# Prioritizing Fish Passage Improvement Projects in the Copper River Watershed


**Prepared by:**

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**Project Partners:**
Alaska Department of Fish & Game
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Ecotrust
United States Fish and Wildlife Service

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## Introduction

The Copper River Watershed Project (CRWP) and partners recognize that access to spawning and rearing habitats for salmonids are important factors for maintaining fish productivity in the Pacific Northwest, but culvert replacement projects are very expensive and the ecological benefits can vary greatly from one creek to the next. To help prioritize how to spend limited fish habitat restoration funds, CRWP has developed a protocol that assigns numerical value to ecological condition variables (i.e. fish presence/absence and quantity/quality of fish habitat) associated with road crossings and to culvert conditions. This scoring system will generate a number score for each culvert, providing an objective prioritization of potential fish passage improvement projects that make the best of available resources while maximizing ecological benefits to the aquatic system.

A 2002 project initiated by the Alaska Department of Transportation & Public Facilities (DOT&PF) and Alaska Department of Fish & Game (ADF&G) evaluated the status of fish passage conditions in the Copper River drainage along state highways and secondary roads within the Copper River Basin. Study results showed that 62% of culverts were inadequate for juvenile fish passage, 34% required additional information to assess juvenile fish passage status, and only 4% were assumed to maintain adequate juvenile fish passage conditions (Albert, S.W. & D. Beers, 2002; data cataloged in ADF&G's Fish Passage Inventory Database (FPID)).

Furthermore, not all crossings posing potential problems to fish passage were identified in the 2002 DOT&PF/ ADF&G survey. For example, the McCarthy Road, which crosses through important sockeye and silver salmon spawning habitat, was not addressed in this study, nor were roads on private lands. Therefore, this protocol that allows for a consistent, rapid assessment of un-inventoried culverts can help to identify potential barriers to fish passage that might not otherwise be known, and help focus limited human and financial resources on these streams as well.

## Purpose

The primary purpose of this tool is to **identify high priority fish improvement projects** in the Copper River watershed that make the best use of available resources while maximizing ecological benefits to the system. This is being accomplished by developing a scoring system for both culvert condition and ecological conditions. When possible, culvert condition will be scored on measurements from the FPID, and ecological conditions will be scored based on the field protocol included in this document. Once scores are assigned for each category, they can be compared graphically to separate out poorly functioning culverts (high culvert score) with high ecologic potential (high ecological condition score) from the rest, providing a set of high priority fish passage improvement projects.

Because the habitat assessment protocol includes field site visits, a secondary benefit **is the ability to identify other potential problems at or near the stream crossings** that can be remedied through restoration opportunities. CRWP has a successful track record of engaging community volunteers and partner organizations in habitat restoration projects and can use information collected during this process to identify future habitat improvement projects.

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Data collected during these assessments can also help identify streams not currently in the State of Alaska Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes, and can help keep ADF&G's culvert data up to date. Having people in the field conducting systematic assessments, including taking photographs, can help identify these changes over time and help keep ADF&G's database current.

## Background

Salmon, rich in food value and spiritual significance, are deeply rooted in the history of the Copper River and its inhabitants. The decline of Pacific Northwest salmonid populations is primarily attributed to loss of freshwater habitat and the fragmentation of habitat units. Connectivity of habitats is necessary for allowing fish to utilize wintering, rearing and spawning habitat over the course of a year.

Certain species of salmonids can spend 2-4 years in freshwater using a variety of habitat types before smolting and migrating to the ocean. Juvenile salmon radio tracking studies show active fish movement between habitat units, often migrating to different streams for over-wintering and summer feeding. Resident species such as grayling can be very nomadic as well. Poorly designed, installed, maintained and/or failed culverts can impede fish passage and limit connectivity of habitats, potentially harming fish populations.

A poorly designed or failed culvert not only restricts fish passage but can also degrade fish habitat by not accommodating stream function, leading to erosion and sedimentation, resulting in degradation of water quality and destruction and/or alteration of stream habitats downstream and potentially upstream (stream bed agradation). If designed properly, however, culverts can have little to no effects on fish passage and water quality.

## Overview of Culvert & Ecological Condition Scoring Protocols

All streams will be identified with ADF&G's naming system and field crews will use common shape files on hand-held GPS units to ensure partners are consistent with how they refer to culverts. For all sites, GPS points for the culvert location will be recorded with the data and photographs will be taken.

The following is a list of general questions to answer at every stream crossing:

- √ Is it a fish stream or not (catalogued, trapped, electroshocked, local knowledge)? or
- √ Is there potential for fish to be present (or is it a drainage ditch, overflow channel)?
- √ Is the culvert in poor or critical condition, perched and/or undersized?
- √ Are there other potential restoration opportunities that are not necessarily associated with the culvert (e.g. bank stabilization or re-vegetation, old abandoned road crossings)?

### *Culvert Conditions*

For culverts in known or expected fish streams, ADF&G's level 1 assessment is conducted on


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the crossing and these data are used to score culvert conditions. Level 1 assessments collect detailed information on culvert characteristics including constriction ratios, gradients, perch height and residual inlet depth. These scores ultimately determine whether a culvert is classified as red (conditions not passable to juvenile fish), green (assumed to be passable to juvenile fish) or gray (may not be adequate; not enough is known about crossing).

In the 2010 field season, a Copper River Watershed Project employee was trained to conduct ADF&G's Level 1 Assessments of culverts in order to assess *current* conditions of culverts (last assessment conducted in 2002) and culverts *that were not previously assessed*.

In general, green culverts are not scored and are assumed to be passable to juvenile fish. However when in the field, photographs of green culverts in the targeted subdrainage are taken to provide updated information on current condition of the culvert.

***Ecological Conditions***
The stream survey protocol was adapted from a United States Forest Service fish habitat assessment protocol. Measurements collected in surveys will include length of upstream habitat, species composition and upstream habitat quality. Additional site notes will also be documented while in the field, including any found barriers or water quality impacts, but will not be scored in this protocol. Culverts will be compared across subdrainages, and modification to scores/relative weight may be necessary depending on the local habitat and known resident fish species in each subdrainage.

***Secondary Criteria***
Other ecological conditions are included with a set of "bonus points" to help prioritize culverts based on other issues at the site, including erosion, downstream barriers and pipe condition. Cost estimates of replacing culverts are included as secondary criterion in order to further separate out projects that might be economically infeasible. Opportunities for action are also included as secondary criteria in order to provide prioritize projects that have strong community partners or align with other roadwork already scheduled to occur.

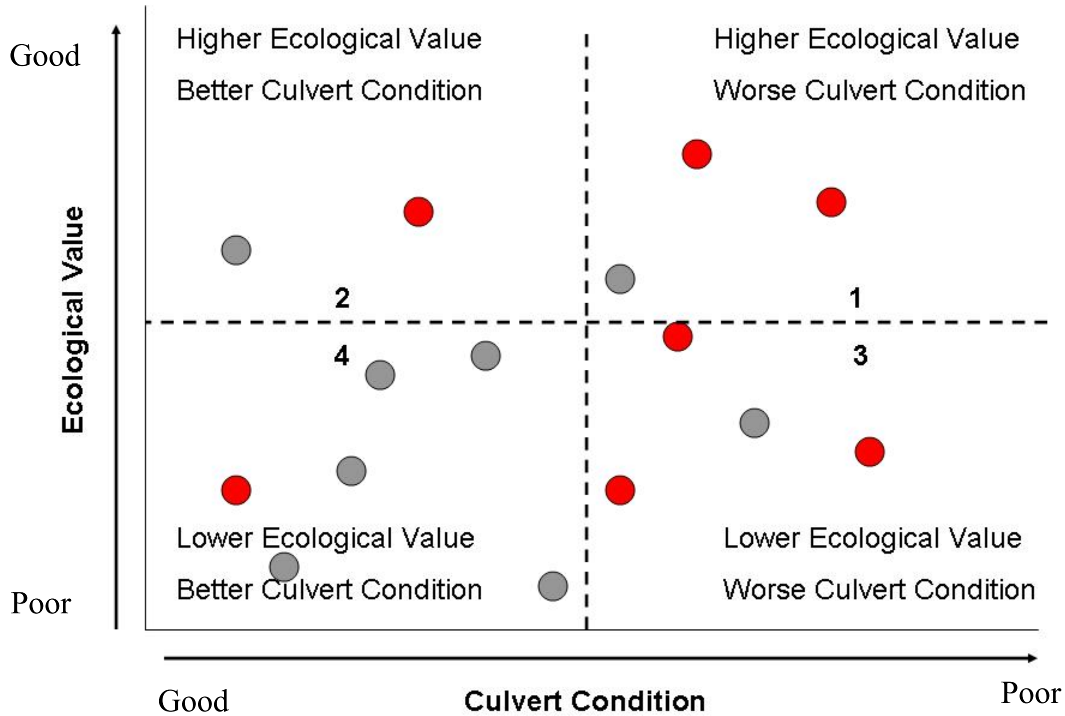
## Summary of Culvert and Ecological Conditions Scoring Matrix

For stream crossings that are classified as red or gray, the following is a summary of the categories evaluated for each crossing, with the maximum score for each category recorded in parenthesis:

| | |
|---|---|
| ***Culvert Conditions (****high score=worse condition)* | (30) |
| Constriction | 10 |
| Gradient | 10 |
| Perch | 10 |
| | |
| ***Ecological Conditions*** *(high score = better quality)* | (30) |
| Fish Species | 10 |
| Upstream Habitat Length | 10 |

| | |
|---|---|
| Upstream Habitat Quality | 10 |

The scores for each category are then graphed illustrating relative biological impact:




**Secondary criteria for analyzing culverts in quadrant 1 or 2 include:**

| | |
|---|---|
| ***Other ecological considerations*** | (25) |
| Erosion Issues | 5 |
| Downstream Barriers | 10 |
| Pipe Condition | 10 |
| | |
| ***Cost Assessment*** | (10) |
| Estimated cost based on road types, location, etc. | 10 |
| | |
| ***Opportunities for Action*** | (15) |
| Partnership potential | 5 |
| Local resident need/support | 5 |
| Maintenance potential | 5 |

# Detailed Description of Parameters

## Culvert Condition (*Culverts in FPID[1] or Assessed Later to Level 1 Standards)*

***Constriction***: based on stream simulation guidelines and Level 1 assessment cutoffs; assessed outside of influence of road and culvert

Culvert span to OHW ratio > 1.0 or continually backwatered ('N/A' value), = 0;
Culvert span to OHW ratio 0.9 – 1.0, = 1;
Culvert span to OHW ratio 0.75 – 0.9, = 2;
Culvert span to OHW ratio 0.5 - 0.75, = 5;
Culvert span to OHW ration 0.5 – 0.4 = 7
Culvert span to OHW ratio < 0.4 = 10;

***Gradient***: based on Level 1 assessment cutoffs;

If blank or 'N/A' value, = 0
If culvert embedded
Culvert gradient < 1.0%, = 0;
Culvert gradient >1.0%, = 2;

If culvert NOT embedded
Culvert gradient < 0.5%, = 0;
Culvert gradient 0.5 – 1.0%, = 1;
Culvert gradient 1.0 – 2.0%, = 2;
Culvert gradient 2.0 – 3.5%, = 3;
Culvert gradient 3.5 – 5%, = 7
Culvert gradient >5%, = 10.

***Perch***: based on Level 1 assessment calculation:

If blank or 'N/A' value = 0
Perch ≤ 2 inches = 0
Perch 2-4 inches = 1
Perch 4-6 inches = 6
Perch > 6 inches = 10
Perch > 3 foot = plus 10 points for major adult barrier

**Notes from 2010 Field Season:**
If level 1 surveys were not conducted, 2002 ADFG data was used to obtain gradient and perch values. If no data was available then a '0' value was given, and shown in red on the culvert scoring spreadsheet. OHW and culvert width was taken at every crossing in 2010, constriction ratios are based on those values. Many crossings inspected, especially the Copper River Highway, are sprawled wetlands with no discernable channels to measure OHW. A score of '0' was given to those crossings and shown in red on the culvert scoring

[1]Developed by Matanuska-Susitna Basin Salmon Habitat Partnership group. Used with permission from The Nature Conservancy.



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spreadsheet. For wide flooded sloughs, active channel widths were taken for OHW or an associated upstream upland channel width.

## Ecological Conditions to be scored

***Fish Species Composition***: verified from best available information, including field observations or other confirmed sources; local and traditional historic knowledge[2]

| Types of species | Score |
|---|---|
| Anadromous | 10 |
| Resident | 5 |
| Unknown | 0 |

**Notes from 2010 Field Season:**
Minnow trapping was used at selected crossings to determine fish presence. Visual observations were also recorded if fish were identifiable.

Minnow trapping along the Richardson Highway, Nabesna Road, and Mentasta Road, proved to be unsuccessful, even when visual observations were made. It could be a timing issue. Future recommendations: if time allowed and equipment available, electroshocking would be much more effective in these areas. Minnow trapping along the Copper River Highway was successful and most times not needed due to the numerous visual observations of salmonids.

The ADFG Anadromous Catalog was consulted for every crossing inspected. For the Richardson Highway, Nabesna Road, and Mentasta Road, ADFG, BLM, Gulkana Village council, and the Mentasta Village council was consulted for fish distribution information. According to local biologists, arctic grayling migrate up many small systems during spring run-off events. Many of the crossings inspected in 2010 were small and little to no information was found. Information obtained on the larger systems was also verified by visual observations and/or recorded in the ADFG Anadromous Catalog.

For the Copper River Delta, the Cordova District Forest Service and their stream layer were consulted. Due to the presence of juvenile coho salmon in many waterways, this parameter may over score some culverts.

***Upstream Length***: Open upstream length from culvert to known natural barriers or manmade (ie. dams). Length past other culverts upstream is included regardless of culvert type unless culvert is deemed a complete adult barrier. Length includes habitat for anadromous and resident fish.

For initial assessment, high resolution photographs (when available) can be used to get an

[2] William E. Simeone and Erica McCall Valentine. 2007. Ahntna knowledge of long-term changes in salmon runs in the Upper Copper River drainage, Alaska. ADF&G Division of Subsistence, Technical Paper No. 324. We also recommend contacting local Village Councils representatives or community members for local perspectives.

estimate of how much habitat is upstream of culvert. Habitat models are also in development for the Copper River Basin, and these can also help to quantify areas likely to have high quality habitat. When feasible, field work will include walking streams until natural or man-made barriers are encountered to verify the accuracy of habitat quantity estimates (necessary to provide habitat length to be "opened" up when pursuing funding for replacements).

| Length of Habitat | Score |
|---|---|
| > 20 miles | 10 |
| 10-20 miles | 8 |
| 5-10 miles | 6 |
| 0.5-5 miles | 4 |
| 0-0.5 miles | 1 |
| 0 miles | 0 |

**Notes from 2010 Field Season:**
Most crossings inspected during the 2010 field season, were very small to small drainages with only a few upstream miles total. Many crossings inspected were given a score of '4', 0.5-5 miles.

A score of '1', was given to ponds and small wetlands with no associated channels.

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***Upstream Habitat Quality***: (from ADF&G and USFS protocol)
For the table below, measurements are determined from a foot survey of 1000 meters, upstream and downstream. All scores are based on field observations outside the influence of the culvert.

| Classification (score) | Habitat description (Outside influence of culvert and road) |
|---|---|
| Unsuitable (0) | The reach upstream of the culvert has excessive gradient (>25%), excessive stream velocities, lacks spawning substrate, or has other hydrological and geomorphological characteristics (i.e. is stagnant, or emphemeral) that would preclude its capability of supporting fish (USFS Class IV ) |
| Low Suitability (2) | Habitat may be suitable for some resident fish and/or anadromous species and life history stages, low in mesohabitat diversity (pools, riffles, runs). May be steep in gradient, >10%, but accessible to fish (most similar to USFS Class II) |
| Moderate Suitability (5) | Habitat is relatively good for one or several species, resident and/or anadromous, moderately diverse (pools, riffles, runs) mesohabitat. (Between USFS Class I and II) |
| High Suitability (10) | Fish habitat favorable for spawning and rearing, for anadromous and resident species, clean and abundant spawning gravels but also a range of substrates; has a diversity of mesohabitat types and channel complexity. (USFS Class 1) |

Due to geomorphology, ponds can be formed as a result of culverts. This should be noted in the field notes, but does not influence the scoring, as all scores should be based on field observations outside of influence of the culvert.

Note: 1000 meter from USFS was a SE estimate of amount of habitat necessary upstream to be a viable length for salmon. The Copper watershed has different kinds of habitat (except around Cordova – which has many of the similarities to SE). 1000 meters certainly will not hurt in the watershed, but may not be needed for certain systems. Recommended lengths can be determined with input from local biologists familiar with the subdrainages of focus.

**Notes from 2010 Field Season:**
Waterways with little to no water and no defined channels were given a score of ‘0’. Most ponds, wetlands, and small wetland channels were given a score of ‘2’. Migratory channels were also given score of ‘2’. Upland channels with more complexity were given scores of ‘5’ or ‘10’, depending on the diversity of habitat types.

## Secondary Criteria for Prioritizing Culverts

After initial prioritization of the culverts based on culvert condition and ecological conditions, the following criteria can be reviewed to help further identify high priority projects.

**Other Ecological Considerations**

***Erosion Issues*** (Culvert significantly affects geomorphology of stream or there are significant erosion issues along the banks or road at crossing)

Erosion Issues 5

| | |
|---|---|
| No Erosion Issues | 0 |

***Downstream Barriers*** (Downstream barriers are not number of barriers or partial barriers but what the overall barriety downstream is. Barriers are preferably determined from field observation, but that might not be practical. May have to use a variety of other sources, including local knowledge. If it is not cataloged need to try to find out why.)

| | |
|---|---|
| None | 10 |
| Intermittent | 5 |
| Impassable | 0 |

Crossings were given a score of '5' if the waterway was deemed non permanent. Side channels of glacial systems and beaver sloughs without defined upland channels were considered non permanent. If passable to fish depended solely on high flow regimes, a score of '5' was given as well.

***Pipe condition***

| ADF&G Pipe Condition Score | CRWP Score |
|---|---|
| 5-new (No deficiencies observed in the designed shape, seams and joints, or culvert material condition.) | 0 |
| 4-Good (Minor crown and/or invert flattening; no openings in joints or seams; some surface rust/corrosion with minor pitting.) | 4 |
| 3-Fair (Measurable flattening at inverts and some distortion in crown locations; minor separation at joints; scattered heavy rusting or corrosion and deep pitting.) | 6 |
| 2-Critical (Major pipe distortion, kinks, and deflection; major joint separation with piping and backfill infiltration; extreme rusting/corrosion and deep pitting with some holes.) | 8 |
| 1-Poor (Not functioning; Severely crushed or total crown collapse inlets damaged; seams/joints failed; bottom rusted through, culvert integrity compromised.) | 10 |

**Estimated Costs**

As stated earlier, culvert replacement projects are expensive, and prioritizing replacement projects with a cost/benefit analysis across the watershed is essential for allocating limited resources. Costs are dependent on the depth of fill used to cover the culvert, whether a road is dirt or asphalt, and other engineering considerations specific to a site and can vary greatly across drainages. Therefore, this scoring system can be developed specific to each region that is being assessed using this tool, with assistance from DOT, ADF&G and other individuals that have an understanding of culvert replacement costs. As a starting point, the following break-down has been developed:

*Culvert Replacement Estimated Cost*

| Cost Estimates | Score |
|---|---|
| Less than $100,000 | 10 |

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| | |
|---|---|
| $100,000-$249,999 | 6 |
| $250,000-499,999 | 4 |
| $500,000-999,999 | 1 |
| Greater than $1 million | 0 |

**Opportunities for Action**
Culvert prioritization and restoration is part of a larger effort of conservation planning and restoring habitat connectivity. Systematic conservation planning is increasingly influencing the decisions of organizations, shaping legislation and policy, and achieving results on the ground and in the water. The CRWP prioritization model is an example of this process, incorporating ecological conditions as well as social, political, and economic considerations.

Knight, Cowling & Campbell[3] argue that conservation scientists should be better at understanding and responding to opportunities for action. Informed opportunism balances biological priorities with opportunities for action. A dynamic qualitative characterization of the social and economic costs of implementation will likely suggest more possibilities for success than a static analysis. The CRWP model's "Opportunities for Action" criteria qualitatively measure the degree of local and regional capacity that is available for the project. Partnership potential with governmental and non-governmental organizations may offer monetary support or expertise to help complete a successful project. Specifically, the maintenance potential criterion is included to capitalize on opportunities for piggy-backing on scheduled DOT maintenance.

In addition, local resident need/support is an important consideration for the longevity and community well-being that may be engendered through the project. Less than satisfactory results have occurred when ecological considerations are not balanced with local residential support, and we hope to include these lessons in our analysis by giving weight to local and regional needs.

*Partnership potential*

| | |
|---|---|
| Willing partners (NGO, tribe, state, federal, etc.) | 5 |
| No willing partners | 0 |

*Local resident need/support*

| | |
|---|---|
| Project has support/benefits local residents | 5 |
| Project has no support/no benefits to local residents | 0 |

*Maintenance Potential* (Statewide Transportation Improvement Plan (STIP); from DOT if available; whether culvert and/or targeted road is included in the upcoming paving/Maintenance Plan)

| | |
|---|---|
| Included in STIP, or upcoming maintenance | 5 |
| Not included STIP or upcoming maintenance | 0 |

[3] Knight, A. Cowling, R.M., Campbell, B.M. 2006. An operational model for implementing conservation action. *Conservation Biology* 20:408-419.

## Conclusion

The Copper River Watershed Project's culvert prioritization model is a work in progress, and we will continue to work with ADF&G, USFWS, DOT and others to fine-tune and modify this model as more data becomes available or new scoring and/or assessment techniques are identified.

We have already been communicating with other watershed-focused groups to help inform their efforts to approach fish passage improvements in a systematic way. We intend to apply the model in our future water quality and habitat restoration efforts as a tool that can help us advocate to funders and partners for salmon habitat restoration needs. A systematic process for prioritizing culverts will also serve as a powerful tool in raising funds among partners to cover the costs of culvert re-design. Continued field work in the watershed will also keep eyes on these streams to help identify other water quality and/or fish habitat issues that could be remediated with other restoration work.

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