Assessment of Road Culverts for Fish Passage Problems on State- and County-Owned Roads

Statewide Summary Report

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Preface

Between mid-1996 and mid-1999, the Oregon Department of Fish and Wildlife (ODFW) conducted assessments of fish passage conditions at State- and county-owned road culverts. At the conclusion of each phase of the assessments, the Department produced and distributed a limited number of reports for the Oregon Department of Transportation (ODOT) and the counties which summarized road culvert assessment activities by river basin.

Public interest in these reports was underestimated. Each month, ODFW and ODOT receive numerous requests for these reports that can not be filled because the reports are out of print.

In order to meet the current and future demand for this information, ODFW is offering this summary report as a substitute for the original reports. This report contains all the basic information contained in the original reports plus all the inventory data collected over the 3-year assessment project. Where the original reports were tailored for either State or county road authority use, this report contains information for both.

At some point in the near future, this summary report and all database tables will be offered electronically on the Oregon Department of Fish and Wildlife Home Page via the Internet. Contact the ODFW Fish Passage Coordinator at the ODFW headquarters office in Portland for progress on this posting.

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Introduction

Human activities have created impediments to fish passage in Oregon streams that have reduced the number of stream miles available to salmonids (CSRI 1997). An undetermined number of road culverts present barriers to upstream migration of adult and juvenile salmonids on essentially all Oregon streams. These barriers seriously limit fish production in an unknown number of miles of historic habitat. Based on limited survey information, the problem appears to be significant and warrants investigation.

Botkin et al (1994) and the National Research Council (1996) concluded that migration barriers have substantially impacted fish populations. The extent to which culverts impede or block fish migration appears to be substantial. During fish presence surveys conducted in coastal basins during 1995, 96% of the barriers identified were culverts associated with road crossings (CSRI 1997).

Movement of salmonids throughout a watershed is necessary to meet a number of life history needs:

< Upstream migration of anadromous and resident adults to access suitable spawning areas;
< Juvenile and resident adult fish must be able to move upstream and downstream to adjust to changing habitat conditions (i.e., temperature fluctuations, high or low flows, competition for available food and cover);
< Resident fish need continuity of stream networks to prevent population fragmentation which decreases gene flow and genetic integrity;
< Catastrophic events can displace entire resident fish populations. Barriers can prevent the recolonization of these habitats.

Because there is no comprehensive inventory of in-channel obstructions on which to base a fish passage improvement program, the logical first step to improve fish passage at road culverts is to collect the required assessments. In mid-1996, the Oregon Department of Transportation (ODOT) and the Oregon Department of Fish and Wildlife (ODFW) entered into a contract (see Appendix 1) which committed ODFW to inventory, assess and prioritize for repair, all culverts associated with State- and county-owned roadways in the coastal river basins. These surveys did not include private (i.e., forest lands, residential property, etc.), federal or city roads. The contract was subsequently amended several times to include all river basins in the State.

The contract and culvert assessment effort responded to two primary incentives:

< Oregon Revised Statutes (Chapters 498 and 509) which require any person, municipal corporation or government agency placing an artificial obstruction across a stream to provide and maintain fish passage for anadromous, food and game fish species where these are present; and
< The Oregon Plan for Salmon and Watersheds (formerly the Oregon Coastal Salmon

Restoration Initiative) which identifies restoration of fish passage at artificial in-channel barriers as a high priority.

This project summary report describes:

< the inventory and assessment process in general;
< specific assessment methods used;
< criteria used to determine which culverts potentially impede passage; and
< the priority-setting process;

Process Overview

Prior to actual field surveys, possible culvert crossings were located on black-and-white copies (where available) of USGS 7.5-minute quadrangle maps obtained from the Oregon Department of Forestry, Salem. These maps had been previously modified with information from ODFW to indicate known or suspected (unverified) fish presence. Points where Afish-bearing≅ streams intersected with State or county roads (possible culverts) were marked for field inspection.[1] Project personnel then conducted on-site assessments of each intersection identified.

For each culvert failing to meet established fish passage criteria, information collected included:

UTM Coordinates	Culvert Type	Drop to Pool Below
Road Number or Name	Culvert Length	Depth of Pool Below
Road Mile (if known)	Culvert Diameter	Meets Criteria: Yes/No
Roadway Owner	Culvert Slope	Additional Comments
Stream Name and Basin	Stream Slope Above	
	Stream Slope Below	

For culverts judged to be fish-passable, only name and location were recorded in the database

Information regarding fish species present, stream habitat quality and miles of stream above (to end of fish distribution or another blockage) were not determined at this time; these data were obtained later with assistance from ODFW field staff most familiar with the stream systems.

Methods

UTM Coordinate System

The geographic location of each culvert was fixed in two ways: (1) using Universal Transverse Mercator (UTM) coordinates (see Appendix 2 for an explanation of this system) and (2) by roadway number or name and road mile (where established). UTMs were chosen because the

[1] In many instances, culverts were selected for assessment on streams not marked as fish-bearing if the stream appeared to the surveyor to have the potential to support fish.

degree of accuracy obtained using available maps was far superior to that obtainable using latitude-longitude or township-range-section systems. UTM coordinates are also completely compatible with GIS (Geographic Information System). Culvert locations were usually recorded in UTMs to the nearest 25 meters unless their location could be reasonably established to a closer tolerance.

State roads are usually identified by state route (highway) number and ODOT road number. County roads are usually identified by the number assigned by the subject county. In a few cases, road names were used. Whenever possible road miles were recorded to the nearest one hundredth of a mile as established in the ODOT straight-line charts or county atlas of roads. Occasionally, a stream crossing was not listed in either document, or it was unclear exactly which small tributary listed was the one in question. In these cases, road miles were approximated to the nearest 0.1 mile using odometer readings.

Fish Passage Criteria

Culverts on fish-bearing streams were evaluated against established passage criteria[2] for juvenile and adult salmonids. Parameters measured or estimated and recorded were:

< culvert diameter (inches) and length (feet);
< culvert slope (percent);
< presence/absence of a pool at the culvert outlet;
< distance (inches) of drop, if any, to the streambed or pool at the culvert outlet;
< pool depth, if present, in inches

Culvert diameter was usually measured. Where culverts were not entirely round (distended) or were arched pipe configurations, the width was recorded.

Water velocity, although a critical factor for upstream fish passage, was not measured directly. At the time of survey, flows were generally much lower than those typically encountered by adults moving upstream to spawning areas. Culvert slope is used as a surrogate indicator for possible velocity barriers in culverts.

Culvert slope was established using a clinometer whenever possible. Because this method requires a fixed point at eye level to sight on, it was occasionally impractical to use. Experience measuring many culverts, coupled with regular measurements where possible, gave the surveyors the ability to estimate slope where direct measurements were not practical. Also noted was whether slope was constant throughout the culvert length.

Generally, non-embedded metal and concrete culverts are considered impassable if the slope exceeds 0.5 to 1.0 per cent. At slopes greater than this, water velocities within the culvert are likely to be excessive and hinder passage, especially for juveniles fish.

[2] See Appendix 3; ODFW Guidelines and Criteria for Stream-Road Crossings

Conditions at the culvert outlet were evaluated for drop (distance from culvert invert to stream below) and the presence or absence of a jump pool. If a pool was present, its depth was recorded. The general criteria for pool depth is 1.5- to 2.0-times the height of the jump (drop) into the culvert; pools shallower than this are considered inadequate for fish needing to jump to enter a culvert.

If the height of the jump (pool surface to water level in the culvert) into a culvert would exceed 12 inches during the period of adult migration, the culvert was judged inadequate for adult fish passage and listed as needing attention. If the jump was judged to be greater than 6 inches during juvenile migration periods, the culvert was judged to be a passage problem for juvenile. In many cases, estimating the effect of moderate to high flows on the height of the jump was difficult and based on limited knowledge of the particular stream in question. Seasonally passable culverts, when noted, were listed as such in the comments section of the database.

Other culvert-related factors, recorded as miscellaneous comments, include:

< whether the culvert was embedded into the streambed or contained natural substrate;
< whether water ran beneath (outside) the culvert at the upstream end (a problem for downstream migration of juvenile fish in low water) or the downstream end (often caused by holes in the culvert bottom, due to corrosion)
< fish size (juvenile, adult or both) likely to be hindered or blocked;
< other features bearing on the culvert=s condition and ability to pass fish. (presence of baffles, debris jams, trash racks, fishways, etc.)

All culverts surveyed were placed in one of 2 categories; *passable* or *deficient*, as indicated in the AOK?≅ field of the database. Culverts meeting ODFW fish passage criteria were judged to be passable (OK = Yes). Culverts failing one or more criteria were judged deficient (OK = No) and in need of maintenance or remedial construction.

Assigning Priority for Repair

Ranking deficient culverts for repair is a difficult task. Several approaches were explored with all but one rejected because one or more critical information elements were missing. In the end, each listed culvert was rated as HIGH, MEDIUM or LOW priority for repair by ODFW field staff most familiar with fish populations and habitat in each stream. The ratings indicated in the database are generally based on:

< the number and status of species present;
< population size and condition; and
< the estimated quantity and quality of habitat blocked.

No effort was made to include factors such as estimated cost of repair, proportion of passage improvement or estimated increase in production; there were too many unknowns associated with these elements.

In most cases, staff were sufficiently familiar with the relevant factors to assign a priority for

repair. In some cases (usually small unnamed tributaries or headwater areas), ratings are based on uncertain knowledge and are no more than Abest estimates≅.

Data Summaries

All information collected pertaining to each culvert assessed was input into a Microsoft[8] Access[8] 7.0 database for storage, sorting, display, analysis, summarization, reporting and distribution to interested parties. Summary tables appearing at the end of this report contain information on both good and problem culverts; those that meet passage criteria as well as those that do not. Electronic copies of database information are also available from the ODFW Fish Passage Coordinator.

Microsoft Access[8] 7.0 Database

The following is a listing of the database fields in the culvert database printouts at the end of this report. Each parameter (units of measure, source of data, process of collection, etc) is explained below along with important limitations as to the accuracy and use of the information.

OK?--Does the culvert meet fish passage standards; YES or NO?

A ANO≅ does not mean that all fish are blocked at all flows; only that the culvert does not meet accepted fish passage criteria. The culvert probably inhibits or blocks adult and/or juvenile fish passage at some or all flows.

OWNER--the entity responsible for maintaining the culvert.

ZONE--the Universal Transverse Mercator (UTM) zone in which the culvert is located. Oregon contains 2 zones; zone 10 is to the west of 120° longitude, zone 11 to the east.

EASTING--the location of the culvert in meters east of 126° longitude.

NORTHING--the location of the culvert in meters north of the Equator.

ROAD--the State (ODOT) or county highway number (or name if unnumbered).

RM--Road mile of the culvert=s location listed in ODOT Bridge Log, ODOT straight-line chart or county road atlas. Odometer readings were used where stream crossings were not listed in these references. Points of origin for these are noted in the Acomments≅ section.

STREAM--the name of the stream containing the culvert. Names are taken from USGS quadrangle maps and information supplied by ODFW fish district personnel.

SUBBASIN--the stream or river into which STREAM flows.

BASIN--the stream or river into which SUBBASIN flows.

TYPE--the material that the culvert is composed of and the culvert=s shape. Where shape is not indicated, culverts are round. Codes used are standard ODOT abbreviations and are summarized in Appendix 6.

LENGTH--length of culvert in feet; determined from ODOT Bridge Log, ODOT straight-line chart, county road atlas or estimated by striding over the road surface.

DIAM--culvert diameter (or width if not round) in inches; determined from ODOT Bridge Log, county atlas, tape measure, or estimated.

DROP--measured or estimated distance in inches between water surface in culvert to the water surface of the stream below at the time of the survey.

DEPTH--measured or estimated depth, in inches, of the pool below the culvert (if present) during the period of migration.

SLOPE--measured or estimated slope of the culvert from horizontal, in per cent.

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SPECIES--fish species present in the subject stream. Species suspected to be present (not verified) are enclosed in parentheses. Abbreviations used are summarized in Appendix 7.

STMMILE--estimated miles of stream above the subject culvert to (1) the verified end of fish distribution, (2) next known upstream passage barrier or (3) the end of stream as indicated on USGS 7.5 quadrangle maps. The maps used were previously modified to indicate known or suspected (unverified) fish presence. Since fish presence was not absolutely known in all cases, these figures should be considered estimates only, giving a general indication of how much stream is blocked by the culvert. Stream miles do not necessarily reflect miles of fish habitat.

HABQUAL--assessment of habitat quality by ODFW field personnel. Possible ratings are *Good*, *Fair*, *Poor*, and *Unknown* In some cases, the rating reflects firsthand knowledge of the stream. In others, the streams are not known individually and are ranked based on the raters knowledge of the area in general. When the rater was uncomfortable assigning rating because of uncertainty, a rating of *unknown* was used.

PRIORITY--ODFW district personnel rated each culvert as *High, Medium* or *Low* priority for repair based on personal knowledge of fish populations present and habitat conditions.

Disclaimer

Although we made every effort to trap and eliminate errors at each phase of this project, some undoubtedly were missed. With 5,500 culverts assessed, recorded and summarized in this effort, some undetected errors in determining, recording and transcribing UTM coordinates and other

data are likely. If apparent errors are encountered, we wish to be informed so our records can be updated and improved. Please report any questionable data to the ODFW Fish Passage Coordinator, PO Box 59, Portland, OR 97207.

References

Botkin, D., K. Cummins, T. Dunne, H. Regier, M. Sobel, and L. Talbot. 1994. *Status and future of salmon of western Oregon and northern California: findings and options.* Report #8. the Center for the Study of the Environment, Santa Barbara, CA.

CSRI (Oregon Coastal Salmon Restoration Initiative) Plan, Draft Revision, February 24, 1997. State of Oregon, Salem, Oregon.

NRC (National Research Council). 1996. *Upstream--Salmon and Society in the Pacific Northwest,* National Academy Press, Washington, D.C.

Appendix 1

Culvert Assessment Contract #15,433

Oregon Department of Fish and Wildlife
and
Oregon Department of Transportation

Appendix 2

Universal Transverse Mercator (UTM) Coordinate Grid

Appendix 3

Oregon Department of Fish and Wildlife
Guidelines and Criteria for
Stream-Road Crossings

Appendix 4

Oregon Department of Transportation
Structure Codes

Appendix 5

ODFW Fish Species Abbreviations

Culvert Database Tables