

Technical Report

TR 02-01

**Summary Report:
Hoko and Skokomish River Coho Salmon
Spawning Escapement Evaluation Studies**

1986-1990

PNPTC Technical Report TR 02-1

**SUMMARY REPORT:
HOKO AND SKOKOMISH RIVER COHO SALMON
SPAWNING ESCAPEMENT EVALUATION STUDIES
1986-1990**

Prepared by

**LAWRENCE C. LESTELLE
Mobrand Biometrics, Inc.**

and

**CHRISTOPHER WELLER
Point No Point Treaty Council**

**Research Relating to Implementation of the
U.S. / Canada Pacific Salmon Treaty
Funded Through the
Northwest Indian Fisheries Commission**

May 2002

**POINT NO POINT TREATY COUNCIL
7999 N.E. Salish Lane
Kingston, Washington 98346**

ABSTRACT

In 1986 the Point No Point Treaty Council (PNPTC) initiated two studies to evaluate the redd enumeration methodology for assessing coho salmon escapements in the Hoko and Skokomish rivers. The studies were performed over a period of five spawning seasons. Their purpose was to investigate how the methodology should be applied to the two rivers and to attempt to quantify sampling variance and associated confidence limits. We summarize and synthesize the results of the studies in this report. We also present results of a new analysis that compares abundance estimates derived with the redd count methodology to those obtained using the live spawner count, area-under-the-curve (AUC) approach.

We found that the extent of some potential sources of error could not be sufficiently defined to compute total sampling variance. We summarize study findings related to four categories of potential error that affect results of the redd enumeration approach. These categories are sampling design, surveyor variability in counting, redd visibility, and expansion of redds to adult fish. The live spawner count, AUC methodology is subject to some of these same sources of error in addition to one other, stream residency time of adult fish. We discuss aspects of these sources of error as related to the AUC approach.

Our observations from this study suggest the AUC approach likely will estimate lower spawner abundance than the redd count method at relatively low to moderate spawner densities and, conversely, the AUC method likely will estimate higher spawner abundance at higher spawner densities. We therefore infer that the AUC approach will tend to underestimate the actual spawner abundance at low to moderate densities: coho spawners are generally more difficult to spot during surveys at these densities, whereas individual redds are more easily spotted and a more accurate accounting may be achieved with the redd count method. The situation appears reversed at much higher densities: the redd count method is more likely to underestimate actual spawner abundance because of the difficulty of distinguishing overlapping redds and the greater likelihood of redd superimposition. Thus, the AUC method may better represent actual spawner abundance at higher densities.

We conclude that the redd enumeration methodology would be more effective at monitoring escapements in western Washington at the current, generally low to moderate levels of spawner abundance. However, because the currently used fish count methods are often associated with long-term databases, it would be undesirable to lose continuity of such databases by switching to the redd count method. In such cases, it would be preferable to use the redd count method in conjunction with fish counts to give alternative measures of abundance and provide a means of checking accuracy.

On-going or future escapement assessment programs that use either estimation methodology should include efforts to understand the various sources of potential error well enough to manage and control it. We provide several recommendations for improving escapement assessment programs.

TABLE OF CONTENTS

ABSTRACT	i
LIST OF FIGURES	v
LIST OF TABLES	vi
PREFACE	ix
1. INTRODUCTION	1
2. DESCRIPTION OF STUDY AREAS	3
3. METHODS	6
3.1 APPROACH	6
3.2 SAMPLING DESIGN FOR SPAWNING SURVEYS	7
3.2.1 Hoko River	7
3.2.2 Skokomish River	7
3.3 SURVEY PROCEDURES	8
3.4 ESCAPEMENT ESTIMATION WITH SURVEY DATA	10
3.4.1 Estimates based on redd counts	10
3.4.2 Estimates based on fish counts	13
3.5 VALIDATION OF ESTIMATES	14
3.6 ASSESSMENT OF SURVEYOR VARIABILITY	16
4. RESULTS	18
4.1 HOKO RIVER	18
4.1.1 Extent of survey coverage	18
4.1.2 Escapement estimation with survey data	19
4.1.3 Validation	21
4.2 SKOKOMISH RIVER	28
4.2.1 Extent of survey coverage	28
4.2.2 Escapement estimation with survey data	29
4.2.3 Validation	32
5. DISCUSSION	40
5.1 SAMPLING DESIGN	40
5.2 SURVEYOR VARIABILITY	41
5.3 REDD VISIBILITY	41
5.4 EXPANSION OF REDDS TO ADULT SPAWNERS	43

5.5	VALIDATION	44
5.6	UTILITY OF AUC VS. REDD COUNT METHODOLOGY	47
5.7	RECOMMENDATIONS	49
	REFERENCES	50
	APPENDICES	55

LIST OF FIGURES

Figure 1.	The Hoko River system.	4
Figure 2.	The Skokomish River.	5
Figure 3.	Comparison between total adult coho salmon spawner abundance estimates of redd count and AUC method in the Hoko River, 1986-87 through 1989-90. Redd count expansion to adult abundance assumes a 1:1 sex ratio.	22
Figure 4.	Relationships between total redd counts and AUC estimates of adult coho salmon in index survey reaches in the Hoko River system, 1986-87 through 1990-91. .	25
Figure 5.	Comparison between total adult coho salmon spawner abundance estimates of redd counts and the AUC method in the Skokomish River, 1986-87 through 1990-91. Redd count to adult abundance expansion assumes a 1:1 sex ratio.	33
Figure 6.	Relationships between total redd counts and AUC estimates of adult coho salmon in index survey reaches in the Skokomish River system, 1986-87 through 1990-91.	36
Figure 7.	Relationship between estimated total redd abundance and AUC estimates of coho salmon for the Hoko and Skokomish River systems, 1986-87 through 1990-91. The line where estimates are equal for both methodologies is also shown.	48

LIST OF TABLES

Table 1.	Summary of methods to capture migrating adult coho salmon, objectives for capture, and capture locations within the Hoko and Skokomish River system, 1986-87 through 1990-91. Locations are expressed in miles (RM) from the stream mouth.	15
Table 2.	Numbers of survey strata, index and supplemental survey reaches, and stream miles surveyed and unsurveyed associated with coho salmon spawning in the Hoko River system, 1986-87 through 1990-91.	18
Table 3.	Estimated numbers of coho salmon redds dug in the Hoko River system during the 1986-87 through 1990-91 spawning seasons. The estimates are listed by location within the river system: within the Little Hoko River subbasin, below river mile (RM) 10.0 (including tributaries), and upstream of RM 10.0 (including tributaries). Miles of stream represented and redd densities are shown.	19
Table 4.	Partial estimates of variance (Var), standard deviation (SD), and coefficients of variation (CV) associated with total redd estimates for the Hoko River, 1986-87 through 1990-91. The variance measures represent sampling variation due to the overall sampling design. No estimates were made for 1987-88. Additional sources of error exist and are not contained in these variance measures.	20
Table 5.	Estimated total numbers of adult coho salmon natural spawners in the Hoko River system, 1986-87 through 1990-91, using two approaches of estimation: (1) extrapolation from redd estimates with a standard expansion of 2.0 and (2) AUC estimates from fish counts. No AUC estimate was made for 1990-91.	21
Table 6.	Cumulative redd counts and estimated numbers of adult spawners, derived using the AUC method, for index survey reaches in the Hoko River system, 1986-87 through 1990-91. WRIA stream numbers are given for unnamed streams.	23
Table 7.	Regression equations and coefficients of determination (r^2) for relationships between total redd counts (X) and AUC estimates (Y) of adult coho salmon in index survey reaches in the Hoko River system. * indicates significance at $P < 0.05$	26
Table 8.	Summary of mark-recapture results to estimate coho spawning escapement in the Hoko River, 1987-88. Adult migrants were caught and marked at RM 3.0. Recaptures occurred at various locations upstream.	27

Table 9.	Results of surveyor bias tests that compared counts of visible coho salmon redds in a tributary (one mile reach) to the Hoko River on November 17 and 18, 1988	27
Table 10.	Results of surveyor bias tests that compared counts of visible coho salmon redds in stream reaches in the Hoko River system, 1989-90. Each test was conducted on the same date by all surveyors.	28
Table 11.	Numbers of survey strata, index and supplemental survey reaches, and stream miles surveyed and unsurveyed associated with coho salmon spawning in the Skokomish River system, 1986-87 through 1990-91.	29
Table 12.	Estimated numbers of coho salmon redds dug in the Skokomish River system during the 1986-87 through 1990-91 spawning seasons. The estimates are listed by location within the river system: below the confluence of the South and North Fork, the South Fork subbasin, and the North Fork subbasin. Miles of stream represented and redd densities are also shown.	30
Table 13.	Partial estimates of variance (Var), standard deviation (SD), and coefficients of variation (CV) associated with total redd estimates for the Skokomish River, 1986-87 through 1990-91. The variance measures represent sampling variation due to the overall sampling design. No estimates were made for 1987-88 and 1988-89 due to incomplete sampling. Additional sources of errors exist and are not contained in these variance measures.	31
Table 14.	Estimated total numbers of adult coho salmon natural spawners in the Skokomish River system, 1986-87 through 1990-91, using two approaches of estimation: (1) extrapolation from redd estimates with a standard expansion of 2.0 and (2) AUC estimates from fish counts.	32
Table 15.	Cumulative redd counts and estimated numbers of adult spawners derived using the AUC methods for index reaches in the Skokomish River system, 1986-1990. WRIA stream numbers are given for unnamed streams.	34
Table 16.	Regression equations and coefficients of determination (r^2) for relationships between total redd counts (X) and AUC estimates (Y) of adult coho salmon in index survey reaches in the Skokomish River system. * indicates significance at $P < 0.05$	35
Table 17.	Numbers of female coho salmon spawners trapped and released at a weir on the North Fork Skokomish River (RM 13.6) and coho salmon redds enumerated upstream, 1988-89 through 1990-91.	37

Table 18.	Numbers of adult coho salmon trapped at the North Fork Skokomish River (RM 13.6) weir and associated sex ratios, 1988-89 through 1990-91.	37
Table 19.	Counts of coho salmon redds made by three surveyors on stream reaches in the Skokomish River system, 1989-90 and 1990-91.	38
Table 20.	Estimated redd life of coho redds dug in the Hoko River system by stratum, 1986-87 through 1988-89. Information is not available for 1990-91. Redd life is the duration that redds are visible to a surveyor.	42
Table 21.	Estimated redd life of coho redds dug in the Skokomish River system by stratum, 1986-87 through 1988-89. Information is not available for 1989-90. Redd life is the duration that redds are visible to a surveyor.	43
Table 22.	Sex ratios of adult natural coho populations at four fish passage facilities in western Washington, 1976 through 1990. Two year old fish (jacks) are not included in table.	45
Table 23.	Comparisons of independent estimates of coho spawning escapements and estimates derived using redd counts within the Hoko and Skokomish river systems. The estimates shown for the Hoko River are for both sexes; North Fork Skokomish River estimates are for females only.	46

PREFACE

There was a limited distribution of this report in 1995. However, it was decided to ask several biologists (see below) to review and comment on the report. As a result of this review, the report was modified to improve clarity and correct minor errors, but its substance remained the same. Owing to the press of other business and to neglect, the modified report languished. Recent requests led to its resurrection and distribution at this time. This report would not have been possible without the contributions of the following people.

The project biologists who supervised field crews, participated in data collection, and compiled, summarized and made initial assessments of the data included: Dan Dougherty, Don Gruber, Greg Volkhardt and Tim Willson of the Hoko River studies; and Ted Arnold, Ken Keller, Gregg Martenson and Murray Schuh of the Skokomish River studies. Ken Newman assisted with project planning and early assessments of study results. Chuck Baranski and Tim Flint provided comments on project planning and coordinated the WDFW cooperation and data exchange. Chuck Baranski, Scott Chitwood and Bob Hayman provided comments on an early version of this report that substantially improved this final version. Gary Graves helped coordinate the report review. Katie Mobernd typed the report and organized the physical preparation and integration of the text, tables and figures.

