WENATCHEE RIVER SALMON ESCAPEMENT ESTIMATES USING VIDEO TAPE TECHNOLOGY IN 1991

Technical Report 92-3

Douglas R. Hatch
Andrew Wand
Matthew Schwartzberg

March 12, 1992

Columbia River Inter-Tribal Fish Commission
729 N.E. Oregon St., Portland, OR 97232
(503) 238-0667

WENATCHEE RIVER SALMON ESCAPEMENT ESTIMATES USING VIDEO TAPE TECHNOLOGY IN 1991

Technical Report 92-3

Douglas R. Hatch
Andrew Wand
Matthew Schwartzberg

March 12, 1992

ABSTRACT

Accurate determination of escapement is necessary for fish stock status analysis. In an effort to devise more accurate salmon escapement estimation techniques, a time-lapse video tape recording system was installed and operated from 22 April through 23 September, 1991, in the fish counting station at Tumwater Dam on the Wenatchee River. This was a continuation of studies conducted in 1989, and 1990.

Wenatchee River salmon escapement above Tumwater Dam was estimated to be 33,233 and 2,435 for sockeye *Oncorhynchus nerka* and chinook salmon *O. tshawytscha*, respectively, in 1991. Salmon migatory timing has remained similar from 1989 through 1991. The mean dates of passage for salmon in 1991 were 8/4/91 (SD = 5.2) for sockeye, and 8/1/91 (SD = 16.2) for chinook. Night passage of sockeye salmon was estimated to include 5% of the run. That estimate is similar to estimates made at Bonneville Dam in 1973 and 1974 (Calvin 1975). Tests comparing 50 min expanded and 60 min fish counts concluded that there was no statistical difference in counts of sockeye salmon ($p = 0.085$) and chinook salmon ($p = 0.023$).

Estimating salmon escapement using time-lapse video technology has been successful at Tumwater Dam on the Wenatchee River, Washington. Our findings indicate that by implementing video counting at other locations where salmon passage is monitored, fish count accuracy would increase (by accounting for night passage), individual specimen identification would be more precise, and a permanent record of fish passage events would be created.

ACKNOWLEDGEMENTS

We thank the following individuals for their assistance with this project: Jeff Fryer, Carolyn Pearson, Dan Kane, and Phil Mundy of the Columbia River Inter-Tribal Fish Commission; Steve Hays and Dick Nason of Public Utility District Number 1 of Chelan County; John Easterbrooks and Larrie LaVoy of the Washington Department of Fisheries; Tom Ruehle of the National Marine Fisheries Service; Joanne Turner of the Washington Department of Wildlife; and Jennifer Molesworth a private consultant who changed tapes.

This report is the result of research funded by U.S. Government (Bureau of Indian Affairs, Department of Interior) Contract No. P00C1409445 for implementation of the U.S.-Canada Pacific Salmon Treaty.

TABLE OF CONTENTS

Abstract i

Acknowledgments ii

Table of Contents iii

List of Tables iv

List of Figures v

Introduction 1

Methods 3
- Study Area 3
- Escapement Estimation 5
- Migratory Timing 5
- Comparison Between Video Counts and Traditional Mainstem Counts . 5
- Method for Quick Escapement Estimation from Video 6
- Night Fish Passage 6

Results 8
- Escapement Estimation 8
- Migratory Timing 8
- Comparison Between Video Counts and Traditional Mainstem Counts . 8
- Method for Quick Escapement Estimation from Video 11
- Night Fish Passage 11

Discussion 19

References 23

Appendix 1 (Equipment List) 25

Appendix 2 (Daily Fish Counts) 26

LIST OF TABLES

Table 1. Average date and standard deviation of salmon migration at Tumwater Dam for 1989, 1990, and 1991.. 10

Table 2. Average night/day fish count ratios, standard errors, y-intercept constants, coefficients of determination, and sample sizes for sockeye salmon at Bonneville and Tumwater dams. 17

LIST OF FIGURES

Figure 1. Map of the Wenatchee River Basin showing location of Tumwater and Dryden dams. 4

Figure 2. Wenatchee River sockeye and chinook salmon escapement in 1991 estimated by video tape count and including fish trapped at Tumwater and Dryden dams. 9

Figure 3. Expanded 50 min and 60 min counts for sockeye and chinook salmon and steelhead. 12

Figure 4. Estimates of sockeye salmon escapement using 1 in k systematic sampling. 13

Figure 5. Composite sockeye and chinook salmon counts as a function of time of day with approximate hours of darkness shaded, recorded at Tumwater Dam in 1991. 14

Figure 6. Least squares linear regression lines with 95% confidence intervals fit to night/day fish count data at Tumwater Dam in 1989, 90, and 91. Dashed lines represent night/day fish count data from Bonneville Dam (Calvin 1975). 15

Figure 7. Least squares linear regression line with 95% confidence intervals fit to pooled night/day fish count data at Tumwater Dam in 1989, 90, and 91. Dashed lines represent night/day fish count data from Bonneville Dam (Calvin 1975). 16

Figure 8. Comparison of sockeye salmon counts between video tape analysis at Tumwater Dam and calculated inter-dam counts from 1989 through 1991. 20

INTRODUCTION

Accurately estimating escapement of salmon is critically important to permit analysis of stock status. In the Columbia Basin, the Northwest Power Planning Council (1987) has established a management goal of doubling run sizes. Presently, the only way to determine if strategies designed to increase salmon stock abundances are successful is to accurately count the number of returning adult salmon to natal streams. Toward this goal, the Columbia River Inter-Tribal Fish Commission (CRITFC) has been developing the use of time-lapse video technology for use in salmon escapement estimation.

The use of video technology as a tool for monitoring biological systems is becoming increasingly popular. For example, Irvine et al. (1991) recently developed a video-based method for counting fish captured in a trap. The feasibility of estimating salmon escapement using underwater video has been investigated (Hatch et al. 1991). The Columbia River Inter-Tribal Fish Commission (CRITFC) has, over the past 4 years, developed a successful salmon escapement estimation program utilizing time-lapse video technology at Tumwater Dam, Washington (Hatch and Schwartzberg 1990,1991).

Previous work has investigated the effects of several reviewers on count precision in video estimates (Hatch and Schwartzberg 1991), the effect of different time-lapse modes on fish counts (Hatch and Schwartzberg 1990), and night fish passage. Together, these studies have demonstrated that time-lapse video can be used to successfully estimate salmon passage at a fish ladder viewing window.

The current study continues to estimate Wenatchee River escapement, and to document night fish passage. In previous years studies we have noted a significant amount of night fish passage. We investigated whether this was a phenomenon specific to Tumwater Dam or if this was a general characteristic of Columbia River Salmon Migration. Additionally, this year we investigated potential fish count discrepancy between continuous 24-hour video monitoring and the current Army Corp of Engineers (COE) mainstem dam fish counting protocols. Also, we developed a sampling scheme that we will use in future years to estimate fish abundance in-season for management purposes.

The objectives for this report are:

1. To compare time-lapse video and inter-dam techniques for the purpose of estimating sockeye *Oncorhynchus nerka* and chinook salmon *O. tshawytscha* escapement;
2. To document sockeye and chinook salmon migratory timing at Tumwater Dam in 1989, 1990, and 1991;
3. To compare 50 min expanded fish counts with 60 min fish counts, and;
4. To develop a statistical method that could be used to quickly estimate escapement in-season.

METHODS

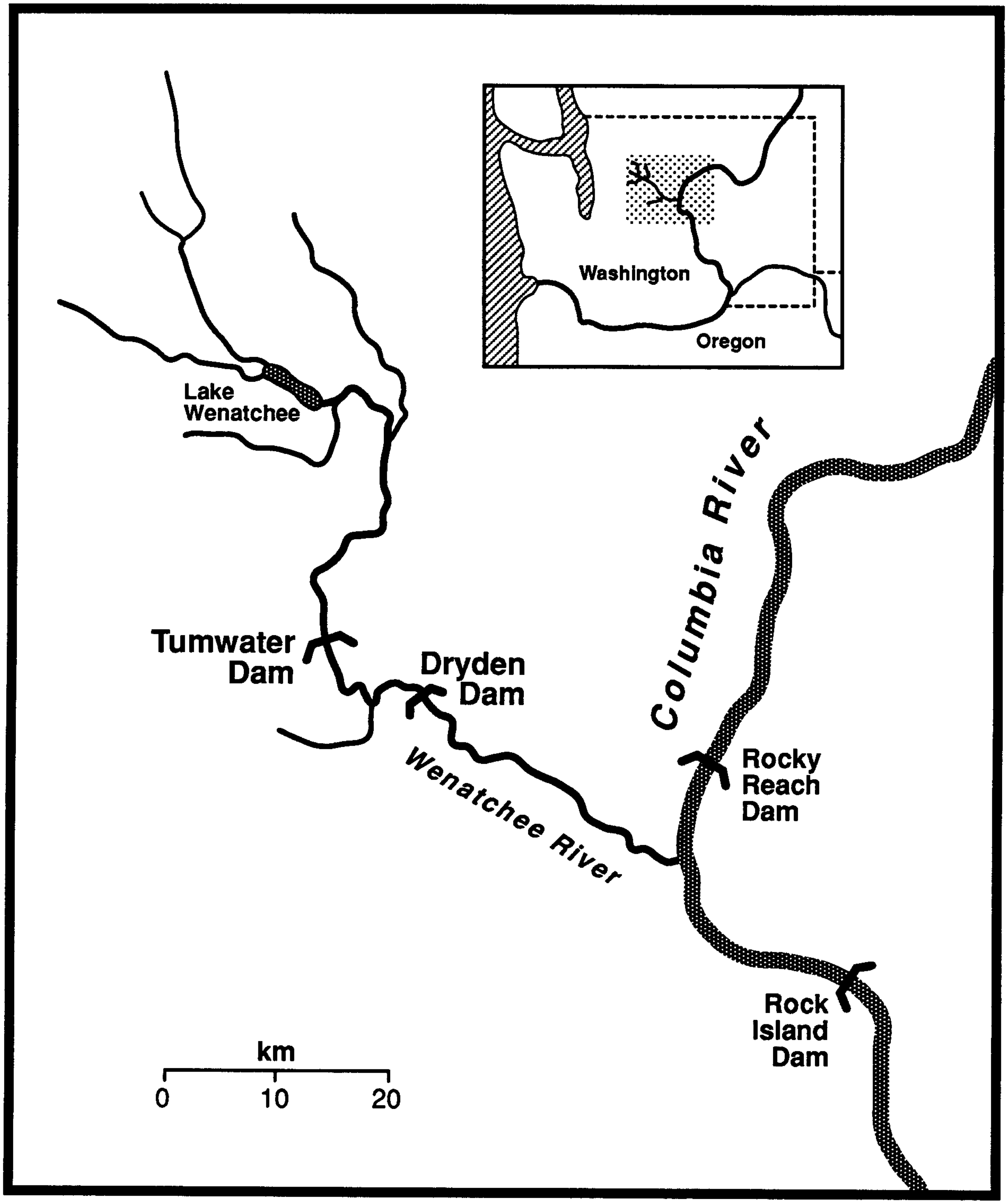
Study Area

Tumwater Dam is located at river kilometer (rkm) 52 on the Wenatchee River, Washington (Figure 1). Constructed in 1907 by the Great Northern Railroad, Tumwater Dam was the first hydroelectric dam built in the Pacific Northwest. It is 7m high and 122m long, and was built with an adult fish passage facility. This fish ladder allowed adult salmonid migration across what would otherwise have been an impassable dam. By 1956, all electricity generating capabilities had been removed from Tumwater Dam. In 1987 and 1988, the fish ladder was redesigned, and a fish viewing window and trapping facilities were installed.

For this project, a video camera was placed on a tripod and aimed at the fish viewing window. Two time-lapse S-VHS video tape recorders (VTRs) were connected to the camera in series, so that when the first VTR finished recording the second would immediately begin recording. In this manner, it was possible to record continuously for up to seven days without changing tapes. Ten 150-watt flood lights surrounded the fish viewing window to provide sufficient illumination for the video camera. The entire system was connected to a backup battery unit, in case of power failure (see Appendix 1 for a complete equipment list). The camera and VTRs were operated continuously from 22 April, 1991 through 23 September, 1991. A few gaps in the video record, ranging from two hours to 87 hours, occurred because of operator error and equipment malfunction. For those gaps of less than 24 hours, counts were imputed for each hour by averaging the hourly counts for the previous and following days.

In addition to those fish captured on the video record, several other agencies used Tumwater and Dryden (rkm 27) dams as sites for fish trapping associated with other research and management programs. These counts were collected and

Figure 1. Map of the Wenatchee River Basin showing location of Tumwater and Dryden dams.



added to the daily video counts.

Escapement Estimation

Video Based Estimate

Video tapes were reviewed by an experienced fish counter. Counting was performed on an editing VTR equipped with jog and shuttle controls, for frame-specific viewing, and a 33cm color monitor. At the time of recording, the VTRs imprinted a time and date "stamp" upon each frame of video tape, thereby providing the exact time at which each fish on the tape passed through the viewing window. Using this feature, hourly counts were determined for each species. Hourly counts were also summed to provide daily counts by species.

Inter-dam Based Estimate

For the purpose of comparison, a second, independent escapement estimate was calculated for sockeye salmon. In order to obtain this estimate, counts at Rocky Reach Dam (rkm 762) were subtracted from counts at Rock Island Dam (rkm 730), giving an "inter-dam" count. The Wenatchee River is the only major tributary entering the Columbia River between Rock Island and Rocky Reach dams (Figure 1), and sockeye salmon do not spawn in the Columbia River or in the lower Wenatchee River (Mullan 1986). Therefore, assuming that no mortality occurs between the two dams, all sockeye salmon that pass over Rock Island Dam but not Rocky Reach Dam must migrate past Tumwater Dam.

Migratory Timing

The average dates of migratory timing and their associated standard deviations were calculated for sockeye and chinook salmon during migration passage at Tumwater Dam during 1989, 1990, and 1991.

Comparison Between Video Counts and Traditional Mainstem Counts

Traditional fish counting protocol at mainstem COE dams calls for individuals to count fish for the first 50 min of each hour and to then expand that 50 min count to account for passage during the subsequent 10 min break period (U.S. Army Corps of Engineers 1989). To investigate possible errors associated with interpolating 50 min counts to reflect hourly fish passage, we compared 50 min counts that were expanded to estimate hourly passage with actual 60 min counts. Paired Wilcoxon and paired t-tests (Hays 1988) were used to determine differences ($\alpha = 0.05$) between expanded 50 min counts and 60 min counts for sockeye and chinook salmon and steelhead *O. mykiss* counts.

Method for Quick Escapement Estimation From Video

A method to determine a quick and reliable escapement estimation method to be used in-season in the future was tested. One in k (where k = 2 through 7) systematic sampling (Scheaffer et al. 1990) was applied to daily video counts to estimate annual sockeye salmon escapement.

Night Fish Passage

Estimates of night passage (fish passage between 2000 and 0400 hours) were made for sockeye and chinook salmon and steelhead at Tumwater Dam. Total counts for each species made between 2000 and 0400 hours were divided by their respective escapement estimates to calculate the percentage of the total count for each species that represented night migration.

The relationship between night sockeye salmon passage as a function of the previous day's fish passage was investigated using least squares linear regression (Scheaffer 1990) for data collected in 1989, 1990, and 1991. Because the x variable, day sockeye salmon count, was occasionally zero or very low, giving unstable ratio estimates, days with less than a count of 30 were added to give effective day counts of 30 or more. This same procedure was followed by Calvin (1975) who investigated night fish passage at Bonneville, John Day, and The

Dalles dams. Analysis of covariance ANCOVA (Hays 1988) was used to determine if the regression lines produced from each year's data were similar.

RESULTS

Escapement Estimation

Sockeye and chinook salmon and steelhead counts derived from video tape in 1991 were 29,077, 2,307, and 283, respectively. At Tumwater and Dryden dams a number of fish were trapped and removed or bypassed around the video counting station. These fish included 4,156 sockeye salmon, 128 chinook salmon, and 18 steelhead. Total Wenatchee River escapement in 1991 was derived by combining video counts with counts of fish trapped and removed or bypassed around the video counting station. The total Wenatchee River escapement in 1991 was estimated as 33,233 for sockeye salmon and 2,435 for chinook salmon, (Figure 2; Appendix 2). It was impossible to obtain a total escapement estimate for steelhead, since most steelhead passage occurs during periods when the video counting station is not operating (10/1 through 4/31). However, a partial escapement of 301 steelhead was calculated.

Migratory Timing

The mean date of passage at Tumwater Dam was 8/4/91 and 8/1/91 for sockeye and chinook salmon, respectively. A summary of migratory timing statistics for salmon passage at Tumwater Dam during 1989 through 1991 are presented in Table (1).

Comparison Between Video Counts and Traditional Mainstem Counts

The mean differences between hourly 50 min expanded and 60 min fish counts were 0.273, 0.037, and 0.024 for sockeye and chinook salmon and steelhead, respectively. The paired Wilcoxon Test probability results were $p=0.998$, $p=0.055$, and $p<0.000$ for sockeye and chinook salmon, and steelhead, respectively. Paired t-test probability results were $p=0.085$, $p=0.023$, and $p<0.000$, for sockeye and chinook salmon and steelhead, respectively.

Figure 2. Wenatchee River sockeye and chinook salmon escapement in 1991 estimated by video tape count and including fish trapped at Tumwater and Dryden dams.

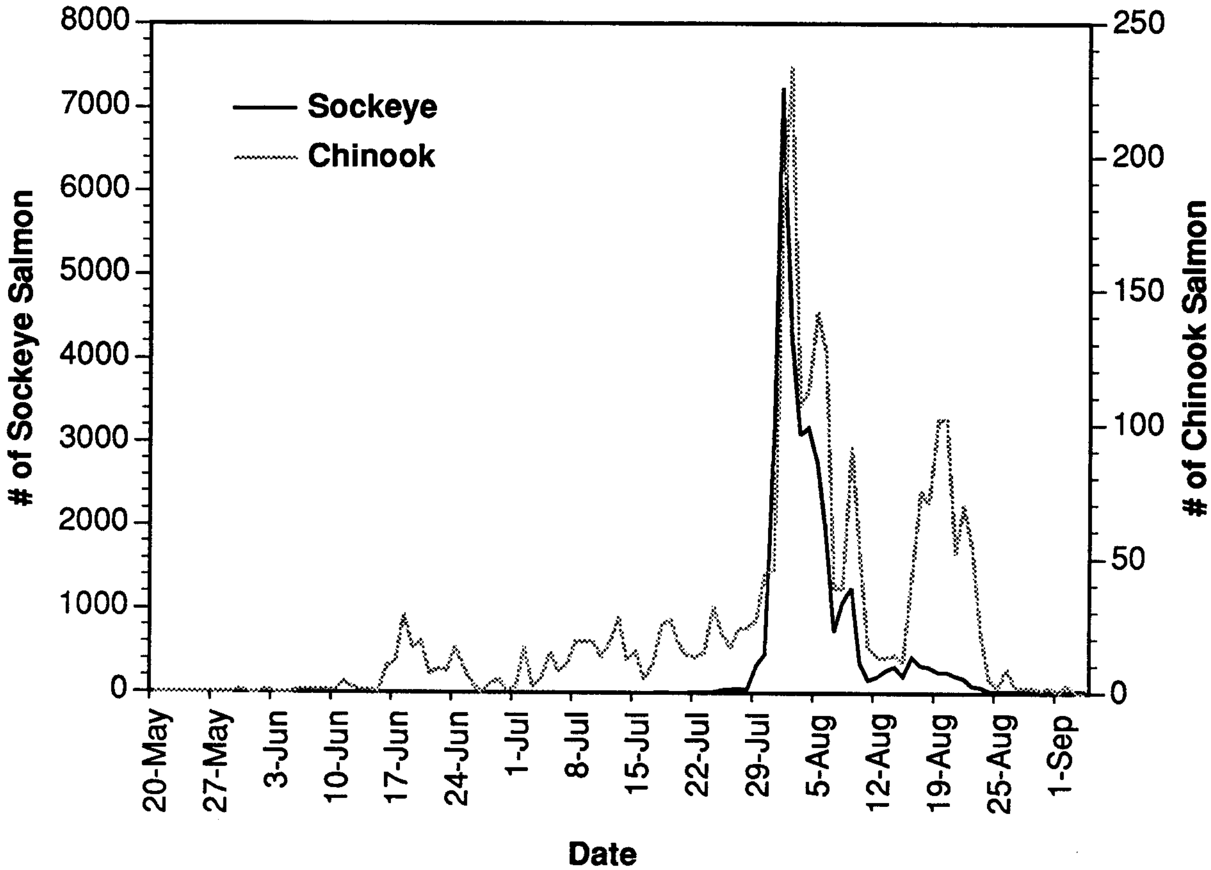


Table 1. Average date and standard deviation of salmon migration at Tumwater Dam for 1989, 1990, and 1991.

Sockeye

Year	Mean Date	S.D
1989	7/25	7.2
1990	7/29	6.2
1991	8/04	5.2

Chinook

Year	Mean Date	S.D
1989	7/18	18.8
1990	7/24	16.9
1991	8/01	16.2

Comparisons of total 50 min expanded and 60 min fish counts derived from video tape yielded a 1% difference for sockeye salmon counts (29,371 for 50 min expanded, and 29,077 for 60 min), a 1.9% difference for chinook salmon counts (2,264 for 50 min expanded, and 2,307 for 60 min), and a 14.5% difference of steelhead counts (242 for 50 min expanded, and 283 for 60 min). Figure (3) shows the differences between total 50 min expanded and 60 min counts for all species.

Method for Quick Escapement Estimation From Video

Using 1 in k systematic sampling revealed that sockeye salmon abundance estimates increased in variability as k increased (Figure 4). The low estimate was 19,829 (40% of the actual count) and the highest estimate was 61,894 (86% of the actual count).

Night Fish Passage

Over the entire 1991 migratory period, 2,091 sockeye salmon were video recorded migrating past Tumwater Dam between 2000 and 0400 hours (Figure 5).

This represents 6.3% of the total Wenatchee River sockeye salmon escapement estimate. Night migration was also observed for chinook salmon and steelhead with 14.6% and 17.9%, respectively, migrating over Tumwater Dam between 2000 and 0400 hours (Figure 5).

Positive, significant correlations were found between night sockeye salmon passage and the previous day's sockeye salmon passage for 1989, 1990, and 1991 data (Figure 6) and for all years combined (Figure 7). Coefficients of determination (R^2) for night sockeye salmon passage as a function of the previous day's passage ranged from .617 to .732 (Table 2). Ratio estimates for night sockeye salmon passage as a function of the previous day's passage ranged from

Figure 3. Expanded 50 min and 60 min counts for sockeye and chinook salmon and steelhead.

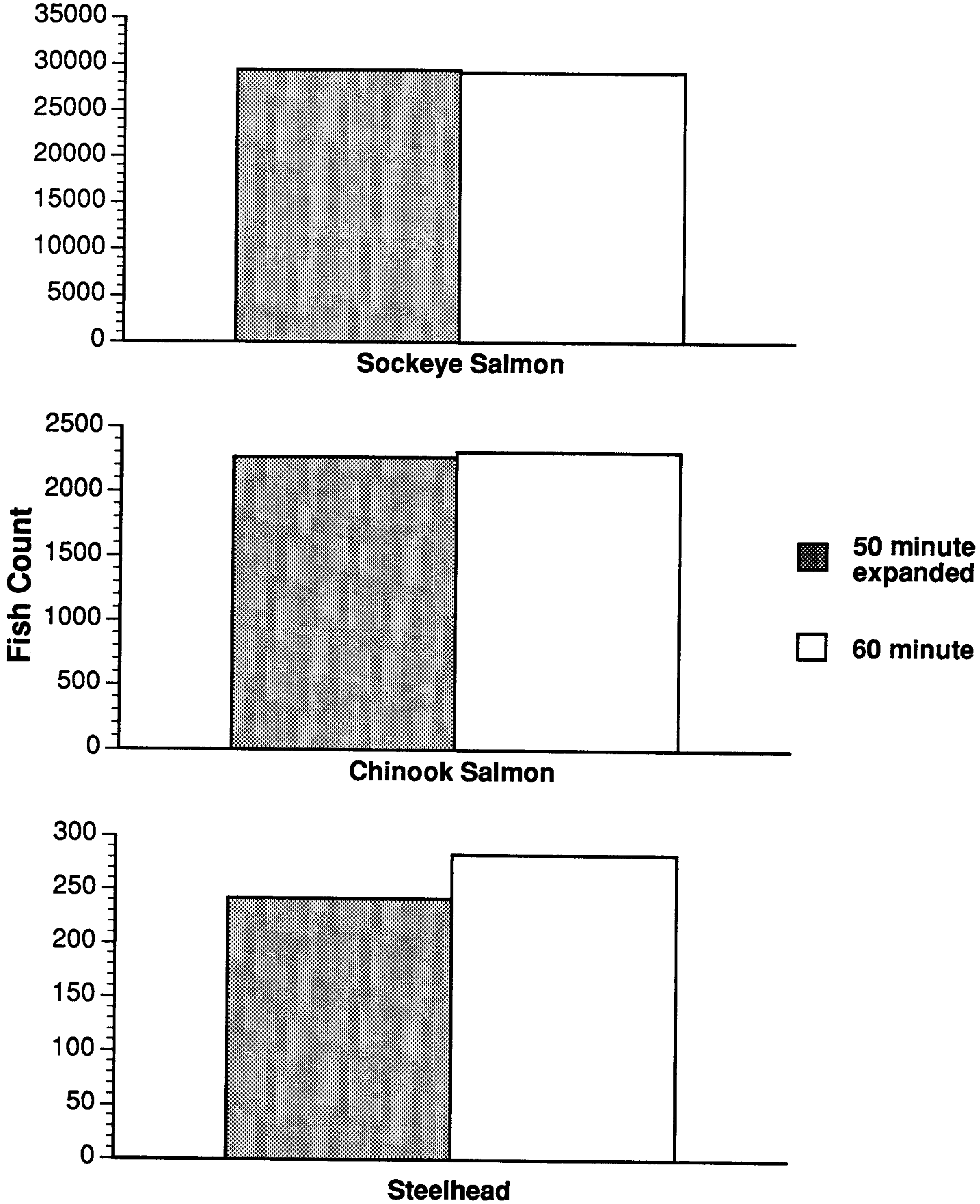


Figure 4. Estimates of sockeye salmon escapement using 1 in k systematic sampling.

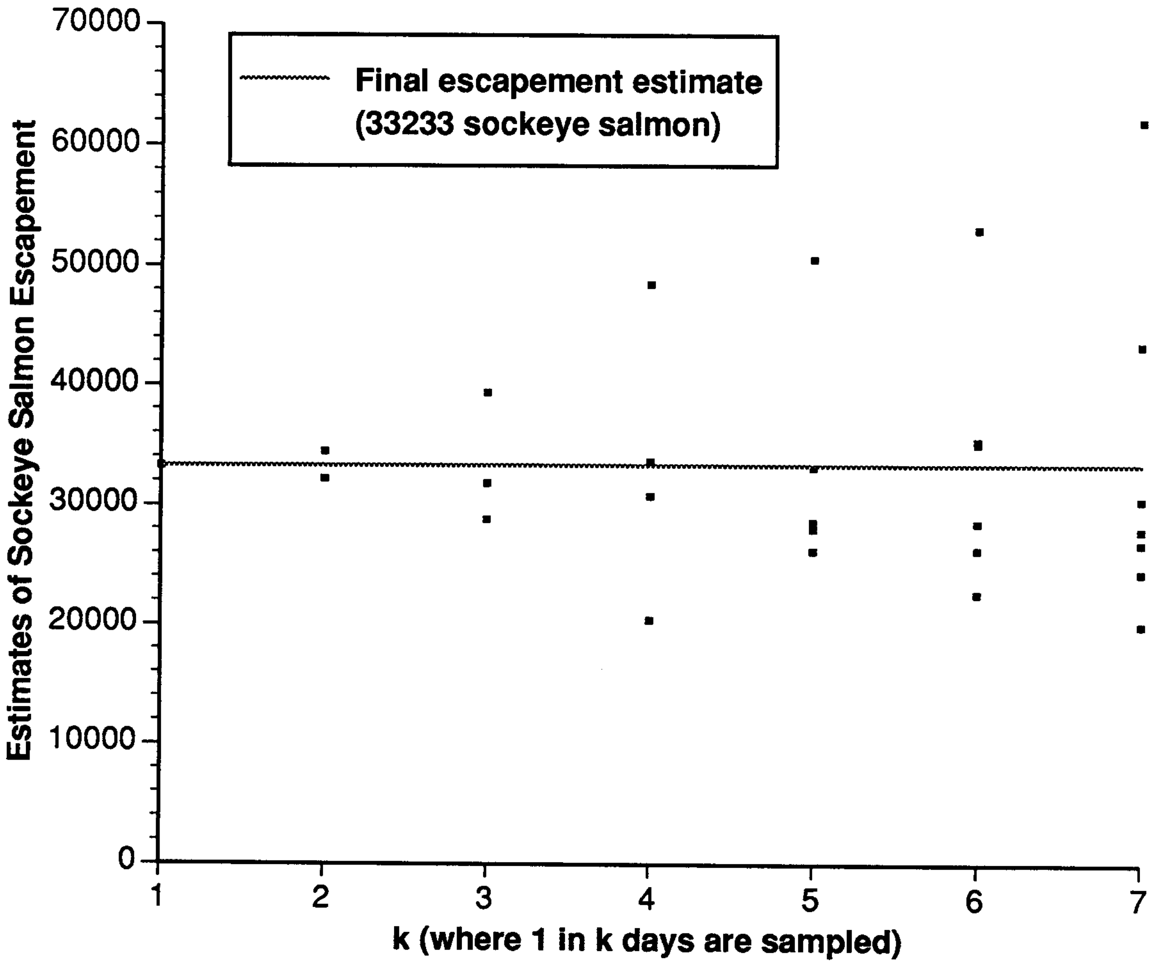


Figure 5. **Composite sockeye and chinook salmon counts as a function of time of day with approximate hours of darkness shaded, recorded at Tumwater Dam in 1991.**

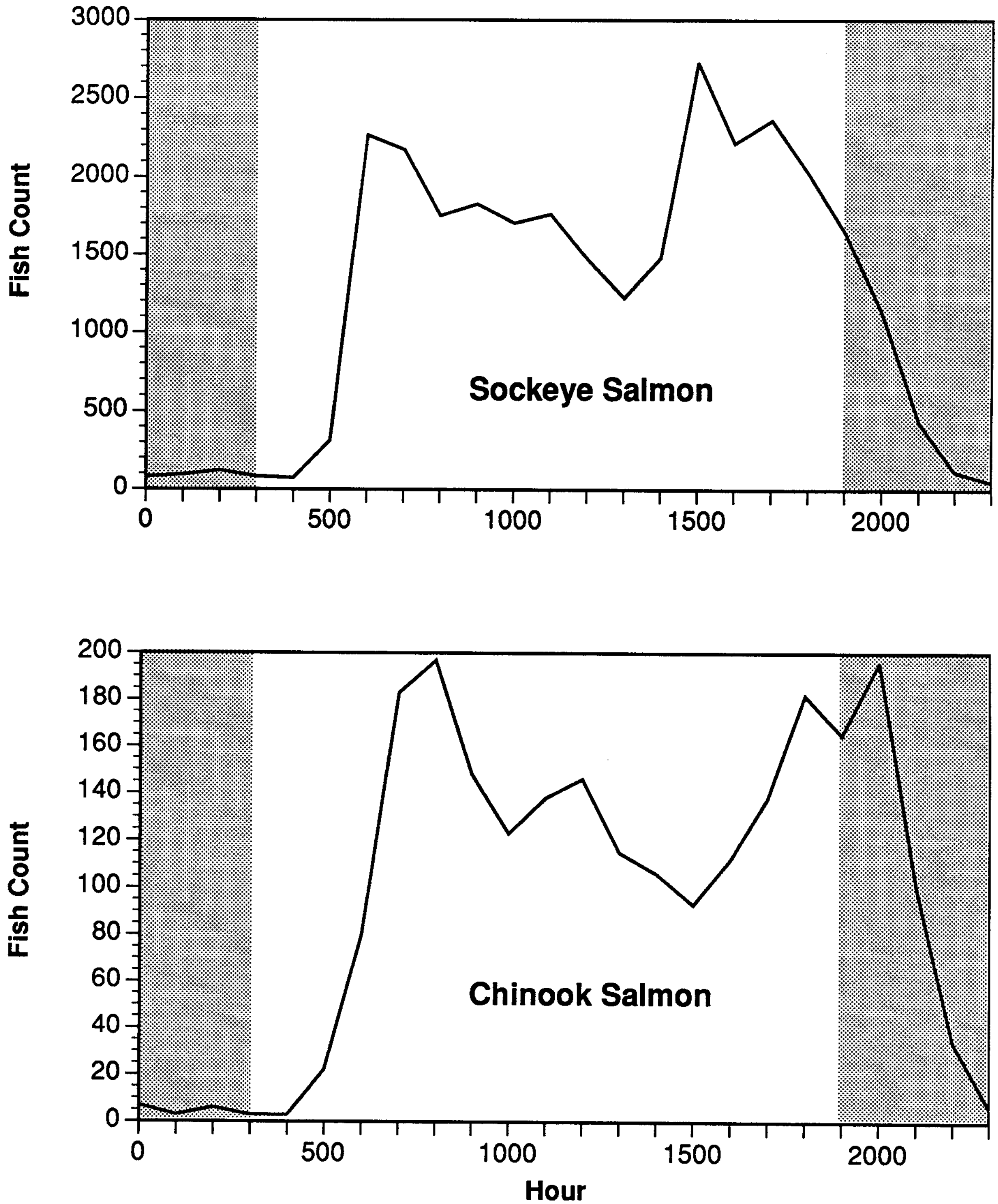


Figure 6. Least squares linear regression lines with 95% confidence intervals fit to night/day fish count data at Tumwater Dam in 1989, 90, and 91. Dashed lines represent night/day fish count data from Bonneville Dam (Calvin 1975).

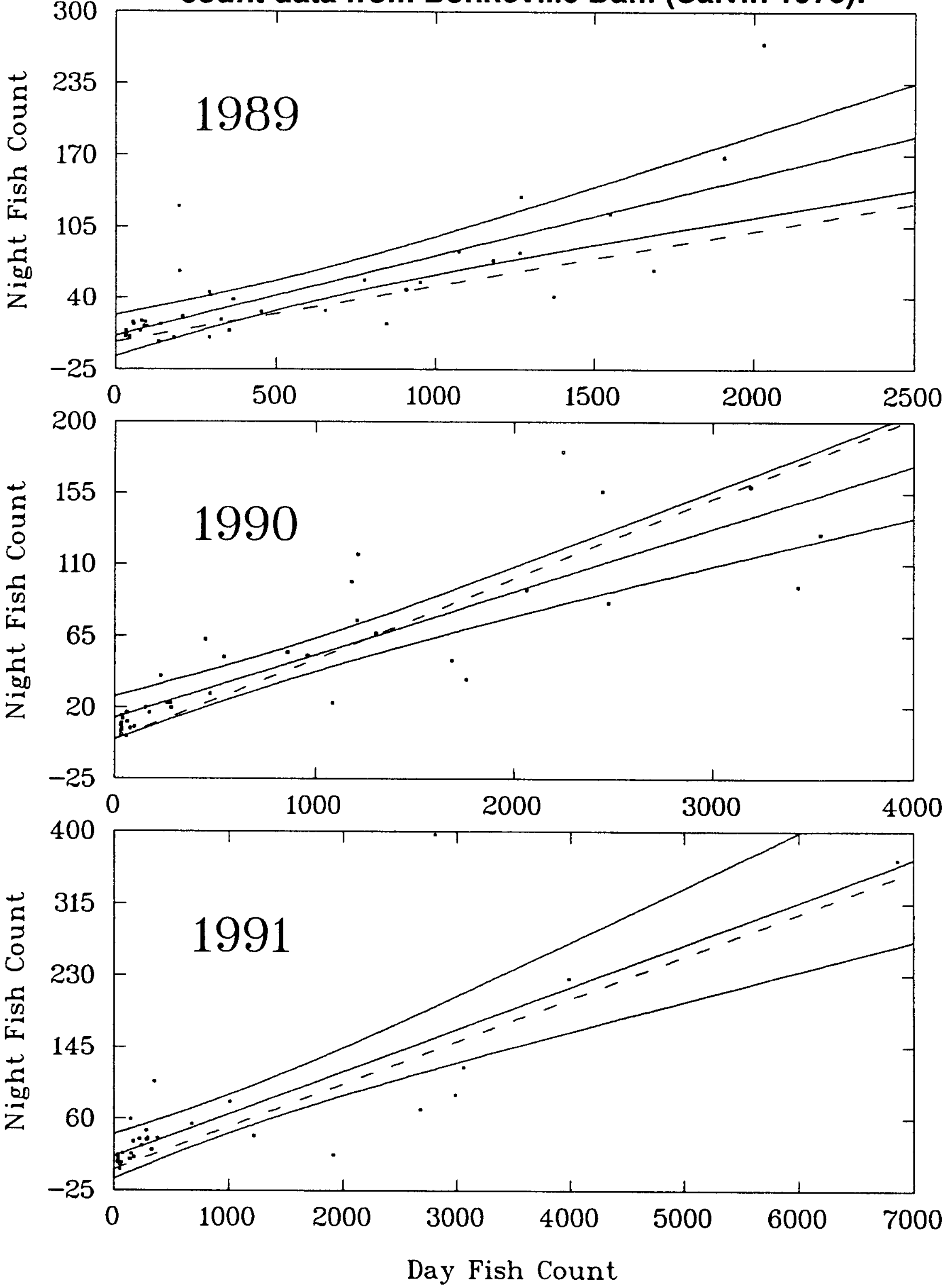


Figure 7. Least squares linear regression line with 95% confidence intervals fit to pooled night/day fish count data at Tumwater Dam in 1989, 90, and 91. Dashed lines represent night/day fish count data from Bonneville Dam (Calvin 1975).

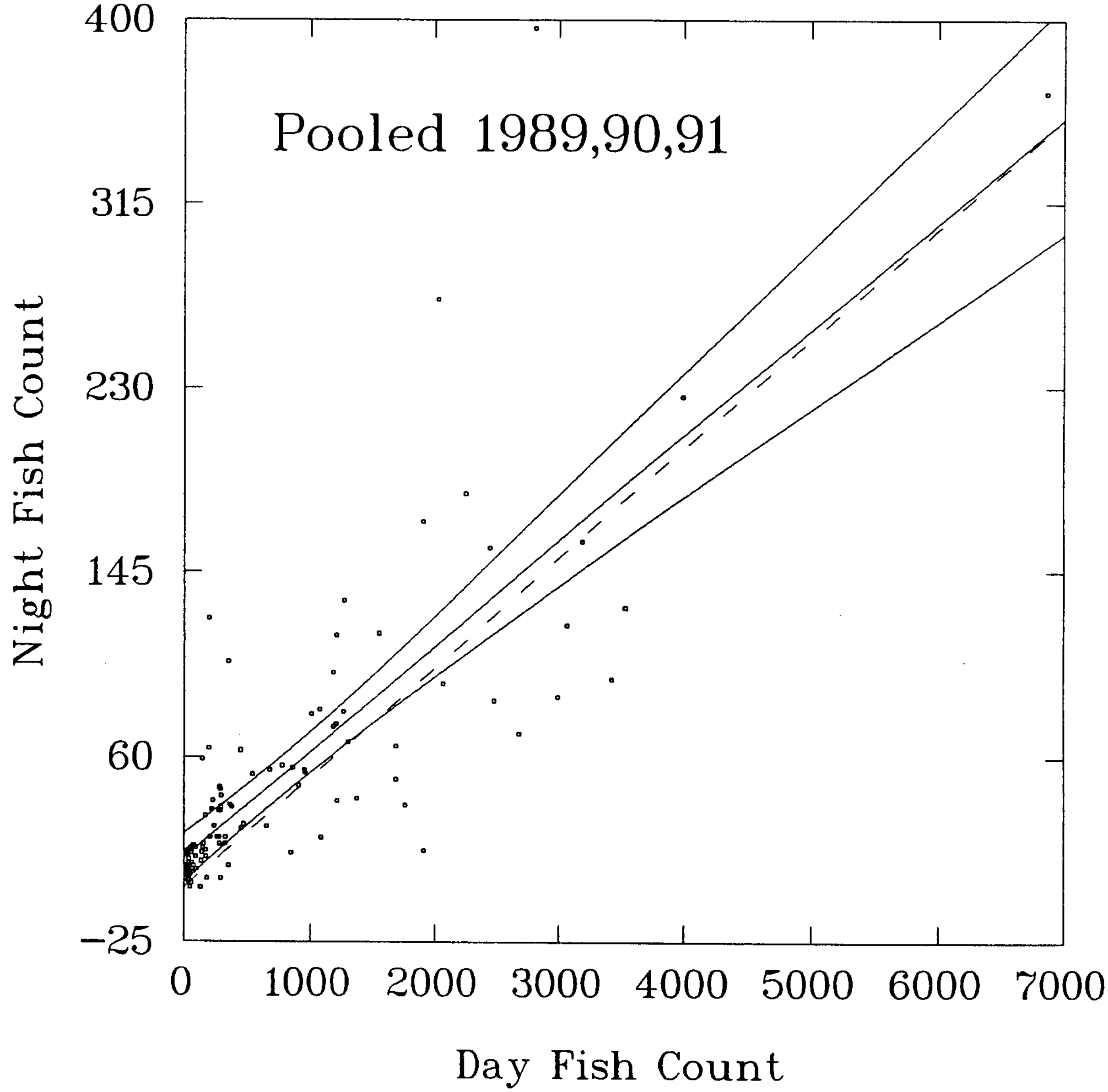


Table 2. **Average night/day fish count ratios, standard errors, y-intercept constants, coefficients of determination, and sample sizes for sockeye salmon at Bonneville and Tumwater dams..**

Location	n	Constant	Ratio	S.E. of Ratio	R^2
Tumwater_{89}	40	5.586	0.073	0.009	0.617
Tumwater_{90}	39	13.561	0.040	0.004	0.732
Tumwater_{91}	35	15.066	0.050	0.006	0.680
$\text{Tumwater}_{\text{Pooled}}$	114	13.498	0.049	0.003	0.647
$\text{Bonn.}_{\text{North}}$ ('73 & '74)	57	0.000	0.050	0.006	---
$\text{Bonn.}_{\text{South}}$ ('73 & '74)	60	0.000	0.051	0.005	---

0.040 to 0.073 (Table 2). Using ANCOVA, it was determined that there was a nonsignificant difference ($p = 0.025$) among ratio estimates from 1989-1991 at Tumwater Dam.

DISCUSSION

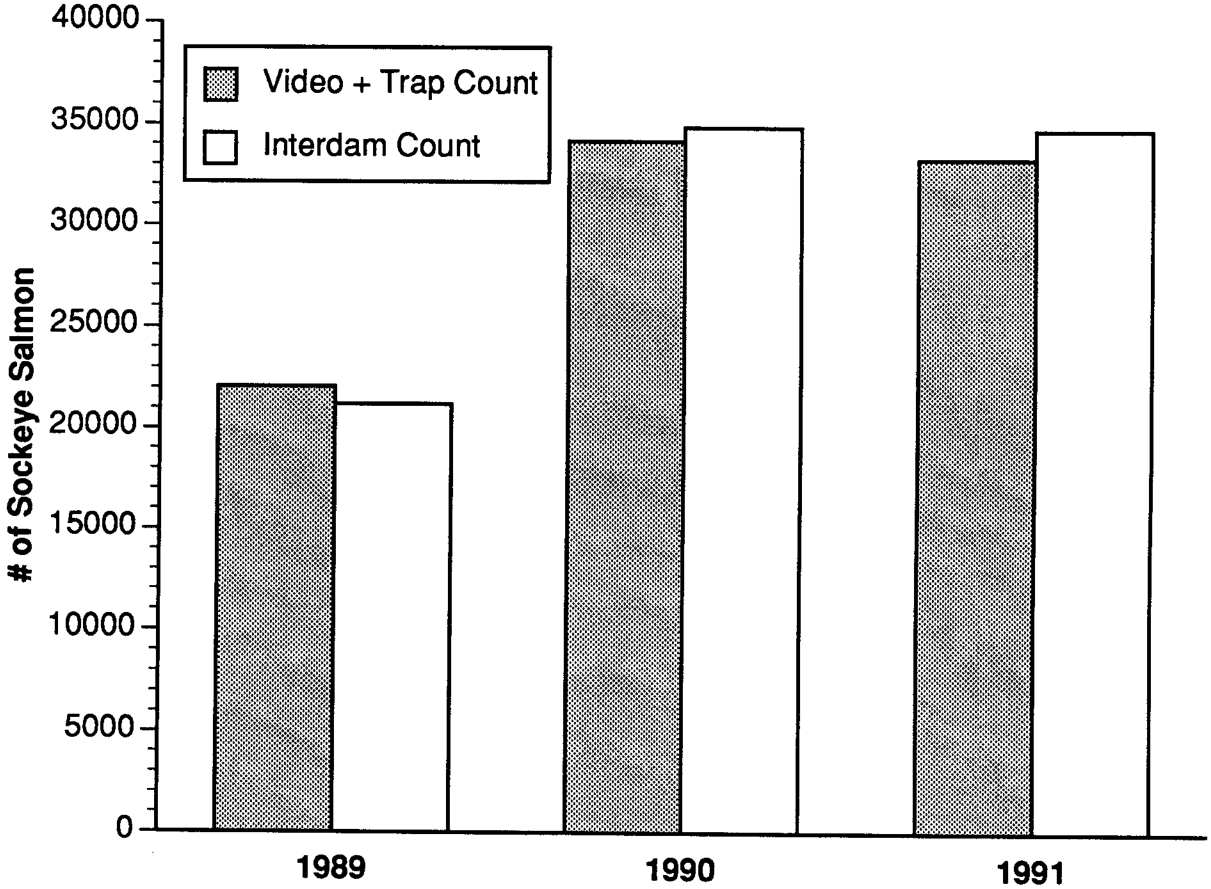
The 1991 sockeye salmon escapement estimate based on video tape analysis was within 4% of the inter-dam based estimate. Video based sockeye salmon escapement estimates made in 1990 and 1989 were within 2% and 4% of inter-dam based estimates for those years (Figure 8). This indicates that the video method is accurate relative to inter-dam based counts.

The 1991 steelhead count was 301 fish. Although this is not a complete escapement estimate, it shows an increase from last year's count of 248. The 1991 steelhead count was comprised of 43% hatchery and 57% origin fish, based on detection of an adipose fin on video images. This is a substantial increase in the percent of hatchery fish from last year's (1990) estimates of 5.7%.

The mean dates of passage and their respective standard deviations of salmon passage (sockeye and chinook) at Tumwater Dam have remained similar during the last three years (1989 through 1991). A total of 108 chinook salmon passed Tumwater Dam before June 22 a date used to distinguish between spring and summer chinook salmon at Wells Dam (COE 1987). Wells Dam is located on the Columbia River (rkm 829) upstream of the confluence of the Wenatchee River thus using the date that distinguishes spring from summer chinook at Wells Dam produces a conservative Wenatchee River spring chinook salmon estimate above Tumwater Dam. Based on a June 22 chinook race determiner, the majority (95.6%) of the chinook salmon that pass Tumwater Dam would be classified as summer chinook salmon.

Differences between 50 min expanded and 60 min counts of sockeye salmon were statistically nonsignificant for sockeye salmon ($p=0.998$ and $p=0.085$, for paired Wilcoxon and t-tests, respectively). The mean difference

Figure 8. **Comparison of sockeye salmon counts between video tape analysis at Tumwater Dam and calculated inter-dam counts from 1989 through 1991.**



between the two counts was negligible, indicating that 50 min expanded counts were sufficiently accurate. Differences between 50 min expanded and 60 min counts of chinook salmon were nonsignificant using a Wilcoxon Test ($p=0.055$) and statistically significant using a paired t-test ($p=0.023$). The mean difference between the two chinook salmon counts was 0.037 fish per hour. This difference is certainly not biologically significant and indicate that 50 min expanded counts are relatively accurate.

Noticeable amounts of night fish passage occurred at Tumwater Dam during 1991 as well as 1990, and 1989 studies. Video records from 1989, 1990, and 1991 indicated that the three-year mean percentage of escapement for each species represented by night passage was 16.24%, SD=1.82; 13.56%, SD=1.06; and 6.68%, SD=1.38 for steelhead, chinook, and sockeye salmon, respectively. Currently, fish counts made at mainstem Columbia River dams assume that no night passage occurs and, therefore, fish are not generally counted in these programs (US Army Corps of Engineers 1989) between 2000 and 0400 hours. Based on our studies we believe that video technology could be used to record night passage at these sites for improvements in fish counting accuracy.

An attempt was made to determine the magnitude of night fish passage at Bonneville, The Dalles, and John Day dams during 1973-1974 (Calvin 1975). In his study Calvin (1975) found that the night / day sockeye salmon passage at Bonneville Dam was approximately 5.1%. This finding is similar to our ratio estimates for sockeye salmon passage at Tumwater Dam during 1989 through 1991 (Table 2). This evidence suggests that night fish passage observed at Tumwater Dam is not a result of the dam's location in the basin (near headwater areas), but that night fish passage may occur at similar rates at mainstem dams (Figure 7). Neglecting to account for night fish passage at mainstem dams may be introducing a minimum 5% error to counts. The actual error could be much higher since we only performed this analysis with sockeye salmon. Among the salmon species that we have studied at Tumwater Dam, sockeye salmon night passage was found to be the lowest of the three species (steelhead, and chinook and sockeye salmon) present.

During the course of this project, we have not produced in-season fish counts at Tumwater Dam. Such counts would however be beneficial to fishery managers. To accomplish this logistical problems associated with data collection and synthesis would have to be overcome. Another approach to producing in-season counts would be to first review a systematic sample of tapes and estimate fish abundance. Next year we plan to implement a systematic sampling procedure to estimate fish counts and provide these counts to interested parties on a weekly basis. We plan to use a systematic sampling scheme similar to the procedure described above. The sample interval that we will use may be 1 in 3, however, this will depend on available resources. A greater interval is more desirable in terms of personnel costs but precision is sacrificed. Precision in a given year may be greater than those shown in Figure (4) that were biased by one day of extremely high counts.

REFERENCES

Calvin, L.D. 1975. Estimating night fish passage over Bonneville, The Dalles and John Day Dams. U.S. Corps of Engineers Report , Portland District, Portland, Oregon.

Hatch, D.R., and M. Schwartzberg. 1990. Wenatchee River salmon escapement estimates using video tape technology in 1989. Columbia River Inter-Tribal Fish Commission, Technical Report 90-4, Portland, Oregon.

Hatch, D.R., and M. Schwartzberg. 1991. Wenatchee River salmon escapement estimates using video tape technology in 1990. Columbia River Inter-Tribal Fish Commission, Technical Report 91-3, Portland, Oregon.

Hatch, D.R., M. Schwartzberg, and A. Wand. 1991. The feasibility of estimating sockeye salmon escapement at Zosel Dam, Washington using underwater video technology. Columbia River Inter-Tribal Fish Commission, 1991 Project Progress Report, Portland, Oregon.

Hays, W.L. 1988. Statistics. Holt, Rinehart and Winston, Inc., New York, New York.

Irvine, J.R., B.R. Ward, P.A. Teti, and N.B.F. Cousens. 1991. Evaluation of a method to count and measure live salmonids in the field with a video camera and computer. North American Journal of Fisheries Management 11:20-26.

Mullan, J.W. 1986. Determinants of sockeye salmon abundance in the Columbia River, 1880's-1982: a review and synthesis. United States Fish and

Wildlife Service Biological Report 86(12).

Northwest Power Planning Council. 1987. 1987 Columbia River Basin Fish and Wildlife Program. Portland, Oregon.

Scheaffer R.L., W. Mendenhall, and L. Ott. 1990. Elementary survey sampling. PWS-KENT Publishing Company, Boston, Massachusetts.

U.S. Army Corps of Engineers. 1989. Annual fish passage report Columbia and Snake rivers for salmon, steelhead and shad. North Pacific Division Corps of Engineers, Portland, Oregon.

Appendix 1. **Specifications of equipment used in the Wenatchee River Salmon Escapement Esimation Project.**

Item	Number	Make	Model
Camera	1	Panasonic	WV-D5100
Tripod	1	Bogen	3046
Time-lapes VTR	2	Panasonic	AG-7620
Viewing VTR	1	Panasonic	AG-1960
Monitor	1	Sony	PMV1340
VHS Video Tape	43	Panasonic	NV-T160SP
S-VHS Video Tape	26	Panasonic	—
Battery Backup	1	Tripp-lite	SB-200a
Lighting	8	Phillips	150 watt flood

Appendix 2. Daily fish passage estimates at Tumwater Dam, using video tape counts and additional counts from fish trapped in 1991.

Date	Sockeye	Adult Chinook	Jack Chinook	Steelhead
4/22	0	0	0	0
4/23	0	0	0	1
4/24	0	0	0	0
4/25	0	0	0	0
4/26	0	0	0	0
4/27	0	0	0	0
4/28	0	0	0	0
4/29	0	0	0	2
4/30	0	0	0	1
5/01	0	0	0	0
5/02	0	0	0	0
5/03	0	0	0	1
5/04	0	0	0	1
5/05	0	0	0	1
5/06	0	0	0	0
5/07	0	0	0	0
5/08	0	0	0	0
5/09	0	0	0	0
5/10	0	0	0	0
5/11	0	0	0	0
5/12	0	0	0	0
5/13	0	0	0	0
5/14	0	0	0	0
5/15	0	0	0	0
5/16	0	0	0	0
5/17	0	0	0	0
5/18	0	0	0	0
5/19	0	0	0	0
5/20	0	0	0	0
5/21	0	0	0	0
5/22	0	0	0	0
5/23	0	0	0	1
5/24	0	0	0	0
5/25	0	0	0	0
5/26	0	0	0	0
5/27	0	0	0	0
5/28	0	0	0	1
5/29	0	0	0	0
5/30	0	1	0	1
5/31	0	0	0	0
6/01	0	0	0	0
6/02	0	1	0	0
6/03	0	0	0	0
6/04	0	0	0	0
6/05	0	0	0	0
6/06	0	1	0	1
6/07	0	1	0	0
6/08	0	1	0	1

Appendix 2. Continued.

Date	Sockeye	Adult Chinook	Jack Chinook	Steelhead
6/09	0	1	0	0
6/10	0	1	0	1
6/11	0	4	0	0
6/12	0	2	0	1
6/13	0	1	0	0
6/14	0	1	0	0
6/15	0	0	0	0
6/16	0	10	0	1
6/17	0	11	0	1
6/18	0	29	0	2
6/19	0	17	0	1
6/20	0	19	0	0
6/21	0	7	0	0
6/22	0	9	0	0
6/23	0	8	0	0
6/24	0	17	0	1
6/25	0	9	0	0
6/26	0	3	0	1
6/27	0	0	0	0
6/28	0	3	0	0
6/29	0	5	0	0
6/30	0	1	0	2
7/01	0	2	0	1
7/02	0	17	0	0
7/03	1	2	0	1
7/04	0	5	0	0
7/05	1	15	0	1
7/06	0	8	0	0
7/07	0	10	0	0
7/08	0	19	0	0
7/09	0	19	0	0
7/10	0	19	0	1
7/11	0	13	0	2
7/12	0	19	0	1
7/13	3	28	0	1
7/14	3	12	0	0
7/15	2	15	1	0
7/16	0	5	1	2
7/17	1	11	0	1
7/18	9	25	0	0
7/19	0	27	0	1
7/20	1	18	2	0
7/21	3	14	0	1
7/22	6	13	0	4
7/23	7	15	0	2
7/24	8	32	0	0
7/25	30	22	0	0
7/26	41	17	0	5

Appendix 2. Continued.

Date	Sockeye	Adult Chinook	Jack Chinook	Steelhead
7/27	48	24	0	5
7/28	50	24	0	2
7/29	326	27	1	16
7/30	455	45	0	10
7/31	3181	46	0	7
8/01	7230	174	0	10
8/02	4226	234	1	3
8/03	3085	107	1	2
8/04	3170	113	0	14
8/05	2749	142	2	16
8/06	1937	127	0	10
8/07	729	39	0	9
8/08	1078	39	1	10
8/09	1258	92	0	4
8/10	361	51	0	5
8/11	153	17	0	4
8/12	190	13	0	4
8/13	265	13	0	4
8/14	313	14	0	3
8/15	202	11	0	5
8/16	427	44	0	8
8/17	326	75	0	2
8/18	311	71	0	6
8/19	255	102	0	18
8/20	205	52	0	12
8/21	173	70	0	11
8/22	87	54	0	10
8/23	72	22	0	9
8/24	28	5	0	3
8/25	19	2	0	1
8/26	28	9	0	3
8/27	23	2	0	2
8/28	28	2	0	4
8/29	11	2	0	3
8/30	18	1	0	3
8/31	26	2	0	2
9/01	15	0	0	1
9/02	11	3	0	3
9/03	24	0	0	7
9/04	24	0	0	3