Feature

A Discussion of Fish Passage at Culverts in the Cariboo Region, British Columbia

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Issues related to fish passage at culvert crossings have long been an underlying concern of fisheries managers in the Cariboo Region. Some documentation of crossing problems has occurred through fish inventories, but obvious sites are usually known to field personnel from the Ministry of Environment, Lands and Parks, the Department of Fisheries and Oceans, and community groups. The magnitude of the problem of culvert barriers, however, has not been fully appreciated.

With the development of the Watershed Restoration Program (WRP), an informal evaluation of culvert crossings was occasionally conducted during a field assessment. This would occur if the road crossing happened to be within the portion of stream reach from which data was being collected during a Fish Habitat Assessment Procedure (FHAP) - Level 1 Field Assessment (Johnston and Slaney 1996). In such cases, however, there was no formal evaluation of the culvert, or specific data collection required, to evaluate passage. Nor would any culverts above or below the site neccessarily be assessed, and certainly not all culverts in the watershed were assessed. Similarly, the Sediment Source Surveys (Moore, G. D. 1994) funded by FRBC do not assess fish passage, although designed to evaluate every culvert crossing in a watershed for sediment concerns.

Since 1997, a number of Fish Passage Culvert Inspections (FPCI) (Parker 1998) have been conducted around the Cariboo Region under the auspices of the Forest Renewal BC via the Watershed Restoration Program. FPCI draft procedures, now available on the web at http://www.elp.gov.bc.ca/car, have been developed to identify road crossings at which the culvert may be a barrier to fish passage.

To prioritize the sites for works, the intention of the FPCI is that the assessments be done on 100% of the crossings in a basin, that meet the four basic criteria listed below:

- The stream is known fish-bearing, or linked by a gradient not in excess of 20% (25% for bull trout) to a known fish-bearing reach.
- The crossing is on a first or second order stream based on current 1:50,000 scale maps of the watershed. (All others are assumed to have bridges.)
- The stream is an actual culvert crossing, confirmed by a field visit. (Note that locations at which culverts are expected are often found, upon inspection, to be fords, bridges, or deactivated.)
- The stream is not an undefined channel through a draw, or a dry channel, at time of evaluation.

A variety of measurements are taken at the culvert crossing to determine whether a fish passage problem exists. Measurements include culvert slope and water velocity, outfall drop, plunge pool depth, stream gradient, and bankfull width. A minimum of fish sampling effort and habitat evaluation is also required above and below each culvert assessed, according to the FPCI methods. This allows for more accurate determination of priority for works at an identified barrier site. The priority is determined by a weighted score based on: whether an additional culvert barrier exists upstream; the length of stream habitat upstream of the barrier; the degree of barrier; the fish species present; and a subjective score for the value of the physical fish habitat to be gained (Figure 1).

In reviewing the summary of culvert assessments conducted to date (Figure 2), the magnitude of fish access issues in the Cariboo Region becomes somewhat clearer. First, the number of culverts that met all four criteria for an assessment, as noted above, was only 35% of those that met the first two selection criteria of gradient and stream order. The

	Fish Species	Habitat Value		Barrier		Length of New Habitat		Limiting to Upstream Barrier	
Multiple or Significant	10	H	10	Full	10	≥ 1 km	10	Yes	5
Single	6	M	6	Partial	6	< 1 km ≥ 500 m	6	No	0
Other	3	L	3	Undeter.	3	< 500 m	3		

Figure 1. FPCI Scoring Matrix (0 - 10) to prioritize culvert barriers for works.

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Project Location	Total crossings considered	Total number of culverts assessed[2]	Crossings assessed as full or partial barriers	Culverts assessed as barriers (%)	Total km of stream barred	Avg. Stream Length (km) to be gained per high priority crossing
Woodjam Cr.	43	8	7	87	4	3.6
Little River	NA	6	3	50	4.1	1.4
Eagle / Bradley[1]	167	66	26	39	52	2
Jim / Windy[1]	81	30	18	60	36	2
Upper Cariboo	70	9	6	67	11.7	1.7
Boss	-	33	13	39	8.3	1.4
Upper Bowron	NA	36	9	25	12.9	1.5
Cottonwood	NA	27	22	81	55.8	1.7
Nazko	244	49	22	45	217	7.2
Regional Average	**NA**	**NA**	**NA**	**55**	**NA**	**2.5**
Regional Total	**NA**	**264**	**126**	**NA**	**402**	**NA**

[1] report only specified > 2 km upstream of barrier, therefore, results are understated.
[2] these are crossings that meet the four basic requirements for a culvert assessment.

Figure 2. Summary of Cariboo Region FPCI Reports.

benefits of field visits is clear, given that this may reduce the anticipated number of culvert crossings to be assessed by approximately 65%. Upon inspection, many expected culverts turned out to be ephemeral streams, deactivated crossings, or ford and bridge crossings. Field visits allow for better planning and budgeting of works. However, until the field visit, it is not apparent whether a crossing will meet the eligibility criteria, and therefore the number of sites visited will remain well in excess of those proven to be in need of assessment.

Of those culverts that met all four criteria and were subsequently assessed using the procedures outlined in the FPCI guide, 48% of the crossings were identified as being either a full or partial barrier. A full barrier is a barrier to all species present at all life stages, whereas a partial barrier is a barrier to passage of a given target species or life stage of a target species. There is, then, a significant number of culverts that need some attention to ensure fish access to upstream reaches. Through the nine assessments completed in the Cariboo Region, over 400 kilometers of stream were identified as not being fully accessible. As these nine projects cover only a small portion of the region, the poor fish passage at culvert crossings in the Cariboo Region is expected to have a significant impact on the migratory behaviour of anadromous and resident populations.

There also appears to be a correlation between the length of stream habitat to be gained and the topography of the land. The Nazko River watershed is significantly different than the other project areas. In this flat area where there are fewer, but longer, drainages, the average length of stream to be gained per high-priority crossing is much greater than the other basins (7.2km/crossing, as compared to an average 1.9 km/crossing for all others). This compares to the average result of three culvert assessments in the Fort St. John area, where an average of 5.9km/crossing was found (MacMahon 1999).

Management Considerations:

Of particular note is the fact that current FPCI assessments do not identify the length of the fish-bearing stream that is barred by a known culvert barrier. This does not allow us to evaluate the relative importance of what may otherwise seem to be a small habitat gain to a system. On the coastal and more mountainous systems of British Columbia, it has been common practice to run mainline roads parallel and close to the mainstem of the river systems. Barrier crossings on such a road are often not perceived to have a significant impact on the fish productivity of a system, as such short lengths of moderate gradient stream typically lie above these crossings. However, since this stable rearing and refuge habitat is such a small proportion of the system, it could very well be the limiting habitat feature, and therefore highly important to the long-term survival of local fish populations. For example, a study on the Skagit River in the Puget Sound area of Washington estimated culvert barriers to decrease summer and winter coho smolt production by 13% and 6%, respectively, on a basin-wide scale. However, in tributary-type habitats, the production losses increased drastically, to 44% and 58%, respectively (Beechie *et al.* 1994).

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Therefore, careful identification of potentially limiting habitat on a watershed scale, not just on length to be gained, could provide more accurate cost-benefit analysis to determine in which coastal streams attention to fish passage at culverts is particularly warranted.

The problem of culverts is an issue that needs to be addressed around the province, as the example above indicates. Those FPCI assessments that have been completed throughout the Northern Interior show that there are many improvements to be made. A compilation of 16 culvert assessment projects through the Cariboo Region and Omenica/Peace sub-regions have shown that an average of 36% of the culverts assessed are barriers to fish passage (438 in total). To address these barriers would improve access to almost 2000 km of stream habitat (not including off-channel, pond, and lake habitats). FRBC Interior/Coastal Watershed Assessments Procedures (Province of British Columbia, Ministry of Environment Lands and Parks and Ministry of Forests 1995) identifies the number of crossings per kilometer of stream. This can serve as an indicator of systems in which crossings might be a primary focus, where the implementation of culvert assessments is needed, and where re-establishing fish access is a priority.

Finally, there is an important cost-comparison exercise to be considered, that may recommend culvert crossing restoration over other restoration efforts. In 1998, 19 high-priority culvert crossings in the Cariboo Region were addressed by WRP culvert replacement, bridge installation, or weir construction. This work will provide fish access to all life stages of target species to an estimated 67 kilometers of stream habitat (pond and lake habitat has not been calculated), or an average of 3.5 km per crossing. This is in excess of the 2.5 kilometer average identified for all high-priority crossings in the completed Cariboo Region FPCI assessments. These works were completed for an average cost of $10,300/km habitat gained, varying from less than $1,000/km for weir structures in the Cottonwood River drainage to approximately $26,000/km for a bridge installation on Canimred Creek. The first cost-comparison to be made is a direct comparison of these activities to stream restoration activities that may be as much as $50,000/km for pond excavation, LWD placement, channel excavation, and other complexing activities. Second, there is a need to consider what the productivity gain will be for a given investment, regardless of the amount. For example, we might estimate that impacts have reduced the productive capacity of an 0.5 ha off-channel by 30-50%. In restoring such a system, therefore, that same percentage is the most we can hope to gain back for our investment. If access is the issue, a full barrier to an 0.5 ha off channel is a 100% reduction in its productive capacity, and we can expect to get a 100% production increase out of that habitat by restoring fish access. If both of these projects cost $10,000, a culvert restoration providing a 100% productivity gain is a better investment than a project costing the same amount, but in which we expect a 30-50% gain. The degree of barriers to fish passage at culvert crossings is therefore an important one to consider for fish managers in all regions of the province.

Figure 3. Before and after pictures of a culvert crossing on the a tributary to the Cottonwood River, near Quesnel B.C., for which a weir was constructed to backflood the culverts to provide fish passage.

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Cottonwood Culverts Post-Flood Assessment August 1999

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In the fall of 1998, West Fraser Mills - Quesnel undertook Forest Renewal BC funded Watershed Restoration Program activities in the Cottonwood River drainage, Quesnel Forest District, Cariboo Region of British Columbia. Part of these activities was to restore fish passage at four culvert road crossings on the 1300 Road. Scour of the stream bed below all four of these sites had left the outlet with drops between 25 and 60 centimeters (Figures 1 and 2). The four separate systems all had a bankfull width of approximately 3 meters. Rainbow trout were the primary target species of these works, although bull trout have been found in the watershed at other locations. Although the outlet drops alone were not definitive barriers to fish passage, in combination with culvert water velocities, lack of

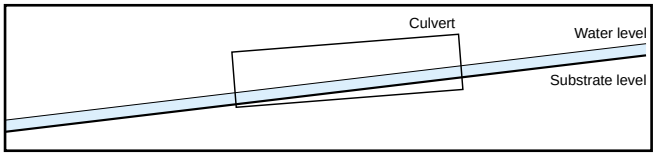

Figure 1. Initial placement - culvert near stream gradient, substrate throughout.