Fish Passage at Road Crossings Assessment Boise National Forest FY 2004

Feather River at Road #135 Crossing

By

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EXECUTIVE SUMMARY

Inventory

The Fish Passage at Road Crossings Project for FY 2004 on the Boise National Forest evaluated 351 road/stream crossings and completed full culvert inventory assessments on 181 of those crossings on fish-bearing streams (Table 1). Boise National Forest crews completed a partial assessment to collect basic descriptive data on any crossing that did not warrant a full inventory (i.e. bridges and fords). The total number of road crossings on fish-bearing streams across the Forest is estimated to be about 1,741 (Table 2). Approximately 90% of the culvert crossings fully assessed in 2004 do not meet the criteria to pass fish (RED), and are a barrier for at least one life stage (Table 1). Most of the "RED" crossings were associated with circular or squashed pipe-arch culverts (Table 3). Most of the "RED" crossings were a barrier at least due to the outlet drop (Table 9), but upon further evaluation may also be a barrier for other reasons. Only eight of the evaluated culverts met the passage criteria and were not a barrier (GREEN) to juvenile or adult fish. These crossings included four open-bottom arches, two circular culverts, and two squashed pipe-arch culverts. The remaining 5% of the evaluated culverts were found to be undeterminable (GREY) and candidates for further evaluation (e.g.; Fish Xing software).

Table 1: Summary of Aquatic Organism Passage Barriers

Lifestage	RED	GREY	GREEN	Total
Adult	162	11	8	181
Juvenile	166	7	8	181

Red = is a barrier to fish. GREY = is unknown and requires further assessment to determine passability. Green = is passable to these life stages of fish. As seen in the table, of the 181 crossings inventoried, a large majority (90%) were found to be barriers to all life stages of fish.

This report summarizes the prioritization of sites, the methods and assumptions, the evaluation criteria, the results, and a proposal for rehabilitation or reconstruction. For a more detailed description of the results by Hydrologic Unit Code, refer to the appendices. All of the assessments, whether full or partial, are summarized by watershed in the appendices.

Table 2: Summary of Regional Priority Crossings Inventoried and those Estimated to be Remaining

Priority	# Crossing Sites Done	# Crossing Sites Remaining
1st (Chinook, Steelhead)	81	0
2nd (Bull Trout)	343	0
3rd (Cutthroat)	46	0
4th (Other Species)	192	1079
Total	662	1079

This table summarizes the priorities identified within Region 4 and the accomplishment compared to the remaining sites in each priority category. As illustrated the top 3 priorities were completed on the Boise National Forest by the end of the 2004 survey. All of the 1st & 3rd priority sites were within the SFSR, making it possible to accomplish them concurrently. The 2nd priority sites were scattered across the Forest. The most efficient method was to move systematically from the anadromous drainages south across the Forest allowing for effective use of government quarters and travel distances.

Inventory Results

The majority of culverts (90%) in the nine 4^{th} field subbasins surveyed rated out in the "RED" category (Table 1, Appendix A). All but five of these barriers are circular or squashed pipe-arch culverts (Table 3).

Table 3: Crossing Type Designations by Lifestage and Passability

Crossing Type	Adult Red	Juvenile Red	Adult Grey	Juvenile Grey	Adult Green	Juvenile Green

Recommendations

We have taken these results and focused our energy on those crossings considered "RED." Priority was assigned mainly by calculating the miles of habitat available upstream from the crossing. The Boise and Sawtooth National Forests Fishery Biologists also asked the following questions to verify that these crossings were located in areas considered to be priorities for restoration.

- Is the project in a high priority subwatershed as determined by the Watershed Aquatic Recovery Strategy and/or Aquatic Conservation Strategy?
- How many listed fish or other aquatic species would benefit from upgrading the barrier?
- Does critical habitat occur above the culvert?
- How many miles would be made accessible if passage was restored?
- Will correction of this barrier make the stream more accessible to introduced species?

The order within Table 4 is not necessarily firm, but is listed in order according to the amount of suitable habitat upstream. Also, note that the miles of perennial stream above each culvert varies greatly. Some perennial stream miles may not necessarily provide suitable fisheries habitat, but may provide habitat for other aquatic-dependent species.

The cost of replacement is based on an average cost for replacing similar-sized culverts with open-bottom arches. Based on a limited number of replacements on the Boise National Forest, construction and supplies alone average approximately $60,000. Planning costs are added to the construction and supply cost to estimate the total cost. However, some culvert replacements will cost substantially more than this average. For example, Roaring River is a large stream that will require a very wide replacement structure to span the bankfull width, resulting in costs 4-5 times the average described above.

Boise National Forest personnel worked with a contractor to replace Rammage Meadows and Wilson Creek culverts in 2004. The Renwyck Creek culvert is scheduled for replacement in 2005. Several of the remaining culverts on this list are in the Salmon River basin, which is an anadromous priority. This inventory made it easier to apply some of the more recent research currently underway at the Rocky Mountain Research Station to evaluate culvert combinations for their importance in terms of patch size for the various priority fish species. We plan to accomplish this with the data that we have collected as we complete some of the identified "highest" priorities.

Further recommendations include continuing the inventory across the Forest for at least another three field seasons (as funding allows) to fill data gaps for priority four fish species, such as redband trout. As illustrated in Table 2, the Boise National Forest has over 1,000 stream crossings that have not been assessed. The results to date provide a compelling reason to evaluate the remaining crossings for all species, regardless of priority, because the data is a precursor to restoration of connectivity within and among local populations.

Table 4: Top 25 Priority Sites for Culvert Replacement on the Boise National Forest

Forest-wide Priority based on 2003 & 2004 San Dimas Aquatic Organism Passage Inventory Protocol Results

Stream Name	Survey Year	R4 Fish Species Inventory Priority	Miles of Accessible Habitat Upstream	Perennial Miles Upstream	ACS Priority	Watershed & Aquatic Recovery Strategy
Feather River	2004	2nd	54.9	125.0	No	Active - Moderate
Willow Creek	2004	4th	18.7	22.7	No	Active - Moderate
Wood Creek	2004	4th	13.0	17.6	No	Active - Moderate
Deer Creek	2004	4th	12.7	27.8	No	Passive-Moderate
Big Pine Creek	2004	4th	12.5	35.3	No	Active - Moderate
Cottonwood Creek	2003	4th	8.2	23.5	No	Active - Low
Fivemile Creek	2004	4th	7.3	20.5	No	Passive-Moderate
Rammage Meadows*	2003	2nd	7.0	8.2	Yes	Active - High
Browns Creek	2004	4th	6.2	20.7	No	Passive-Moderate
Wilson Creek*	2003	2nd	6.1	7.3	Yes	Active - High
Fir Creek	2003	1st	6.0	12.2	No	Active - High
Fawn Creek	2004	4th	5.8	14.3	No	Active - Low
E. Fork Big Pine Cr.	2004	4th	5.4	16.3	No	Active - Moderate
Rattlesnake	2004	4th	5.3	12.2	No	Active - High
Bear Creek	2003	2nd	5.0	9.4	No	Active - High
Big Owl Creek	2004	4th	5.0	8.9	No	Active - Moderate
Miller Creek	2003	4th	4.8	16.0	No	Active - Moderate
Roaring River	2003	2nd	4.5	35.0	Yes	Passive-Moderate
Six-Bit Creek	2003	2nd	4.5	11.9	No	Active - High
N. Fork Canyon Cr.	2004	2nd	4.4	9.8	Yes	Conservation-High
Granite Creek	2004	4th	4.3	14.8	No	Active - Moderate
Dog Creek	2003	2nd	4.3	20.2	No	Active - Moderate
Mores Creek	2003	2nd	4.2	11.5	No	Active - Moderate
Renwyck Creek	2003	2nd	3.8	7.3	Yes	Active - Moderate
N. Fork Dollar Creek	2003	1st	3.8	11.5	No	Active - High

Criteria for ranking culverts are weighted mainly on the miles of habitat that will be accessible after replacement. However, our criteria included the inventory priority for species, the aquatic conservation strategy, the watershed and aquatic recovery strategy, the benefit to listed species, and the accessibility to introduced species. The Fir Creek and N. Fork Dollar Creek sites are within designated chinook critical habitat. Rather than providing an order to the top 25 replacement culverts, we plan to complete as funding, planning, and workforce allow. *Indicates culverts that were replaced in 2004 based on 2003 data.

Inventory Procedure Discussion

Initial Prioritization of Sites

Upon learning that the Boise National Forest would be funded for culvert assessment again in FY 04, the Resource Staff assembled information to determine how big of an inventory task remained. The Forest Team first focused on those subbasins that contained the key species emphasized by the Regional Office (Table 5). These included salmon, steelhead, bull trout, and cutthroat trout as priorities, respectively. We then determined how many stream crossings occurred in fish-bearing streams within these selected subbasins by using GIS stream and road coverages. Because the Forest does not yet have a linear fish distribution layer, perennial streams were intersected with roads to estimate the number potential survey sites. The INFRA database was queried to identify road-stream intersections that were bridges. District personnel reviewed maps displaying this information to help verify which crossings were bridges, fords, or culverts. This provided a starting point for the surveys. Further field verification confirmed the presence of bridges, fords, and culverts.

Table 5. Threatened, endangered, sensitive, Idaho state special concern fish species present on the B.N.F.

Fish Species	Status	Subbasin								
		S.F. Salmon	M.F. Salmon	S.F. Boise	Payette (Squaw Creek)	N.F. Payette	M.F. Payette	S.F. Payette	N.F. M.F. Boise	Boise Mores
Snake River Spring/Summer Chinook	Threatened	X	X	--	--	--	--	--	--	--
Snake River Steelhead	Threatened	X	X	--	--	--	--	--	--	--
Bull Trout	Threatened	X	X	X	X	X	X	X	X	X
Westslope Cutthroat Trout	Sensitive	X	X	--	--	--	--	--	--	--

Field Crews and Inventory Collaboration

The Boise and Sawtooth National Forests entered into a challenge cost-share agreement to accomplish the FY2004 target of completing culvert inventories (Agreement #03-CS-11040214-061 and #03-CS-11041430-022). These agreements established a working partnership with the Southwest Idaho High Country and West Central Highlands Resource Conservation and Development Councils (RC&Ds). The partnership provided necessary equipment to the Forest Service to accomplish the inventories within budget, while providing the RC&Ds information on privately owned barrier culverts to facilitate future partnerships for culvert replacements. The two Region 4 Forests also entered into a partnership for funding the crews and vehicles. The field crews consisted of internship students provided to the FS under an agreement with the Student Conservation Association (Agreement #03-PA-11040214-053). This allowed us to pay for a total of six students to accomplish the task in three months within a $65,000 budget. The two forests also hired one individual under a Personnel Services Contract to provide logistics, training, and organization for the field crews. Field crews consisted of two persons per crew with one vehicle for a total of three crews; two crews worked on the Boise National Forest. Because of the partnerships established with the RC&Ds, one of the most important tasks involved communication about private property owners adjacent to federal land that were willing to cooperate by allowing inventory on their lands. The funding worked well for the two Forests. However, the budget was still very tight due to high overhead, vehicle, and equipment costs associated with this cooperative project. It is highly recommended to continue and expand this type of partnership improve cost-effectiveness and productivity for this effort.

Crew production was tracked throughout the season for two reasons. The first was to continue to reorganize the crews based on most productive pairs and ensure there was an even match of expertise across both Forests. The second reason was to establish an accurate estimate of the costs and time required to complete extensive inventories like the San Dimas Aquatic Organism Passage Inventory Protocol. Tracking the production gives us a much more accurate method for requesting budget for completing the remaining crossing sites on these Forests or other Forests using the same protocol.

The crews were given the responsibility for determining what sites warranted a full inventory and the local professional fisheries biologist or hydrologist verified this decision. The Boise and Sawtooth Forest Fishery Biologists also tasked the crews with locating on a paper USGS 7.5 minute quad topographic map or during an initial driveby, those sites that were inaccessible or mapped inaccurately (i.e. locations where the road was mapped on the wrong side of the stream). The third set of sites was labeled as partial assessments because the crew was not responsible for a full assessment. The partial assessment provided the Forest with information on stream crossings that were not culverts, or unlikely to be perennial/fish bearing. This information will be used as an aid in future analysis documents to evaluate stream connectivity and interactions between the road and stream systems.

Additional Methods & Assumptions

Evaluation Criteria

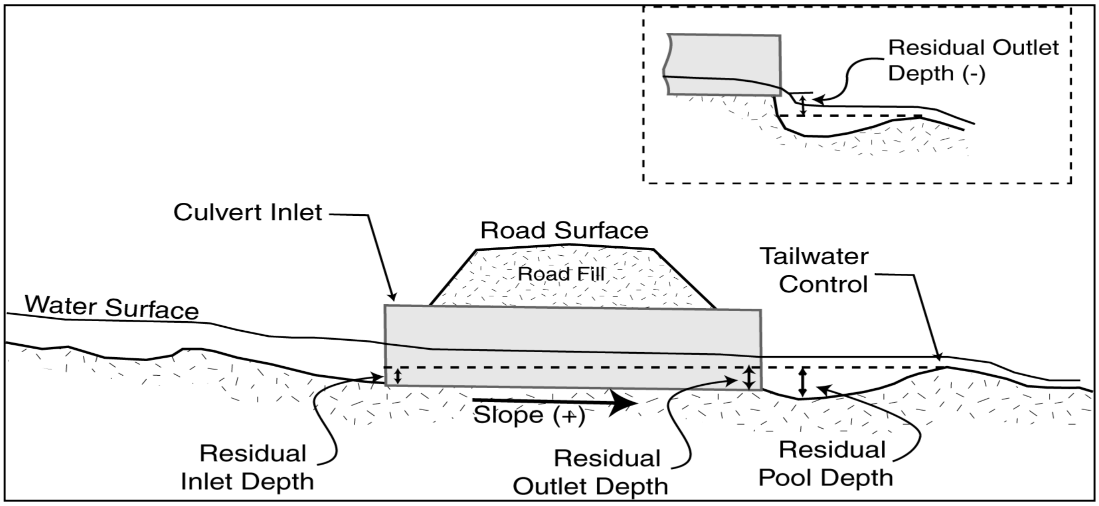
The USFS Region 1 fish passage evaluation criteria screening process was used to classify existing crossings as meeting, needing further hydraulic analysis, or failing to meet fish passage criteria for selected **resident** fish species. Region 1 constructed two flow charts (Figures 1 and 2), similar to ones developed by the California Department of Fish and Game (2001), for juvenile and adult cutthroat and bull trout. These flowcharts attempt to define whether passage is provided through existing structures at the time of survey.

The regional passage evaluation criteria flowcharts first determine whether the crossing meets natural channel simulation criteria. It is important to remember that these evaluation criteria are not as rigorous as stream simulation DESIGN criteria. Criteria for evaluating natural channel simulation include:

- Streambed substrate is continuous in character and profile throughout the entire length of structure (Representative bed material must be arranged in a stable configuration that provides for flow diversity, energy dissipation, and continuity of bedload transport throughout the structure).
- Crossing is set at or below stream grade – no outlet perch (No perch is assumed if streambed substrate is continuous throughout the structure).
- Structure width is equal to or greater than the average bankfull width of the channel out of the influence of the crossing – no constriction of the active channel exists.
- No steep drops occur immediately upstream of structure – channel slope between the crossing inlet and the first upstream holding habitat is similar to overall channel gradient (This must be verified for all crossings initially considered passable from the screen).

If the site inventory data verifies the above natural channel simulation criteria, the crossing is considered adequate for passage of all salmonids, including the weakest swimming lifestage. If not, one proceeds through the flowcharts to further evaluate each culvert until a passage status is determined. These criteria can be viewed in three stages:

1. getting into the culvert,
2. getting through the culvert,
3. and getting out of the culvert.



Residual Pool Depth = $(\text{Elev}_{\text{Tailwater Control}} - \text{Elev}_{\text{Pool Bottom}})$
Outlet Drop = $(\text{Elev}_{\text{Tailwater Control}} - \text{Elev}_{\text{Outlet Invert}})$
Residual Inlet Depth = $(\text{Elev}_{\text{Tailwater Control}} - \text{Elev}_{\text{Culvert Inlet}})$
Culvert Slope Percent = $(\text{Elev}_{\text{(Inlet Invert – Outlet Invert)}} / \text{Dist}_{\text{(Inlet Invert – Outlet Invert)}} \times 100)$
Inlet Gradient = $(\text{Elev}_{\text{(Inlet Gradient Control Point – Inlet Invert)}} / \text{Dist}_{\text{(Inlet Gradient control Point – Inlet Invert)}} \times$

Figure 3. Measurements used in evaluation criteria (from Taylor and Love, 2001).

Getting into the Culvert

Outlet Drop

Culvert outlets that are perched above the water surface are common obstacles to fish passage. Perch height is flow-dependent. Therefore, the stream discharge at the time of the field assessment does not provide for a comprehensive measurement of perch height. The Region 1 protocol uses a conservative assessment of perch height by comparing the outlet invert elevation to the tailwater control elevation (Figure 3). This is a flow-independent measurement. Ideally, the perch height should be evaluated at various discharges up to the high-flow design discharge. However, this would be too time consuming for this comprehensive assessment of all culverts in the region.

The Boise National Forest Fishery Biologist developed the following screening criteria to evaluate culvert outlets. These criteria are based on literature review and consultation with fisheries biologists, which is also documented in this section.

Table 6. Culvert Outlet Screening Criteria.

	GREEN (juvenile)	**GREEN (adult)**	**GREY (juvenile)**	**GREY (adult)**	**RED (juvenile)**	**RED (adult)**
Culvert Outlet	Not perched	Perch ≤ 0.5’	Perch < 0.34’ plus Outlet pool depth at least 1.25 times perch height	Perch 0-0.8’ plus Outlet pool depth at least 1.25 times perch height	Perch > 0.34’ or Outlet pool depth < 1.25 times perch height	Perch > 0.8’ or Outlet pool depth < 1.25 times perch height
			Note: Hydraulic analysis required to determine passability.			

Through biological monitoring, fish have been observed jumping considerable vertical and horizontal distances to clear obstacles. However, few studies have actually documented the jumping ability of fish, especially for young and small fish. Lab studies have determined that ideal jumping conditions for fish occur when the ratio of the jump height to the depth of the pool below the jump is 1:1.25 (Robison et al 1999). NMFS SW Region (2001) states that culvert perch needs to be evaluated for both high design flow and low design flow and should not exceed 1 foot for adult fish and 6 inches for juveniles with a jump pool of at least 2 feet. Burton (1998) states in his protocol for assessing fish passage at culverts on the Boise National Forest that the standard maximum jumpable height for adult trout is 0.984 foot (11.8 inches) and 1.968 foot (23.6 inches) for adult salmon. The Idaho Dept of Lands (1998) guidelines for new stream crossing installation permits a maximum drop of 1 foot from the culvert outlet when a holding pool is provided. The USFS R6 and R10 fish passage assessment screening criteria indicate that culverts with an outlet perch height of less than four inches may accommodate upstream movement of juvenile Coho salmon, but the crossing is only considered passable (GREEN) when the structure is not perched.

Getting through the Culvert

Culvert Slope

Water velocity within a culvert is determined primarily by culvert length, width, gradient and roughness. If the culvert gradient is too steep, or the culvert width is narrower than the streambed width, the water velocity will be increased within the culvert. Even very slight changes in the slope of the culvert (0.5% to 1.0%, for example) or substrate roughness within the structure may significantly change the culvert velocity.

The Boise National Forest Fishery Biologist developed the following screening criteria to evaluate culvert slope. This criterion is based on literature review and consultation with fisheries biologists, which is also documented in this section.

Table 7. Culvert Slope Screening Criteria.

	GREEN (juvenile)	**GREEN (adult)**	**GREY (juvenile)**	**GREY (adult)**	**RED (juvenile)**	**RED (adult)**
Embedded Culvert	Maximum Gradient ≤1% (unless inlet depth > 0.34') plus Culvert width/ Bankfull width ratio ≥ 0.7 plus No outlet drop	Maximum Gradient ≤2% (unless inlet depth > 0.34') plus Culvert width/ Bankfull width ratio ≥ 0.7 plus Perch ≤ 0.5'	Maximum Gradient ≤1% plus Perch < 0.34' plus Insufficient Backwatering	Maximum Gradient ≤2% plus Perch 0.5-0.8' plus Insufficient Backwatering	Gradient >1%	Gradient >2%
Culvert not embedded	Maximum Gradient ≤0.5% (unless inlet depth > 0.34') plus Culvert width/ Bankfull width ratio ≥ 0.7 plus No outlet drop	Maximum Gradient ≤1% (unless inlet depth > 0.5') plus Culvert width/ Bankfull width ratio ≥ 0.7 plus Perch ≤ 0.5'	Same as above	Same as above	Same as above	Same as above
Note: In cases where the residual inlet depth meets the minimum depth criteria, backwatering exists, and there is no outlet perch (or up to 0.5 foot perch for adults), then culvert gradient is automatically allowed to be higher to some degree.			Note: Hydraulic analysis required to determine passability.			

According to Idaho Dept. of Lands (1998), bare culverts greater than 50 ft long will cause fish-passage problems for adult spring-migrating trout (6-12 inches) if installed at over a 0.5% gradient and for juvenile and weak-swimming fish if over 0%, unless properly backwatered. If adequately backwatered, the culvert could be up to 4% gradient for adults and 3% for juveniles and still allow upstream passage. The Idaho guidelines state that culverts without streambed substrate that are less than 50 ft long can be installed up to 1% gradient for adult passage and 0.5% for juvenile passage. NMFS SW Region (2001) new installation guidelines require the slope of a non-embedded culvert to be less than 0.5% for salmon and steelhead. In the USFS Region 6 and 10 passage assessment matrices for juvenile Coho salmon, culvert grade for bare culverts must be less than 0.5% to be considered passable (GREEN). Bare culvert crossings with gradients between 0.5% and 1% would be considered GRAY for juvenile passage and would require hydraulic analysis to determine passability. Pipe arches with less than 100% substrate coverage can have a gradient of up to 2% (GRAY) before being considered non-passable (RED). If the culvert contained 100% substrate coverage of adequate depth (20% of culvert rise), then culvert gradient could be up to 2% in circular culverts with 2x6 corrugations and still be passable (GREEN) and go as high as 4% in that same situation before being considered non-passable (RED). The California Dept of Fish and Game (2001) assessment flowchart determines that culverts with slopes greater than 2% and not adequately backwatered and/or with a perch are considered non-passable (RED) for adult and juvenile anadromous salmonids. Culverts with less than 2% gradient and not adequately backwatered and/or with a perch are considered GRAY, thus requiring hydraulic analysis.

Residual Inlet Depth

Residual inlet depth is the depth of water at the inlet of the structure under no flow (or very low flow) conditions. When the outlet tailwater control elevation is higher than that of the inlet invert, the residual inlet depth will be a positive number and the structure will be backwatered at all flows (Figure 3). This positive depth, i.e. backwatering, is generally conducive to passage of most species and life stages since it tends to reduce velocities within the structure. It is important to note that spring-fed streams may never experience very low flows and therefore maintain ample water depth throughout the structure even without a positive residual inlet depth. The main reasons for setting a minimum residual inlet depth are to ensure that depth is adequate to allow passage at low flow conditions, and to acknowledge that backwatering may facilitate passage through culverts that are otherwise too steep.

The minimum depth necessary for successful passage depends on fish size, as larger fish require more water for passage. Based on a review of research findings and stream crossing design guidelines, the minimum water depths that allow most adult and juvenile trout to pass through a culvert range from 0.25 foot (3 inches) to 1 foot (12 inches). For adult steelhead and salmon the minimum water depth required for passage varies from 0.59 foot to 1 foot. Belford and Gould (1989) found that 0.26 foot (3.12 inches) was a sufficient depth to pass adult trout through the six Montana highway culverts evaluated in their study. The Idaho Department of Lands fish passage manual (1998) sets minimum depth criteria of 0.25 foot (3 inches) during migration. California Department of Fish and Game (1998) has a minimum of 1 foot for adult Chinook and steelhead and 0.5 ft for juvenile salmon and all trout. The Washington Department of Fish and Wildlife (2000) has a design standard minimum depth criterion of 0.8 foot for adult trout and 1 foot for adult Chinook and steelhead. Thompson (1972) found that for successful upstream migration of adult salmon and trout through non-embedded culverts, a minimum water depth of 0.59 foot (7.1 inches) for steelhead and 0.79 foot (9.5 inches) for Chinook is required. The NMFS SW Region (2001) requires a minimum water depth of 1 foot (12 inches) for adult steelhead and salmon and 0.5 foot (6 inches) for juvenile salmon when designing non-embedded culverts. Burton (1998) suggests having a minimum water depth of 0.49 foot (5.9 inches) for adult trout, and 0.984 foot (11.8 inches) for adult salmon on the Boise National Forest. Virginia's trout can maneuver a minimum depth of flow of 0.29 foot (3.5 inches) (Warren and Pardew 1998).

Getting out of the Culvert

Average Bankfull Width to Inlet Width Ratio

Constriction is addressed at two levels within the flowchart. The first discriminator is found within the natural channel simulation criteria – the culvert width must be equal to or greater than the average bankfull width and have substrate retained throughout the structure. If the crossing meets these criteria, it is not constricting the channel and considered GREEN. Secondly, in all other structures (embedded or non-embedded), the culvert width must be at least equal to 70% (ratio of 0.7) of the bankfull channel width as well as meeting requirements for outlet drop and slope to be categorized as GREEN. If the culvert width is less than 50% (ratio of 0.5) of the average bankfull channel width, it is considered RED for all life stages. In most cases, if a culvert overly constricts the channel, the tailwater control becomes scoured and incised by the higher velocity, backwatering is significantly reduced or eliminated and a perch may or may not form. In other words, if the structure overly constricts the channel, most likely there is an outlet perch as well. Constriction thresholds are based on initial culvert inventory data review and hydraulic analysis for a number of sites in R1.

Note that for all natural channel simulation crossings and other structures categorized as GREEN, it will still be necessary to review the inlet gradient and identify sites that have a steep drop in the channel profile directly in front of the culvert inlet providing evidence that the crossing does indeed constrict the channel (Evidenced by hourglass shapes that suggest velocities within the structure are higher than that of the stream channel). This steep slope can be a migration barrier to both adult and juvenile fish, because it creates supercritical flow just inside the inlet. Therefore, if the inlet gradient is excessive compared to channel gradient upstream of the crossing, the site will be designated as GRAY until hydraulic analysis can be completed for the site.

Evaluation Categories

The following categories will be used to classify crossings for juvenile and adult cutthroat and Bull trout for Region 1:

CHANNEL SIMULATION: Conditions assumed to be passable for all species/life stages.

GREEN: Conditions assumed adequate for passage of the analysis species life stage.

GREY: Conditions may not be adequate for the analysis species life stage presumed present. Additional analysis is required to determine the extent of barrier. It is here where we would denote possible flow barriers using hydraulic analysis.

RED: Conditions do not meet passage criteria at all desired flows for the analysis species life stage; assumed to be a barrier for that life stage.

It is important to note that fish may be able to pass through a number of the culverts identified in the RED and GREY categories during portions of the year, i.e. the culvert may actually be only a partial (flow) barrier. However, passage may only be possible during a very discrete period. The primary concern is that passage may not be possible for a particular life stage during the more extreme flow periods and most important migration times of the year such as during spring runoff and low base flows.

The passage evaluation criteria flowcharts do not cover all possible scenarios, thus the inventory data need to be thoroughly reviewed for any unique passage problems that may exist at crossings initially categorized as CHANNEL SIMULATION or GREEN. For example, a crossing may meet all flowchart criteria for passage but may still have an inlet drop, significant debris or sediment blockage, or a break within the structure itself. Further manual data review will identify and redefine these crossings appropriately.

The literature indicates that Chinook salmon and steelhead tend to demonstrate swimming and jumping abilities that are superior to other salmonids. However, anadromous fish-bearing streams on the Boise N.F. also support populations of bull trout and/or westslope cutthrout trout. Therefore, the Boise National Forest Fishery Biologist did not develop separate screening criteria for anadromous fish.