Calapooia Watershed Fish Passage Assessment

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Prepared by

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&
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For the

The Calapooia Watershed Council

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Table of Contents

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Introduction and Overview

In the summer of 2003, potential fish passage barriers at road-stream crossings were assessed for tributary streams to the Middle Calapooia River Watershed and the Courtney Creek Watershed. The middle portion of the watershed was selected for the inventory because most of the road crossings in the area have not be assessed and the tributaries to the Calapooia River (Brush, Pugh, Sawyer, and other streams) are important habitat for fish species including juvenile winter steelhead and spring chinook salmon. Winter steelhead and Chinook salmon are listed species under the federal Endangered Species Act.

Photo 1. Outlet drop from a culvert located in the headwaters of Brush Creek. This outlet drop is greater than the jumping ability of fish.

A total of 110 road-stream crossings were examined on private, Linn County and federal Bureau of Land Management roads: 80 culverts and 30 bridges. Culverts at road crossings were the primary target for the assessment, but valuable information on fish passage was also collected at bridge sites. At culvert sites, stream and culvert information noted included culvert diameter, gradient, depth of water in the culvert, and drop to pool from the bottom lip of the culvert outlet. Stream gradient and bankfull width upstream of the culvert, and pool length and depth below the culvert were also recorded. General observations on fish passage issues (for example, changes in flow velocity and drops) were noted at bridge sites. In addition, photographs were taken and sketch maps were recorded to note culvert/bridge characteristics and stream habitat conditions.

Photo 2. The inlet to a culvert located in the headwaters of Courtney Creek. This culvert has a steep gradient (12%) and shallow water that prevent fish passage.

Information from the inventory of fish passage at road crossings helps the Calapooia Watershed Council identify road crossings where there are fish passage problems. With this information, the Council can work cooperatively with landowners to address fish passage issues.

Of the sites surveyed, only 4 road crossings had culverts that all met the Oregon Department of Fish and Wildlife's (ODFW) criteria for fish passage (many sites had multiple culverts). To characterize the relative condition of the culvert sites and to aid in focusing restoration efforts, priority ratings were assigned to all culverts that did not meet ODFW criteria. In addition, several bridge sites have potential fish passage issues.

Why Fish Passage is Important

Culverts commonly block fish passage by creating high water velocities within the culvert and creating a significant drop at their outlet. At the outlet of culverts, the stream bed is scoured, creating a pool (outlet pool) and a drop from the culvert (Photo 1). In addition, the slope of the culvert contributes significantly to increasing stream velocities, often producing currents greater than a fish's ability to swim (Photo 2).

Fish passage is a concern for both adult and juvenile fish. Although some adult salmon and trout are powerful swimmers and can jump over 3 feet, most fish do not have this ability and are blocked by the jump at the outlet drop or the increased water velocities and shallow depths within the culvert. Small juvenile trout, salmon and other fish are the weakest swimmers and can be stopped by less than a 1-foot fall at a culvert outlet.

Fish passage at road crossings is important for two reasons. First, adult salmon, trout and steelhead need to move around the watershed to access spawning areas. Second, juvenile fish need to move through streams to escape unfavorable conditions such as warm water temperatures in the summer and high flows in the winter. Fish use most of the lower gradient stream channels in the watershed, even in seasonal streams. Juvenile winter steelhead and spring chinook salmon in the Calapooia River Watershed use the lower portions of seasonal and perennial tributary streams.

Fish passage guidelines developed by ODFW were used to determine whether the culverts were fish passage barriers. These guidelines are designed to evaluate if the culvert can accommodate the passage of juvenile fish (particularly trout and salmon) since they are the weakest swimmers. The ODFW guidelines focus on the jump height into the outlet of the culvert and the gradient. According to these guidelines, culverts should have an outlet fall of no more than six inches and no more than 0.5% gradient.

Table 1. Field data collected at the road-stream crossings to evaluate fish passage.

Field Data Collected

General (Culvert and Bridge)
GPS location: UTM coordinates
Road name
Road type: paved, gravel, dirt
Thickness of fill over culvert
Ownership
Sketch map: road crossing and stream
Photographs: Of culver and upstream and down from culvert inlet and outlet

Culvert
Material: concrete, steel, etc.
Condition: damage, rust, etc.
Corrugation depth and wavelength
Shape
Diameter(s)
Length
Water depth within culvert
Drop to outlet pool
Bottom gradient

Bridge
Field observations (no measurements)

Stream
Outlet pool length
Pool depth below culvert outlet
Maximum outlet pool depth
Channel gradient
Bankfull width

Field Methods

Table 1 outlines all of the information that was collected at each of the road crossings.

Stream-road crossings were identified in a Geographic Information Systems (GIS) analysis by locating all intersections of streams and roads. Each road-stream crossing was assigned a unique identification number and maps were created showing all crossings in the basin. These maps were used to locate the crossings in the field. For any crossings that were found in the field that had not been identified on the GIS map, an ID was assigned, and GPS coordinates were collected for subsequent mapping of the site. .

Before visiting the road-stream crossing sites, the field crew contacted landowners seeking permission for access. Where tax lot data included landowner information for sites, landowner permission was sought via telephone. For sites where no landowner information was available within the tax lot data, we asked for landowner permission upon arrival at site.

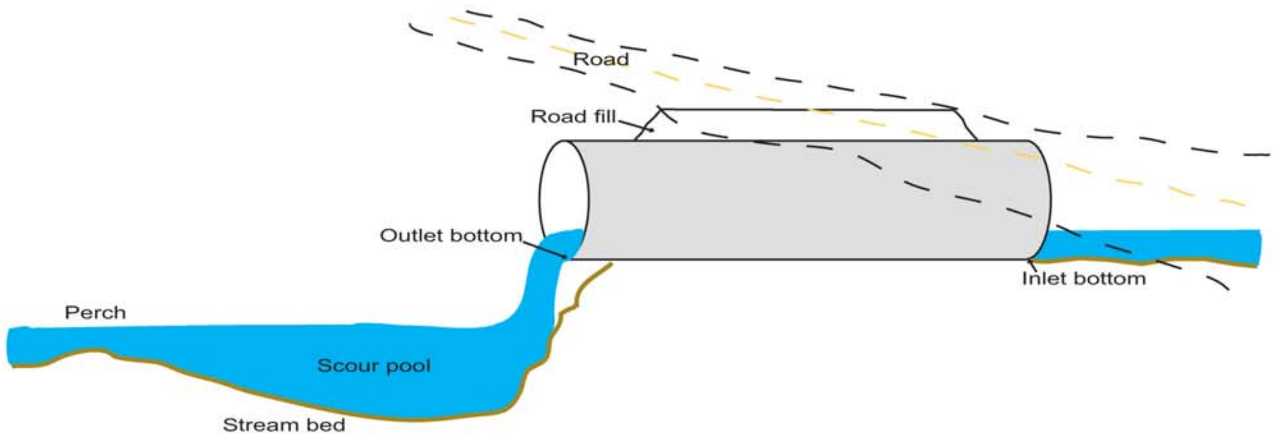
At each road-stream crossing, location information was collected using a geographic position system (GPS) receiver. Surveying methods (Figure 1) were used to collect the road crossing and stream data necessary to evaluate fish passage.[1] At some sites, alternative techniques using a clinometer had to be utilized in lieu of survey transit measurements because of the conditions or terrain at the site. In addition to the measurements and observations, photographs were taken of the culvert (or bridge) and stream channel habitat from four perspectives: 1) from the outlet looking downstream, 2) from a downstream location looking into the outlet, 3) from the inlet looking upstream, and 4) from an upstream location looking into the inlet. A sketch map was also completed noting the culvert/bridge, site, and stream channel conditions. Photos 3-5 illustrate the field measurements. Appendix A provides an example field sheet and explanation of the measurements.

As a general rule, culvert characteristics were measured (drop to pool, culvert gradient, etc.) while bridge conditions related to fish passage were based on general observations (obstructions to passage, changes in flow velocity, etc.) noted by the field crew. Exceptions on the measurement methods were based upon field crew's judgment about the relative significance of each particular crossing to the study. To increase the number of crossings examined, less time was taken at culvert crossings on small headwater streams since these channels are less important for fish.

[1] Diana Sharps assisted with the design of the field survey methods.

Figure 1. Schematic of culvert

1a. Generalized cross section of culvert at road-stream crossing.



1b. Generalized dimensions of a culvert at a road-stream crossing. Transit measurements are shown in red, and other dimensions are shown in black.

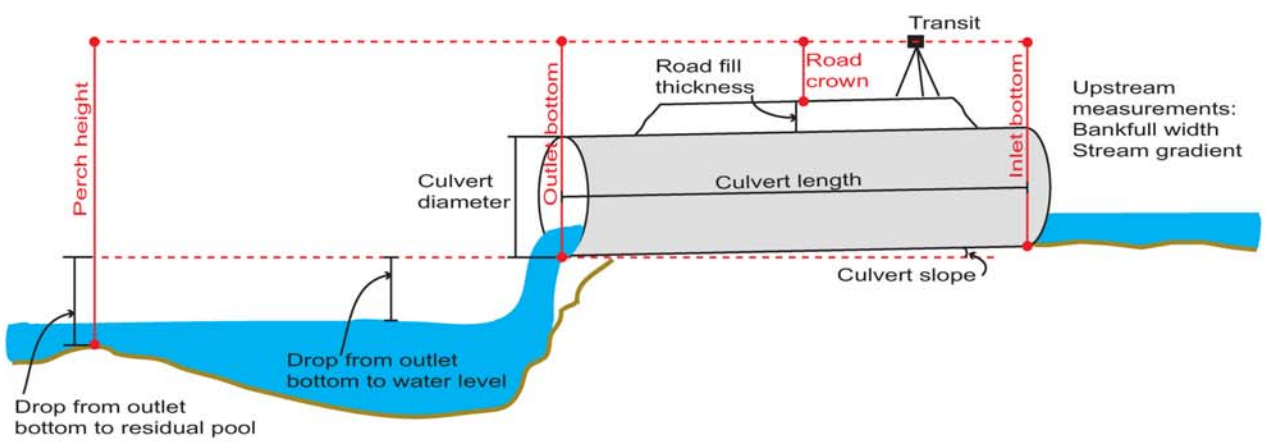


Photo 3. Culvert 435B where Brush Creek Road crosses West Fork Brush Creek. Setting up the transit for the field survey and recording location information with the GPS.

Photo 4. Culvert 323 in the headwaters of Brush Creek. Below the culvert outlet collecting maximum scour pool depth measurements.

Photo 5. Culvert BC1 in the headwaters of Brush Creek. Noting the conditions of the culvert outlet.

Results

The Database

All information from the fish passage site surveys (with the exception of sketch maps) was transferred daily from field sheets into a Microsoft Excel spreadsheet. In this process, data from the field sheets were sometimes corrected or supplemented with additional information based upon examination of maps or other materials. Digital photographs of the culvert/bridge sites were also archived. The spreadsheet and the digital photographs provide a comprehensive database of the fish passage information and priority evaluations. Culvert and bridge identification numbers are used to reference the information and photographs for each of the road crossing sites. Table 2 describes each worksheet as a guide for using the database.

Table 2. Description of the Calapooia River Watershed fish passage database (Excel spreadsheet). (To obtain a copy of the fish passage database, contact the Calapooia Watershed Council.)

Worksheet	Contents of worksheet
Original data sheet	This worksheet contains all original data from field investigations, with each column representing all the data for one site. Calculations for drop to residual pool (see figure 1) and culvert slope are made in this worksheet. Also, in this worksheet, qualitative information gathered in the field was entered into the data sheet in the form of yes/no questions. In these cases, a ***1*** in the cell indicates yes, while a ***0*** in the cell indicates no. All cells with calculations or yes/no questions are highlighted in yellow. Evaluation of ODFW criteria for all appropriate sites is done in this worksheet using the *1*=yes and *0*=no.
Reorganized data sheet	This worksheet also contains all original data and calculations. However, the data is reorganized so that each row represents an individual culvert or bridge. At sites where more than one culvert was at the site, each individual culvert has its own row.
All crossings	This worksheet is linked to "reorganized data sheet." Much of the raw data (i.e., transit data) that were used to calculate variables of interest were omitted in this worksheet for simplification.
Culverts	This worksheet contains the same information as in "all crossings," but only for those sites that are culverts.
Bridges	This worksheet contains the same information as in "all crossings," but only for those sites that are bridges. Bridge sites that may pose fish passage problems are indicated in yellow highlighting.
Culverts-priority	This worksheet contains culvert data for culverts that do not meet ODFW criteria along with their calculated priority rating. (See text for a description of the rating criteria.)
Low priority	This worksheet includes records for all culverts that are in the low priority group, a subset of all inventoried culverts.
Medium priority	This worksheet includes records for all culverts that are in the medium priority group, a subset of all inventoried culverts.
High priority	This worksheet includes records for all culverts that are in the high priority group, a subset of all inventoried culverts.
Highest priority	This worksheet includes records for all culverts that are in the highest priority group, a subset of all inventoried culverts.

Fish Passage Evaluation Criteria

For each culvert site, drop to the outlet pool (the jump height into the culvert) and culvert gradient measurements were evaluated based on ODFW criteria for juvenile fish passage. The drop to the residual pool (calculated as the elevation difference between the culvert outlet bottom lip and the low water level of the pool) was usually used as the drop to pool calculation (see Figure 1). Where there was no defined pool or perch, the drop from the outlet bottom lip to the water level was used as the drop to pool figure.

It would be difficult and expensive to address all of the potential fish passage barriers in this portion of the watershed. However, it is not necessary to address all of the inventoried culverts that do not meet the fish passage criteria. For example, there are culverts on high gradient streams that are at or near the end of cutthroat trout distribution. Since addressing fish passage at these culverts would gain access to very little habitat, these culverts would be a lower priority.[*] For this reason, criteria were developed to help the Calapooia Watershed Council prioritize opportunities to correct fish passage problems. The criteria used information about the culvert (jump height and gradient) to assess fish passage issues and the stream characteristics (size of the stream and gradient) to characterize fish habitat quality. Since there is no information on the quality of stream habitat or fish use for the stream reaches above the inventoried culverts, stream width and gradient were used as an indicator of fish use and potential habitat quality. This information can be used to identify priority culverts, and then seek opportunities to work collaboratively with willing landowners to address the fish passage problems. The priority system for addressing fish passage issues is outlined in Table 3.

Results of the Evaluation

Very few culverts in the inventoried area meet the ODFW criteria for juvenile fish passage. Out of a total of 80 culverts evaluated, 75 had outlet jump heights and/or gradients that did not meet the criteria. Of the culverts that did not meet the fish passage criteria, 16 had the highest priority rating; 23 had high priority ratings; 24 had medium ratings; and 12 culverts had low priority ratings. Highest and high priority culverts were found across all land uses and ownership categories: private, Linn County, and Bureau of Land Management. Figure 2 is a map of all of the inventoried culverts. Photos 6-11 provide examples of culverts with different priority ratings for addressing fish passage. Table 4 outlines the results of the evaluation, listing the priority ratings of culverts that did not meet ODFW criteria and bridge sites with fish passage problems. Many road crossings had more than one culvert in use (see Photos 6, 8 and 10), and each individual culvert was evaluated.

[*] Most of the inventoried culverts in small streams with high gradients were on forest lands. The Oregon Forest Practices Act requires that forest landowners provide fish passage for road crossings when they are replacing culverts or building new roads. Many of the forest landowners in the watershed have replaced culverts with installations that provide for fish passage.

Table 3. The ODFW criteria for juvenile fish passage and the priority rating system for addressing fish passage problems in the Calapooia River Watershed.

Status for action	Criteria	Rational
Exceeds (no action)	Jump < 6”, culvert gradient ≤ 0.5%	Meets ODFW criteria for juvenile passage
Culverts that do not meet the ODFW criteria: Jump ≥ 6”, culvert gradient > 0.5%		
Low priority	Stream gradient > 10%	These streams are at or near the end of fish distribution.
Medium priority	Stream gradient ≥ 4% and ≤ 10%	Although these streams usually have fish during at least part of the year, they do not provide the highest quality habitat and many of the culverts are near the end of fish distribution.
High priority	Stream gradient < 4%; culvert jump height < 6” and/or bankfull width < 10’	Most of these streams are in the lower portions of the watershed and have significant fish habitat above the culvert. Bankfull width is used as an indicator of channel habitat quantity.
Highest priority	Stream gradients < 4%; culvert jump heights ≥ 6” and bankfull widths ≥ 10’	Most of these streams are in the lower portions of the watershed and have significant fish habitat above the culvert; because the culverts have excessive jump heights, many of these barriers are also barriers to adult fish movement. Bankfull width is used as an indicator of channel habitat quantity.

Thus, a crossing with multiple culverts can be found in more than one priority group. Although culverts within one priority group share several key characteristics, their overall character can vary widely. When allocating resources for culvert improvement, all information collected at each crossing should be considered comprehensively with willing landowner cooperation.

Most of the inventoried bridges had no fish passage issues. Since bridges usually do not change the stream channel or fish habitat, these crossings are less likely to present fish passage issues. Out of the 30 bridges assessed, four of the bridges may create fish passage problems due to changes in water velocities or the development of a drop over the structure. In several cases, concrete surfaces under the bridge created a potential fish passage barrier (bridges are not marked on the maps).

Figure 2. Map of the inventoried culverts and priority designations (bridge sites are not mapped).

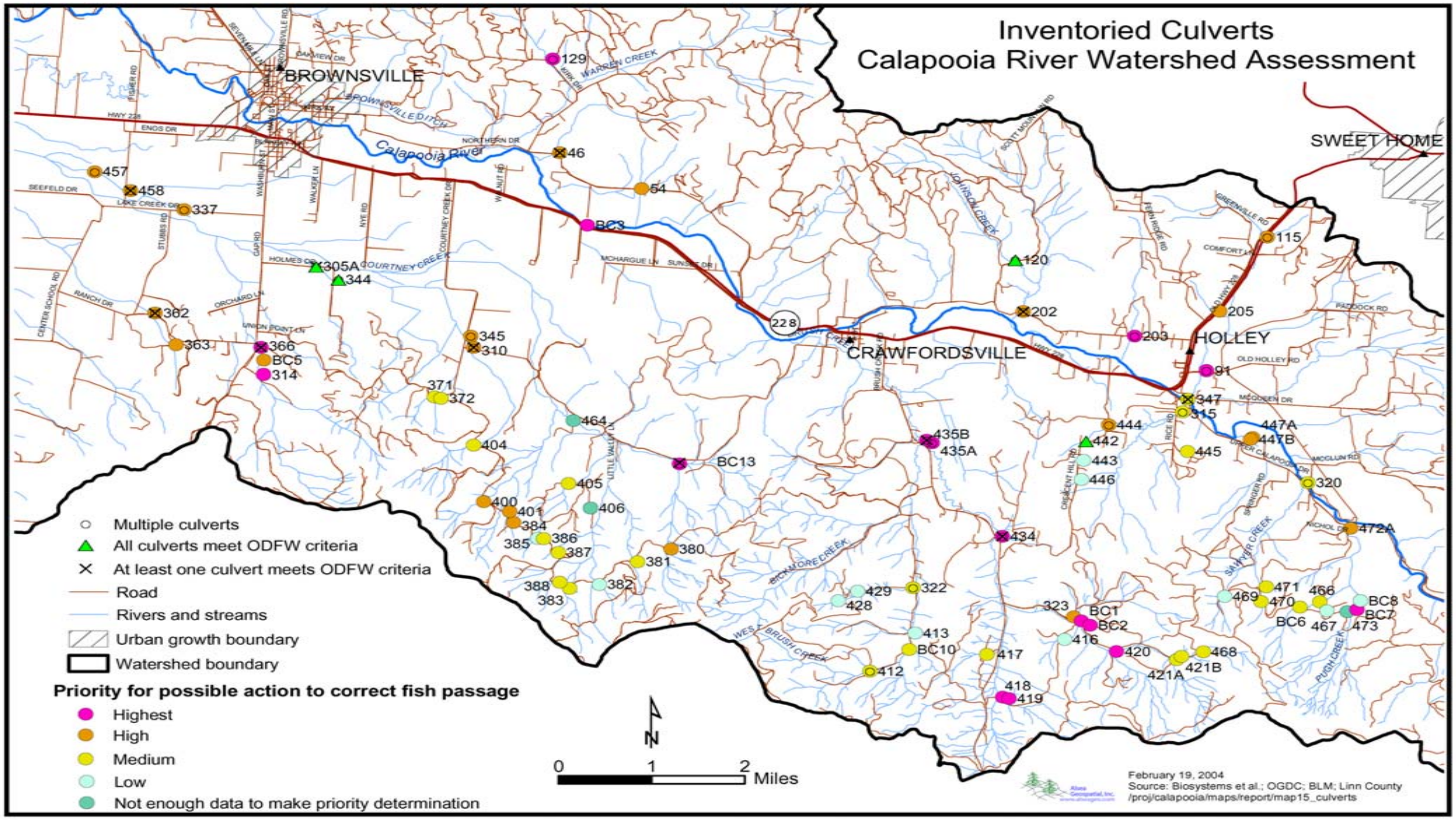


Photo 6. Culvert 203, located where Crawfordsville Drive crosses an unnamed tributary that flows directly into the Calapooia River from the north. This is an example of a highest priority culvert: stream gradient is 1.5%, bankfull width is 14 feet, jump height is ~1.5 feet, and culvert gradient is 1.0%.

Photo 7. Culvert 54, located where Northern Drive crosses a tributary to the Calapooia River from the north. This is an example of a high priority culvert: stream gradient is 0.7%, bankfull width is 7 feet, jump height is 0.7 feet, and culvert gradient is 3.1%.

Photo 8. Culvert 412, located in the headwaters of the West Fork Brush Creek. This is an example of a medium priority culvert: the jump height into the outlet (~1.5 feet, culvert gradient is 9.6%, and the drop onto rock for these two culverts would not allow for fish passage, but the location of the crossing in a high gradient part of the watershed (5% stream channel gradient) gives it a lower priority than culverts located in low gradient (4% or less) streams.

Photo 9. Crossing 382-482, located on a headwater tributary stream to Courtney Creek. This is a low priority culvert: the stream gradient (11%) is very steep and this is probably not a part of the stream used by fish.

Photo 10. Culvert 12, located on a tributary to Johnson Creek. This is an example of crossing with multiple culverts that both meet ODFW criteria with a culvert gradient of less than 0.5% and a jump height into the culvert of less than 6 inches.

Photo 11. Culvert 323, located on the west fork of Brush Creek. This embedded culvert is an excellent example of a culvert designed to pass juvenile and adult fish. There is no outlet drop and the culvert gradient is the same as the stream channel gradient.

Table 4. Culverts that do not meet ODFW criteria and bridge sites that may pose fish passage problems. Culverts are described by priority rating: highest, high, medium, and low.

Stream (Lited by order of ID#)	Barrier ID (# of culverts)	Diameter or width (ft)	Drop of water from culvert bottom to pool (ft)	Culvert gradient (%)	Bankfull width (ft)	Upstream gradient (clinometer) (%)	Priority rating
Trib. to Calapooia	91 (4)[2]	3.0	1.3	1.3	16	1	Highest
Trib. to Calapooia	129 (2)	3.5	1.3	1.6	17	0.5	Highest
Trib. to Calapooia	203 (2)	2.3	1.5	1.0	14	1.5	Highest
Trib. to Courtney Ck	314	6.0	0.6	4.5	17	2.5	Highest
Trib. to Courtney Ck	366 (3)	4.0	0.9	0.4	20	2	Highest
Trib. to Brush Ck	418	4.5	5.5	8.5	15	2	Highest
Brush Ck	419	3.0	2.4	5.7	11	1	Highest
Trib. to Brush Ck	420	7.0	0.6	6.2	27	2.5	Highest
Brush Ck	434 (2)	4.0	0.6	0.1	27	2	Highest
Brush Ck	435A	9.0	1.7	0.8	33	1	Highest
W. Brush Ck	435B (4)	4.0	0.9	0.3	40	1	Highest
Trib. to Brush Ck	BC1	6.0	0.9	2.1	33	2	Highest
Trib. to Brush Ck	BC2	3.8	3.6	6.1	20	1	Highest
Trib. to Calapooia	BC3	5.8	4.1	0.8	10	0.5	Highest
Trib. to Pugh Ck	BC7	3.0	3.7	3.6	15	2	Highest
Trib. to Courtney Ck	BC13	3.0	1.4	-7.5	11	3	Highest
Trib. to Calapooia	46 (2)	2.0	-1.0	1.0	13	0.5	High
Trib. to Calapooia	54	2.0	0.7	3.1	7	0.75	High
Trib. to Calapooia	115 (4)	1.9	0.0	2.6	17	0.5	High
Johnson Ck	202	4.0	-0.1	2.2	18	1	High
Trib. to Calapooia	205	2.0	0.1	1.9	7	1.5	High
Courtney Ck	310 (2)	2.0	-2.0	0.9	25	0.5	High
Trib. to Brush Ck	323	12.0	-0.8	1.0	21	1.5	High
Trib. to Courtney Ck	337 (2)	2.5	-0.3	1.5	8	0.5	High
Courtney Ck	345 (3)	3.0	0.2	0.8	18	1	High
Trib. to Courtney Ck	362 (2)	2.5	-1.0	0.9	10	1	High
Trib. to Courtney Ck	363	2.0	-0.7	3.7	5	0.5	High
Trib. to Courtney Ck	380	4.0	3.1	15.0	9	3	High
Trib. to Courtney Ck	384	2.0	1.2	11.8	7	2	High
Trib. to Courtney Ck	400	4.0	5.1	7.3	8	3	High
Trib. to Courtney Ck	401	2.0	-2.2	3.0	4	0	High
Brush Ck	435A	6.0	-0.6	4.5	33	1	High
Trib. to Calapooia	444 (3)	1.0	-0.3	5.9	6	2	High
Trib. to Calapooia	447A	1.3	-0.6	4.0	21	0.5	High
Trib. to Calapooia	447B	1.5	no pool	1.0	6	1	High
Trib. to Courtney Ck	457 (2)	1.5	-0.5	0.6	7	0	High
Trib. to Courtney Ck	458 (2)	2.5	-1.6	1.1	5	0	High
Pugh Ck	472A	5.0	-0.1	2.7	24	1.5	High
Trib. to Courtney Ck	BC5	8.0	0.1	4.0	18	2	High

[2] For crossings with multiple culverts, values given are calculated averages.

Table 3 continued. Bridges with potential fish passage issues are listed.

Stream (Lited by order of ID#)	Barrier ID (# of culverts)	Diameter or width (ft)	Drop of water from culvert bottom to pool (ft)	Culvert gradient (%)	Bankfull width (ft)	Upstream gradient (clinometer) (%)	Priority rating
Trib. to Calapooia	315 (4)	3.0	2.6	5.0	25	4	Medium
Sawyer Ck	320 (2)	2.5	-0.2	2.6	18	5	Medium
W. Brush Ck	322 (2)	2.0	1.2	2.6	9	6	Medium
Trib. to Calapooia	347 (4)	4.0	0.4	0.7	17	4	Medium
Trib. to Courtney Ck	371	2.0	0.0	4.8	6	6	Medium
Trib. to Courtney Ck	372	2.0	4.9	9.3	5	10	Medium
Trib. to Courtney Ck	381	3.5	15.0	11.8	8	7	Medium
Trib. to Courtney Ck	383	3.0	1.0	5.3	7	7	Medium
Trib. to Courtney Ck	386	1.5	1.7	3.5	2	4	Medium
Trib. to Courtney Ck	387	2.0	2.2	9.4	3	6	Medium
Trib. to Courtney Ck	388	1.5	4.1	0.5	3	4	Medium
Trib. to Courtney Ck	404	3.5	1.4	8.1	16	5	Medium
Trib. to Courtney Ck	405	1.0	0.0	3.0	1.5	7	Medium
W. Brush Ck	412 (2)	4.0		9.6	16	5	Medium
Trib. to Brush Ck	417	3.0	3.0	20.0	15	7	Medium
Trib. to Brush Ck	421A	5.0	-1.1	3.8	16	4	Medium
Trib. to Brush Ck	421B	8.0	0.0	4.0	9	5	Medium
Trib. to Calapooia	445	1.5	0.0	5.0	7	8.5	Medium
Carrie Fork Ck	466	8.0	0.0	6.6	13	9	Medium
Trib. to Brush Ck	468	3.0	1.1	6.1	12	7	Medium
Trib. to Sawyer Ck	470	2.5	0.0	2.7	8	4	Medium
Trib. to Sawyer Ck	471	3.0	4.1	3.9	13	5	Medium
Carrie Fork Ck	BC6	8.0	0.0	3.5	7	6	Medium
W. Brush Ck	BC10	6.0	1.3	6.4	10	7	Medium
Trib. to Courtney Ck	382	2.0	2.6	10.3	6	11	Low
Trib. to Courtney Ck	385	1.5	3.3	9.7	4.5	23	Low
Trib. to W. Brush Ck	413	3.0	0.3	4.3	8	11	Low
Trib. to Brush Ck	416	2.5	2.6	5.3	8	15	Low
Trib. to W. Brush Ck	428	2.0	1.7	15.5	15	20	Low
Trib. to W. Brush Ck	429	1.5	0.0	10.0	8	15	Low
Trib. to Calapooia	443	1.5	2.0	15.0	5	20	Low
Trib. to Calapooia	446	1.3	1.9	5.0	4	20	Low
Trib. to Carrie Fk Ck	467	1.5	0.3	3.0	4	12	Low
Sawyer Ck	469	3.5	2.5	8.6	16	11	Low
Trib. to Courtney Ck	482	2.0	2.6	10.3	6	11	Low
Pugh Ck	BC8	5.0	15.0	4.3	27	12	Low
Bridges:		**Condition:**					
W. Brush Ck	425	> 2' drop and high flow velocity					
W. Brush Ck	431	Old bridge structure to NW of current bridge poses velocity problems					
W. Brush Ck	432	Old remnants of former bridge structure has 1' drop to pool					
Brush Ck	484	Potential velocity problem under bridge					

Recommendations

The evaluation of fish passage barriers at road-stream crossings for some of the tributaries to the Calapooia River is the first step in addressing fish passage issues. These evaluations should be supplemented with more detailed information on fish use and stream habitat quality above the culverts. As a general rule, culverts near the lower end of tributaries that block large amounts of habitat should be addressed before fish passage barriers in the headwaters. The priority ratings for culverts provide a framework for addressing fish passage problems. The highest and high rated culverts should be addressed first. Surveys to assess fish use in the stream will provide information on whether the channel above the culvert supports (or could support) populations of resident trout and/or juvenile chinook salmon or steelhead. Working cooperatively with landowners and ODFW, the Council can begin to assess fish use and habitat quality above the fish passage barriers.

There are a number of fish passage barriers on the lower portions of tributaries that drain directly into the Calapooia River. It is critical to allow fish in the river to access both perennial and seasonal streams. Perennial streams can provide critical cold water areas where fish can escape the river's higher water temperatures during the summer. Seasonal streams provide areas where young cutthroat trout, winter steelhead, and spring chinook salmon can escape from high river flows during the winter.

Many of the culverts on Linn County roads present key opportunities to address fish passage problems. Most of these roads are in the lower portions of the watershed, often paralleling the Calapooia River or key tributaries such as Brush Creek. The Council can work with the County to begin to address some of the culverts that have been identified as fish passage barriers.

Appendix 1. Example field sheet and description

Calapooia Fish Passage Barrier Evaluation Evaluators: Kristin Anderson, Eric Urbigkeit

Barrier ID: 54	Date: 6-03-03	Time: 11:40	GPS(UTM): wpt 180 elev 137 m E 507641 N 4914073
Stream: UNKNOWN	Sub-basin: CALAPOOIA	sec. 2 R. 2W T. 14S	
Road: NORTHERN DR	Milepost or nearest intersection: driveway 37147 to west		

DOWNSTREAM MEASUREMENTS/OBSERVATIONS

Barrier type: ✓ Culvert ___Other:	Material: concrete

Culvert conditions (water flow around culvert, rusted, bent): fair condition, no major obstructions
pool is not well defined – flow stagnant
↳ mostly just a channel
at inlet, a berm ~1.5-2' upstream has built up, dry at inlet

Culvert dimensions (diameter or w X h): 2.0'	Shape: (round, ellipse)	Water depth in culvert: dry
Corrugation depth: /	Corrugation wavelength: /	Drop to pool: 0.6'
Pool length: 13'	Depth of pool at drop: 0.4'	Maximum pool depth: 1.2'
Culvert outlet bottom (transit): 9.75'		Perch height (transit): 10.43'
Pictures: 113 Looking downstream at stream		114 Looking upstream at barrier

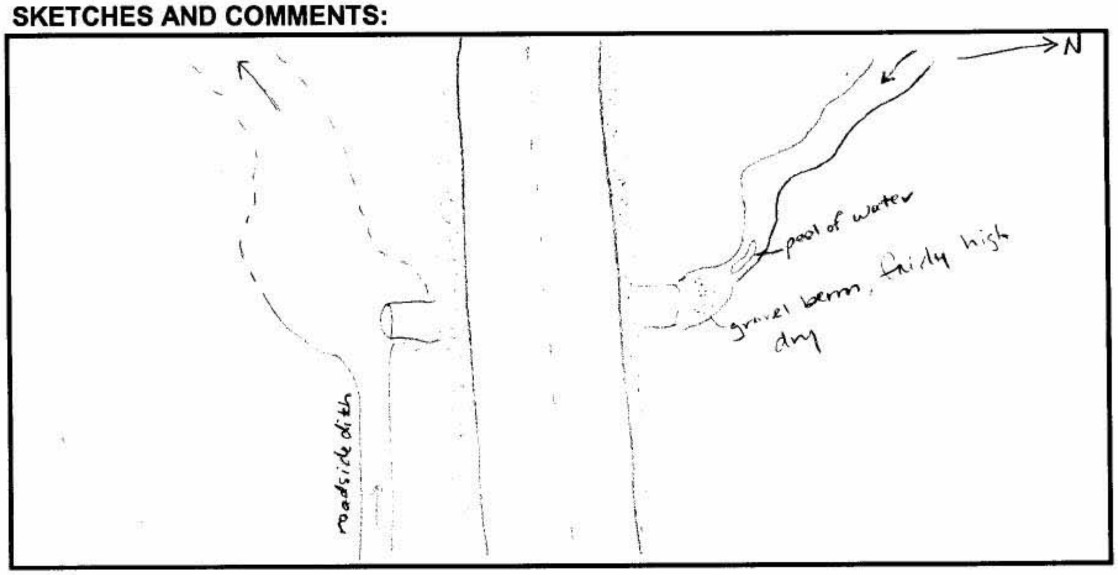
ROAD MEASUREMENTS/OBSERVATIONS:

Road type (paved, gravel, dirt)	Fill depth (transit): 4.67'	Barrier length: 47.5'

UPSTREAM MEASUREMENTS/OBSERVATIONS:

Bottom of inlet (transit): 8.30'	% slope:	Bankfull width: 7'	Upstream gradient (clinometer): 0.5 - 1 %
Pictures: 115 Looking upstream at stream		116 Looking downstream at barrier	

SKETCHES AND COMMENTS:



Explanation of the field sheet

The data sheet is organized with basic road crossing identifying information at the top, and subsequent sections of the data sheet are laid out in the sequence in which measurements were taken in the field. Highlighted areas denote where raw measurements need to be used to calculate variables significant to fish passage.

Identifying information at the top includes the unique ID number assigned to the crossing, the date and time of measurement, location information from both a GPS handheld unit and from the Township, Range, and Section shown on maps, road information, and stream and subbasin name.

Downstream measurements

Data collection started at the downstream end of the road crossing. Here, information on the type of road crossing (culvert or bridge), the material of which it was made, its condition, its dimensions, and the water depth within the barrier were collected. For bridge sites, usually only general observations were recorded. At culvert sites, corrugation depth and wavelength measurements were taken (to indicate bed roughness) if the culverts were made of corrugated metal. Information about the scour pool and the drop from the outlet to the pool were recorded. Survey measurements of the outlet bottom and the distance between the outlet pool and culvert were collected, and photos of the downstream end were taken.

Road measurements

Road material (dirt, gravel, paved) was noted, a transit measurement at the crown of the road was taken, and the length of the culvert was measured.

Upstream measurements

A transit measurement of the bottom of the inlet was taken, the bankfull width of the stream was measured, the gradient of the stream upstream of the culvert was measured with a clinometer, and photos of the upstream end were taken.

A sketch of the road-stream crossing was drawn along with its compass orientation, and any additional comments were included on the bottom of the sheet. Items noted in the sketch included the nature of the culvert or bridge, road location, and general stream habitat characteristics.

Photographs

Photographs were taken of the culvert (or bridge) and stream channel habitat from four perspectives: 1) from the outlet looking downstream, 2) from a downstream location looking into the outlet, 3) from the inlet looking upstream, and 4) from an upstream location looking into the inlet.