

**THE DESIGN AND ANALYSIS OF SALMONID TAGGING  
STUDIES IN THE COLUMBIA BASIN**

**VOLUME XXV**

A Bibliography of Literature on Estimating Salmon Escapement  
with Focus on the Pacific Northwest

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## The Design and Analysis of Salmonid Tagging Studies in the Columbia Basin

### **Other Publications in this Series**

**Volume I:** Skalski, J. R., J. A. Perez-Comas, R. L. Townsend, and J. Lady. 1998. Assessment of temporal trends in daily survival estimates of spring chinook, 1994-1996. Technical report submitted to BPA, Project 89-107-00, Contract DE-BI79-90BP02341. 24 pp. plus appendix.

**Volume II:** Newman, K. 1998. Estimating salmonid survival with combined PIT-CWT tagging. Technical report (DOE/BP-35885-11) to BPA, Project 91-051-00, Contract 87-BI-35885.

**Volume III:** Newman, K. 1998. Experiment designs and statistical models to estimate the effect of transportation on survival of Columbia River system salmonids. Technical report (DOE/BP-35885-11a) to BPA, Project 91-051-00, Contract 87-BI-35885.

**Volume IV:** Perez-Comas, J. A., and J. R. Skalski. Submitted. Preliminary assessment of the effects of pulsed flows on smolt migratory behavior. Technical report to BPA, Project 89-107-00, Contract DE-BI79-90BP02341.

**Volume V:** Perez-Comas, J. A., and J. R. Skalski. Submitted. Analysis of in-river growth for PIT-tagged spring chinook smolt. Technical report to BPA, Project 89-107-00, Contract DE-BI79-90BP02341.

**Volume VI:** Skalski, J. R., J. A. Perez-Comas, P. Westhagen, and S. G. Smith. 1998. Assessment of season-wild survival of Snake River yearling chinook salmon, 1994-1996. Technical report to BPA, Project 89-107-00, Contract DE-BI79-90BP02341. 23 pp. plus appendix.

**Volume VII:** Lowther, A. B., and J. R. Skalski. 1998. Monte-Carlo comparison of confidence interval procedures for estimating survival in a release-recapture study, with applications to Snake River salmonids. Technical report (DOE/BP-02341-5) to BPA, Project 89-107-00, Contract 90-BI-02341.

**Volume VIII:** Lowther, A. B., and J. R. Skalski. 1998. Improved survival and residualization estimates for fall chinook using release-recapture methods. Technical report (DOE/BP-02341-6) to BPA, Project 89-107-00, Contract 90-BI-02341.

**Volume IX:** Townsend, R. L., and J. R. Skalski. Submitted. A comparison of statistical methods of estimating treatment-control ratios (transportation benefit ratios), based on spring chinook salmon on the Columbia River, 1986-1988. Technical report to BPA, Project 91-051-00, Contract 87-BI-35885.

**Volume X:** Westhagen, P., and J. R. Skalski. 1998. Instructional guide to using program CaptHist to create SURPH files for survival analysis using PTAGIS data files. Technical report (DOE/BP-02341-4) to BPA, Project 89-107-00, Contract 90-BI-02341.

**Volume XI:** Skalski, J. R., R. L. Townsend, A. E. Giorgi, and J. R. Stevenson. Submitted. Recommendations on the design and analysis of radiotelemetry studies of salmonid smolts to estimate survival and passage efficiencies. Technical report to BPA, Project 89-107-00, Contract DE-BI79-90BP02341. 33 pp.

**Volume XII:** Ryding, K. E., and J. R. Skalski. 1999. A multinomial model for estimating ocean survival from salmonid coded wire-tag data. Technical report (DOE/BP-91572-3) to BPA, Project 91-051-00, Contract 96-BI-91572.

**Volume XIII:** Perez-Comas, J. A., and J. R. Skalski. 2000. Appraisal of system-wide survival estimation of Snake River yearling chinook salmon using PIT-tags recovered from Caspian tern and double-crested cormorant breeding colonies on Rice Island. Technical report to BPA, Project No. 8910700, Contract DE-BI79-90BP02341.

**Volume XIV:** Perez-Comas, J. A., and J. R. Skalski. 2000. Appraisal of the relationship between tag detection efficiency at Bonneville Dam and the precision in estuarine and marine survival estimates of returning pit-tagged chinook salmon. Technical report to BPA, Project No. 8910700, Contract DE-BI79-90BP02341.

**Volume XV:** Perez-Comas, J. A., and J. R. Skalski. 2000. Appraisal of the relationship between tag detection efficiency at Bonneville Dam and the precision in-river survival estimates of returning PIT-tagged chinook salmon. Technical report to BPA, Project No. 8910700, Contract DE-BI79-90BP02341.

**Volume XVI:** Skalski, J. R., and J. A. Perez-Comas. 2000. Alternative designs for future adult PIT-tag detection studies. Technical report to BPA, Project No. 8910700, Contract DEBI79-90BP02341.

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**Volume XIX:** Buchanan, R. A., and J. R. Skalski. 2006. Analysis of fall Chinook salmon PIT-tag data: Estimating transportation effects. Technical report to BPA, Project No. 198910700, Contract 00012494.

**Volume XX:** J. R. Skalski. 2006. Evaluation and recommendations on alternative hydroacoustic array deployments for the mouth of the Columbia River to provide estimates of salmonid smolt survival and movements. Technical report to BPA, Project No. 198910700, Contract 00012494.

**Volume XXI:** J. R. Skalski and J. Griswold. 2006. A summary of methods for conducting salmonid fry mark-recapture studies for estimating survival in tributaries. Technical report to BPA, Project No. 198910700, Contract 00012494.

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**Volume XXIII:** R. W. Perry and J. R. Skalski. 2008. Effects of array configuration on statistical independence of replicated telemetry arrays used in smolt survival studies. Technical report to BPA, Project No. 198910700, Contract 00012494.

**Volume XXIV:** A. L. Parsons and J. R. Skalski. 2009. A statistical critique of estimating salmon escapement in the Pacific Northwest. Technical report to BPA, Project No. 98910700, Contract 00039987.

### **Other Publications Related to this Series**

Other related publications, reports and papers available through the professional literature or from the Bonneville Power Administration (BPA) Public Information Center - CKPS-1, P.O. Box 3621, Portland, OR 97208.

Skalski, J. R., R. A. Buchanan, and J. Griswold. 2009. Review of marking methods and release-recapture designs for estimating salmonid fry survival in tributary waters. *Reviews in Fisheries Science* 17(3):391–401.

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## **PREFACE**

Project 1989-107-00 was initiated to develop the statistical theory, methods, and statistical software to design and analyze PIT-tag survival studies. This project developed the initial study designs for the NOAA Fisheries/University of Washington (UW) Snake River survival studies of 1993 – present. This project continues to respond to the changing needs of the scientific community in the Pacific Northwest as they face new challenges to extract life-history data from an increasing variety of fish-tagging studies. The project’s mission is to help assure tagging studies are designed and analyzed from the onset to extract the best available information using state-of-the-art statistical methods. In so doing, investigators can focus on the management implications of their findings without being distracted by concerns of whether the study’s design and analyses are correct.

All studies in the current series, the Design and Analysis of Tagging Studies in the Columbia Basin, were conducted to help maximize the amount of information that can be obtained from fish tagging studies for the purposes of monitoring fish survival and related demographic parameters throughout its life cycle. Volume XXV of this series provides a comprehensive bibliography of the statistical literature on estimating salmon escapement in the Pacific Northwest.

## **ABSTRACT**

A bibliography of 301 papers and reports has been compiled through 2008 associated with estimating salmonid escapement. While the literature review focuses on methods used in the Pacific Northwest, it covers many of the escapement methods used through the United States and Canada. The bibliography sorts the articles by escapement methods including area-under-the-curve, carcass count methods, dam and weir counts, mark-recapture, peak count, redd count, and hydroacoustic (i.e., sonar) methods. The bibliography also includes review articles that compare and contrast alternative methods of estimating salmon escapement.

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## 1.0 Introduction

Salmon escapement or spawner abundance is one of the most crucial measures of the health of salmonid populations and a key indicator for the recovery of threatened and endangered evolutionarily significant units (ESUs). Nevertheless, approaches to the design and implementation of escapement surveys are as diverse as the investigators performing the task. Much of the variation in approaches can be explained by differences in the salmonid populations and the stream environments where the surveys occurred. Other sources of variation are associated with the level of financial resources for conducting the surveys and with the training and experience of the surveyors. In many situations, the escapement surveys simply provide indices of total escapement, and few studies provide measures of reliability or variance.

Proper design and conduct of escapement surveys is a delicate balance between the biology of the species, the environment of the spawning area, logistics, and statistics. No one best survey option exists for all circumstances. Investigators need to know what the options are for surveying salmon escapement and under what circumstances specific methods are recommended. To this end, this bibliography was created.

In Volume XXIV of this series, titled “A Statistical Critique of Estimating Salmon Escapement in the Pacific Northwest,” statistics and fisheries literature were reviewed for the purposes of assessing the statistical validity and precision of alternative escapement estimation techniques. The review examined methods of estimating escapement such as the area-under-the-curve method, mark-recapture, passage counts, peak counts, redd counts, and carcass count methods. Also included in Volume XXIV were a statistical review on sonar methods and a review of estimating stream residence time.

This bibliography in Volume XXV includes not only the technical reports and papers cited in the statistical review but also other articles related to the design, implementation, conduct, and results of field applications of escapement estimation techniques. This bibliography contains 301 citations from papers and reports published through 2008. We hope this bibliography will be useful to investigators interested in determining the best approach to surveying spawner abundance.

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