other distinctive physical characteristics.

3: An embedded culvert must have 100% bedload coverage. Circular culverts must be embedded at least 20% of the diameter. A pipe-arch must be embedded so that the mean bedload depth is greater than or equal to the vertical distance from the bottom of the pipe to the point of maximum horizontal dimension of the culvert (haunch height) or is 1 foot deep, whichever is greater.

4: A culvert is considered backwatered if the elevation of the tailwater control exceeds the elevation of the invert at both the outlet and inlet of the culvert. Culvert gradient, span to OHW ratio, and outfall height criteria are not considered in the assessment of fish passage in backwatered culverts. A culvert is not backwatered if a hydraulic jump occurs within the barrel.

5. Outfall height is the difference in water surface elevation in the outlet and the elevation of the tailwater surface.

Appendix 2: Prioritized Crossing Sites in the Mat-Su with Criteria Scores

						Criteria Scores for Prioritization					
site code	AWC Stream Number	Stream Name	Road Name	Latitude	Longitude	Anad-romy	Block-age	Constri ction	Gradi-ent	Total Score	Tier
20501051			PHILLIPS DRIVE	61.611	-149.639	10	7	10	10	37	1
20501233		Unk (Connects pond to marsh)	Suzanna Street	61.582	-149.571	8	7	10	10	35	1
20400592		Eska Creek	Eska Road	61.739	-148.906	8	7	10	10	35	1
20401363	247-50-10260-2019-3041	Trib Wasilla Ck	private drive (near Hyer Rd)	61.576	-149.295	10	7	10	7	34	1
20501086			BRITTANY DRIVE	61.577	-149.729	10	7	10	7	34	1
20401288		Connects Nekleson and unnamed lakes	Home Built Circle	61.627	-149.283	10	7	10	7	34	1
20501055		Seymore Lake Drainage	MEADOW LAKES DRIVE	61.598	-149.678	8	7	10	7	32	1
20501207		Unk Trib to Little Susitna	Palmer Fishhook Rd	61.747	-149.232	10	7	5	10	32	1
20501148			MOOSE MEADOWS RD	61.678	-149.405	10	7	7	7	31	1
20401266	247-50-10200-2071-3025-403C	Bodenberg Ck	driveway at Bodenberg	61.573	-149.036	10	7	10	3	30	1
20400628		NULL	Old Glenn Highway	61.474	-149.170	8	7	5	10	30	1
20501466		Caswell Ck	Hidden Hills Rd	61.989	-149.997	10	7	10	3	30	1
20401340		Tributary Wasilla Creek u/s of Wright Lk	Bonnie	61.647	-149.190	10	7	10	3	30	1
20401330	247-50-10260-2019-3066-4025	Trib Wasilla Creek	Seagull Drive	61.616	-149.212	10	7	10	3	30	1
20501402	247-41-10200-2081-3194-4016	SEVENTEEN MILE Ck Trib	Petersville Rd	62.337	-150.564	10	7	10	3	30	1
20501493		Unk Trib to Cache Ck	Petersville Rd	62.490	-150.985	10	7	10	3	30	1
20401273	247-50-10300-2080	Trib Cottonwood Ck	Driveway	61.625	-149.314	10	7	10	2	29	1
20501383		Horeshoe Ck	Parks Highway	62.867	-149.853	10	7	10	2	29	1
20501419	247-41-10200-2300-3011	Question Ck	Talkeetna Spur	62.222	-150.087	10	7	10	2	29	1
20501424	247-41-10200-2226	Unk Trib	PARKS HIGHWAY	62.044	-150.060	10	7	10	2	29	1
20501429	247-41-10100-2231-3018	Unk Trib	PARKS Highway	61.646	-149.876	10	7	5	7	29	1
20501156		Crocker Ck	SETTLERS BAY DRIVE	61.512	-149.629	10	7	10	2	29	1
20501223		O'Brian Ck	Royal Lane	61.484	-149.683	10	7	10	2	29	1
20501173		Goose Ck	Cameo	61.422	-149.919	10	7	5	7	29	1
20501167		Trib to Nancy Ck	Arthur Circle	61.688	-149.957	10	7	10	2	29	1
20401268	247-50-10300-2054	Connects Cornelius and Neklason Lakes	Engstrom Road	61.629	-149.261	10	7	10	2	29	1
20401359	247-50-10260-2019-3038	Wasilla Creek	Fireweed Road	61.567	-149.313	10	7	10	2	29	1
20401302	247-50-10300	Cottonwood Creek	Marble Way	61.542	-149.523	10	7	10	2	29	1
20401315	247-50-10260-2019-3020	Spring Creek	Old Matanuska Rd	61.548	-149.229	10	7	10	2	29	1
20401263	247-50-10200-2071-3025	Trib Bodenberg Creek	private drive - Goodrich	61.570	-149.040	10	7	10	2	29	1
20501077		Little Meadow Creek	RIDGECREST RD	61.573	-149.693	10	7	10	2	29	1
20501526		Buddy Ck	Unnamed Primitive Rd	62.140	-149.987	10	7	10	2	29	1
20501494		Unk Trib to Cache Ck	Petersville Rd	62.514	-150.914	10	7	10	2	29	1
20501213		Trib to Little Su	Palmer Fishhook Rd	61.775	-149.204	10	7	10	2	29	1
20401260	247-50-10200-2071-3023	Tributary to Bodenberg Creek	Private Drive	61.566	-149.043	10	7	10	2	29	1
20400600		NULL	Knik River Rd	61.463	-148.860	8	7	10	3	28	1
20400601		NULL	Knik River Rd	61.457	-148.840	8	7	10	3	28	1
20501413	247-41-10200-2291-3025	Trib TO RABIDEUX Ck	PARKS Highway	62.217	-150.230	10	7	10	1	28	1
20501431	247-50-10330-2050-3050-4019	Unk Trib	PARKS HIGHWAY	61.578	-149.730	10	7	10	1	28	1
20501459		Unk Trib to Susitna R	Bradley	62.281	-150.179	8	7	10	3	28	1
20501258		Trib to Lake Ck	Zero Lakes Rd	61.672	-149.824	8	7	10	3	28	1
20501105		Meadow Creek	BEAVER LAKE RD	61.563	-149.826	10	7	10	1	28	1
20500568	247-41-10100-2379	Tribute to Little Susitna	Fish Hook Rd	61.751	-149.233	10	7	10	1	28	1
20501192		Connects 2 Lakes	Lancaster	61.473	-149.959	8	7	10	3	28	1

						Criteria Scores for Prioritization					
site code	AWC Stream Number	Stream Name	Road Name	Latitude	Longitude	Anad-romy	Block-age	Constri ction	Gradi-ent	Total Score	Tier
20501143		Crocker Creek	SETTLERS BAY DRIVE	61.501	-149.620	10	7	10	1	28	1
20401262	247-50-10200-2071	Bodenberg Ck	private drive	61.564	-149.041	10	5	10	2	27	1
20401264	247-50-10200-2071-3025-4030	Bodenberg Ck	private drive - Goodrich	61.570	-149.039	10	7	10	0	27	1
20401309	247-50-10260-2035	Rabbit Slough	Alaska Railroad	61.538	-149.234	10	7	10	0	27	1
20401310	247-50-10260	Rabbit Slough	Alaska Railroad	61.535	-149.235	10	5	10	2	27	1
20401312	247-50-10260	Rabbit Slough	Glenn Highway	61.535	-149.252	10	7	10	0	27	1
20401278	247-50-10300	Cottonwood Ck	Palmer Wasilla Highway	61.583	-149.396	10	5	10	2	27	1
20401301	247-50-10300	Cottonwood Ck	Riverdell	61.532	-149.528	10	5	10	2	27	1
20400590	247-50-10220-2109-3012	NULL	Glenn Highway	61.724	-148.830	10	7	0	10	27	1
20400593		NULL	Jone Village Rd	61.733	-148.919	0	7	10	10	27	1
20501384		Trib to PASS Ck	Parks Highway	62.908	-149.719	0	7	10	10	27	1
20501416		MONTANA LAKES	PARKS Highway	62.139	-150.051	10	5	10	2	27	1
20401279	247-50-10300	Cottonwood Ck	Parks Highway	61.575	-149.404	10	7	10	0	27	1
20501092			BIRCH RD	61.576	-149.775	10	5	10	2	27	1
20501130			BEAVER LAKE RD	61.573	-149.839	10	5	10	2	27	1
20501146			SNUFFY'S RD	61.652	-149.597	0	7	10	10	27	1
20501456		Unk Trib to Susitna	Bradley	62.303	-150.179	8	7	10	2	27	1
20501513		Unk Trib to Susitna R	Saunders	62.307	-150.185	8	7	10	2	27	1
20501516		Unk Trib to Trapper Ck	Susitna River Rd	62.315	-150.198	8	7	10	2	27	1
20501485		Unk trib to Moose Ck	Petersville Rd	62.320	-150.463	10	7	10	0	27	1
20501236		Upper Willow Ck	Upper Willow Rd	61.773	-149.330	0	7	10	10	27	1
20401303	247-50-10300	Cottonwood Creek	Edlund	61.554	-149.488	10	7	10	0	27	1
20501060		Rainbow Lake Drainage	KAREN STREET	61.599	-149.622	10	5	10	2	27	1
20500569	247-41-10100	Tributary to Little Susitna	Fish Hook Road	61.758	-149.228	10	7	7	3	27	1
20401339		Wasilla Creek tributary @ Wright Lake	N. Bonnie Dr.	61.643	-149.194	10	7	10	0	27	1
20401265	247-50-10200-2071-3025	Tributary Bodenberg Creek	private drive - north of Good	61.572	-149.042	10	7	10	0	27	1
20501882			Wolf Road	61.576	-149.840	10	5	10	2	27	1
20400587		Muddy Creek	Glenn Highway	61.796	-147.997	0	7	10	10	27	1
20501803		Unnamed Tributary to Susitna River	Alaska Railroad	62.044	-150.071	10	5	10	2	27	1
20500276		Unk	Denali Highway	63.193	-147.618	0	7	10	10	27	1
20500282		Waterfall Ck	Denali Highway	63.033	-147.183	0	7	10	10	27	1
20501469		Unk	Malaspina	62.144	-149.921	0	7	10	10	27	1
20501473		Unk	Oil Well Rd	62.182	-150.517	0	7	10	10	27	1
20401292	247-50-10300-2022	Tributary to Cottonwood Creek	Redoubt	61.530	-149.525	10	7	10	0	27	1
20401820		Glacial Fan Creek	Glenn Highway	61.816	-147.468	0	7	10	10	27	1
20401329	247-50-10260-2019-3066	trib Wasilla Ck (Walby Ck?)	private drive	61.612	-149.238	10	5	10	1	26	1
20501393	247-41-10200-2381-3007-4029	Unk Trib	Parks Highway	62.393	-150.263	10	7	7	2	26	1
20501038			SHORTY STREET	61.666	-149.339	8	7	10	1	26	1
20501082			AIROLO DRIVE	61.582	-149.725	10	7	2	7	26	1
20501435	247-50-10330-2050	Meadow Ck	BEAVER LAKE RD	61.563	-149.825	10	5	10	1	26	1
20501409	247-41-10200-2341	TRAPPER Ck	Susitna River Rd	62.315	-150.219	10	7	7	2	26	1
20401354	247-50-10260-2019-3041-4013	Trib Wasilla Ck	Lower Rd - near Hyer Rd	61.579	-149.293	10	5	10	1	26	1
20501188		Unk	Karsten Drive	61.594	-149.582	8	7	10	1	26	1
20401284	247-50-10300-2012	Cottonwood Slough	driveway - 2540 Trapline Drive	61.526	-149.515	10	5	10	1	26	1

						Criteria Scores for Prioritization					
site code	AWC Stream Number	Stream Name	Road Name	Latitude	Longitude	Anad-romy	Block-age	Constri ction	Gradi-ent	Total Score	Tier
20401337	247-50-10260-2019	Wasilla Creek	Fishhook Road	61.643	-149.198	10	7	7	2	26	1
20400591		Eska Creek	Jone Village Road	61.728	-148.911	8	5	10	3	26	1
20401322	247-50-10260-2019-3020	Spring Creek	Nelson Road	61.548	-149.264	10	5	10	1	26	1
20501463		Unk. Trib to Talkeetna R.	Cummings	62.344	-150.066	8	7	10	1	26	1
20501807		Unnamed Tributary to Sustina River	Alaska Railroad	62.454	-150.118	10	7	7	2	26	1
20401316	247-50-10260-2019-3020	Spring Ck	Alaska Railroad	61.548	-149.229	10	5	10	0	25	1
20401323	247-50-10260-2019-3030	Trib Spring Ck	Parks Highway	61.556	-149.250	10	5	10	0	25	1
20401317	247-50-10260-2019-3020	Spring Ck	private	61.551	-149.262	10	5	10	0	25	1
20401325	247-50-10260-2019-3020	Spring Ck	Glenn Highway	61.553	-149.249	10	5	10	0	25	1
20401308	247-50-10300	Cottonwood Ck	Trail near Palmer Elks	61.609	-149.292	10	5	10	0	25	1
20501422		NULL	PARKS Highway	62.156	-150.100	10	5	10	0	25	1
20501428		Trib TO LAKE Ck	PARKS Highway	61.659	-149.935	10	7	5	3	25	1
20501047			SUNRISE RD	61.650	-149.564	10	7	5	3	25	1
20501430	247-50-10330-2050-3025	Unk Trib	PARKS HIGHWAY	61.584	-149.743	10	5	10	0	25	1
20501434	247-50-10330-2050-3030	Lucille Ck	Big Lake Rd	61.561	-149.778	10	7	5	3	25	1
20501153			TRAIL	61.591	-149.741	10	7	5	3	25	1
20501490		Unk Trib to Peters Ck	Petersville Rd	62.479	-150.747	10	5	10	0	25	1
20501512		Unk trib to Peters Ck	Petersville Road	62.384	-150.724	10	7	5	3	25	1
20501418	247-41-10200-2300-3011-4008	Unk Trib	Talkeetna Spur	62.211	-150.078	10	7	5	3	25	1
20501221		Trib to Nancy Ck	Driveway	61.689	-149.957	10	7	7	1	25	1
20501238		Shirley Lake outlet	Willow Creek Parkway	61.758	-150.107	10	7	7	1	25	1
20401271	247-50-10300	Anderson Lake outlet		61.623	-149.324	10	7	5	3	25	1
20401304	247-50-10300	Cottonwood Creek	Fern	61.563	-149.450	10	5	10	0	25	1
20401261	247-50-10200-2071-3023	Bodenberg Creek	private drive	61.564	-149.043	10	5	10	0	25	1
20501799		Question Creek	Alaska Railroad	62.196	-150.088	8	5	10	2	25	1
20501420	247-41-10200-2320-3010	EXITS FISH LAKE	TALKEETNA SPUR	62.255	-150.081	10	5	10	0	25	1
20501404		Unamed Trib	Oil Well Rd	62.238	-150.439	8	7	10	0	25	1
20501193		Unk Trib to Fish Ck	Lewis Loop	61.455	-149.809	8	7	10	0	25	1
20401338		Trib Wasilla Creek	Fishhook Road	61.642	-149.196	10	7	7	1	25	1
20401270		Cottonwood Ckk NW Neklason Lk Trib	Camp Challenge Trail	61.633	-149.274	0	7	10	7	24	1
20401274		outlet stream Wolf Lake	Driveway	61.626	-149.312	0	7	10	7	24	1
20400589		NULL	Glenn Highway	61.803	-148.070	0	7	7	10	24	1
20400626		NULL	Old Glenn Highway	61.474	-149.189	0	7	7	10	24	1
20501377		Trib of Little Honolulu Ck	Parks Highway	63.059	-149.553	0	7	10	7	24	1
20501403		Unk Trib	Oil Well Rd	62.283	-150.423	0	7	10	7	24	1
20501449		Meadow Ck	CHURCH RD	61.604	-149.511	8	7	7	2	24	1
20501054			MEADOW LAKES LOOP	61.612	-149.646	8	7	2	7	24	1
20501094			LARAE RD	61.580	-149.746	10	7	5	2	24	1
20500294		Unk	Denali Highway	63.145	-147.532	0	7	10	7	24	1
20500315		Windy Ck	Clear Water Creek Access Rd	63.114	-147.507	0	7	10	7	24	1
20501461		Unk	Caswell Lakes Rd	62.001	-149.956	0	7	10	7	24	1
20501483		Unk Trib to NineMile Ck	Petersville Rd	62.311	-150.374	10	7	7	0	24	1
20501216		Trib to Little Su	Palmer Fishhook Rd	61.778	-149.204	0	7	7	10	24	1
20501204		Unk - drains marsh	Bike Path	61.581	-149.573	8	5	10	1	24	1

						Criteria Scores for Prioritization					
site code	AWC Stream Number	Stream Name	Road Name	Latitude	Longitude	Anad-romy	Block-age	Constri ction	Gradi-ent	Total Score	Tier
20401887		Packsaddle Creek	Lee Drive	61.805	-147.982	0	7	7	10	24	1
20501155		Lucille Creek	BAILEY AVENUE	61.570	-149.510	10	7	7	0	24	1
20501417	247-41-10200-2300-3011-4006	Answer Ck	TALKEETNA SPUR	62.202	-150.067	10	7	5	2	24	1
20501222		O'Brian Ck	Rubacaba	61.493	-149.660	10	7	5	2	24	1
20501165			Railroad	61.658	-149.937	10	7	5	2	24	1
20501795			Alaska Railroad	62.991	-149.630	0	7	7	10	24	1
20401307	247-50-10300	Cottonwood Ck	Bogard Rd	61.614	-149.291	10	5	7	1	23	1
20501426		GREYS Ck	PARKS Highway	61.896	-150.078	10	7	5	1	23	1
20501139		Little Meadow Ck	Alaska Railroad	61.586	-149.670	10	7	5	1	23	1
20501159		Unk	Railroad	61.582	-149.594	8	7	5	3	23	1
20501172		Connects 2 Lakes	Bryant	61.473	-149.960	8	7	7	1	23	1
20401170		trib to Moose Ck	Buffalo Mine Rd	61.730	-149.040	10	5	5	3	23	1
20400583		NULL	Glenn Highway	61.850	-147.388	0	7	5	10	22	2
20400627		NULL	Old Glenn Highway	61.474	-149.175	0	7	5	10	22	2
20400597		NULL	Knik River Rd	61.488	-148.903	0	7	5	10	22	2
20500570		NULL	Fish Hook Rd	61.772	-149.209	0	7	5	10	22	2
20501414	247-41-10200-2291	RABIDUEX Ck	PARKS Highway	62.190	-150.210	10	5	7	0	22	2
20501427	247-41-10100-2231-3050	NANCY Ck	PARKS Highway	61.687	-149.970	10	5	0	7	22	2
20501080			CANNON DRIVE	61.588	-149.723	10	5	7	0	22	2
20501154		Lucille Ck	FOOTHILLS BOULEVARD	61.562	-149.571	10	5	7	0	22	2
40500274		Unk	Denali Highway	63.227	-147.729	0	7	5	10	22	2
20501470		Unk. Trib of Birch Ck.	Mastodon	62.283	-149.951	10	5	5	2	22	2
20501462		Caswell Ck	Caswell Lakes Rd	62.008	-149.986	10	5	5	2	22	2
20501398	247-41-10200-2081-3194	Seventeen Mile Ck	Petersville Rd	62.337	-150.574	10	7	5	0	22	2
20501157		Unk Trib to Little Su	Armstrong	61.632	-149.780	10	5	0	7	22	2
20401198		MCkoberts Ck	Maud Rd	61.585	-148.987	10	5	5	2	22	2
20401290	247-50-10300-2012	Cottonwood Slough	Fairview Loop	61.528	-149.507	10	7	2	3	22	2
20501385		Tributary to Lily Creek	Denali Highway	62.662	-150.226	8	7	7	0	22	2
20501876		Colter Creek	Driveway off Sitze Road	61.658	-149.497	10	5	5	2	22	2
20501479		Unk Trib to Rabideux Ck	Petersville Rd	62.317	-150.309	8	7	5	2	22	2
20501499		Unk Trib to Peters Ck	Petersville Rd	62.498	-150.768	0	7	5	10	22	2
20501214		Trib to Fishhook Ck	Palmer Fishhook Rd	61.773	-149.272	0	7	5	10	22	2
20401191		trib to Friday Ck	Knik River Rd	61.435	-148.782	0	7	5	10	22	2
20401169		trib to Moose Ck	Buffalo Mine Rd	61.710	-149.092	0	7	5	10	22	2
20501254		trib to Willow Ck	Willow Fishhook Rd	61.764	-149.474	0	7	5	10	22	2
20501255		trib to Willow Ck	Willow Fishhook Rd	61.769	-149.433	0	7	5	10	22	2
20401269		Neklason Lake Tributary	Twin Lakes Drive	61.632	-149.264	0	7	5	10	22	2
20401848		Tributary to Wasilla Creek	Driveway off Oceanview Road	61.719	-149.104	0	7	5	10	22	2
20401879		Packsaddle Creek	Victory Road	61.801	-147.986	0	7	5	10	22	2
20501376		Herdage Creek	Parks Highway	63.134	-149.493	0	7	5	10	22	2
20501392	247-41-10200-2381-3051	Tributary to Chulitna River	Parks Highway	62.454	-150.273	10	7	5	0	22	2
20500281		Alpine Ck	Denali Highway	63.042	-147.248	0	7	5	10	22	2
20501212		Trib to Little Su	Palmer Fishhook Rd	61.770	-149.212	0	7	5	10	22	2
20501217		Trib to Little Su	Palmer Fishhook Rd	61.776	-149.213	0	7	5	10	22	2

						Criteria Scores for Prioritization					
site code	AWC Stream Number	Stream Name	Road Name	Latitude	Longitude	Anad-romy	Block-age	Constri ction	Gradi-ent	Total Score	Tier
20501232		Coal Ck	Sushana Rd	61.662	-149.467	10	7	5	0	22	2
20501387		Unk Trib	Parks Highway	62.509	-150.259	10	5	5	1	21	2
20501442	247-41-10100-2231-3080	LILLY Ck	Old Parks Highway	61.707	-150.000	10	5	5	1	21	2
20501050			SUNRISE RD	61.650	-149.568	10	7	1	3	21	2
20501074			BEVERLY LAKE RD	61.616	-149.566	0	7	7	7	21	2
20501492		Rambler Ck	Petersville Rd	62.492	-150.979	0	7	7	7	21	2
20401289	247-50-10300-2039	Tributary to Cottonwood Creek	East Larch Drive	61.601	-149.342	10	7	2	2	21	2
40500292		Unk	Denali Highway	63.276	-147.925	0	7	7	7	21	2
20401327	247-50-10260-2019	Wasilla Ck	Bogard Rd	61.614	-149.242	10	5	5	0	20	2
20401360	247-50-10260-2019-3038	Wasilla Ck	Alaska Railroad	61.566	-149.313	10	5	5	0	20	2
20401333		Trib Wasilla Ck	N 49th State Street	61.616	-149.209	0	7	10	3	20	2
20500567		NULL	Fish Hook Rd	61.713	-149.234	0	7	10	3	20	2
20501382		Coal Ck Trib	Parks Highway	62.877	-149.814	0	7	10	3	20	2
20501425	247-41-10200-2190	CASWELL Ck	PARKS Highway	61.948	-150.055	10	5	5	0	20	2
20501048			DAN JOE STREET	61.662	-149.594	0	7	10	3	20	2
20501049			SUNRISE RD	61.651	-149.586	8	7	2	3	20	2
20501066			JOLLY ROGER DRIVE	61.632	-149.609	0	7	10	3	20	2
20501085			PARKS HIGHWAY	61.577	-149.728	10	7	0	3	20	2
20501467		Unk	Makuskin	62.147	-149.913	0	7	10	3	20	2
20501181		side slough of Willow Ck	Creekside	61.766	-149.995	0	7	10	3	20	2
20501182		Rainbow Lk to Long Lk connex.	Crystal Lake Rd	61.707	-150.085	10	7	0	3	20	2
20501160		Wetland connector	Railroad	61.584	-149.648	0	7	10	3	20	2
20401234		Trib to Knik R	Unnamed Side Rd	61.455	-148.838	0	7	10	3	20	2
20501246		Trib to Willow Ck	Willow Fishhook Rd (offshoot)	61.764	-149.582	0	7	10	3	20	2
20401357		Tributary to Wasilla Creek u/s of Wight Lak	Bains Jordan	61.653	-149.189	0	7	10	3	20	2
20401299	247-50-10300-2001	Tributary to Lucy Creek	Lucy Lake Road	61.514	-149.574	10	5	5	0	20	2
20401328	247-50-10260-2019-3066	Walby Creek (Wasilla Creek tributary)	Colony Schools Drive	61.613	-149.236	10	5	5	0	20	2
20401334	247-50-10260-2019-3066	Trib Wasilla Creek	Trunk Road	61.608	-149.244	10	5	5	0	20	2
20501084		Little Meadow Creek	BRITTANY DRIVE	61.578	-149.730	10	5	5	0	20	2
20501126		Unknown	Ballard Rd.	61.556	-149.783	0	7	10	3	20	2
20501802		Unnamed Tributary of Susitna River	Alaska Railroad	62.100	-150.069	0	7	10	3	20	2
20501808		Unnamed Tributary of the Susitna River	Alaska Railroad	62.503	-150.102	0	7	10	3	20	2
20500275		Unk	Denali Highway	63.213	-147.672	0	7	10	3	20	2
20501520		Unk	Silver Salmon Drive	61.994	-149.963	0	7	10	3	20	2
20501497		Unk trib to Peters Ck	Petersville Rd	62.537	-150.841	0	7	10	3	20	2
20501210		Trib to Little Su	Palmer Fishhook Rd	61.764	-149.221	0	7	10	3	20	2
20501241		Trib to Willow Ck	Willow Fishhook Rd	61.765	-149.615	0	7	10	3	20	2
20501244		Trib to Willow Ck	Willow Fishhook Rd	61.764	-149.588	0	7	10	3	20	2
20501218		Fishhook Ck	Palmer Fishhook Rd	61.776	-149.279	0	7	10	3	20	2
20501152			Alaska Railroad	61.591	-149.741	10	7	0	3	20	2
20501245		Trib to Willow Ck	Willow Fishhook Rd	61.765	-149.582	0	7	10	3	20	2
20501251		Shorty Ck	Willow Fishhook Rd	61.762	-149.490	0	7	10	3	20	2
20501388	247-41-10200-2381-3060	Tributary to Chulitna River	PARKS HIGHWAY	62.474	-150.271	10	7	2	1	20	2
20400586		NULL	Glenn Highway	61.798	-147.991	0	7	5	7	19	2

						Criteria Scores for Prioritization					
site code	AWC Stream Number	Stream Name	Road Name	Latitude	Longitude	Anad-romy	Block-age	Constri ction	Gradi-ent	Total Score	Tier
20400588		NULL	Glenn Highway	61.731	-148.797	0	7	10	2	19	2
20400599		NULL	Knik River Rd	61.469	-148.869	0	7	2	10	19	2
20501381		Unk Trib	Parks Highway	62.876	-149.818	0	7	5	7	19	2
20501394	247-41-10200-2341	Trapper Ck	Parks Highway	62.328	-150.241	10	7	2	0	19	2
20501053			MEADOW LAKES LOOP	61.611	-149.641	10	5	1	3	19	2
20501073			WYOMING DRIVE	61.625	-149.587	0	7	10	2	19	2
20501095			HAWK LANE	61.585	-149.781	0	7	10	2	19	2
20501116			PRIVATE off LAKES BOULEVARD	61.542	-149.949	0	7	10	2	19	2
20501145			SNUFFY'S RD	61.651	-149.602	0	7	5	7	19	2
20501460		Question Ck.	Barge Rd	62.228	-150.052	0	7	10	2	19	2
20501514		Caswell Ck	Shaman	62.018	-149.948	0	7	10	2	19	2
20501480		Nine Mile Ck	Petersville Rd	62.313	-150.348	10	5	2	2	19	2
20501481		Unk Trib to NineMile Ck	Petersville Rd	62.310	-150.362	8	7	2	2	19	2
20501498		Trib to Peters Ck	Petersville Rd	62.535	-150.824	0	7	5	7	19	2
20501208		Unk Trib to Little Su	Palmer Fishhook Rd	61.759	-149.226	0	7	2	10	19	2
20501190			Kenny Boulevard	61.773	-149.987	0	7	10	2	19	2
20501197			Mack Rd	61.577	-149.512	0	7	10	2	19	2
20401355	247-50-10260-2019-3041	Trib Wasilla Ck	Lower Rd - near Hyer Rd	61.578	-149.287	10	5	2	2	19	2
20400594		Tributary to Eska Creek	Eska Mine Road	61.733	-148.915	0	7	10	2	19	2
20101821		Old Man Creek.	Glenn Highway	61.990	-147.023	0	7	2	10	19	2
20401790		Connects ponds to Trail Lake	Alascom Drive	61.842	-147.342	0	7	10	2	19	2
20401791			Alascom Drive	61.851	-147.354	0	7	10	2	19	2
20501823			Jolly Roger Drive	61.633	-149.609	0	7	10	2	19	2
20501071		Fuller Lake Drainage	PITTMAN ROAD	61.605	-149.632	0	7	10	2	19	2
20501800		Sunshine Creek	Alaska Railroad	62.176	-150.077	0	7	10	2	19	2
40500273		Unk	Denali Highway	63.279	-148.053	0	7	10	2	19	2
20500280		Raft Ck	Denali Highway	63.050	-147.275	0	7	2	10	19	2
20500286		Unk	Denali Highway	63.093	-146.677	0	7	10	2	19	2
20501489		Unk Trib to Peters Ck	Petersville Rd	62.471	-150.723	10	5	1	3	19	2
20401176		Trib to Knik River	Clare Way	61.478	-148.892	0	7	5	7	19	2
20401235		trib to Moose Ck	side road off Buffalo Mine Rd	61.710	-149.093	0	7	10	2	19	2
20401171		Premier Ck	Buffalo Mine Rd	61.711	-149.090	0	7	5	7	19	2
20501248		Trib to Willow Ck	Willow Fishhook Rd	61.765	-149.555	0	7	2	10	19	2
20501250		Francie Ck	Willow Fishhook Rd	61.765	-149.521	0	7	10	2	19	2
20501253		trib to Willow Ck	Willow Fishhook Rd	61.764	-149.475	0	7	5	7	19	2
20501187		Fishhook Ck	Gold Chord Rd	61.781	-149.278	0	7	5	7	19	2
20501433	247-41-10100-2231-3080	LILLY Ck	BUCKINGHAM	61.704	-150.003	10	5	0	3	18	2
20501114			HORSESHOE LAKE RD	61.560	-149.933	0	5	10	3	18	2
20501131			UNKNOWN	61.589	-149.821	0	5	10	3	18	2
20501144			SNUFFY'S RD	61.652	-149.606	0	7	1	10	18	2
20500279		Unk	Denali Highway	63.093	-147.480	0	7	10	1	18	2
20501215		Trib to Fishook Ck	Old Palmer Fishhook Rd	61.774	-149.272	0	7	10	1	18	2
20501247		Trib to Willow Ck	Willow Fishhook Rd	61.765	-149.572	0	7	10	1	18	2
20401336	247-50-10260-2019-3076	Carnegie Creek- Tributary to Wasilla Creek	Fishhook Road	61.636	-149.191	10	7	0	1	18	2

						Criteria Scores for Prioritization					
site code	AWC Stream Number	Stream Name	Road Name	Latitude	Longitude	Anad-romy	Block-age	Constri ction	Gradi-ent	Total Score	Tier
20501052		Drainage	DEAN DRIVE	61.613	-149.646	0	7	10	1	18	2
20501209		Trib to Little Su	Palmer Fishhook Rd	61.762	-149.224	0	7	1	10	18	2
20401275		outlet stream Wolf Lake		61.628	-149.309	0	7	10	0	17	2
20401294	247-50-10300-2022	Trib Cottonwood Ck		61.530	-149.520	10	5	2	0	17	2
20501410	247-41-10200-2291-3049	Unk Trib	Parks Highway	62.285	-150.248	10	5	0	2	17	2
20501423		Twister Ck	TALKEETNA SPUR	62.310	-150.104	0	7	10	0	17	2
20501028			EDGERTON PARKS RD	61.693	-149.316	0	7	0	10	17	2
20501037			WELCH WAY	61.664	-149.335	0	5	10	2	17	2
20501117			PRIVATE/ LAKES BOULEVARD	61.540	-149.951	0	7	10	0	17	2
20501133			Driveway off CHERRYWOOD DR	61.550	-149.783	0	7	10	0	17	2
20501135			Driveway off CHERRYWOOD DR	61.550	-149.785	0	7	10	0	17	2
20500283		Unk	Denali Highway	63.046	-147.001	0	7	7	3	17	2
20501464		Unk	Hidden Hills Rd	61.989	-149.960	0	7	7	3	17	2
20501478		Unk. Trib to Rabideux Ck	Petersville Rd	62.317	-150.290	10	5	0	2	17	2
20401286	247-50-10300-2012	Cottonwood Slough	Trapline Drive	61.526	-149.515	10	7	0	0	17	2
20501137		Crooked Lake Outflow	PAPOOSE TWINS ROAD	61.513	-150.067	10	5	2	0	17	2
20401881		Tributary to Wasilla Creek	Samovar Way	61.719	-149.103	0	7	0	10	17	2
20401326	247-50-10260-2019	Wasilla Creek	Palmer Wasilla Highway	61.599	-149.251	10	5	2	0	17	2
20501436	247-50-10330-2050-3019-4011-5011	LYNDA LAKE PORTAGE	BEAVER LAKE RD	61.570	-149.841	10	5	1	1	17	2
20501076			KALMBACH LAKE DRIVE	61.615	-149.588	0	5	10	2	17	2
20500293		Unk	Denali Highway	63.207	-147.653	0	7	0	10	17	2
20500288		Unk	Denali Highway	63.109	-146.587	0	7	0	10	17	2
20501081			Alaska Railroad	61.588	-149.722	10	7	0	0	17	2
20401259		Bodenberg Creek	Driveway off Old Glenn Highway	61.576	-149.042	0	7	10	0	17	2
20401341		Tributary Wasilla Creek	Falk Road	61.657	-149.217	0	7	10	0	17	2
20501851		Tributray to the East fork of the Chulitna Ri	Parks Highway	63.128	-149.454	0	7	0	10	17	2
20501809		Unnamed Tributary to Susitna River	Alaska Railroad	62.504	-150.104	0	7	10	0	17	2
20401311		Spring Ck		61.544	-149.252	0	5	10	1	16	2
20401313		Trib Rabbit Slough	Alaska Railroad	61.542	-149.232	0	5	10	1	16	2
20501411		Unk Trib	Parks Highway	62.270	-150.243	0	5	10	1	16	2
20501070		Cloudy Lake Drainage	Driveway off DOUBLE BOTHER	61.616	-149.626	8	5	0	3	16	2
20501090			LITTLE MEADOW CREEK RD	61.575	-149.736	0	5	10	1	16	2
20501096			HAWK LANE	61.586	-149.797	0	5	10	1	16	2
20500316		Unk	Clear Water Creek Access Rd	63.113	-147.509	0	7	7	2	16	2
20501465			Hidden Hills Rd	61.989	-149.979	0	5	10	1	16	2
20501472		Unk Trib to Chijuk	Oil Well Rd	62.106	-150.526	0	7	7	2	16	2
20501502		Trib to Deep Ck	Petersville Rd	62.432	-150.703	10	5	0	1	16	2
20401272		King Lake outlet	Sierra Street	61.621	-149.344	0	5	10	1	16	2
20401886		Tributary to Eska Creek	Unknown road	61.732	-148.926	0	7	7	2	16	2
20401845		Tributary to Fish Lake	Fish Lake Road	61.783	-148.555	0	7	2	7	16	2
20500277		Unk	Denali Highway	63.141	-147.535	0	7	2	7	16	2
20501508		Unk trib to TwentyMile Ck	Petersville Road	62.355	-150.669	0	5	10	1	16	2
20501206		Unk Trib to Little Su	Palmer Fishhook Rd	61.736	-149.233	0	7	7	2	16	2
20501256		Craigie Ck	Willow Fishhook Rd	61.776	-149.397	0	7	7	2	16	2

						Criteria Scores for Prioritization					
site code	AWC Stream Number	Stream Name	Road Name	Latitude	Longitude	Anad-romy	Block-age	Constri ction	Gradi-ent	Total Score	Tier
20501374		Fourth of July Creek	Parks Highway	63.206	-149.328	0	5	10	1	16	2
20401319		Trib Spring Ck	Glenn Highway	61.544	-149.251	0	5	10	0	15	3
20401362		Trib Wasilla Ck	private drive	61.653	-149.189	0	5	10	0	15	3
20500603		NULL	Lake Louise Rd	62.300	-146.589	0	5	10	0	15	3
20500604		NULL	Lake Louise Rd	62.277	-146.548	0	7	5	3	15	3
20400602		NULL	Knik River Rd	61.508	-148.998	0	7	5	3	15	3
20501063			DRIVEWAY off PITTMAN RD	61.616	-149.620	0	5	10	0	15	3
20501075			BEVERLY LAKE RD	61.616	-149.565	0	7	1	7	15	3
20501097			HAWK LANE	61.585	-149.761	0	5	10	0	15	3
20501107			HORSESHOE LAKE RD	61.566	-149.909	0	5	10	0	15	3
20501108			HORSESHOE LAKE RD	61.566	-149.912	0	5	10	0	15	3
20501109			HORSESHOE LAKE RD	61.566	-149.916	0	5	10	0	15	3
20501118			LAKES BOULEVARD	61.564	-149.892	0	5	10	0	15	3
20501115			HORSESHOE LAKE RD	61.585	-149.933	0	5	10	0	15	3
20501132			VICTOR RD	61.590	-149.820	0	5	10	0	15	3
40501797		Inlet to Summit Lake	Alaska Railroad	63.312	-149.158	0	5	10	0	15	3
20500285		Unk	Denali Highway	63.054	-146.766	0	7	5	3	15	3
20501252		trib to Willow Ck	Willow Fishhook Rd	61.763	-149.482	0	7	5	3	15	3
20100582			Glenn Highway	61.907	-147.305	0	5	10	0	15	3
20501211		Trib to Little Su	Palmer Fishhook Rd	61.769	-149.216	0	7	5	3	15	3
20401880		Packsaddle Creek	Victory Road	61.800	-147.986	0	7	1	7	15	3
20501380		Unk Trib	Parks Highway	62.878	-149.805	0	7	0	7	14	3
20501067			PITTMAN RD	61.620	-149.624	0	7	5	2	14	3
20501099			VICTOR RD	61.590	-149.819	0	7	5	2	14	3
20501120			LAKES BOULEVARD	61.563	-149.848	0	7	5	2	14	3
20501147			MOOSE MEADOWS RD	61.683	-149.409	0	7	7	0	14	3
40500290		Unk	Denali Highway	63.299	-148.150	0	7	0	7	14	3
20501471		Buddy Ck	Montana Cr Rd	62.136	-149.940	0	7	7	0	14	3
20501515		Caswell Ck	Shaman	62.019	-149.948	0	7	5	2	14	3
20501249		Trib to Willow Ck	Willow Fishhook Rd	61.765	-149.550	0	7	5	2	14	3
20400584		Trail Creek	Alascom Drive	61.847	-147.349	0	7	5	2	14	3
20401844		Trib to Fish Lake	Fish Lake Road	61.791	-148.537	0	7	5	2	14	3
20501379		Pass Ck	Parks Highway	62.911	-149.714	0	5	7	1	13	3
20501491		Unk Trib to Peters Ck	Petersville Rd	62.485	-150.764	0	7	5	1	13	3
20400585		NULL	Glenn Highway	61.794	-147.930	0	5	5	2	12	3
20400598		NULL	Knik River Rd	61.479	-148.889	0	7	2	3	12	3
20501375		Hardage Ck	Parks Highway	63.134	-149.448	0	7	2	3	12	3
20501378		Granite Ck	Parks Highway	62.977	-149.632	0	5	5	2	12	3
40500291		Unk	Denali Highway	63.301	-148.132	0	7	2	3	12	3
20400595		Tributary to Knik River	Knik River Road	61.506	-148.969	0	5	5	2	12	3
20500284		Unk	Denali Highway	63.054	-146.772	0	7	2	3	12	3
20501503		Trib to Deep Ck	Petersville Rd	62.431	-150.707	0	7	2	3	12	3
20501239		Trib to Willow Ck	Willow Fishhook Rd	61.772	-149.807	0	7	2	3	12	3
20501240		Trib to Willow Ck	Willow Fishhook Rd	61.769	-149.713	0	7	2	3	12	3

						Criteria Scores for Prioritization					
site code	AWC Stream Number	Stream Name	Road Name	Latitude	Longitude	Anad-romy	Block-age	Constri ction	Gradi-ent	Total Score	Tier
20501257		Upper Willow Ck	Willow Fishhook Rd	61.768	-149.336	0	7	2	3	12	3
20401346		Tributary to Wasilla Creek	East Oceanview Rd.	61.718	-149.104	0	7	2	3	12	3
20501850		Herdage Creek	Parks Highway	63.134	-149.449	0	7	2	3	12	3
20501793		Unnamed Tributary to Susitna River	Alaska Railroad	62.450	-150.120	0	7	2	3	12	3
20401044			RIDGEVIEW DRIVE	61.632	-149.400	0	7	1	3	11	3
20501100			SHORELINE COURT	61.589	-149.821	0	7	2	2	11	3
20501104			ASHLEY RD	61.576	-149.800	0	5	5	1	11	3
20501123			BIG LAKE STATE RECREATION PA	61.547	-149.854	0	5	5	1	11	3
20500287		Unk	Denali Highway	63.102	-146.669	0	7	2	2	11	3
20501405		Unk Trib	Oil Well Rd	62.228	-150.445	0	5	5	1	11	3
20501166		NULL	Railroad	61.674	-149.964	0	7	2	2	11	3
20101822		Eureka Creek	Glenn Highway	61.926	-147.220	0	7	1	3	11	3
20501798		Unnamed Trib to Susitna River	Alaska Railroad	62.301	-150.108	0	7	2	2	11	3
20500605		NULL	Lake Louise Rd	62.272	-146.536	0	7	1	2	10	3
20501415		Unk Trib	PARKS Highway	62.180	-150.187	0	7	0	3	10	3
20501029			EDGERTON PARKS RD	61.693	-149.321	0	7	0	3	10	3
20501030			EDGERTON PARKS RD	61.693	-149.306	0	7	0	3	10	3
20401043			BLACK BEAR DRIVE	61.624	-149.394	0	7	1	2	10	3
20501062			PITTMAN RD	61.616	-149.620	0	7	0	3	10	3
20501121			BIG LAKE STATE RECREATION PA	61.548	-149.854	0	7	2	1	10	3
20501138		Crooked Lake Outflow	PAPOOSE TWINS RD	61.513	-150.051	0	7	0	3	10	3
20401296		Trib Lucy Ck	Cardiff	61.523	-149.571	0	7	1	2	10	3
20501468		Unk	Malaspina	62.160	-149.933	0	7	0	3	10	3
20501396		unamed Trib	Petersville Rd	62.312	-150.392	0	7	2	1	10	3
20501504		Trib to Peters Ck	Petersville Rd	62.390	-150.723	0	7	0	3	10	3
20400596		NULL	Knik River Rd	61.490	-148.912	0	7	0	2	9	3
20501149			MOOSE MEADOWS RD	61.675	-149.413	0	7	0	2	9	3
20501150			MOOSE MEADOWS RD	61.673	-149.418	0	7	0	2	9	3
20401295		Trib Lucy Ck	Cardiff	61.525	-149.571	0	5	1	3	9	3
20501496		Long Ck	Petersville Rd	62.533	-150.850	0	7	0	2	9	3
20100580		Little Nelchina River	Glenn Highway	61.988	-147.014	0	5	2	1	8	3
20501386		Unk Trib	Parks Highway	62.639	-150.224	0	5	0	2	7	3
20501438		Unk Trib	KENLAR RD	61.578	-149.753	0	5	0	2	7	3
20501122			BIG LAKE STATE RECREATION PA	61.547	-149.854	0	5	2	0	7	3
20100581		Startup Creek	Glenn Highway	61.906	-147.300	0	5	1	1	7	3
20501878		Tributary To Little Susitna	Runyon Circle	61.694	-149.295	0	5	0	2	7	3
20501796		4th of July Creek	Alaska Railroad	63.206	-149.332	0	5	0	2	7	3
20501804		Unnamed Tributary to Susitna River	Alaska Railroad	62.417	-150.122	0	5	0	2	7	3
20501162		Unk	Railroad	61.595	-149.756	0	5	0	1	6	3
20501151			MOOSE MEADOWS RD	61.671	-149.421	0	5	0	0	5	3
20501883			Tamarack Road	61.531	-149.866	0	5	0	0	5	3
20401331	247-50-10260-2019-3066-4022	Trib Wasilla Ck	N 49th State Street	61.614	-149.209	10	0	0	0	0	4
20401335	247-50-10260-2019	Wasilla Ck	private drive	61.632	-149.200	10	0	0	0	0	4
20401352	247-50-10260-2019	Wasilla Ck	Hyer Rd	61.575	-149.295	10	0	0	0	0	4

						Criteria Scores for Prioritization					
site code	AWC Stream Number	Stream Name	Road Name	Latitude	Longitude	Anad-romy	Block-age	Constri ction	Gradi-ent	Total Score	Tier
20401358	247-50-10260-2019	Wasilla Ck	Nelson Rd	61.552	-149.299	10	0	0	0	0	4
20401361	247-50-10260-2019-3038	Trib Wasilla Ck	Parks Highway	61.567	-149.311	10	0	0	0	0	4
20401342		Trib Wasilla Ck	Bush Rd	61.657	-149.215	0	0	0	0	0	4
20401324		Trib Spring Ck	Glen Highway	61.554	-149.240	0	0	0	0	0	4
20401318	247-50-10260-2019-3030	Spring Ck	private	61.552	-149.268	10	0	0	0	0	4
20501412	247-41-10200-2291-3041	Unk Trib	Parks Highway	62.243	-150.253	10	0	0	0	0	4
20501421	247-41-10200-2230	Goose Ck	PARKS Highway	62.061	-150.060	10	0	0	0	0	4
20501450		Meadow Ck	Lucille Rd	61.617	-149.448	0	0	0	0	0	4
20401455	247-50-10260-2019-3030	Spring Ck	Parks Highway	61.556	-149.250	10	0	0	0	0	4
20501056		Laylen Lake Drainage	SKYVIEW DRIVE	61.600	-149.692	0	0	0	0	0	4
20501057		Layen Lake Drainage	CAROUSEL WAY	61.599	-149.693	0	0	0	0	0	4
20501432	247-50-10330-2050-3050	Little Meadow Ck	PARKS HIGHWAY	61.576	-149.725	10	0	0	0	0	4
20501079			FOREST LAKE DRIVE	61.578	-149.725	10	0	0	0	0	4
20501087			BRITTANY DRIVE	61.576	-149.728	10	0	0	0	0	4
20501089			BIKE PATH	61.584	-149.743	10	0	0	0	0	4
20501437	247-50-10330-2050-3050	LITTLE MEADOW Ck	KENLAR RD	61.569	-149.760	10	0	0	0	0	4
20501098			DELROY RD	61.599	-149.770	0	0	0	0	0	4
20501448	247-41-10100-2150-3070	Unk Trib	HORSESHOE LK RD	61.567	-149.917	10	0	0	0	0	4
20501447		Unk Trib	HORSESHOE LK RD	61.581	-149.923	8	0	0	0	0	4
20501119			LAKES BOULEVARD	61.563	-149.856	0	0	0	0	0	4
20501127			WALNUT WOOD DRIVE	61.554	-149.785	0	0	0	0	0	4
20501128			BEECHWOOD CIRCLE	61.553	-149.789	0	0	0	0	0	4
20501134			Driveway off CHERRYWOOD DR	61.550	-149.784	0	0	0	0	0	4
20501136			PAPOOSE TWINS RD	61.514	-150.086	0	0	0	0	0	4
20501445		Lucille Ck	VINE RD	61.562	-149.601	0	0	0	0	0	4
20501446		Lucille Ck	LAKE LUCILLE RD	61.573	-149.500	10	0	0	0	0	4
20500278		Unk	Denali Highway	63.105	-147.512	0	0	0	0	0	4
20501521		Unk. Trib to Willow Ck	Stinson Rd	61.772	-150.062	8	0	0	0	0	4
20501524		Twister Ck	Talkeetna Spur	62.310	-150.015	8	0	0	0	0	4
20501457		Unk Trib to Susitna	Bradley	62.302	-150.179	8	0	0	0	0	4
20501517		Unk Trib to Trapper Ck	Susitna River Rd	62.315	-150.204	0	0	0	0	0	4
20501458		Unk Trib to Susitna R	Bradley	62.278	-150.179	8	0	0	0	0	4
20501407		Unk Trib TO TRAPPER Ck	Susitna River Rd	62.316	-150.221	0	0	0	0	0	4
20501395	247-41-10200-2081-3100-4136-5027	TRIB TO NINE MILE Ck	Petersville Rd	62.310	-150.369	10	0	0	0	0	4
20501397	247-41-10200-2081-3100-4167-5045	Gate Ck	Petersville Rd	62.324	-150.518	10	0	0	0	0	4
20501474		Unk	Oil Well Rd	62.192	-150.495	0	0	0	0	0	4
20501495		Long Ck	Petersville Rd	62.529	-150.870	0	0	0	0	0	4
20501501		Deep Ck	Petersville Rd	62.443	-150.700	10	0	0	0	0	4
20501505		Unk trib to Kroto Ck	Petersville	62.341	-150.606	8	0	0	0	0	4
20501506		Unk trib to Kroto Ck	Petersville	62.353	-150.649	8	0	0	0	0	4
20501401	247-41-10200-2081-3181	Twenty Mile Ck	Petersville Rd	62.354	-150.663	10	0	0	0	0	4
20501406	247-41-10200-2081-3100-4155-5008	unamed Trib	Oil Well Rd	62.213	-150.473	10	0	0	0	0	4
20501509		Unk trib to TwentyMile Ck	Petersville Road	62.359	-150.692	0	0	0	0	0	4
20501399	247-41-10200-2053-3150-4060-5026	Kenny Ck	Petersville Rd	62.364	-150.703	10	0	0	0	0	4

						Criteria Scores for Prioritization					
site code	AWC Stream Number	Stream Name	Road Name	Latitude	Longitude	Anad-romy	Block-age	Constri ction	Gradi-ent	Total Score	Tier
20501400	247-41-10200-2053-3150-4060-5026-6011	Trib TO KENNY Ck	Petersville Rd	62.368	-150.714	10	0	0	0	0	4
20501183		Unk Trib to Little Su	Driveway	61.682	-149.286	10	0	0	0	0	4
20501184		NULL	Driveway on Elk Ranch	61.686	-149.298	10	0	0	0	0	4
20501203		O'Brian Ck	O'Grady Drive	61.489	-149.673	10	0	0	0	0	4
20501242		Trib to Willow Ck	Willow Fishhook Rd	61.764	-149.598	0	0	0	0	0	4
20501243		Trib to Willow Ck	Willow Fishhook Rd	61.764	-149.596	0	0	0	0	0	4
20501189		Connects pond to Nancy Lake	Kime Lane	61.697	-149.997	0	0	0	0	0	4
20501042			COLES RD	61.664	-149.382	0	0	0	0	0	4
20501041			COLES RD	61.664	-149.385	0	0	0	0	0	4
20401291	247-50-10300-2012	Cottonwood Slough	Surrey Rd	61.522	-149.527	10	0	0	0	0	4
20401230		Trib to Cottonwood Ck	Surrey Rd	61.524	-149.529	10	0	0	0	0	4
20401231		Cottonwood Ck	Surrey Rd	61.525	-149.530	10	0	0	0	0	4
20401267	247-50-10300-2054	Cottonwood Ck	Settlement Rd	61.632	-149.243	10	0	0	0	0	4
20401297		Trib Lucy Ck	Lupine	61.522	-149.571	0	0	0	0	0	4
20401298			Starflower	61.522	-149.571	0	0	0	0	0	4
20501237		Connects marshes	Vienna Woods Access	61.582	-149.572	8	0	0	0	0	4
20501219		Unk lake outlet	Point MacKenzie Rd	61.314	-150.030	0	0	0	0	0	4
20501224		Crocker Ck	Settlers Bay Drive	61.496	-149.613	10	0	0	0	0	4
20501158		Wetland	Railroad	61.581	-149.573	8	0	0	0	0	4
20501220		Wetland	Parks Highway	61.580	-149.573	0	0	0	0	0	4
20501039			SCHWALD RD	61.659	-149.433	10	0	0	0	0	4
20501046			SITZE RD	61.653	-149.499	10	0	0	0	0	4
20401347			ATV Trail	61.720	-149.118	0	0	0	0	0	4
20401344	247-50-10260-2019-3120	Wasilla Ck	Murphy Rd	61.718	-149.121	10	0	0	0	0	4
20501444	247-50-10330-2050-3050-4027	Unk Trib	MEADOW LAKE RD	61.591	-149.666	10	0	0	0	0	4
20501205		Unk	Bike Path	61.581	-149.594	8	0	0	0	0	4
20401348	247-50-10260-2019	Wasilla Ck	Falk Rd	61.655	-149.201	10	0	0	0	0	4
20401343	247-50-10260-2019-3120	Wasilla Ck	Murphy Rd	61.710	-149.119	10	0	0	0	0	4
20401300	247-50-10300	Cottonwood Ck	Fairview Loop	61.527	-149.527	10	0	0	0	0	4
20401349	247-50-10260-2019-3087	Spring Creek	Crabb Circle	61.661	-149.193	10	0	0	0	0	4
20401350	247-50-10260-2019	Wasilla Creek	Crabb Circle	61.661	-149.188	10	0	0	0	0	4
20401285	247-50-10300-2012	Cottonwood Slough	driveway - Trapline Drive	61.526	-149.515	10	0	0	0	0	4
20401283	247-50-10300-2012	Cottonwood Slough	driveway - Trapline Drive	61.526	-149.514	10	0	0	0	0	4
20401885		Cottonwood Slough	Trapline Drive	61.526	-149.514	10	0	0	0	0	4
20401282	247-50-10300-2012	Cottonwood Slough	driveway - 2450 Trapline Drive	61.526	-149.512	10	0	0	0	0	4
20401280	247-50-10300-2012	Cottonwood Slough	Snowshoe Road	61.526	-149.511	10	0	0	0	0	4
20401281	247-50-10300-2012	Cottonwood Slough	driveway - 2420 Trapline Drive	61.526	-149.512	10	0	0	0	0	4
20401306	247-50-10300	Cottonwood Creek	North Shoreline Drive	61.595	-149.340	10	0	0	0	0	4
20401277	247-50-10300	Cottonwood Creek	Seward Meridian Road	61.596	-149.360	10	0	0	0	0	4
20401305	247-50-10300	Cottonwood Creek	Glennwood	61.570	-149.422	10	0	0	0	0	4
20401353	247-50-10260-2019-3041	Trib Wasilla Ck	Hyer Rd	61.576	-149.295	10	0	0	0	0	4
20401332		Trib Wasilla Creek	Seagull Drive	61.616	-149.208	0	0	0	0	0	4
20401293	247-50-10300-2022	Tributary to Cottonwood Crrk	Harness	61.531	-149.518	10	0	0	0	0	4
20501059		Rainbow Lake Drainage	LAKEVIEW CIRCLE	61.593	-149.629	0	0	0	0	0	4

						Criteria Scores for Prioritization					
site code	AWC Stream Number	Stream Name	Road Name	Latitude	Longitude	Anad-romy	Block-age	Constri ction	Gradi-ent	Total Score	Tier
20501061		Meadow Creek	PITTMAN ROAD	61.594	-149.632	0	0	0	0	0	4
20501140		Lucille Creek	JOHNSONS ROAD	61.553	-149.708	10	0	0	0	0	4
20401789		Connects pond to Knob Lake	Alascom Drive	61.837	-147.333	0	0	0	0	0	4
20401314		Tributary to Rabbit Slough	Old Matanuska Road	61.542	-149.231	0	0	0	0	0	4
20401321	247-50-10260-2019-3030	Spring Creek	Nelson Road	61.549	-149.273	10	0	0	0	0	4
20401320	247-50-10260-2019-3032	Spring Ck	Nelson Rd	61.549	-149.280	10	0	0	0	0	4
20501040		Nurse Creek	HOLOBINKO ROAD	61.659	-149.419	10	0	0	0	0	4
20401287	247-50-10300	Cottonwood Creek	Caribou	61.623	-149.314	10	0	0	0	0	4
20501453	247-50-10360	Goose Creek	Point Mckenzie Road	61.426	-149.873	10	0	0	0	0	4
20501451		Goose Creek	Point Mckenzie Road	61.426	-149.872	0	0	0	0	0	4
20501452		Goose Creek	Point Mckenzie Road	61.426	-149.871	0	0	0	0	0	4
20501276		outlet stream Orchid Lake	West Lakes Boulvard	61.566	-149.892	10	0	0	0	0	4
20501113		Horseshoe Lake.Outlet.	HORSESHOE LAKE ROAD	61.562	-149.944	10	0	0	0	0	4
20501111		Horseshoe Lake Outlet	HORSESHOE LAKE ROAD	61.581	-149.924	8	0	0	0	0	4
20501112		Horshshoe Lake Inlet	HORSESHOE LAKE ROAD	61.569	-149.948	10	0	0	0	0	4
20501064		Drainage	COVE DRIVE	61.634	-149.613	0	0	0	0	0	4
20501065			JOLLY ROGER DRIVE	61.633	-149.611	0	0	0	0	0	4
20401884		Wasilla Creek	Tributary Avenue	61.588	-149.252	10	0	0	0	0	4
20501817		Moose Lick Creek	East Alberta Circle	61.693	-149.299	10	0	0	0	0	4
20501819		Government Creek	Edgerton Park Road	61.693	-149.310	10	0	0	0	0	4
20501841		Moose Lick creek	Moose Lick Circle	61.694	-149.300	10	0	0	0	0	4
20501818		Tributary To Little Susitna River	East Alberta Circle	61.693	-149.295	0	0	0	0	0	4
20501846		Tributary To Little Susitna River	Russett Road.	61.684	-149.300	10	0	0	0	0	4
20401810		Tributary To Carniege Creek	Babcock Drive	61.638	-149.194	10	0	0	0	0	4
20501068		Colter Creek	DRIVEWAY off SITZE RD	61.656	-149.499	0	0	0	0	0	4
20501069		Colter Creek	Driveway off SITZE ROAD	61.657	-149.498	0	0	0	0	0	4
20401843		Trib to Fish Lake	N Fish Lake Rd	61.788	-148.548	0	0	0	0	0	4
20501792			Alaska Railroad	63.085	-149.550	0	0	0	0	0	4
20501794			Alaska Railroad	62.997	-149.628	0	0	0	0	0	4
20501801		Montana Creek side channel	Alaska Railroad	62.106	-150.069	0	0	0	0	0	4
20501805		Unnamed Tributary to Susitna River	Alaska Railroad	62.435	-150.124	0	0	0	0	0	4
20501806			Alaska Railroad	62.440	-150.123	8	0	0	0	0	4
20501877		Twister Creek	Talkeetna AKRR Depot Access Rc	62.313	-150.104	8	0	0	0	0	4
20501500		Unk Trib to Peters Ck	Petersville Rd	62.486	-150.766	0	0	0	0	0	4

Appendix 3: Perched Crossing Sites in the Mat-Su with Criteria Scores

						Criteria Scores for Prioritization									
site code	AWC Stream Number	Stream Name	Road Name	Latitude	Longitude	Anad-romy	Block-age	Constric tion	Gradi-ent	Total Score	Tier	Perch (inches)	Perch score	New Total Score	New Tier
20501232		Coal Ck	Sushana Rd	61.66169	-149.46677	10	7	5	0	22	2	62.40	3	25	1
20401260	247-50-10200-2071-3023	Tributary to Bodenberg Creek	Private Drive	61.56648	-149.04286	10	7	10	2	29	1	32.16	3	32	
20501417	247-41-10200-2300-3011-4006	Answer Ck	TALKEETNA SPUR	62.20234	-150.06689	10	7	5	2	24	1	29.28	3	27	
20501172		Connects 2 Lakes	Bryant	61.47315	-149.95956	8	7	7	1	23	1	25.32	3	26	
20501402	247-41-10200-2081-3194-4016	SEVENTEEN MILE Ck Trib	Petersville Rd	62.33683	-150.56422	10	7	10	3	30	1	22.20	3	33	
20501213		Trib to Little Su	Palmer Fishhook Rd	61.77467	-149.20396	10	7	10	2	29	1	18.96	3	32	
20501493		Unk Trib to Cache Ck	Petersville Rd	62.49026	-150.98520	10	7	10	3	30	1	17.40	3	33	
20400592		Eska Creek	Eska Road	61.73853	-148.90602	8	7	10	10	35	1	15.36	3	38	
20501081			Alaska Railroad	61.58806	-149.72222	10	7	0	0	17	2	12.72	3	20	
20501388	247-41-10200-2381-3060	Tributary to Chulitna River	PARKS HIGHWAY	62.47444	-150.27147	10	7	2	1	20	2	11.40	2	22	
20501392	247-41-10200-2381-3051	Tributary to Chulitna River	Parks Highway	62.45379	-150.27282	10	7	5	0	22	2	10.44	2	24	1
20501143		Crocker Creek	SETTLERS BAY DRIVE	61.50106	-149.62028	10	7	10	1	28	1	9.84	2	30	
20501463		Unk. Trib to Talkeetna R.	Cummings	62.34392	-150.06609	8	7	10	1	26	1	9.24	2	28	
20501479		Unk Trib to Rabideux Ck	Petersville Rd	62.31733	-150.30853	8	7	5	2	22	2	9.12	2	24	1
20401338		Trib Wasilla Creek	Fishhook Road	61.64203	-149.19631	10	7	7	1	25	1	8.40	2	27	
20501494		Unk Trib to Cache Ck	Petersville Rd	62.51407	-150.91388	10	7	10	2	29	1	7.80	2	31	
20501165			Railroad	61.65770	-149.93669	10	7	5	2	24	1	5.76	2	26	
20501193		Unk Trib to Fish Ck	Lewis Loop	61.45493	-149.80894	8	7	10	0	25	1	5.52	2	27	
20501192		Connects 2 Lakes	Lancaster	61.47297	-149.95947	8	7	10	3	28	1	4.44	2	30	
20501420	247-41-10200-2320-3010	EXITS FISH LAKE	TALKEETNA SPUR	62.25486	-150.08141	10	5	10	0	25	1	4.20	2	27	
20501152			Alaska Railroad	61.59139	-149.74056	10	7	0	3	20	2	3.96	1	21	
20501404		Unamed Trib	Oil Well Rd	62.23787	-150.43933	8	7	10	0	25	1	2.76	1	26	
20501489		Unk Trib to Peters Ck	Petersville Rd	62.47121	-150.72270	10	5	1	3	19	2	2.52	1	20	
20401292	247-50-10300-2022	Tributary to Cottonwood Creek	Redoubt	61.53035	-149.52456	10	7	10	0	27	1	2.52	1	28	
20501222		O'Brian Ck	Rubacaba	61.49331	-149.65999	10	7	5	2	24	1	2.52	1	25	
20501207		Unk Trib to Little Susitna	Palmer Fishhook Rd	61.74695	-149.23218	10	7	5	10	32	1	2.28	1	33	
20501807		Unnamed Tributary to Sustina River	Alaska Railroad	62.45379	-150.11838	10	7	7	2	26	1	1.08	1	27	
20501526		Buddy Ck	Unnamed Primitive Rd	62.14034	-149.98660	10	7	10	2	29	1	1.08	1	30	
20401170		trib to Moose Ck	Buffalo Mine Rd	61.73028	-149.04044	10	5	5	3	23	1	1.08	1	24	