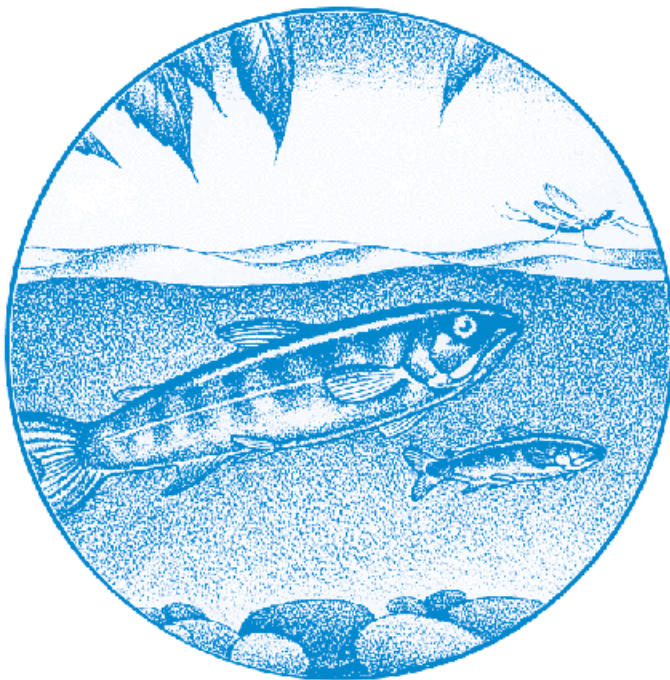


October 1998

**SPRING EMIGRATION OF NATURAL AND HATCHERY
CHINOOK SALMON AND STEELHEAD TROUT SMOLTS
FROM THE IMNAHA RIVER, OREGON**

February 25 - June 27, 1997

1997



DOE/BP-38906-18



This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views of this report are the author's and do not necessarily represent the views of BPA.

This document should be cited as follows:

<i>Blenden, Michael L., P. A. Kucera, E. R. Veach, 1998, Spring Emigration of natural and Hatchery Chinook Salmon and Steelhead Trout Smolts from the Imnaha River, Oregon, 1997 to Bonneville Power Administration, Portland, OR, Contract No. 88BP38906, Project No. 87-127, 161 electronic pages (BPA Report DOE/BP-38906-18)</i>
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FROM THE IMNAHA RIVER, OREGON,
FEBRUARY 25 - JUNE 27,1997

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Project Number 87- 127
Contract Number DE-FC79-88BP38906

October 1998

ABSTRACT

For the fourth consecutive year, the Nez Perce Tribe, in conjunction with the Fish Passage Center, participated in the smolt monitoring program in the Imnaha River. A screw trap was used to collect emigrating natural and hatchery chinook salmon (*Oncorhynchus tshawytscha*) and steelhead trout (*Oncorhynchus mykiss*) smolts from February 25 to June 27, 1997.

A total of 270 natural chinook salmon, 10,616 hatchery chinook salmon, 864 natural steelhead trout (and 13 natural steelhead parr), and 7,345 hatchery steelhead trout smolts were captured during emigration studies on the Imnaha River. Mortality associated with trapping, handling and tagging was low: 0.37% for natural chinook, 0.11% for hatchery chinook, 0.11% for natural steelhead, and 0.39% for hatchery steelhead trout smolts.

Natural chinook salmon smolts emigrated from the Imnaha River from February 25 to June 10 and had a mean length of 108 mm, average weight of 13 g, and mean condition factor of 1.02. The peak period of natural chinook smolt emigration, based on number of fish collected, occurred between March 25 and April 30. Hatchery reared chinook salmon smolts were collected from April 9 to May 9, with 99% of the smolts being caught within 10 days after release. Hatchery chinook smolts mean length, weight, and condition factor were 131 mm, 25.4 g, and 1.12, respectively. Emigration of natural steelhead smolts in the Imnaha River occurred between March 14 and June 25. Peak emigration occurred from May 1 to May 15. Natural steelhead smolts averaged 175 mm in fork length, 55.8 g in weight and had a mean condition factor of 1.00. Hatchery steelhead smolts emigrated from the Imnaha River between April 15 and June 27. Hatchery steelhead smolts averaged 210 mm in fork length, 88 g in weight and had a mean condition factor of 0.93.

Spring runoff water conditions in 1997 provided above average flows for emigrating anadromous salmonid smolts. Imnaha River mean daily discharge during spring emigration ranged from 7.4 cms (260 cfs) on March 9 to 96.6 cms (3,410 cfs) on April 20 at USGS gauge 13292000, Imnaha, OR. Snake River discharge measured at the Anatone gauge station, ranged from 61.1 to 152 kcfs from April 15 to May 18. River discharge at LGR ranged from 79.6 kcfs on March 6 to 225.3 kcfs on May 18. Flows at LGR were generally greater than 100 kcfs during most of the spring runoff period, and discharge exceeded 120 kcfs from March 20 - 31 and April 19 to June 24. The water spill period at LGR occurred continuously from April 10 to June 29 with peak spill of 101.9 kcfs occurring on May 17.

We PIT tagged and released 238 natural chinook salmon smolts, 1,000 hatchery chinook salmon smolts, 782 natural steelhead trout smolts and 6,117 hatchery steelhead trout smolts. Survival of PIT tagged steelhead and chinook smolts was estimated using the Survival with Proportional Hazards (SURPH) model. Survival was estimated from the Imnaha River acclimation facility to the Imnaha River screw trap and from the screw trap to the tailrace of Lower Granite, Little Goose and Lower Monumental dams. Estimated survival of PIT tagged

natural chinook smolts from the Imnaha River screw trap to Lower Granite Dam was 89.8% and fell within the range observed from 1993 to 1996 (80.6-92.3%) Survival of PIT tagged hatchery chinook smolts, based on the SURPH model, from the Imnaha River acclimation facility to the screw trap was 89.2% in 1997. Estimated post-release survival of hatchery reared chinook salmon smolts from release to the Imnaha River screw trap, 66 km downstream, ranged from 88.1 to 102% from 1992-1994 and in 1996 (bootstrap method). These bootstrap derived point estimates had 95% confidence intervals that ranged from 12 to 26% of the estimate. SURPH model estimated survival ranged from 89 to 101% from release at the acclimation facility to the trap site from 1994 to 1997 with 95% confidence intervals ranging from 8.4 to 19%. Survival calculated by the two methods provided fairly consistent and comparable estimates across years. Comparatively, the SURPH model survival estimates were 12% higher than bootstrap in 1994 and were 7% lower in 1996. Estimated survival of hatchery chinook salmon smolts from the screw trap to Lower Granite Dam was 80.4% for smolts released from April 10 to April 18. This was the highest survival of hatchery chinook observed since 1994. Survival of natural steelhead trout smolts PIT tagged and released at the Imnaha River screw trap, from April 16 to May 9, to Lower Granite Dam was 90.2% and fell within the range observed in 1994 and 1996 (73.1 to 93.1%). Survival for seven release groups of hatchery steelhead trout smolts from the Imnaha River screw trap to Lower Granite Dam ranged from 71.4% to 89.1% in 1997. From 1993 to 1996 the survival of PIT tagged hatchery steelhead trout smolts to Lower Granite Dam has ranged from 51.4% to 91.4%.

Peak emigration of PIT tagged Imnaha River natural chinook salmon smolts occurred from early to mid-April at Lower Granite, Little Goose, and Lower Monumental Dams. Median and 90% passage dates for natural chinook salmon smolts at Lower Granite Dam were April 22 and May 11, respectively. The 90% passage date of natural chinook salmon smolts at Lower Granite Dam (May 11) preceded peak Snake River flows (May 18) by seven days. Hatchery chinook salmon exhibited a shorter emigration period through the Snake River than their natural counterparts, with a median Lower Granite Dam passage date of May 5 and 90% passage date of May 14. Median and 90% passage dates at Lower Granite Dam for other PIT tagged groups were: natural steelhead trout - May 8 and May 24; and hatchery steelhead trout - May 23 and June 13.

ACKNOWLEDGMENTS

The Nez Perce Tribe extended the administrative support necessary to complete this project and report. We would like to thank Jack McClaran for access to his land for trapping purposes. Project funding from the U.S. Fish and Wildlife Service's Lower Snake River Compensation Plan (LSRCP) program initiated the Imnaha River emigration project investigation. Smolt monitoring project funds for the Imnaha River were cost-shared with the ongoing LSRCP investigation, and were provided by the Bonneville Power Administration through the Pacific States Marine Fisheries Commission (PSMFC). We wish to thank Glenda Claire for her technical contribution to this report. We would also like to thank the following people for their dedicated work in the field: Joseph McCormack, Neil Miller, Barb Blanc, and Ollicott J. Watters. Steve Smith of the National Marine Fisheries Service provided helpful advice on the use of the SURPH model and survival estimation. Tom Berggren of the Fish Passage Center provided the necessary PIT tagging schedules, and provided helpful comments on survival estimation. Jim Lady of the University of Washington provided assistance in the operation of the SURPH model. The United States Forest Service Thorn Creek guard station facilities were used during the study period.

TABLE OF CONTENTS

	Page
ABSTRACT.	i
ACKNOWLEDGMENTS	iii
TABLE OF CONTENTS.	iv
LIST OF TABLES	vi
LIST OF FIGURES	xi
INTRODUCTION	1
METHODS	2
Study Area Description	2
Equipment Description	2
Trap Operations	2
Trap Efficiency	5
Smolt Yield	6
Biological Characteristics	7
PIT Tagging	7
Travel Timing to Trap Site and Lower Snake River Dams	8
Survival Estimation	9
RESULTS AND DISCUSSION	10
Imnaha River Subbasin Emigration	10
Imnaha River Discharge	10
Trap Operation	10
Emigration Timing and Trends at Trap Site	12
Trap Efficiency and Smolt Yield	16
Biological Characteristics	17
Mortality	20
Incidental Catch	22
Emigration of PIT Tagged Fish	23
Imnaha River Emigration	23
PIT Tag Release Groups	24
Snake River Flows	25
Smolt Interrogation Percentages	29

Survival Estimation	34
Arrival Timing	43
Die1 Smolt Passage at Hydroelectric Facilities	.57
Travel Time to Lower Granite Dam	.67
SUMMARY	73
LITERATURE CITED	78
APPENDIX A - Imnaha River water temperature and discharge	80
APPENDIX B - Fish composition at the Imnaha River screw trap	85
APPENDIX C - Releases of hatchery chinook salmon and steelhead trout smolts	.90
APPENDIX D - Mean daily length, weight and condition factors	91
APPENDIX E - Composition of incidental fish species captured	.97
APPENDIX F - Summary of PIT tag groups released at the Imnaha River screw trap	102
APPENDIX G - Average weekly die1 passage at Snake and Columbia River dams	107

LIST OF TABLES

	Page
Table 1. Position in which screw trap was fished dependent upon staff gauge reading	5
Table 2. Fin clip applied to hatchery chinook salmon smolts used in trap efficiency trials	6
Table 3. PIT tag schedule for natural and hatchery steelhead trout smolts	8
Table 4. Dates the screw trap was not operated during the study period, March 9-June 27,1997	11
Table 5. Weekly catch composition of natural and hatchery chinook salmon and steelhead trout smolts collected in the Imnaha River screw trap, February 25 - June 27, 1997	13
Table 6. Mean trap efficiency, PIT tag interrogation percentage and estimated survival from release to trap (bootstrap and SURPH) and release to Lower Granite Dam (LGR) for hatchery chinook salmon smolts from 1994 to 1997	16
Table 7. Mean and range of fork length (mm), weight (g), and condition factor for natural and hatchery chinook salmon and steelhead trout smolts collected at the Imnaha River screw trap March 9 to June 27, 1997	17
Table 8. Mortality of chinook salmon and steelhead trout smolts due to trapping, handling, and PIT tagging	20
Table 9. Weekly catch composition of incidental fish species collected in the Imnaha River trap from February 23 to June 27, 1997	22
Table 10. Mean fork length (mm), weight (g), and condition factor for weekly PIT tag release groups of natural chinook salmon smolts released at the Imnaha River screw trap from March 12 to May 7, 1997	24
Table 11. Mean fork length (mm), weight (g), and condition factor for weekly PIT tag release groups of hatchery chinook salmon smolts released at the Imnaha River screw trap from April 11 to May 9,1997	25
Table 12. Mean fork length (mm), weight (g), and condition factor for weekly PIT tag release groups of natural steelhead trout smolts released at the Imnaha River screw trap from April 15 to June 25,1997 (na=not available).	26

Table 13.	Mean fork length (mm), weight (g), and condition factor for weekly PIT tag release groups of hatchery steelhead trout smolts released at the Imnaha River screw trap from April 15 to June 27,1997.	27
Table 14.	Cumulative interrogations of PIT tagged Imnaha River natural and hatchery chinook salmon and steelhead trout smolts at Lower Granite, Little Goose, Lower Monumental and McNary dams from 1993 to 1997	30
Table 15.	Interrogation percents (based on first observations) of natural chinook salmon smolt weekly PIT tag release groups from the Imnaha River to Lower Granite, Little Goose, Lower Monumental and McNary dams in 1997	32
Table 16.	Interrogation percents (based on first observations) of hatchery chinook salmon smolt weekly PIT tag release groups to Lower Granite, Little Goose, Lower Monumental and McNary dams in 1997..	32
Table 17.	Interrogation percents (based on first observations) of natural steelhead trout smolt weekly PIT tag release groups from the Imnaha River to Lower Granite, Little Goose, Lower Monumental and McNary dams in 1997.	35
Table 18.	Interrogation percents (based on first observations) of PIT tagged hatchery steelhead trout smolt weekly release groups from the Imnaha River to Lower Granite, Little Goose, Lower Monumental and McNary dams in 1997	35
Table 19.	Comparison of median fork length between weekly PIT tag release groups of Imnaha River natural and hatchery reared steelhead trout smolts detected at Lower Granite Dam in 1997	38
Table 20.	Survival estimates with 95% confidence intervals in parenthesis of chinook salmon (CH) and steelhead (RBT) smolts PIT tagged and released at the Imnaha River screw trap (IMN) to Lower Granite (LGR), from Lower Granite Dam to Little Goose Dam (LGO), and from Little Goose Dam to Lower Monumental Dam (LMO) during the spring of 1997	39
Table 21.	Estimated survival of PIT tagged natural chinook salmon smolts, by year and release date, from the Imnaha River screw trap to Lower Granite Dam, from 1993 to 1996	40
Table 22.	Estimated survival of PIT tagged hatchery reared chinook salmon smolts, by year and release date, from the Imnaha River acclimation facility to the Imnaha River screw trap . . . * .. *	40

Table 23.	Estimated survival of PIT tagged hatchery reared chinook salmon smolts, by year and release date, from the Imnaha River screw trap to Lower Granite Dam in 1994, 1996 and 1997	41
Table 24.	Estimated survival of hatchery reared chinook salmon smolts, by year and release date, from the Imnaha River acclimation facility to Lower Granite Dam (LGR), Lower Granite Dam to Little Goose Dam (LGO), Little Goose Dam to Lower Monumental Dam (LMO), and from release to Lower Monumental Dam (after Smith et al. 1998). Standard error in parenthesis	41
Table 25.	Estimated survival of PIT tagged natural steelhead trout smolts, by year and release date, from the Imnaha River screw trap to Lower Granite Dam in 1994, 1996, and 1997	43
Table 26.	Estimated survival of PIT tagged hatchery reared steelhead trout smolts, by year and release date, from the Imnaha River screw trap to Lower Granite Dam from 1993 to 1997.. . . .	45
Table 27.	Arrival timing of PIT tagged Imnaha River natural chinook salmon smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1993 to 1997	46
Table 28.	Arrival timing of PIT tagged Imnaha River hatchery chinook salmon smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1992 to 1997 * *	50
Table 29.	Arrival timing of PIT tagged Imnaha River natural steelhead trout smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1993 to 1997	53
Table 30.	Arrival timing of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1993 to 1997 *	56
Table 31.	Midnight to sunrise, sunrise to sunset and sunset to midnight weekly passage frequency of PIT tagged Imnaha River natural and hatchery chinook salmon smolts at Lower Granite, Little Goose, Lower Monumental and McNary dams in 1997 . . . ,	60
Table 32.	Midnight to sunrise, sunrise to sunset and sunset to midnight weekly passage frequency of PIT tagged Imnaha River natural steelhead trout smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams in 1997 * *	63

Table 33.	Midnight to sunrise, sunrise to sunset and sunset to midnight weekly passage frequency of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams in 1997	68
Table 34.	Comparison of mean and median travel time between weekly PIT tag release groups of Imnaha River natural and hatchery reared chinook salmon smolts from the Imnaha River screw trap to Lower Granite Dam in 1997	71
Table 35.	Comparison of median travel time (Wilcoxon test) between weekly PIT tag release groups of Imnaha River natural and hatchery reared steelhead trout smolts from the Imnaha River screw trap to Lower Granite Dam in 1997	73

APPENDIX TABLES

Table A. 1.	Imnaha River daily minimum, maximum, and mean water temperatures in degrees Celsius, February 23 to June 25,1997.	80
Table A.2.	Imnaha River daily staff gauge measurements and discharge readings from USGS gauge 13292000 at Imnaha, OR. February 25 - June 27,1997 (NR=NO READING, Q=DISCHARGE (cfs), staff measure in meters).	83
Table B. 1.	Fish composition of Imnaha River screw trap, February, 1997.	85
Table B.2.	Fish composition of Imnaha River screw trap, March, 1997	86
Table B.3.	Fish composition of Imnaha River screw trap, April, 1997.	87
Table B.4.	Fish composition of Imnaha River screw trap, May, 1997.. , , ,	88
Table B.5.	Fish composition of Imnaha River screw trap, June, 1997..	89
Table C.	Releases of hatchery chinook salmon and steelhead trout smolts by ODFW in the Imnaha River, 1997	90
Table D.1.	Mean daily length, weight, and condition factor of natural chinook salmon smolts sampled at the Imnaha River screw trap, February 25 to June 27, 1997.	91

Table D.2.	Mean daily length, weight, and condition factor of hatchery chinook salmon smolts sampled at the Imnaha River screw trap, February 25 to June 27, 1997	92
Table D.3.	Mean daily length, weight, and condition factor of natural steelhead trout smolts sampled at the Imnaha River screw trap, February 25 to June 27, 1997	93
Table D.4.	Mean daily length, weight, and condition factor of hatchery steelhead trout smolts sampled at the Imnaha River screw trap, February 25 to June 27, 1997	95
Table E. 1.	Composition of incidental fish species captured in the Imnaha River screw trap, February, 1997	97
Table E.2.	Composition of incidental fish species captured in the Imnaha River screw trap, March, 1997	98
Table E.3.	Composition of incidental fish species captured in the Imnaha River screw trap, April, 1997	99
Table E.4.	Composition of incidental fish species captured in the Imnaha River screw trap, May, 1997..	100
Table E.5.	Composition of incidental fish species captured in the Imnaha River screw trap, June, 1997	101
Table F. 1.	Summary of natural and hatchery chinook smolt PIT tag groups released at the Imnaha River screw trap, February 25 to June 27, 1997.	102
Table F.2.	Summary of natural and hatchery steelhead trout smolt PIT tag groups released at the Imnaha River screw trap, February 25 to June 27, 1997	104

LIST OF FIGURES

	Page
Figure 1. Map of Imnaha River study area	3
Figure 2. Photograph of screw trap in the lower Imnaha River	4
Figure 3. Mean daily discharge (USGS Gauge 13292000 at Imnaha, OR) and mean daily water temperature of the Imnaha River during the spring emigration period, February 25 - June 27, 1997	10
Figure 4. Emigration timing, based on daily catch at the Imnaha River screw trap, of natural (upper graph) and hatchery (lower graph) chinook salmon smolts. See Table 4 for dates trap not operated.	14
Figure 5. Emigration timing, based on daily catch at the Imnaha River screw trap, of natural (upper graph) and hatchery (lower graph) steelhead trout smolts. See Table 4 for dates trap not operated.	15
Figure 6. Length frequency of natural and hatchery chinook salmon (upper graph) and steelhead trout (lower graph) smolts trapped in the Imnaha River, February 25 to June 27, 1997	18
Figure 7. Weekly mean length and condition factor of natural (upper graph) and hatchery (lower graph) chinook salmon smolts trapped in the Imnaha River, March 23 to May 9, 1997.	19
Figure 8. Weekly mean length and condition factor of natural (upper graph) and hatchery (lower graph) steelhead trout smolts trapped in the Imnaha River, April 1 to June 27, 1997	21
Figure 9. Daily arrival timing frequency to the Imnaha River screw trap of PIT tagged hatchery chinook smolts released at the acclimation facility on April 7, 1997	23
Figure 10. Total water discharge at Lower Granite Dam (top line), spill (shaded) and Snake River discharge at the Anatone gauge station, February 1 to August 31, 1997	28
Figure 11. Cumulative interrogations, by weekly PIT tag release group, of natural chinook salmon smolts from the Imnaha River to Lower Granite, Little Goose, Lower Monumental and McNary dams, April 9 - May 15, 1997 (sample size on top)	31

Figure 12.	Cumulative interrogations, by weekly PIT tag release group, of hatchery chinook salmon smolts from the Imnaha River to Lower Granite, Little Goose, Lower Monumental and McNary dams, April 16 - June 1, 1997 (sample size on top)	31
Figure 13.	Cumulative interrogations, by weekly PIT tag release group, of natural steelhead trout smolts from the Imnaha River to Lower Granite, Little Goose, Lower Monumental and McNary dams, April 20 - June 5, 1997 (sample size on top)	33
Figure 14.	Cumulative interrogations, by weekly PIT tag release group, of hatchery steelhead trout smolts from the Imnaha River to Lower Granite, Little Goose, Lower Monumental and McNary dams, April 19 - July 24, 1997 (sample size on top)	33
Figure 15.	Fork length frequency for PIT tagged natural (upper graph) and hatchery (lower graph) chinook salmon smolts released in the Imnaha River from March 12 - May 9, 1997 and length frequency of fish ultimately detected at Lower Granite Dam in 1997	36
Figure 16.	Fork length frequency for PIT tagged natural (upper graph) and hatchery (lower graph) steelhead trout smolts released in the Imnaha River from April 15 - June 27, 1997 and length frequency of fish ultimately detected at Lower Granite Dam in 1997	37
Figure 17.	Estimated mortality of hatchery reared chinook salmon smolts, by stream reach, from release at the Imnaha River acclimation facility to Lower Monumental Dam from 1994 to 1997 (after Smith et al. 1998)	42
Figure 18.	Estimated survival and 95% confidence intervals of PIT tagged hatchery reared steelhead trout smolts from release at the Imnaha River screw trap to Lower Granite Dam in 1997	44
Figure 19.	Daily arrival timing frequency of PIT tagged Imnaha River natural chinook salmon smolts at Lower Granite Dam, April 6 to May 18, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line)	47
Figure 20.	Daily arrival timing frequency of PIT tagged Imnaha River natural chinook salmon smolts at Little Goose Dam, April 15 to May 22, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line)	47

Figure 2 1.	Daily arrival timing frequency of PIT tagged Imnaha River natural chinook salmon smolts at Lower Monumental Dam, April 20 to June 1, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line)	48
Figure 22.	Daily arrival timing frequency of PIT tagged Imnaha River natural chinook salmon smolts at McNary Dam, April 22 to May 19,1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line)	48
Figure 23.	Daily arrival timing frequency of PIT tagged Imnaha River hatchery chinook salmon smolts at Lower Granite Dam, April 16 to May 22,1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line)	51
Figure 24.	Daily arrival timing frequency of PIT tagged Imnaha River hatchery chinook salmon smolts at Little Goose Dam, April 20 to May 27,1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line)	51
Figure 25.	Daily arrival timing frequency of PIT tagged Imnaha River hatchery chinook salmon smolts at Lower Monumental Dam, April 25 to June 3, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line)	52
Figure 26.	Daily arrival timing frequency of PIT tagged Imnaha River hatchery chinook salmon smolts at McNary Dam, May 1 to June 1, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line)	52
Figure 27.	Daily arrival timing frequency of PIT tagged Imnaha River natural steelhead trout smolts at Lower Granite Dam, April 20 to July 10, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line)*	54
Figure 28.	Daily arrival timing frequency of PIT tagged Imnaha River natural steelhead trout smolts at Little Goose Dam, April 20 to June 19, 1997. Total Project discharge is represented by top line, spill (shaded) and turbine discharge (lower line)	54
Figure 29.	Daily arrival timing frequency of PIT tagged Imnaha River natural steelhead trout smolts at Lower Monumental Dam, April 21 to June 6, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line)	55

Figure 30.	Daily arrival timing frequency of PIT tagged Imnaha River natural steelhead trout smolts at McNary Dam, April 24 to June 5, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line)	55
Figure 31.	Daily arrival timing frequency of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Granite Dam, April 19 to July 24, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line),	58
Figure 32.	Daily arrival timing frequency of PIT tagged Imnaha River hatchery steelhead trout smolts at Little Goose Dam, April 21 to August 23, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line)	58
Figure 33.	Daily arrival timing frequency of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Monumental Dam, April 22 to August 6, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line)	59
Figure 34.	Daily arrival timing frequency of PIT tagged Imnaha River hatchery steelhead trout smolts at McNary Dam, April 23 to August 12, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line) *	59
Figure 35.	Midnight to sunrise, sunrise to sunset, and sunset to midnight weekly passage frequency of PIT tagged Imnaha River hatchery chinook salmon smolts at Lower Granite (upper graph) and Little Goose (lower graph) dams during the spring of 1997,	61
Figure 36.	Midnight to sunrise, sunrise to sunset, and sunset to midnight weekly passage frequency of PIT tagged Imnaha River hatchery chinook salmon smolts at Lower Monumental Dam during the spring of 1997,	62
Figure 37.	Midnight to sunrise, sunrise to sunset, and sunset to midnight weekly passage frequency of PIT tagged Imnaha River natural (upper graph) and hatchery (lower graph) steelhead trout smolts at Lower Granite Dam during the spring of 1997	64
Figure 38.	Midnight to sunrise, sunrise to sunset, and sunset to midnight weekly passage frequency of PIT tagged Imnaha River natural (upper graph) and hatchery (lower graph) steelhead trout smolts at Little Goose Dam during the spring of 1997	65

Figure 39.	Midnight to sunrise, sunrise to sunset, and sunset to midnight weekly passage frequency of PIT tagged Imnaha River natural (upper graph) and hatchery (lower graph) steelhead trout smolts at Lower Monumental Dam during the spring of 1997	66
Figure 40.	Midnight to sunrise, sunrise to sunset, and sunset to midnight weekly passage frequency of PIT tagged Imnaha River hatchery steelhead trout smolts at McNary Dam during the spring of 1997	70
Figure 41.	Mean travel time, by weekly PIT tag release group, of natural and hatchery chinook salmon smolts from the Imnaha River to Lower Granite Dam, April 9 to May 22, 1997 (sample size on top)	70
Figure 42.	Mean travel time, by weekly PIT tag release group, of natural and hatchery steelhead trout smolts from the Imnaha River to Lower Granite Dam, April 19 to July 24, 1997 (sample size on top)	72

APPENDIX FIGURES

Figure G. 1.	Average weekly diel passage of PIT tagged Imnaha River natural chinook salmon smolts at Lower Monumental Dam during the week of April 27 - May 3, 1997	107
Figure G.2.	Average weekly diel passage of PIT tagged Imnaha River hatchery chinook salmon smolts at Lower Granite Dam during the weeks of April 27-May 3 (upper) and May 4-10, 1997 (lower).	108
Figure G.3.	Average weekly diel passage of PIT tagged Imnaha River hatchery chinook salmon smolts at Lower Granite Dam during the week of May 11-17, 1997 . .	109
Figure G.4.	Average weekly diel passage of PIT tagged Imnaha River hatchery chinook salmon smolts at Little Goose Dam during the weeks of April 27-May 3 (upper) and May 4-10, 1997 (lower).	110
Figure G.5.	Average weekly diel passage of PIT tagged Imnaha River hatchery chinook salmon smolts at Little Goose Dam during the weeks of May 11 - 17 (upper) and May 18-24, 1997 (lower)	111
Figure G.6.	Average weekly diel passage of PIT tagged Imnaha River hatchery chinook salmon smolts at Lower Monumental Dam during the weeks of May 4- 10 (upper) and May 11-17, 1997 (lower)	112
Figure G.7.	Average weekly diel passage of PIT tagged Imnaha River hatchery chinook salmon smolts at Lower Monumental Dam during the week of May 18-24, 1997	113

Figure G.8.	Average weekly diel passage of PIT tagged Imnaha River hatchery chinook salmon smolts at McNary Dam during the week of May 4-10,1997	114
Figure G.9.	Average weekly diel passage of PIT tagged Imnaha River natural steelhead trout smolts at Lower Granite Dam during the weeks of April 20-26 (upper) and April 27-May 3,1997 (lower)	115
Figure G. 10.	Average weekly diel passage of PIT tagged Imnaha River natural steelhead trout smolts at Lower Granite Dam during the weeks of May 4- 10 (upper) and May 11-17,1997 (lower)	116
Figure G. 11.	Average weekly diel passage of PIT tagged Imnaha River natural steelhead trout smolts at Little Goose Dam during the weeks of April 20-26 (upper) and April 27-May 3, 1997 (lower)	117
Figure G. 12.	Average weekly diel passage of PIT tagged Imnaha River natural steelhead trout smolts at Little Goose Dam during the weeks of May 4-10 (upper) and May 11-17,1997 (lower)	118
Figure G. 13.	Average weekly diel passage of PIT tagged Imnaha River natural steelhead trout smolts at Lower Monumental Dam during the weeks of April 27- May 3 (upper) and May 4-10,1997 (lower),	119
Figure G. 14.	Average weekly diel passage of PIT tagged Imnaha River natural steelhead trout smolts at Lower Monumental Dam during the week of May 11- 17, 1997	120
Figure G. 15.	Average weekly diel passage of PIT tagged Imnaha River natural steelhead trout smolts at McNary Dam during the week of May 11-17,1997 . . ,	121
Figure G. 16.	Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Granite Dam during the weeks of April 20-26 (upper) and April 27-May 3,1997 (lower)	122
Figure G.17.	Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Granite Dam during the weeks of May 4-10 (upper) and May 11-17,1997 (lower)	123
Figure G. 18.	Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Granite Dam during the weeks of May 18-24 (upper) and May 25-31,1997 (lower)	124

Figure G. 19.	Average weekly die1 passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Granite Dam during the weeks of June 1-7 (upper) and June 8-14, 1997 (lower)	125
Figure G.20.	Average weekly die1 passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Granite Dam during the weeks of June 15-21 (upper) and June 22-28, 1997 (lower)	126
Figure G.21.	Average weekly die1 passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Granite Dam during the week of June 29-July 5, 1997	127
Figure G.22.	Average weekly die1 passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Little Goose Dam during the weeks of April 20-26 (upper) and April 27-May 3, 1997 (lower)	128
Figure G.23.	Average weekly die1 passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Little Goose Dam during the weeks of May 4-10 (upper) and May 11-17, 1997 (lower)	129
Figure G.24.	Average weekly die1 passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Little Goose Dam during the weeks of May 18-24 (upper) and May 25-31, 1997 (lower)	130
Figure G.25.	Average weekly die1 passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Little Goose Dam during the weeks of June 1-7 (upper) and June 8-14, 1997 (lower)	131
Figure G.26.	Average weekly die1 passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Little Goose Dam during the weeks of June 15-21 (upper) and June 22-28, 1997 (lower),	132
Figure G.27.	Average weekly die1 passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Little Goose Dam during the week of June 29-July 5, 1997 (lower)	133
Figure G.28.	Average weekly die1 passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Monumental Dam during the weeks of April 20-26 (upper) and April 27-May 3, 1997 (lower),	134
Figure G.29.	Average weekly die1 passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Monumental Dam during the weeks of May 4-10 (upper) and May 11-17, 1997 (lower)	135

Figure G.30.	Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Monumental Dam during the weeks of May 18-24 (upper) and May 25-31,1997 (lower)	136
Figure G.3 1.	Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Monumental Dam during the weeks of June 1-7 (upper) and June 8-14,1997 (lower)	137
Figure G.32.	Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Monumental Dam during the weeks of June 15-21 (upper) and June 22-28,1997 (lower)	138
Figure G.33.	Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at McNary Dam during the weeks of May 18-24 (upper) and May 25-31,1997 (lower).	139
Figure G.34.	Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at McNary Dam during the week of June 1-7,1997 . .	140

INTRODUCTION

The Nez Perce Tribe (NPT) conducted a smolt monitoring study on the Imnaha River in cooperation with the Fish Passage Center (FPC) in 1997. This study was designed to provide information to conduct the annual Smolt Monitoring Program (SMP), mandated in the Northwest Power Planning Council's (NPPC) Program for water budget and spill management. Information collected will be used to guide future decisions for flow and spill management in the Snake River and proposed drawdowns of Lower Granite Reservoir.

The Pacific States Marine Fisheries Commission contracted the Nez Perce Tribe (NPT) to monitor emigration timing and passive integrated transponder (PIT) tag up to 5,000 actively outmigrating natural and hatchery steelhead trout smolts (*O. mykiss*) from the Imnaha River during the spring emigration period (March 1 - May 31). Natural and hatchery chinook salmon (*O. tshawytscha*) and additional hatchery steelhead smolts were PIT tagged as part of a separate NPT investigation during this same period.

The objectives of this study were to:

1. Determine spring emigration timing of chinook salmon and steelhead trout smolts collected at the Imnaha River screw trap.
2. Evaluate effects of flow, smolt condition and other environmental factors on emigration timing.
3. Collect biological information on Imnaha River emigrants, such as length, weight, and condition factors.
4. Determine emigration timing and/or travel time of PIT tagged hatchery chinook smolts released at the Imnaha River acclimation facility.
5. Determine arrival timing, travel time and recovery rate (as an index of smolt survival) of hatchery chinook and natural and hatchery steelhead trout smolts PIT tagged from the mouth of the Imnaha River to Snake and Columbia river dams.

METHODS

Study Area Description

The Imnaha River subbasin is located in northeastern Oregon (Figure 1) and encompasses an area of approximately 2,538 square kilometers. The mainstem Imnaha River flows in a northerly direction for 129 km from its headwaters in the Eagle Cap Wilderness Area to its confluence with the Snake River at river kilometer (rkm) 308.4 (James 1984; Kucera 1989). The river drains the eastern escarpment of the Wallowa mountains and part of an adjacent plateau located between the Wallowa River drainage to the west and Hells Canyon of the Snake River to the east (Kucera 1989). Elevations in the watershed vary from 3,048 m at the headwaters to about 260 m in lower elevations (Kucera 1989).

The 64 year (1929 - 1993) mean annual discharge of the Imnaha River is 172 cms (6,060 cfs) at Imnaha, Oregon, USGS gauge 13292000. Maximum river discharge generally occurs from April to June with minimum flows from August to February (Kucera 1989).

Equipment Description

A floating rotary screw trap manufactured by E.G. Solutions Inc., Corvallis, Oregon, was used to capture outmigrating salmonid smolts for this study (Figure 2). Similar traps have been used to capture migrating salmonid species in New York and Alaska (Kennen et al. 1994; Thedinga et al. 1994). The screw trap consisted of a non-standard 2.1 m diameter trapping cone supported by a metal A-frame and two six meter pontoons that provided flotation. Fish entering the trapping cone move through to a custom oversize livebox (1.68 m wide x 1.25 m long x 0.55 m deep). The livebox was fitted with a removable baffle to dissipate water velocity during high flows.

Water temperature information for this study was collected using a constant recording Ryan TempMentor which was located approximately 150 m upstream from the screw trap. Discharge information used in this report was provided by the U.S. Geological Survey, USGS gauge 13292000 at Imnaha, Oregon (rkm 32).

Trap Operations

The Imnaha River screw trap was operated on February 25 and from March 9 to June 27, 1997. The SMP project began on March 9 and was completed June 3. The screw trap was operated continuously from Sunday evening through Friday morning during this period. Exceptions to this occurred on several occasions when trap repair was necessary or high flows or debris load in the river precluded safe trap operation. The screw trap was also operated on the weekend of April 11 and 12 after the release of hatchery chinook salmon smolts.

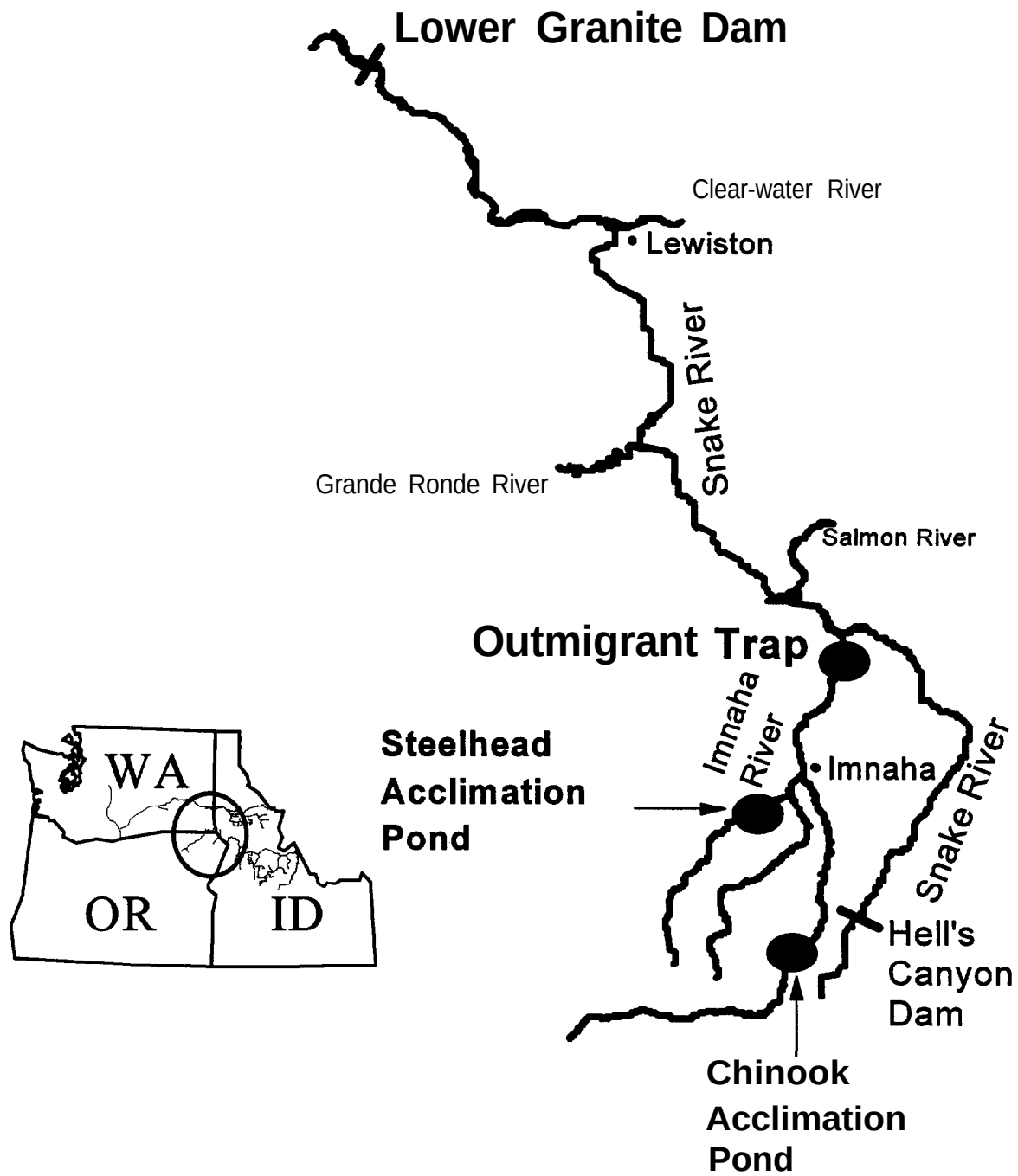


Figure 1. Map of Imnaha River study area.

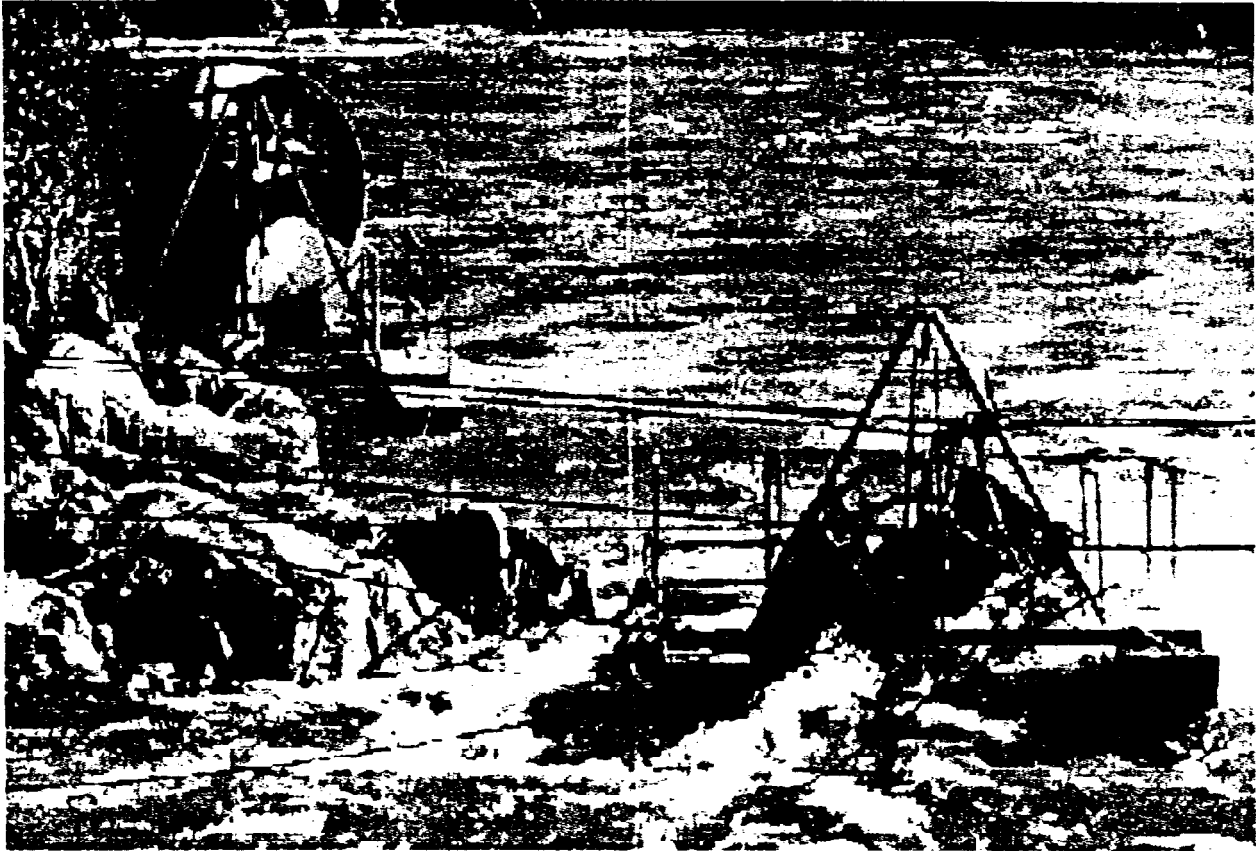


Figure 2. Photograph of screw trap in the lower Inmaha River.

The screw trap was secured on the west bank of the Imnaha River, below the Cow Creek bridge, 6.6 kilometers from the confluence with the Snake River (Figure 1). The trap position in the river was adjusted by manipulating a cable suspension system which allowed side to side and upstream/downstream movement of the trap. This setup allowed the trap to be backed slightly out of the main current and fished during high flows. The trap was fished in one of three positions depending on daily readings from the staff gauge located approximately one kilometer upstream of the trap (Table 1). The staff gauge used in previous years was destroyed by high flows during January 1997. Based on photos and the opinion of staff from previous years, the new staff gauge, used in 1997, produced readings which were 0.1 meters higher than readings taken at similar water levels in previous years.

The livebox of the screw trap was checked at 0800 every morning and several times throughout each night and day. Non-target piscivorous fish and large numbers of other non-target fish were removed from the livebox first. Non-target piscivorous fish were scanned for PIT tags and then released 30-50 meters downstream. Natural juvenile chinook salmon were processed first, followed by hatchery chinook salmon, natural steelhead trout and hatchery steelhead trout smolts, respectively.

Table 1. Position in which screw trap was fished dependent upon staff gauge reading.

Staff Gauge	Trap Position
< 1.0m	Forward
1.0-1.2 m	Intermediate
> 1.2m	Rear

Daily processing procedures were similar to those used by Ashe et al. (1995) and were as follows: 1) Fish were anaesthetized in a MS-222 bath (3 mL MS-222 stock solution (100 g/L) per 19 L of water) buffered with propolyaqua (PRO-NOVAQUA), 2) Each fish was examined for existing marks (e.g. fm clips), and PIT tag insertion scars, 3) Chinook salmon, rainbow trout and large piscivorous fish were scanned with a PIT tag scanner, 4) Up to 300 hatchery chinook salmon smolts were used for trap efficiency trials, 5) A specified number of each species were selected for PIT tag insertion, 6) All other fish were enumerated and released 30-50 m downstream from the trap after recovering from the anaesthetic 7) All fish mortality was recorded.

Trap Efficiency

Trap efficiency trials for hatchery chinook salmon were conducted as often as possible with the requirement that at least 25 healthy individuals were available. The first 100 hatchery

chinook salmon selected for trap efficiency trials were measured (FL) to the nearest mm and weighed to the nearest 0.1 g. All fish selected for trap efficiency trials were marked by clipping the distal portion of one of seven possible fins (Table 2).

Table 2. Fin clip applied to hatchery chinook salmon smolts used in trap efficiency trials.

Day of the week	Fin clip applied
Sunday	Dorsal fin (DC)
Monday	Top caudal fm (TCC)
Tuesday	Lower caudal fm (LCC)
Wednesday	Left ventral fin (LVC)
Thursday	Right ventral fin (RVC)
Friday	Left pectoral fin (LPC)
Saturday	Right pectoral fin (RPC)

Fish marked for trap efficiency trials were held in perforated plastic garbage cans in the river during daytime hours (approximately 12 h) and then transported upstream approximately one km to the release site during evening hours. Fish were released after dark on the day they were marked.

Trap efficiency was determined by: $E = R/M$

where E is estimated trap efficiency, R is number of marked fish recaptured, and **M is number of** fish marked and released.

Smolt Yield

Emigration numbers were estimated by: $N = U/E$;

where N is estimate of total number of emigrants, and U is number of unmarked fish.

In 1996, the spring emigration was visually divided into three flow periods based on discharge (Blenden et al. 1997). This year, however, flows remained relatively constant during the period in which 98 percent of the hatchery chinook smolts trapped were captured. Smolt yield was determined for the period for which trap efficiency was estimated using the bootstrap method (Efron and Tibshirani 1986).

Bootstrap period estimates (NJ) were calculated by: $N_p = U_p / E_p$

where U_p is the total number of unmarked fish captured during the period and E_p is the mean trap efficiency for the period.

Biological Characteristics

Length frequency distributions were created and condition factors calculated for each fish species and origin. Condition factor was calculated using Fulton's condition factor : $(W/L^3) \times 10^5$ (Bagenal and Tesch 1978). Natural steelhead less than 120 mm were assumed not to be smolts and therefore were not used in smolt length, weight and condition factor calculations.

Student's t-test was used to test for significant differences in fork length between various groups of fish (i.e. natural versus hatchery steelhead trout smolts, previously PIT tagged hatchery chinook salmon smolts versus those not previously PIT tagged, hatchery chinook marked and released for trap efficiency versus trap efficiency recaptures). Differences were considered significant at $p < 0.05$.

PIT Tagging

Fish selected for passive integrated transponder (PIT) tagging were examined for previous PIT tagging, descaling and general health before being tagged, measured (FL-mm) and weighed (0.1 g). For chinook salmon, only healthy fish greater than 65 mm were selected for tagging. Steelhead were tagged regardless of condition. Fish were PIT tagged using hand injector units following the general methods described by Prentice et al. (1986,1990b) and Matthews et al. (1990,1992). Hypodermic injector units were sterilized after each use in ethanol for at least 10 minutes prior to tagging. PIT tags were also sterilized for 10 minutes and allowed to air-dry prior to their use. Tagging was discontinued when water temperatures exceeded 15 C.

Weekly steelhead smolt tagging goals were set by FPC (Table 3). These goals were modified as the season progressed based upon catch and interruptions in trapping due to equipment repairs. Up to 200 additional natural chinook salmon, 600 hatchery chinook salmon, 300 natural steelhead trout and 400 hatchery steelhead trout were tagged each week as part of a separate Nez Perce Tribe (NPT) investigations. Steelhead trout smolts tagged for FPC and NPT investigations were held for a minimum of one hour after tagging until fully recovered and then released as a group. Chinook salmon smolts tagged for NPT investigations were held in perforated plastic garbage cans for a minimum of 12 hours and released as a group after dark. The latter methodology is a standard practice employed by the NPT aimed at allowing chinook smolts to recover from tagging stress and increasing predator avoidance through night time release. Mortality due to tagging was recorded.

Tagging data were proofed for mistakes using the PITVAL software program. Tagging and interrogation files were submitted to the Pacific States Marine Fisheries Commission (PSMFC) PIT Tag Information System (PTAGIS) database via modem the day following

collection. PIT tag interrogation data were downloaded from the PTAGIS database.

Table 3. PIT tag schedule for natural and hatchery steelhead trout smolts.

Rearing Type	Tagging Dates	Weekly Goal
Natural	3/09 - 3/15	200
	3/16 - 3/22	200
	3/23 - 3/29	200
	3/30 - 4/05	200
	4/06 - 4/12	200
	4/13 - 4/19	200
	4/20 - 4/26	200
	4/27 - 5/03	200
	5/04 - 5/10	200
	5/11 - 5/17	200
Hatchery	4/20 - 4/26	600
	4/27 - 5/03	600
	5/04 - 5/10	600
	5/11 - 5/17	600
	5/18 - 5/24	600

Travel Timing to Trap Site and Lower Snake River Dams

Emigration timing of natural and hatchery chinook salmon and steelhead trout smolts was determined by daily collection numbers at the screw trap site. Arrival timing and travel time of PIT tagged hatchery chinook salmon smolts released at the Imnaha River acclimation facility and hatchery steelhead trout smolts released at the Little Sheep Creek acclimation facility was determined by daily collection numbers and PIT tag interrogation at the screw trap site (Figure 1).

Arrival timing, travel time and cumulative interrogation percents to Lower Granite Dam, and die1 passage at hydroelectric facilities through the Snake River to McNary Dam was determined for natural and hatchery chinook salmon and steelhead trout smolts. Single coil detections or negative travel time individual fish were deleted from all analysis. Release groups of fish were pooled weekly to determine travel time to Lower Granite Dam. First time PIT tag observations, from all dams, were used to calculate and report the cumulative interrogation percents to Lower Granite Dam by species and origin. Cumulative interrogation percents of each species was determined by dividing the sum of first tag code observations by the total number of fish tagged and released. Fork lengths were compared between length at tagging and lengths, at

tagging, detected at Lower Granite Dam for each species and origin.

Arrival timing at each dam during this report period are based on first-time observations of individual tag codes at each dam. Arrival timing estimates do not include subsequent detections of fish that were captured in the Snake River trap, held in sample rooms or raceways, had negative travel times or single coil detections.

Average weekly die1 smolt passage at Lower Granite, Little Goose, Lower Monumental, and McNary dams were summarized by three passage periods (midnight to sunrise, sunrise to sunset, and sunset to midnight) provided that 30 or more fish were detected at a dam. Passage periods were delineated using a United States Naval Observatory sunrise and sunset table for Lewiston, Idaho. All times used were Pacific Standard Time. Weekly die1 passage was further broken down into hourly passage frequencies. Fish detections not used in the analysis were those previously caught in the Snake River trap or those detected going to a raceway or sample room.

Travel time estimates to Lower Granite Dam during this report period do not include fish captured in the Snake River trap. Differences in mean travel time, from weekly PIT tag release groups, were analyzed by means of a t-test (Statgraphics Plus 1995). In some instances the distributions of travel time were skewed with some kurtosis. It was assumed with independent samples and a combined sample size $n_1 + n_2 \geq 30$, that t-methods were reasonably accurate even with modest skewness in the two populations (Ott 1984). T-test values were calculated and reported from samples with unequal variance. Differences in means were tested and considered significant at the 0.05 level. When the assumption of normality was violated, the t-test was abandoned in favor of the Wilcoxon rank sum test statistic (Ott 1984). This test compared median travel times of hatchery and natural smolts.

Survival Estimation

Survival was estimated by the Jolly (1965) and Seber (1965) methodology using the SURPH model (Smith et. al., 1994). The SURPH model uses repeated detections of individually tagged fish and analysis of their capture histories provides estimates of their survival. Capture histories were generated using a “2” to identify fish which were loaded onto a barge or for which an exit point from a fish bypass facility could not be determined. Survival estimates do not include fish which had negative travel times or single coil detections. The reach survival tables display point estimates of survival for selected reaches with 95% confidence intervals displayed in parentheses. The SURPH model can produce survival estimates which are greater than 1, these estimates generally reflect an underestimation of survival in previous reaches. Estimates for multiple reaches were calculated using estimates for individual reaches generated by the model. Jim Lady of University of Washington and Tom Berggren of Fish Passage Center assisted with generating the model outputs for the PIT tagged hatchery chinook salmon smolts released at the Imnaha River weir. In the tables, the notations Weir, Trap, LGR, LGO, and LMO, denote the Imnaha River Weir, the Imnaha River screw trap, the tailrace of Lower Granite Dam, the tailrace of Little Goose Dam and the tailrace of Lower Monumental Dam, respectively.

RESULTS AND DISCUSSION

Imnaha River Subbasin Emigration

Imnaha River Discharge

Imnaha River mean daily discharge during spring emigration ranged from 7.4 cms (260 cfs) on March 9 to 96.6 cms (3,410 cfs) on April 20 at USGS gauge 13292000, Imnaha, OR (Figure 3). Mean daily water temperatures during the study period ranged from 3.9 °C on March 4 to 13.1 °C on June 15 (Figure 3). Appendix A contains daily discharge readings and daily **minimum**, maximum and mean water temperatures during the study period.

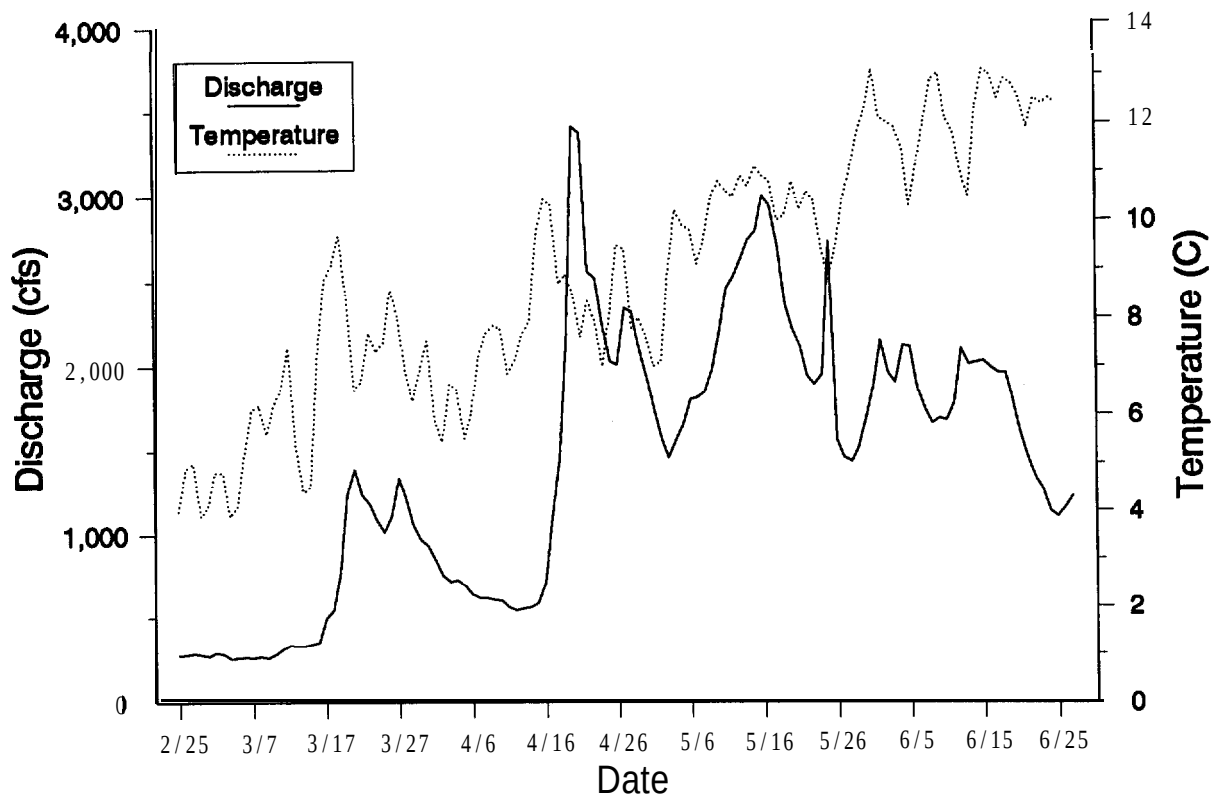


Figure 3. Mean daily discharge (USGS Gauge 13292000 at Imnaha, OR) and mean daily water temperature of the Imnaha River during the spring emigration period, February 25 - June 27, 1997.

Trap Operation

The Imnaha River screw trap was operated for 70 days during the 110 day spring emigration period (March 9 - June 27) and for one day on February 25. There were 19 occasions (affecting 17 days) during which the trap did not operate continuously (Table 4). These

interruptions were due either to high flows, trap malfunction, or high debris load in the river. The trap was operated for 62% of the total possible hours (including weekends and holidays) during the spring emigration period.

Table 4. Dates the screw was not operated during the study period, March 9 -June 27,1997.

Date	Reason
3/14 - 3/15	Weekend
3/21 - 3/22	Weekend
3/28 - 3/29	Weekend
4/04 - 4/05	Weekend
4/18 - 4/19	Weekend
4/21-4/22	Excessive river flow
4/25 - 4/26	Weekend
5/02 - 5/03	Weekend
5/09 - 5/10	Weekend
5/16 - 5/17	Weekend
5/23 - 5/24	Weekend
5/26	Tribal holiday
5/30 - 5/31	Weekend
6/06 - 6/07	Weekend
6/13 - 6/14	Weekend
6/16	Tribal Holiday
6/20 - 6/21	Weekend

Emigration Timing and Trends at Trap Site

A total of 270 natural chinook salmon, 10,616 hatchery chinook salmon, 877 natural steelhead trout and 7,345 hatchery steelhead trout smolts were captured in the Imnaha River screw trap during the study period (Table 5) resulting in a total catch of 19,108 individuals of target species. Appendix B contains daily catch summaries of natural and hatchery fish for both species. Natural chinook salmon were collected throughout the study period and comprised 1.4% of the total target species catch. The low number of natural chinook collected is probably the result of a major increase in river discharge that was estimated to be 12,400 cfs on January 1, 1997. It is believed that these high flows induced emigration from the Imnaha River before trapping started. The peak period of natural chinook smolt collection occurred March 25 to April 30 (Figure 4). Natural chinook salmon smolts were collected throughout the rest of the study period with 23 fish caught in May and two in June (Table 5).

The Oregon Department of Fish and Wildlife (ODFW) released approximately 52,000 hatchery reared chinook salmon smolts into the Imnaha River from the Imnaha River acclimation facility (rkm 73) on April 7. Of these, 13,378 smolts were PIT tagged prior to release. Approximately 20% of the hatchery chinook smolts released were captured during the study period which comprised 55.6% of the total target species catch. Hatchery chinook salmon smolts were first captured on April 9 (Figure 4). Approximately 99% (10,527) of the hatchery chinook salmon trapped were captured within 10 days of release. Small numbers of hatchery chinook salmon smolts were caught through mid-May (Table 5). Appendix C summarizes the ODFW spring release schedule for hatchery chinook salmon and steelhead trout smolts in 1997.

Natural steelhead smolts were first captured at the screw trap on March 14 (Figure 5). Outmigrating natural steelhead trout smolts were captured throughout the rest of the study period, although only low numbers were captured during June. Natural steelhead trout comprised 4.6% of the total target species catch. Natural steelhead catch peaked between May 1 and May 15.

ODFW released 327,460 hatchery reared steelhead trout smolts into the Imnaha River subbasin, at the Little Sheep acclimation facility (rkm 45). A total of 208,936 fish were released on April 15 and 118,524 were released on May 13. We collected 7,343 hatchery reared steelhead trout smolts between April 15 and June 27. Two hatchery steelhead trout were captured prior to the release of the hatchery steelhead smolts. Hatchery steelhead trout comprised 38.4% of the total catch. Only 2.2% of the hatchery steelhead trout smolts released were captured. Hatchery steelhead trout smolts were still being captured at the rate of 8-20 fish per day when screw trap operation ceased (Figure 5).

Table 5. Weekly catch composition of natural and hatchery chinook salmon and steelhead trout smolts collected in the Imnaha River screw trap, February 25 - June 27, 1997.

Week	Chinook			Steelhead			Subtotal
	Natural	Hatchery	Subtotal	Natural	Parr/N	Hatchery	
2/23 - 3/01	1	0	1	0	0	0	0
3/09 - 3/15	6	0	6	0	1	0	1
3/16 - 3/22	4	0	4	1	0	1	2
3/23 - 3/29	19	0	19	11	2	0	13
3/30 - 4/05	71	0	73	14	0	0	14
4/06 - 4/12	64	8,587	8,649	23	0	1	24
4/13 - 4/19	40	1,940	1,980	142	2	939	1,083
4/20 - 4/26	23	14	37	68	3	246	317
4/27 - 5/03	30	56	86	160	0	466	626
5/04 - 5/10	5	19	24	321	1	754	1,076
5/11 - 5/17	0	0	0	22	0	1,939	1,961
5/18 - 5/24	2	0	2	48	1	970	1,019
5/25 - 5/31	3	0	3	42	3	930	975
6/01 - 6/07	1	0	1	9	0	501	510
6/08 - 6/14	1	0	1	2	0	338	340
6/15 - 6/21	0	0	0	0	0	182	182
6/22 - 6/28	0	0	0	1	0	78	79
Total	270	10,616	10,886	864	13	7,345	8,222

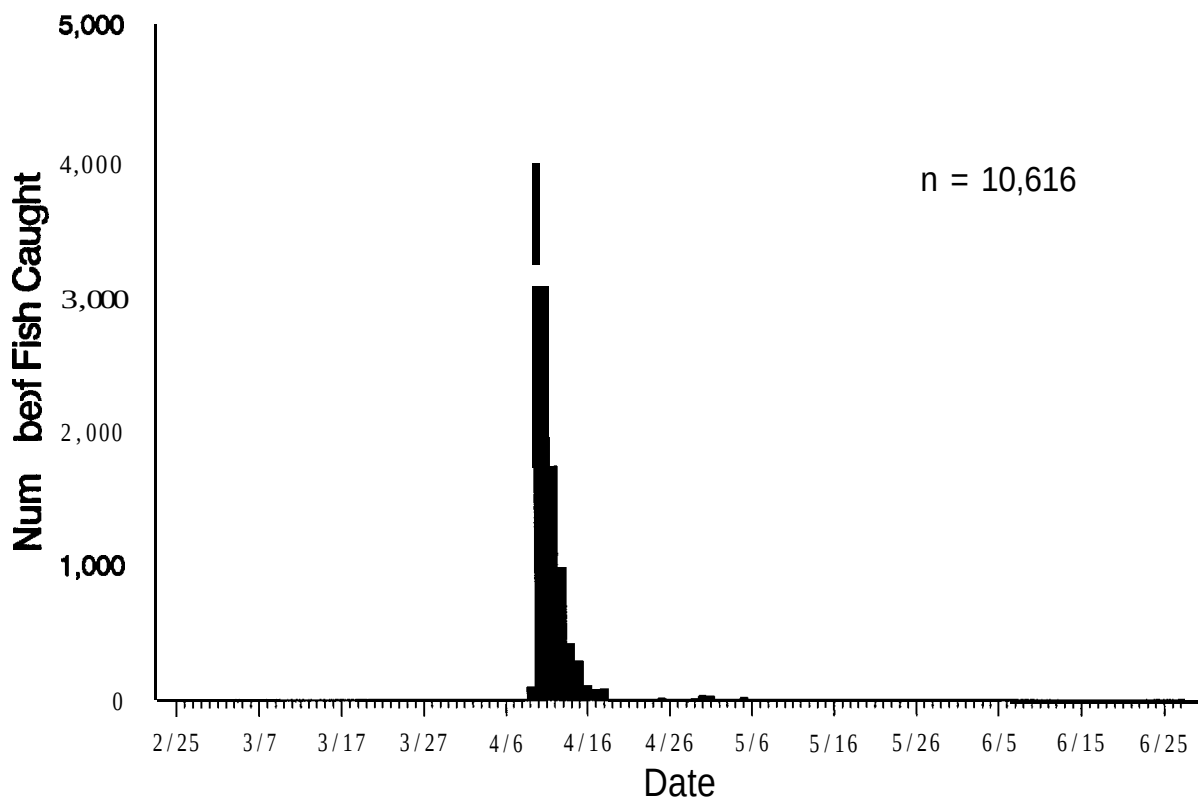
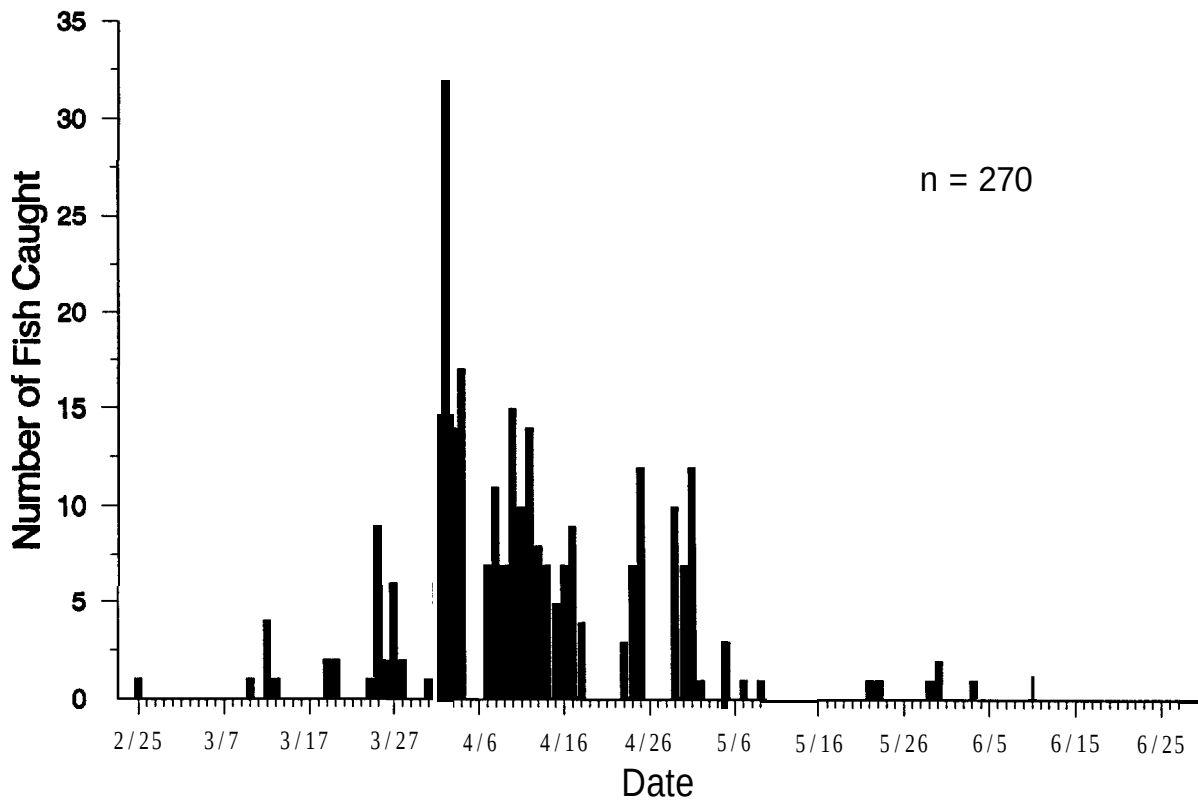


Figure 4. Emigration timing, based on daily catch at the Imnaha River screw trap, of natural (upper graph) and hatchery (lower graph) chinook salmon smolts. See Table 4 for dates trap not operated.

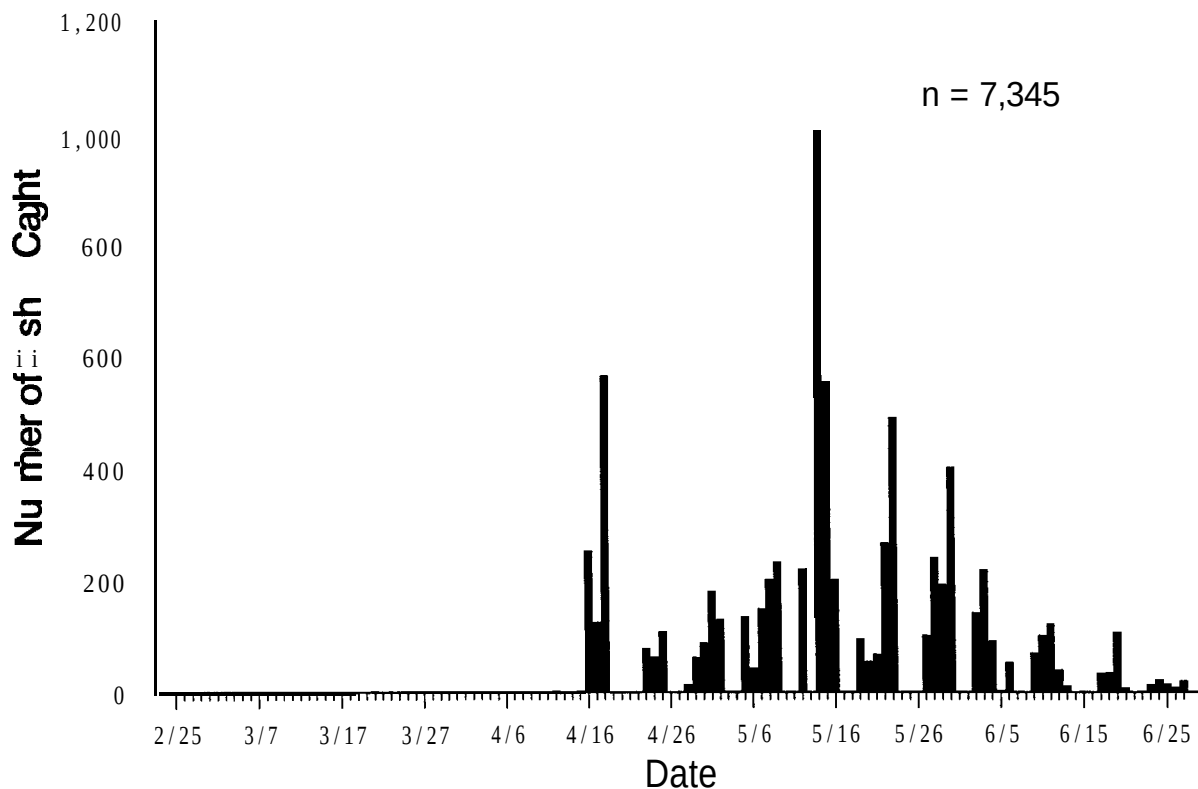
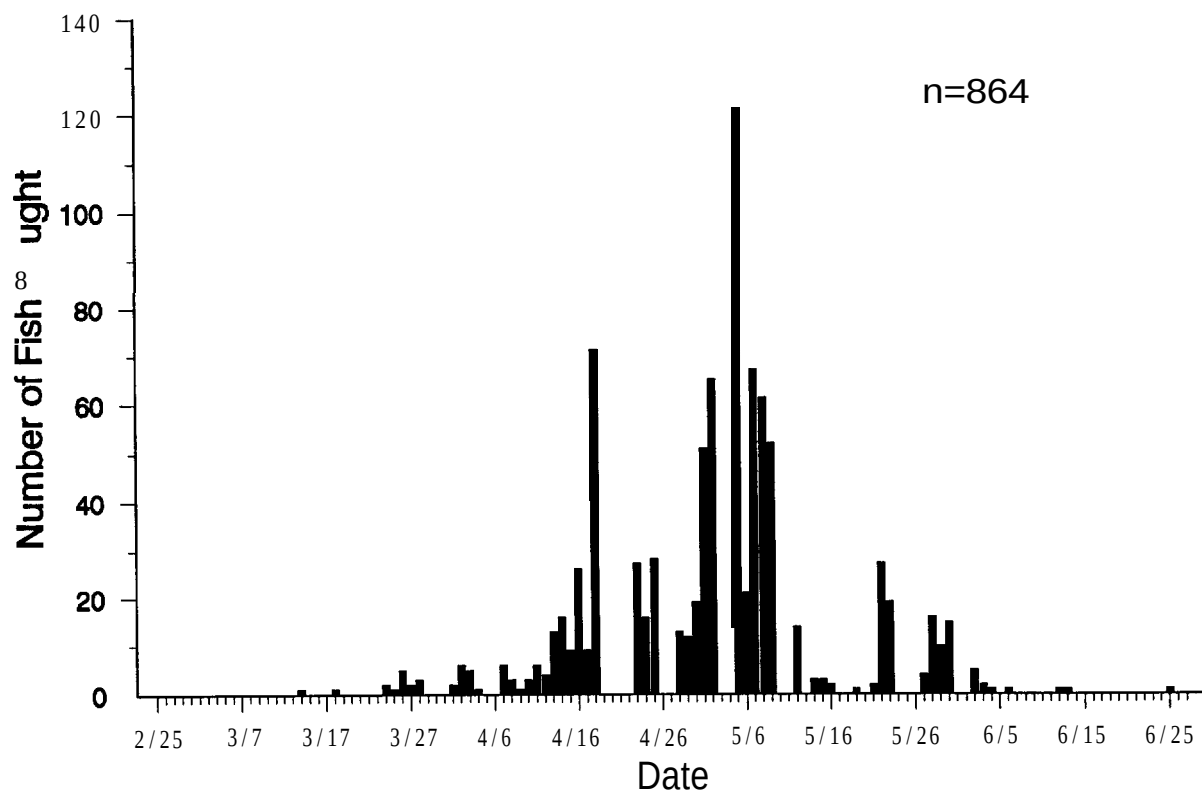


Figure 5. Emigration timing, based on daily catch at the Imnaha River screw trap, of natural (upper graph) and hatchery (lower graph) steelhead trout smolts. See Table 4 for dates trap not operated.

Trap Efficiency and Smolt Yield

In 1997, unlike past years, SURPH model survival estimates were relied on solely to estimate post-release survival and smolt yield of hatchery chinook salmon smolts from acclimation facility release to the lower Imnaha River screw trap. Trap efficiency trials were also conducted and reported below, but difficulty in accurately estimating efficiency precluded utilizing the data to estimate smolt yield (and thus survival). During six consecutive nights, after hatchery chinook smolts were first captured at the trap, 95.8% of the smolts trapped were collected and 99.2% of the PIT tagged smolts trapped were collected.

Survival for PIT tagged hatchery chinook salmon smolts, from release at the Imnaha River acclimation facility to the screw trap, was estimated at 89.2% using the SURPH model (Table 6). This represented a smolt yield of 46,384 fish at the screw trap out of approximately 52,000 hatchery chinook smolts released. Based on this estimate of survival 22% of the surviving PIT tagged hatchery chinook smolts should have been interrogated at the screw trap. We interrogated 19.6% (n=2,624) of the previously PIT tagged hatchery chinook smolts at the screw trap.

Table 6. Mean trap efficiency, PIT tag interrogation percentage and estimated survival from release to trap (bootstrap and SURPH) and release to Lower Granite Dam (LGR) for hatchery chinook salmon smolts from 1994 to 1997.

Year	Mean Trap Efficiency (%)	PIT Tag Interrogation at Screw Trap (%)	<u>Estimated Survival</u>		
			Release to Trap Bootstrap (%)	Release to Trap SURPH (%)	Release to LGR (%)
1994	13.8'	6.2	88.1	100.9	68.5
1995²	---	10.8	---	92.6	61.8
1996	11.6	10.6	101.7	95	56.8
1997	45.9	19.6	44	89.2	61.6

'Based on one trap efficiency trial.

²**Data** for HxW crossed chinook salmon smolts released on March 28.

Mean trap efficiency was estimated at 45.9% in 1997, based on 1,569 marked fish and six trials, with a 95% confidence interval off 8%. This mean trap efficiency appeared high and was over three times higher than that observed in 1994 and 1996 (Table 6). PIT tag interrogation percentage, used as a general index of trap efficiency, was 19.6% or less than half of the mean trap efficiency estimate (45.9%). Finally, the estimated survival from release to Lower Granite Dam (61.6%) was greater than trap efficiency estimated survival from release to the Imnaha River trap (44%), and agreed with previous years survival information. For these reasons the SURPH model estimated survival, and smolt yield, was used for hatchery chinook salmon smolts from release to the trap site in 1997. Over-estimating the trap efficiency this year resulted in the under-estimate of smolt yield and may be due to:

1. Fish held for trap efficiency trials suffered increased stress in comparison to past years and did not disperse throughout the water column similarly to the entire population. Factors which may have resulted in increased stress in comparison to past years include increasing the number of fish held for trap efficiency trials and holding the fish in perforated garbage cans instead of net pens or;
2. Eroded fins were misidentified as being fin clips.

There appears to be no size related bias in trapping of hatchery reared chinook salmon smolts. Mean fork length of hatchery chinook smolts marked and released for trap efficiency was 131.9 mm (n=568), which was not significantly different ($p>0.05$) than the mean fork length of 131.4 mm for recaptured hatchery chinook used in trap efficiency trials (n=720).

Biological Characteristics

Based on length frequency data, the majority of chinook salmon and steelhead trout emigrants collected in the screw trap were age 1' and 2,' respectively (Figure 6). Mean length of natural chinook salmon emigrants was 108 mm, mean weight was 13 g, and mean condition factor (K) was 1.02 (Table 7). Weekly mean length of natural chinook salmon throughout the spring emigration, ranged from 103 mm to 111 mm (Figure 7). Weekly mean condition factors of natural chinook salmon ranged from 0.9 to 1.1 (Figure 7). Hatchery reared chinook salmon smolts were significantly larger ($p<0.05$) than their natural counterparts. Mean length was 131 mm and mean weight was 25.4 g (Table 7). Mean condition factor for hatchery chinook smolts was 1.12. Weekly mean lengths for hatchery chinook smolts ranged from 125 mm to 132 mm (Figure 7). Weekly mean condition factors ranged from 1.06 to 1.15.

Table 7. Mean and range of fork length (mm), weight (g), and condition factor for natural and hatchery chinook salmon and steelhead trout smolts collected at the Imnaha River screw trap from March 9 to June 27, 1997.

	Chinook		Steelhead	
	Natural	Hatchery	Natural	Hatchery
Number Collected	270	10,616	864	7,345
Mean Fork Length	108	131	175	210
Range	84 - 145	97 - 198	121 - 256	118-292
Standard Deviation	9.2	10.6	19.7	19.8
Mean Weight	13.0	25.4	55.8	88.0
Range	6.6 - 33.2	11.3 - 83.8	18.5 - 172.5	27.4 - 252.4
Standard Deviation	3.6	7.2	18.9	26.1
Mean K	1.02	1.12	1.00	0.93
Range	0.75 - 1.55	0.72 - 1.71	0.68 - 1.57	0.60 - 1.70
Standard Deviation	0.13	0.12	0.09	0.09

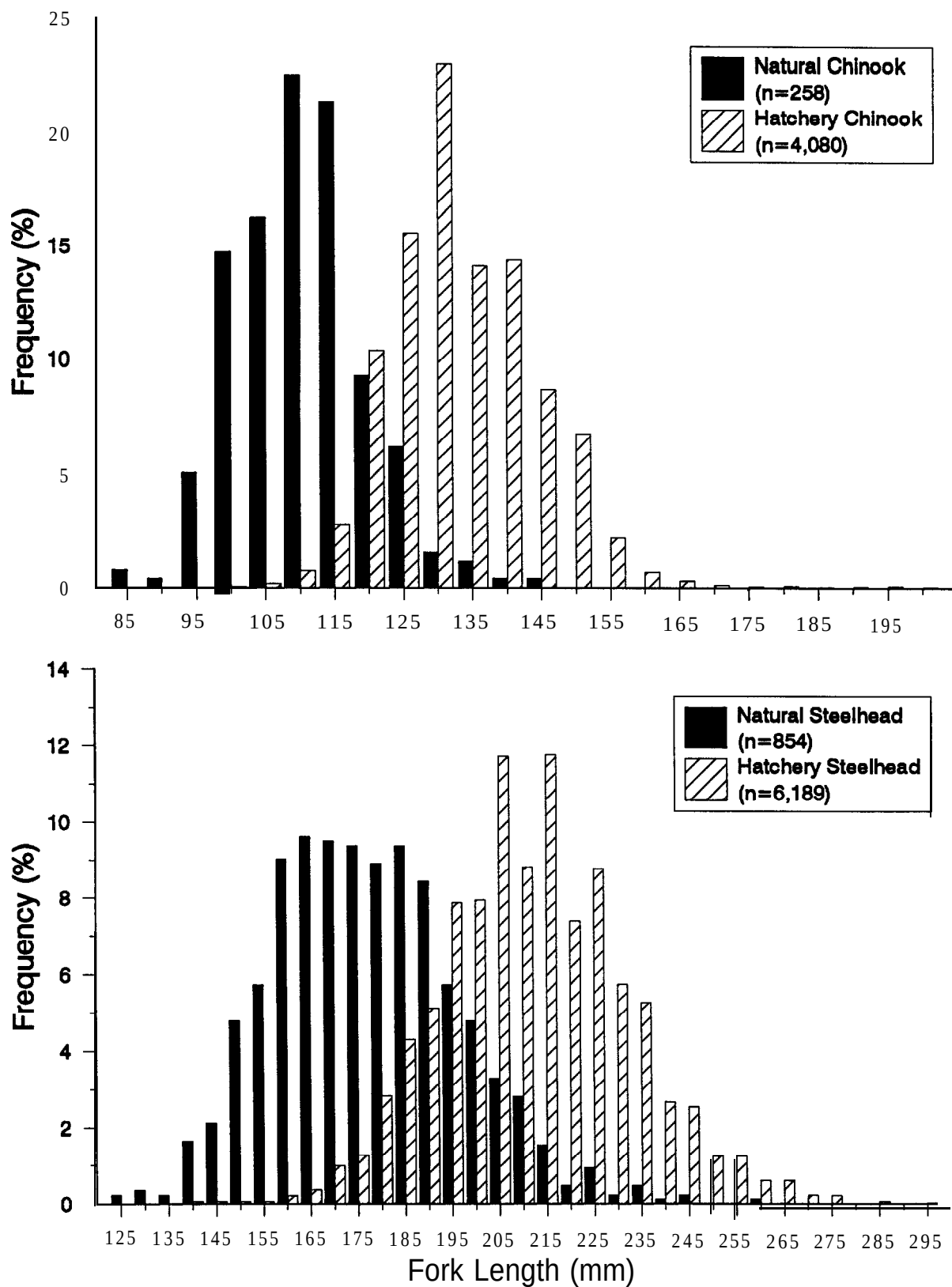


Figure 6. Length frequency of natural and hatchery chinook salmon (upper graph) and steelhead trout (lower graph) smolts trapped in the Imnaha River, February 25 to June 27, 1997.

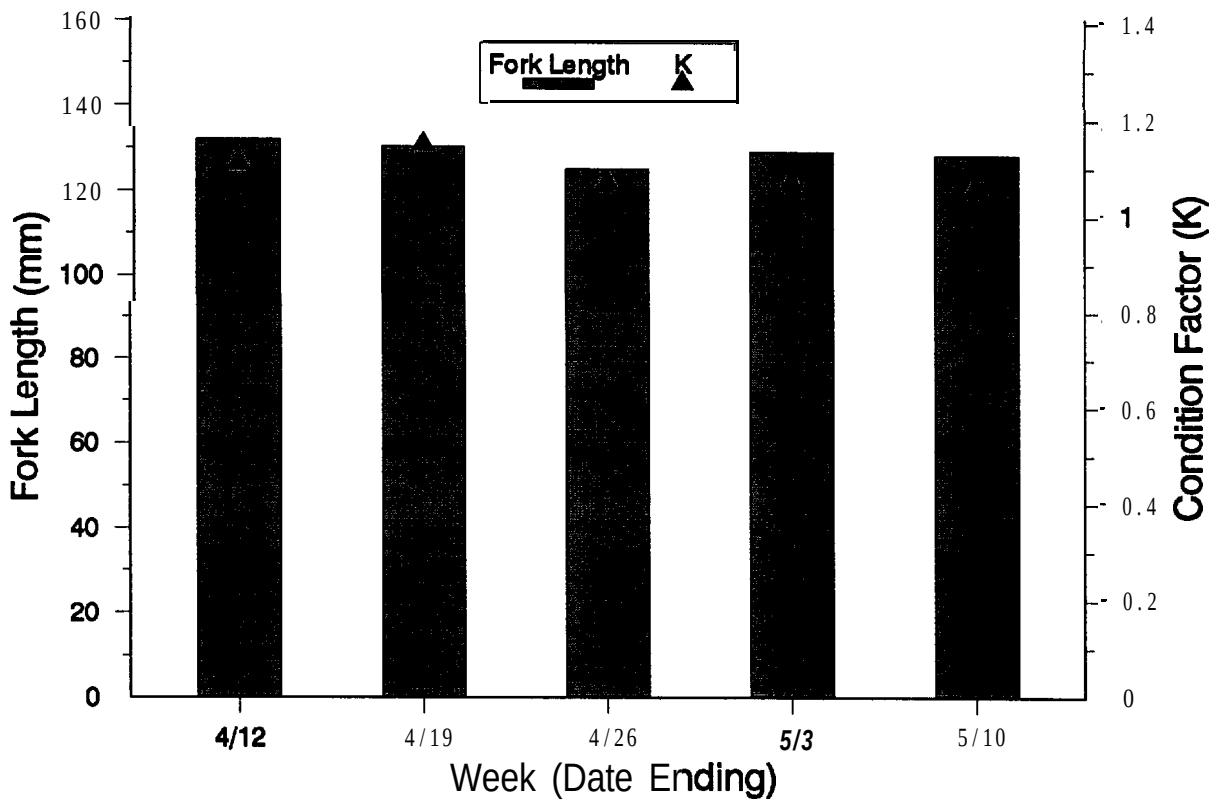
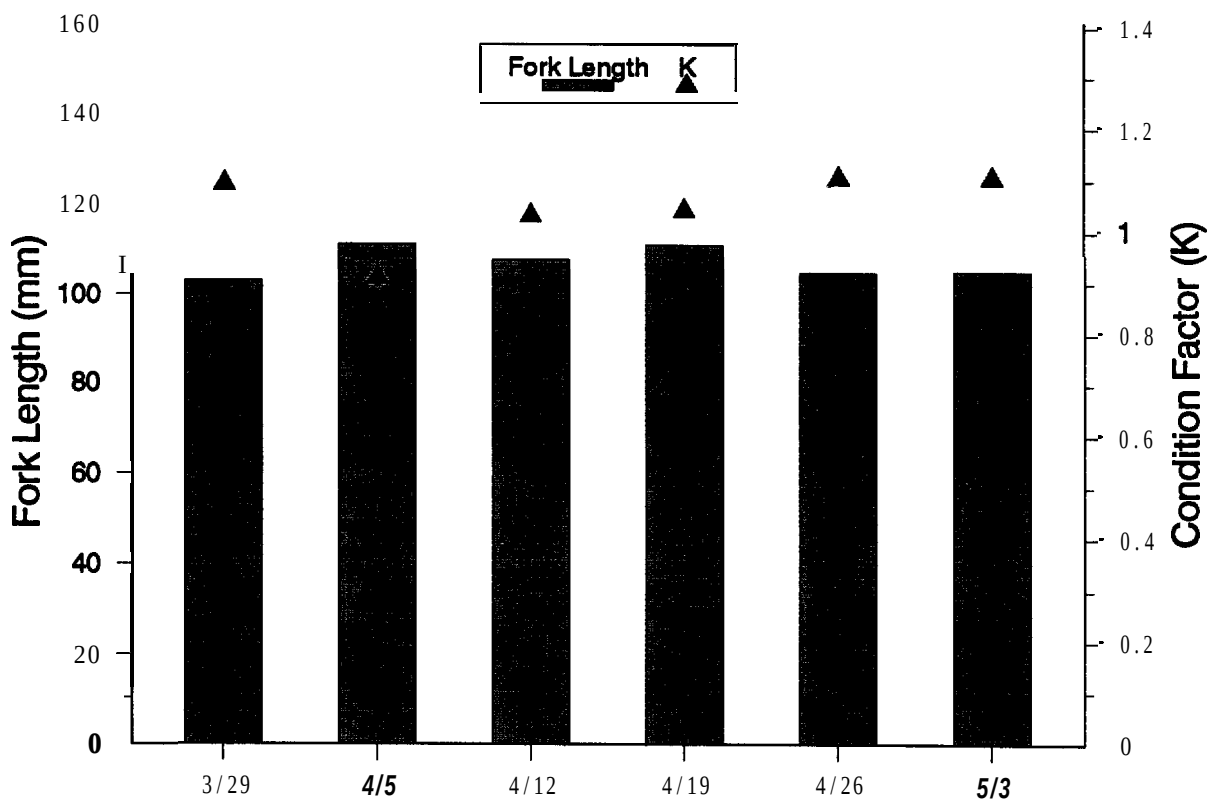


Figure 7. Weekly mean length and condition factor of natural (upper graph) and hatchery (lower graph) chinook salmon smolts trapped in the Imnaha River, March 23 to May 9, 1997.

Mean fork length of previously PIT tagged hatchery chinook salmon smolts (n=2,504) captured in our screw trap was 131.5 mm. This was not significantly different ($p>0.05$) than the mean fork length (131.5) of all non-PIT tagged hatchery chinook smolts (n=2,290) we captured and indicates that the PIT tagged hatchery chinook smolts were representative of the hatchery reared chinook smolts released at the acclimation facility.

Natural steelhead trout smolt mean length was 175 mm, mean weight was 55.8 g, and mean condition factor (K) was 1.00 (Table 7). Weekly mean lengths and condition factor (K) for natural steelhead smolts ranged from 162-184 mm and 0.96-1.03, respectively (Figure 8). Hatchery steelhead were significantly larger ($p<0.05$) with a mean length of 210 mm and a mean weight of 88 g. The mean condition factor for hatchery steelhead smolts (0.93) was lower than for natural steelhead smolts (1.00). Weekly mean lengths and condition factor (K) for hatchery steelhead smolts ranged from 207-215 mm and 0.87-0.98, respectively (Figure 8). Appendix D contains mean daily length, weight and condition factors for natural and hatchery chinook salmon and steelhead trout smolts.

Mortality

Mortality was tallied for each anadromous salmonid species of natural and hatchery origin to determine the effects of trapping, handling and tagging on the fish. Handling was the leading cause of mortality in natural chinook (0.37%), while trapping caused the most mortalities in hatchery chinook (0.07%), natural steelhead (0.11%), and hatchery steelhead (0.26%) (Table 8).

Table 8. Mortality of chinook salmon and steelhead trout smolts due to trapping, handling, and PIT tagging.

	Chinook				Steelhead			
	Natural		Hatchery		Natural		Hatchery	
Number Captured	270		10,616		877		7,345	
Mortality Source	n	%	n	%	n	%	n	%
Trapping	0	0	7	0.07	1	0.11	19	0.26
Handling	1	0.37	4	0.04	0	0	6	0.08
PIT Tagging	0	0	0	0	0	0	4	0.05
Total	1	0.37	11	0.11	1	0.11	29	0.39

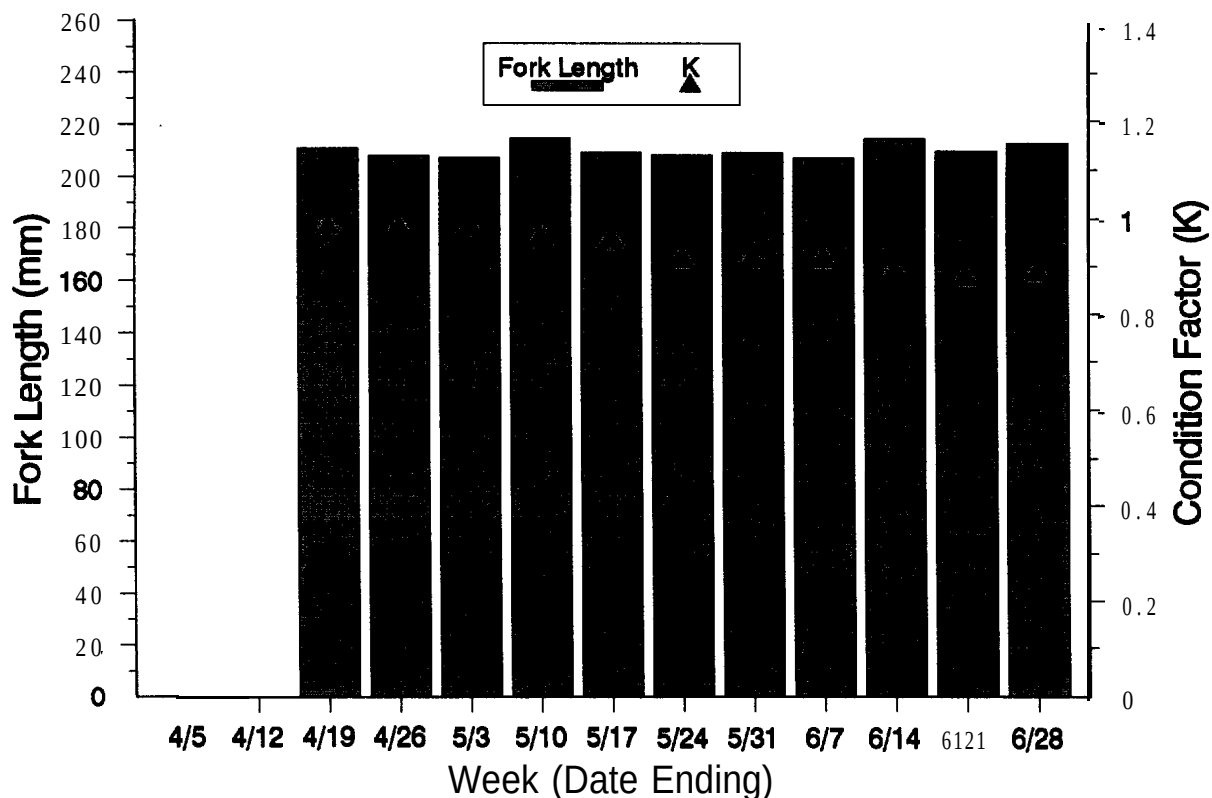
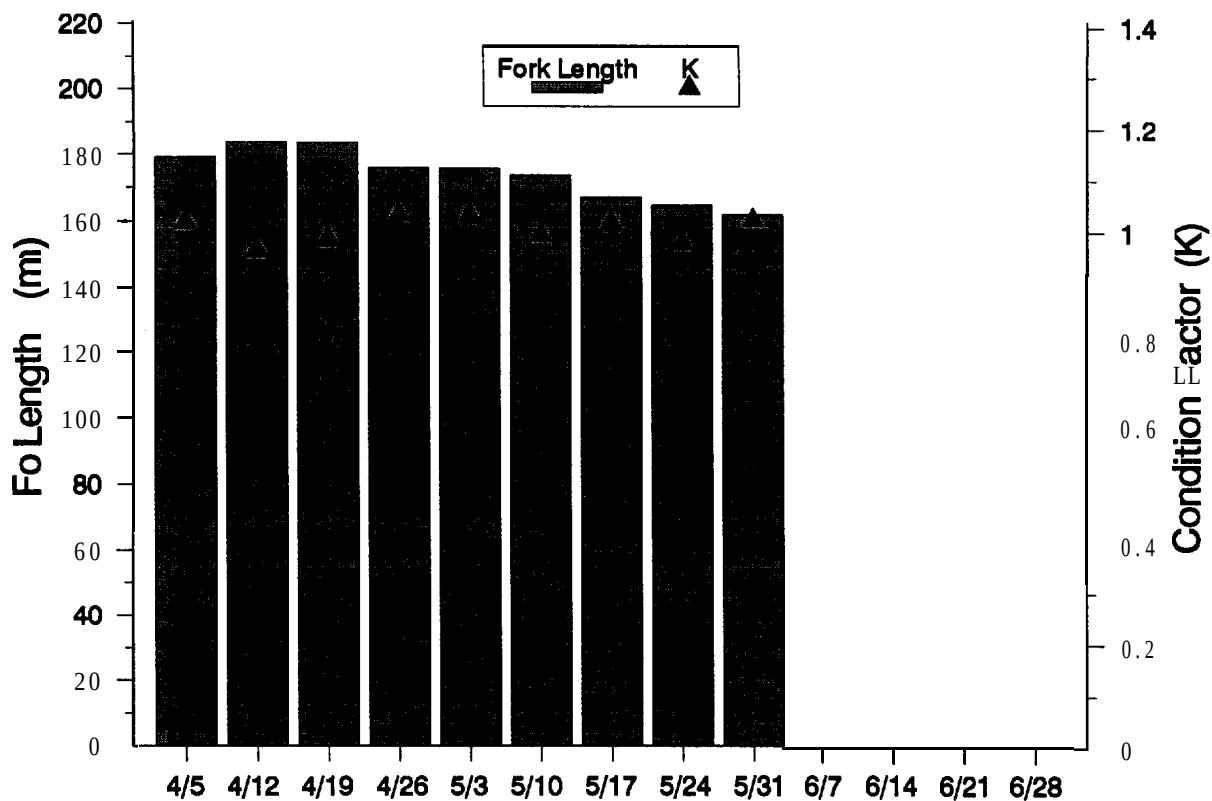


Figure 8. Weekly mean length and condition factor of natural (upper graph) and hatchery (lower graph) steelhead trout smolts trapped in the Imnaha River, April 1 to June 27, 1997.

Incidental Catch

Non-target game fish species incidentally captured during our investigation included: 28 adult steelhead, two bull trout (*Salvelinus confluentus*), and two mountain whitefish (*Prosopium williamsoni*) (Table 9). Non-game fish captured included longnose dace (*Rhinichthys cataractae*), bridgelip sucker (*Catostomus columbianus*), redbase shiner (*Richardsonius balteatus*), northern squawfish (*Ptychocheilus oregonensis*) and sculpin (*Cottus* sp.) (Table 9). Appendix E contains daily incidental catch information.

Table 9. Weekly catch composition of incidental fish species collected in the Imnaha River trap from February 23 to June 27, 1997.

Week	BLS	BT	LND	MWF	NSF	RSS	SC	STHD	TOTAL
2/23 - 3/01	0	0	0	0	0	0	0	0	0
3/02 - 3/08	0	0	0	0	0	0	0	0	0
3/09 - 3/15	17	0	0	0	0	0	3	1	21
3/16 - 3/22	19	0	3	1	0	0	0	0	23
3/23 - 3/29	0	0	16	0	0	0	7	0	23
3/30 - 4/05	0	0	3	0	0	1	2	1	7
4/06 - 4/12	0	0	2	0	0	0	1	1	4
4/13 - 4/19	0	1	3	0	0	0	1	1	6
4/20 - 4/26	0	0	4	0	0	0	2	0	6
4/27 - 5/03	0	0	1	1	0	0	2	1	5
5/04 - 5/10	0	0	0	0	0	0	0	8	8
5/11 - 5/27	0	1	3	0	0	0	0	1	5
5/18 - 5/24	0	0	0	0	0	0	0	6	6
5/25 - 5/31	0	0	4	0	0	1	1	2	8
6/01 - 6/07	13	0	0	0	0	0	1	4	18
6/08 - 6/14	30	0	0	0	1	0	0	1	32
6/15 - 6/21	20	0	3	0	0	0	0	1	24
6/22 - 6/28	41	0	48	0	0	0	0	0	89
Total	140	2	90	2	1	2	20	28	285

BLS Bridgelip Sucker
 BT Bull Trout
 LND Longnose Dace
 MWH Mountain Whitefish

NSF Northern Squawfish
 RSS Redside Shiner
 SC Sculpin
 STHD Adult Steelhead Trout

Emigration of PIT Tagged Fish

Imnaha River Emigration

ODFW released a total of 13,378 PIT tagged hatchery chinook salmon smolts from the Imnaha River acclimation facility on April 7 and 8, 1997. We recaptured 2,624 (19.6%) in our screw trap (Figure 9). The majority (55%) were interrogated by April 10. Mean travel time for hatchery chinook salmon smolts to the Imnaha River screw trap was four days with the 90% arrival date occurring on April 13. Arrival date at the screw trap ranged from April 9 to May 5.

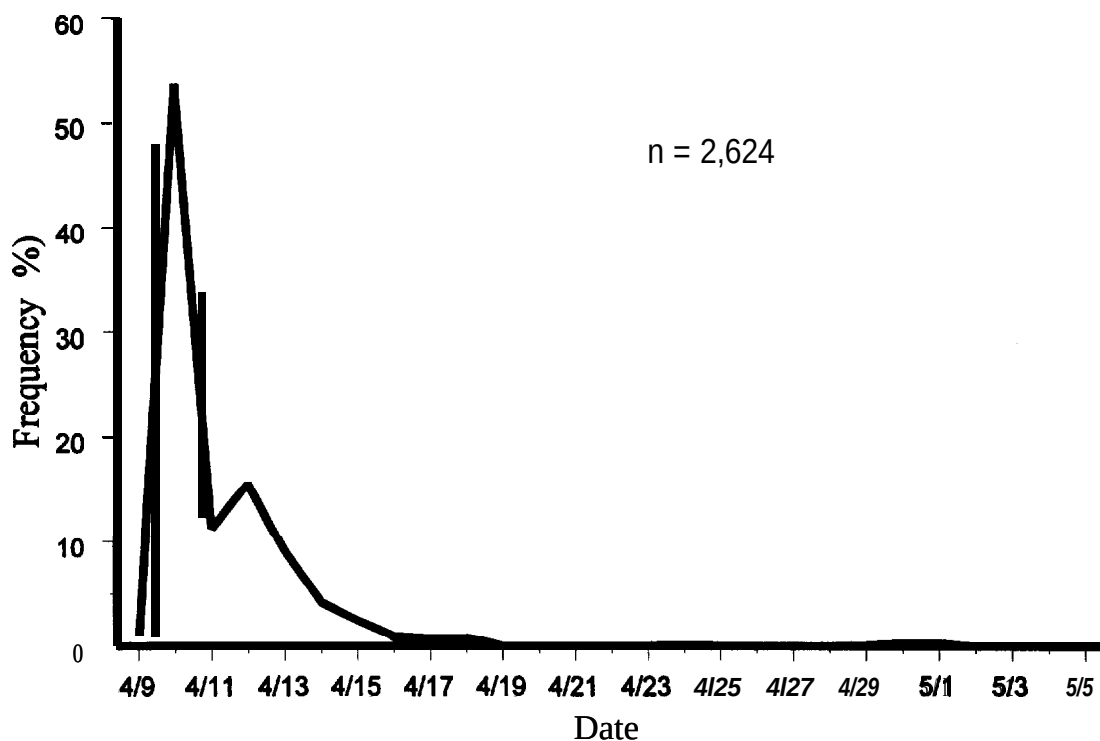


Figure 9. Daily arrival timing frequency to the Imnaha River screw trap of PIT tagged hatchery chinook smolts released at the acclimation facility on April 7, 1997.

A total of 8 12 PIT tagged hatchery steelhead trout smolts were released by ODFW at the Little Sheep Creek acclimation facility on April 15, 1997. We captured two (0.25%) previously PIT tagged steelhead smolts in our screw trap, one on June 3 and one on June 24. Both of these fish had fork lengths under 140 mm.

One natural chinook salmon PIT tagged by ODFW during the summer of 1996 was interrogated at the screw trap during the study period.

PIT Tag Release Groups

We PIT tagged and released 238 natural chinook salmon smolts, with lengths and weights recorded on 237, at the Imnaha River screw trap from March 12 to May 7. Mean lengths of weekly release groups ranged (excluding those with $n < 10$) from 102 to 111 mm, weights from 11.4 to 14.4 g, and condition factors from 0.91 to 1.13 (Table 10). Weekly release groups consisted of over 30 natural chinook salmon from April 5 to April 19, 1997 (Table 10).

Table 10. Mean fork length (mm), weight (g), and condition factor for weekly PIT tag release groups of natural chinook salmon smolts released at the Imnaha River screw trap from March 12 to May 7, 1997.

Release Week Date Ending	Sample Size (n)	Mean Length (S.D.)	Sample Size (n)	Mean Weight (S.D.)	Mean Condition (SD.)
Mar 15	5	106 (13.7)	5	12.4 (4.8)	0.99 (0.06)
Mar 29	14	102 (6.6)	14	11.4 (2.7)	1.06 (0.06)
Apr 5	68	111 (7.2)	68	12.6 (2.9)	0.91 (0.09)
Apr 12	57	108 (10.1)	57	13.0 (3.8)	1.03 (0.14)
Apr 19	39	111 (8.1)	39	14.4 (3.6)	1.04 (0.12)
Apr 26	22	105 (10.7)	22	13.5 (5.1)	1.13 (0.08)
May 3	28	105 (7.3)	28	12.8 (2.8)	1.10 (0.10)
May 10	4	114 (4.4)	4	16.2 (2.1)	1.09 (0.05)
Total	237	108 (9.0)	237	13.0 (3.6)	1.01 (0.13)

A total of 1,000 hatchery chinook salmon smolts were PIT tagged and released during the study period from April 11 to May 9. Mean lengths of weekly release groups ranged from 124 to 133 mm ($n = 997$), weights from 21 to 25.2 g ($n = 401$), and condition factors from 1.05 to 1.08 ($n = 401$) (Table 11). Weekly release groups consisted of over 350 hatchery chinook salmon for the weeks ending April 12 and April 19, 1997 (Table 11).

Table 11. Mean fork length (mm), weight (g), and condition factor for weekly PIT tag release groups of hatchery chinook salmon smolts released at the Imnaha River screw trap from April 11 to May 9, 1997.

Release Week Date Ending	Sample Size (n)	Mean Length (S.D.)	Sample Size (n)	Mean Weight (S.D.)	Mean Condition (S.D.)
Apr 12	568	132 (10.3)	297	25.2 (7.9)	1.07 (0.10)
Apr 19	366	133 (14.5)	41	25.1 (11.8)	1.07 (0.12)
Apr 26	14	124 (9.0)	14	21.0 (4.5)	1.08 (0.09)
May 3	38	130 (10.1)	38	24.0 (6.8)	1.07 (0.10)
May 10	11	128 (8.6)	11	22.8 (5.3)	1.05 (0.10)
Total	997	132 (12.1)	401	24.9 (8.2)	1.07 (0.10)

We PIT tagged 782 natural steelhead trout smolts during the study period from April 15 to June 25 with lengths being taken on 777 and weights and condition factors recorded for 765. Mean lengths of weekly release groups ranged from 165 to 186 mm, weights from 44.6 to 66.2 g, and condition factors from 0.98 to 1.03 (Table 12). Weekly release groups consisted of over 40 natural steelhead from April 19 to May 3 1,1997, with the exception of May 17 (Table 12).

We PIT tagged 6,117 hatchery steelhead trout smolts during the study period from April 15 to June 27. Mean lengths of weekly release groups ranged from 208 to 215 mm (n = 6,087), weights from 83.2 to 96.6 g (n = 2,689), and condition factors from 0.87 to 0.98 (n = 2,689) (Table 13). Weekly release groups consisted of over 150 hatchery steelhead from April 19 to June 21,1997 (Table 13). Appendix F contains PIT tag release groups of natural and hatchery chinook salmon and steelhead trout smolts.

Snake River Flows

Snake River discharge during the study period, measured at the Anatone gauge station (Figure 10), fluctuated from 61.1 kcfs on April 15 to 152 kcfs on May 18. River discharge exceeded 90 kcfs from April 20 to June 24 except for May 3-6. Fluctuations in flows at the Anatone gauge station are a result of springtime freshets and operations at Hells Canyon Dam,

Table 12. Mean fork length (mm), weight (g), and condition factor for weekly PIT tag release groups of natural steelhead trout smolts released at the Imnaha River screw trap from April 15 to June 25, 1997 (na=not available).

Release Week Date Ending	Sample Size (n)	Mean Length (S.D.)	Sample Size (n)	Mean Weight (S.D.)	Mean Condition (S.D.)
Apr 19	108	186 (23.6)	100	66.2 (25.2)	0.99 (0.10)
Apr 26	69	177 (22.1)	69	58.3 (18.0)	1.03 (0.09)
May 3	159	176 (18.2)	157	57.2 (16.7)	1.03 (0.09)
May 10	319	174 (17.7)	318	54.0 (17.4)	0.99 (0.08)
May 17	22	167 (18.0)	22	48.2 (14.3)	1.02 (0.10)
May 24	48	165 (15.0)	48	44.6 (11.3)	0.98 (0.06)
May 31	40	165 (14.0)	40	46.8 (11.7)	1.02 (0.10)
Jun 7	9	164 (9.4)	8	47.0 (8.2)	1.05 (0.07)
Jun 14	2	168 (4.2)	2	50.5 (1.0)	1.07 (0.06)
Jun 28	1	178 (na)	1	56.0 (na)	0.99 (na)
Total	777	175 (19.6)	765	55.4 (18.6)	1.01 (0.09)

Table 13. Mean fork length (mm), weight (g), and condition factor for weekly PIT tag release groups of hatchery steelhead trout smolts released at the Imnaha River screw trap from April 15 to June 27,1997.

Release Week Date Ending	Sample Size (n)	Mean Length (S.D.)	Sample Size (n)	Mean Weight (S.D.)	Mean Condition (S.D.)
Apr 19	891	211 (17.0)	218	93.5 (24.4)	0.98 (0.06)
Apr 26	240	208 (17.3)	224	89.9 (23.7)	0.98 (0.08)
May 3	458	208 (18.9)	236	87.7 (22.7)	0.97 (0.07)
May 10	582	215 (19.4)	296	96.6 (28.3)	0.95 (0.06)
May 17	1004	209 (19.3)	307	83.2 (21.2)	0.95 (0.10)
May 24	951	208 (19.1)	415	85.3 (25.4)	0.91 (0.07)
May 31	920	210 (24.2)	290	86.7 (27.8)	0.91 (0.10)
Jun 7	451	208 (21.3)	225	83.3 (29.3)	0.91 (0.09)
Jun 14	335	215 (20.0)	223	90.2 (26.3)	0.88 (0.07)
Jun21	180	210 (22.5)	180	83.7 (27.8)	0.87 (0.06)
Jun 28	77	214 (21.8)	77	89.2 (29.0)	0.88 (0.06)
Total	6,087	210 (20.1)	2,689	88.0 (26.1)	0.93 (0.08)

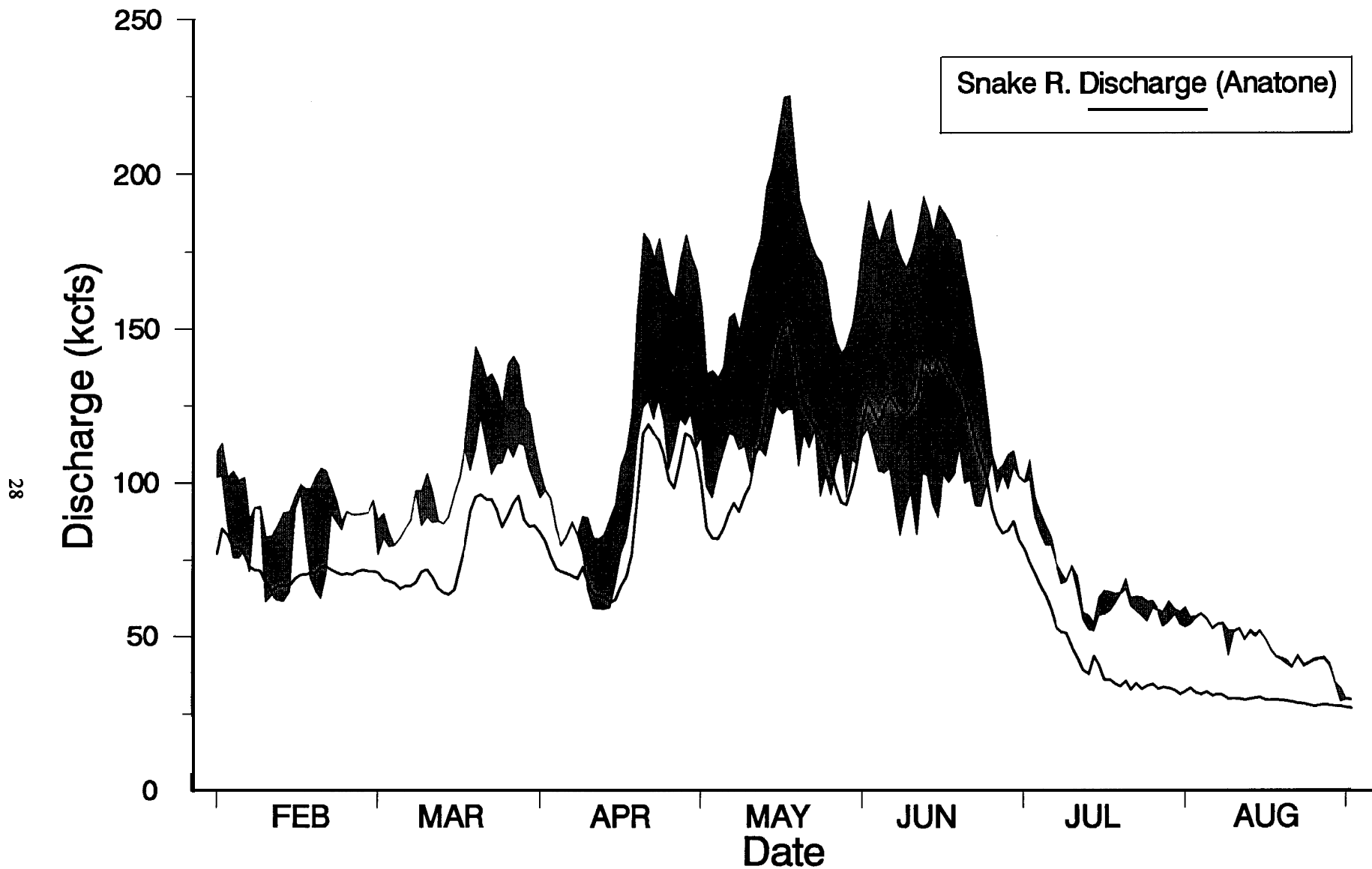


Figure 10. Total water discharge at Lower Granite Dam (top line), spill (shaded) and Snake River discharge at the Anatone gauge station from February 1 to August 31, 1997.

Spring runoff water conditions in 1997 provided above average flows for outmigrating anadromous salmonid smolts. River discharge measured at Lower Granite Dam (LGR) ranged from 79.6 kcfs on March 6 to 225.3 kcfs on May 18 (Figure 10) and paralleled increases in Snake River flows observed at the Anatone gauge station. Flows at LGR were generally greater than 100 kcfs during the majority of the spring period, and river discharge exceeded 120 kcfs from March 20 to 31 and April 19 to June 24.

Spill occurred at LGR from March 3-5, March 11-13, and March 19-April 2. Continuous spill occurred from April 10 to June 29 with peak spill of 101.9 kcfs occurring on May 17. Spill occurred intermittently after June 29.

Smolt Interrogation Percentages

Interrogation percentages were based on cumulative first observation detections at the mainstem Snake River (Lower Granite, Little Goose and Lower Monumental) and Columbia River (McNary) dams.

A total of 160 (67.2%) of the 238 PIT tagged natural chinook salmon smolts released at the Imnaha River screw trap were interrogated (or detected) at mainstem dams (Table 14). Cumulative interrogation percentages for weekly release groups ranged from 67.5% for the April 19 release group to 70.2% for the April 12 release group (Figure 11). The highest percentage of smolts that were observed at Lower Granite Dam (40.4%) occurred from the April 12 weekly release group. The March 15, March 29, April 26, May 3 and May 10 release groups had too few PIT tagged natural chinook interrogated to base analysis on (Table 15). Cumulative interrogation percentages for the migration years 1993-1997 have ranged from 62.2% in 1994 to 78.4% in 1995. Natural chinook smolt cumulative interrogations have ranged from 13.4% to 20.4% higher than hatchery chinook smolt interrogations from 1994-1997 (Table 14).

Of the 1,000 PIT tagged hatchery chinook salmon smolts released at the Imnaha River screw trap, 538 (53.8%) were interrogated (Table 14). Cumulative interrogation percentages for weekly release groups were 53.2% for the April 12 release group and 53.4% for the April 19 release group (Figure 12). Hatchery chinook PIT tag release groups which had less than 30 interrogations were April 26, May 3 and May 10 (Table 16). Migratory year cumulative interrogation percentages for hatchery chinook have ranged from 45.2% in 1994 to 58.9% (HxW crossed chinook salmon smolts) in 1995 (Table 14). No PIT tagged hatchery chinook salmon smolts were released from the Imnaha River screw trap in 1993. In 1992, cumulative interrogation percentages did not include Lower Monumental Dam as it was not yet an interrogation site.

A total of 588 (75.2%) of the 782 PIT tagged natural steelhead trout smolts released at the Imnaha River screw trap were interrogated at mainstem dams (Table 14). Cumulative interrogation percentages of weekly release groups ranged from 62.2% for the April 19 release group to 80% for the May 31 release group (Figure 13). The May 17, June 7, June 14, and June

Table 14. Cumulative interrogations of PIT tagged Imnaha River natural and hatchery chinook salmon and steelhead trout smolts at Lower Granite, Little Goose, Lower Monumental and McNary Dams from 1993 to 1997.

Year	Number Released	Number Interrogated	Cumulative Interrogations (%)
<u>Natural Chinook</u>			
1997	238	160	67.2
1996	1,311	819	62.5
1995	421	330	78.4
1994	956	595	62.2
1993	249	160	64.2
<u>Hatchery Chinook</u>			
1997	1,000	538	53.8
1996	698	335	48.0
1995^a	445	262	58.9
1995^b	302	171	56.6
1994	662	299	45.2
1992 ^c	928	450	48.5
<u>Natural Steelhead</u>			
1997	782	588	75.2
1996	1,503	1,065	70.8
1995	227	173	76.2
1994^c	846	443	52.4
1994^d	604	292	48.3
1993	183	131	71.2
<u>Hatchery Steelhead</u>			
1997	6,117	3,794	62.0
1996	1,346	671	49.8
1995	1,289	897	69.6
1994^e	1,076	216	20.1
1994^d	1,237	479	38.7
1993	526	279	53.0

^a HXW crossed chinook salmon smolts PIT tagged for the Nez Perce Tribe and released at dark.

^b HXH crossed chinook salmon smolts PIT tagged for the Fish Passage Center and released one hour after tagging and recovery.

^c NPT PIT tagged fish.

^d FPC PIT tagged fish

^e Lower Monumental Dam was not an interrogation site

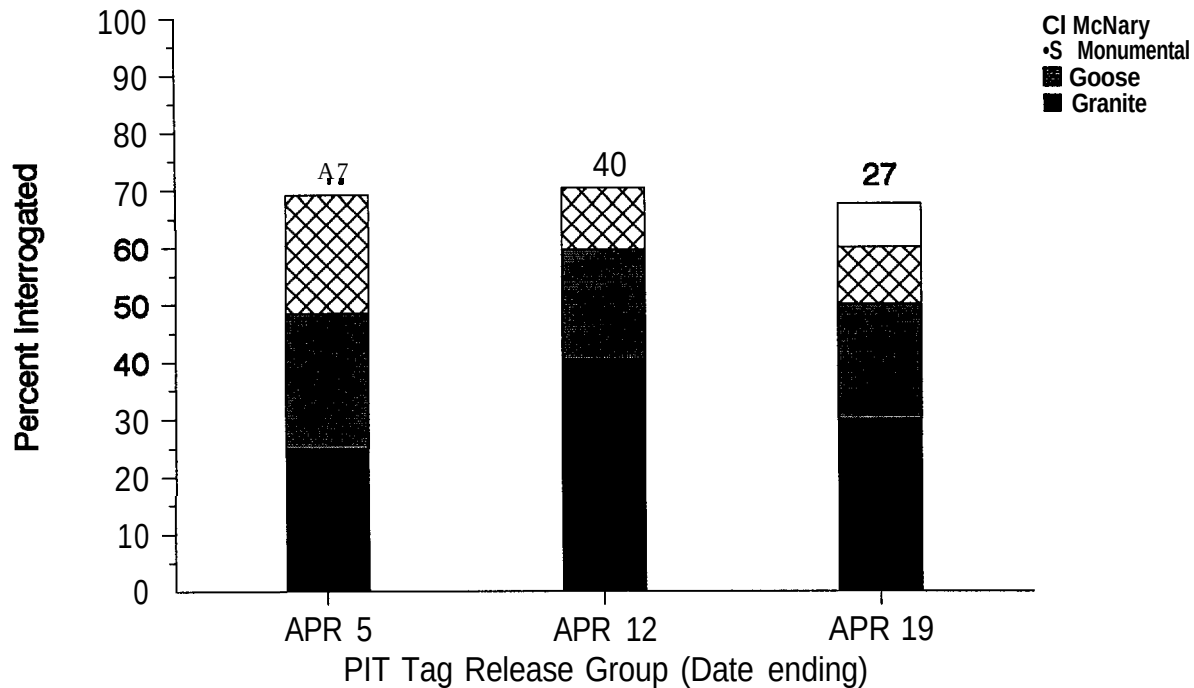


Figure 11. Cumulative interrogations, by weekly PIT tag release group, of natural chinook salmon smolts from the Imnaha River to Lower Granite, Little Goose, Lower Monumental and McNary dams, April 9 - May 15, 1997 (sample size on top).

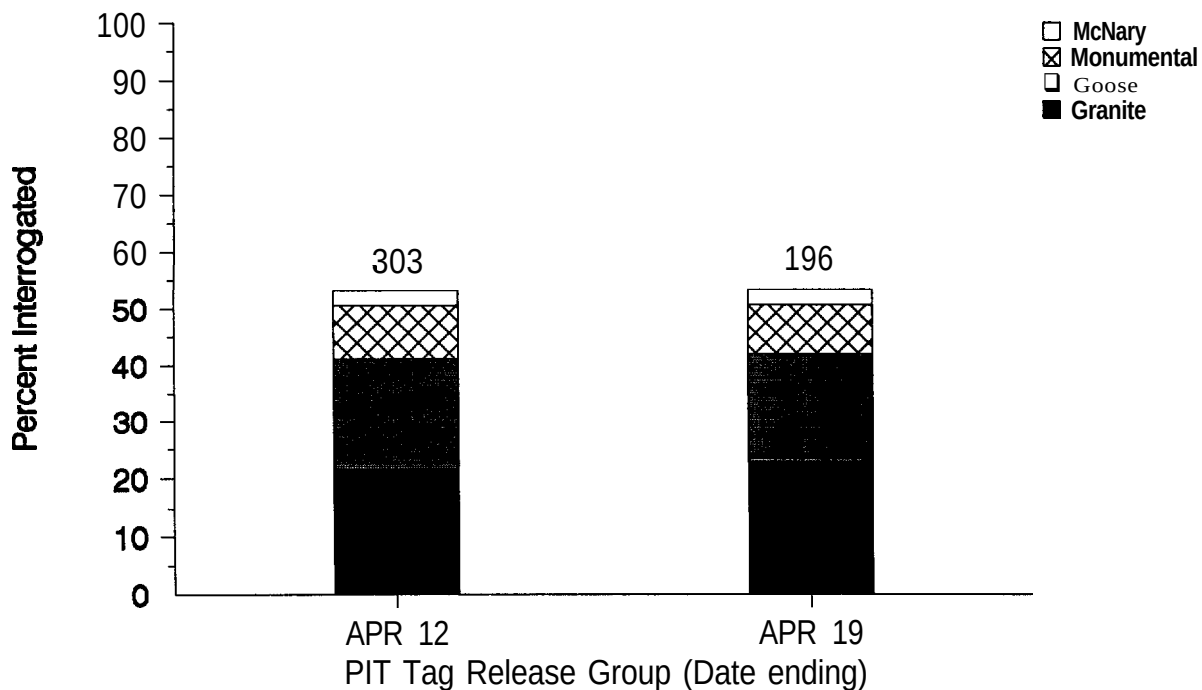


Figure 12. Cumulative interrogations, by weekly PIT tag release group, of hatchery chinook salmon smolts from the Imnaha River to Lower Granite, Little Goose, Lower Monumental and McNary dams, April 16 - June 1, 1997 (sample size on top).

Table 15. Interrogation percents (based on first observations) of natural chinook salmon smolt weekly PIT tag release groups from the Imnaha River to Lower Granite, Little Goose, Lower Monumental and McNary dams in 1997.

Release Date	Week Ending	Number Tagged	Lower Granite		Little Goose		Lower Monumental		McNary		Total	
			n	%	n	%	n	%	n	%	n	%
Mar 15		5	1	20.0	3	60.0	0	0	0	0	4	80.0
Mar 29		14	7	50.0	2	14.3	1	7.1	1	7.1	11	78.6
Apr 5		68	17	25.0	16	23.5	14	20.6	0	0	47	69.1
Apr 12		57	23	40.4	11	19.3	6	10.5	0	0	40	70.2
Apr 19		40	12	30.0	8	20.0	4	10.0	3	7.5	27	67.5
Apr 26		22	3	13.6	3	13.6	4	18.2	1	4.6	11	50.0
May 3		28	9	32.1	5	17.9	3	10.7	0	0	17	60.7
May 10		4	2	50.0	0	0	1	25.0	0	0	3	75.0

Table 16. Interrogation percents (based on first observations) of hatchery chinook salmon smolt weekly PIT tag release groups to Lower Granite, Little Goose, Lower Monumental and McNary dams in 1997.

Release Date	Week Ending	Number Tagged	Lower Granite		Little Goose		Lower Monumental		McNary		Total	
			n	%	n	%	n	%	n	%	n	%
Apr 12		570	123	21.6	111	19.5	54	9.5	15	2.6	303	53.2
Apr 19		367	83	22.6	71	19.4	32	8.7	10	2.7	196	53.4
Apr 26		14	5	35.7	3	21.4	1	7.1	0	0	9	64.3
May 3		38	13	34.2	7	18.4	2	5.3	0	0	22	57.9
May 10		11	3	27.3	2	18.2	3	27.3	0	0	8	72.7

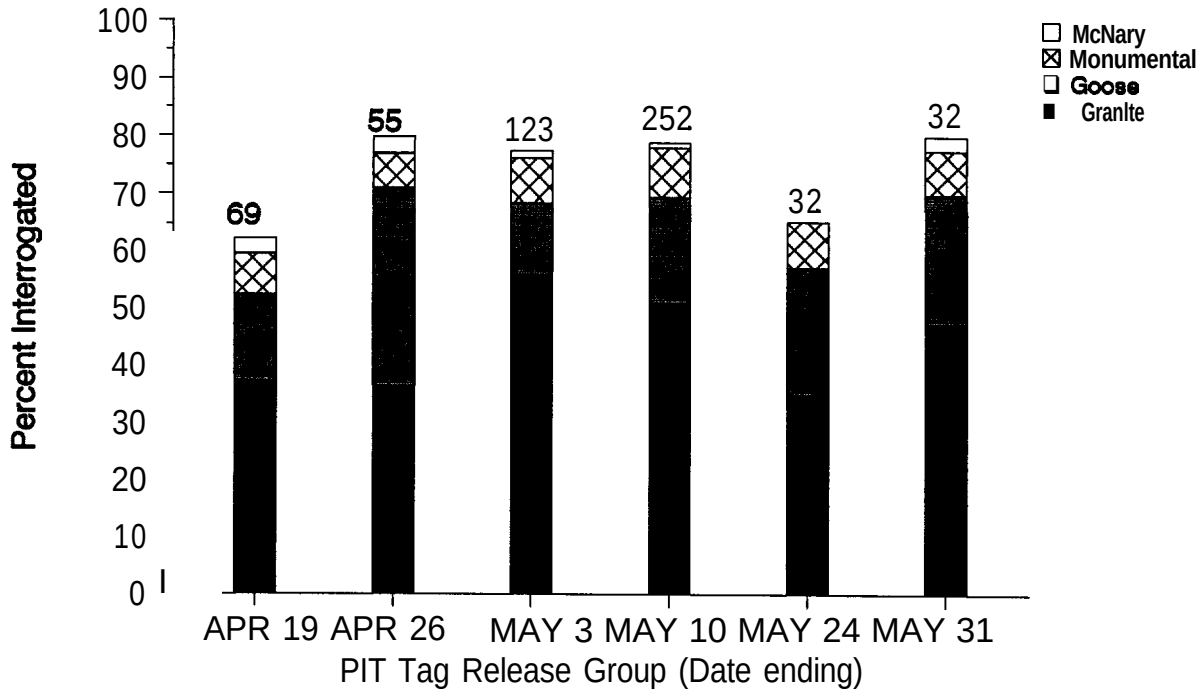


Figure 13. Cumulative interrogations, by weekly PIT tag release group, of natural steelhead trout smolts from the Imnaha River to Lower Granite, Little Goose, Lower Monumental and McNary dams, April 20 - June 5, 1997 (sample size on top).

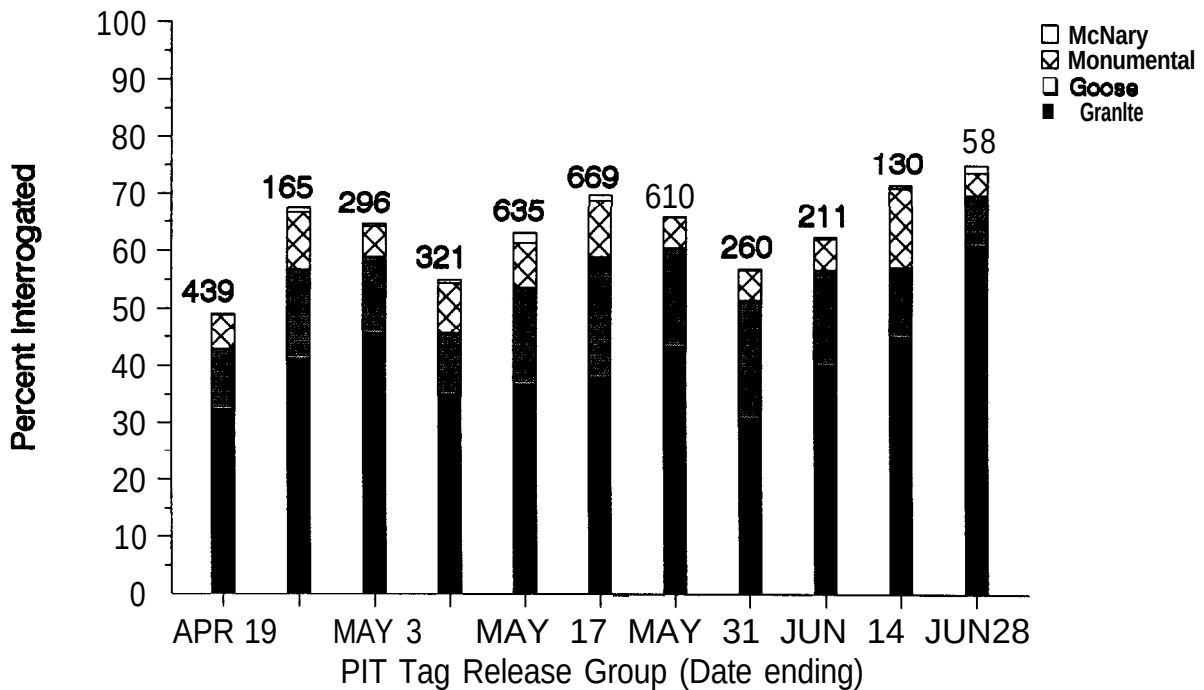


Figure 14. Cumulative interrogations, by weekly PIT tag release group, of hatchery steelhead trout smolts from the Imnaha River to Lower Granite, Little Goose, Lower Monumental and McNary dams, April 19 - July 24, 1997 (sample size on top).

28 release groups had less than 30 interrogations and were not used for analysis (Table 17). Cumulative interrogation percentages, by migratory year, for natural steelhead trout smolts have ranged from 48.3% (fish tagged for the Fish Passage Center and released one hour after tagging) in 1994 to 76.2% in 1995. Natural steelhead trout smolt cumulative interrogations have been 6.6-21% higher than hatchery steelhead trout smolt cumulative interrogations from 1993 to 1997, excluding 1994 due to different holding and release strategies.

Of the 6,117 PIT tagged hatchery steelhead trout smolts released at the Imnaha River screw trap, 3,794 (62%) were interrogated (Table 14). Weekly cumulative interrogation percentages for hatchery steelhead trout ranged from 49.1% for the April 19 release group to 75.3% for the June 28 release group (Figure 14). First interrogations at lower Monumental Dam were slightly higher than Little Goose Dam for the June 21 release group (Table 18). Cumulative interrogation percentages for the migratory years 1993 to 1996 have ranged from 20.1% (fish tagged for the Nez Perce Tribe and released at dark) in 1994 to 69.6% in 1995. The low interrogation percentage in 1994 may be due to the extended holding of fish before release and the protocol has been changed to releasing steelhead approximately one hour after tagging.

Average fork length of PIT tagged Imnaha River natural chinook salmon smolts was 108 mm. The average fork length, at tagging, of natural chinook ultimately detected at Lower Granite Dam was also 108 mm (Figure 15). There appeared to be no size related mortality effects due to the effects of PIT tagging as no significant difference in mean fork length existed between the two groups ($p > 0.05$). Average fork length of Imnaha River hatchery chinook salmon smolts tagged and released and average fork length, at tagging, detected at Lower Granite were 132 and 134 mm (Figure 15). There was a significant difference ($p < 0.05$) in median fork length between these two groups of hatchery chinook smolts but it may not be biologically meaningful. Median fork lengths for PIT tagged natural and hatchery chinook smolts, detected at Lower Granite Dam, released the weeks of April 12 and April 19 were significantly different ($p < 0.05$) although sample sizes for natural chinook were low ($n = 12$ and 23). Natural and hatchery PIT tagged steelhead trout smolts had average fork lengths at tagging of 175 mm and 210 mm, respectively (Figure 16). Average fork lengths, of smolts at tagging, detected at Lower Granite Dam was 176 mm and 210 mm, respectively (Figure 16). No significant difference ($p > 0.05$) was observed between median tagging length and median lengths at tagging of fish detected at Lower Granite Dam for natural steelhead or hatchery steelhead smolts. There was a significant difference ($p < 0.05$) in mean fork lengths of PIT tagged natural and hatchery steelhead smolts, detected at Lower Granite Dam, for all weekly release groups (Table 19).

Survival Estimation

Groups used for survival estimation were identified as the largest combination of released individuals of a species and origin into the smallest release time span. Season-wide survival was also estimated by species and origin for all PIT tagged individuals released from the Imnaha River screw trap. The season-wide estimates are reported for use as an index of smolt survival to compare to future years.

Table 17. Interrogation percents (based on first observations) of natural steelhead trout smolt weekly PIT tag release groups from the Imnaha River to Lower Granite, Little Goose, Lower Monumental and McNary dams in 1997.

Release Date	Week Ending	Number Tagged	Lower Granite		Little Goose		Lower Monumental		McNary		Total	
			n	%	n	%	n	%	n	%	n	%
Apr 19		111	41	36.9	17	15.3	8	7.2	3	2.7	69	62.2
Apr 26		69	25	36.2	24	34.8	4	5.8	2	2.9	55	79.7
May 3		159	89	56.0	20	12.6	12	7.6	2	1.3	123	77.4
May 10		320	163	50.9	59	18.4	27	8.4	3	0.9	252	78.8
May 17		22	10	45.4	3	13.6	3	13.6	0	0	16	72.7
May 24		49	17	34.7	11	22.4	4	8.2	0	0	32	65.3
May 31		40	19	47.5	9	22.5	3	7.5	1	2.5	32	80.0
June 7		9	1	11.1	5	55.6	0	00		0	6	66.7
June 14		2	2	100.0	0	0	0	00		0	2	100.0
June 28		1	1	100.0	0	0	0	00		0	1	100.0

Table 18. Interrogation percents (based on first observations) of PIT tagged hatchery steelhead trout smolt weekly release groups from the Imnaha River to Lower Granite, Little Goose, Lower Monumental and McNary dams in 1997.

Release Date	Week Ending	Number Tagged	Lower Granite		Little Goose		Lower Monumental		McNary		Total	
			n	%	n	%	n	%	n	%	n	%
Apr 19		894	290	32.4	94	10.5	54	6.0	1	0.1	439	49.1
Apr 26		245	101	41.2	38	15.5	24	9.8	2	0.8	165	67.3
May 3		458	209	45.6	61	13.3	24	5.2	2	0.4	296	64.6
May 10		583	205	35.2	62	10.6	51	8.8	3	0.5	321	55.1
May 17		1004	369	36.8	171	17.0	77	7.7	18	1.8	635	63.2
May 24		958	364	38.0	202	21.1	94	9.8	9	0.9	669	69.8
May 31		925	402	43.5	159	17.2	48	5.2	1	0.1	610	65.9
June 7		455	141	31.0	94	20.7	24	5.3	1	0.2	260	57.1
June 14		337	136	40.4	56	16.6	18	5.3	1	0.3	211	62.6
June 21		181	82	45.3	22	12.2	25	13.8	1	0.6	130	71.8
June 28		77	47	61.0	7	9.1	3	3.9	1	1.3	58	75.3

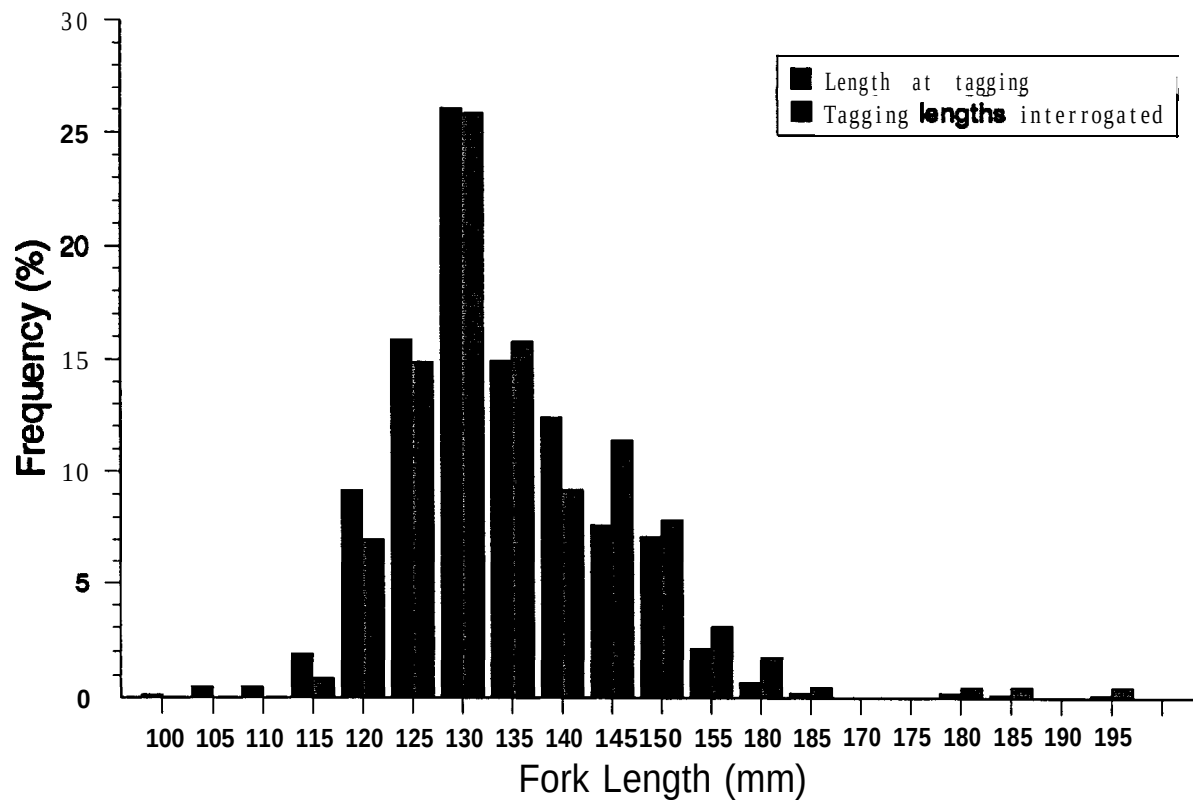
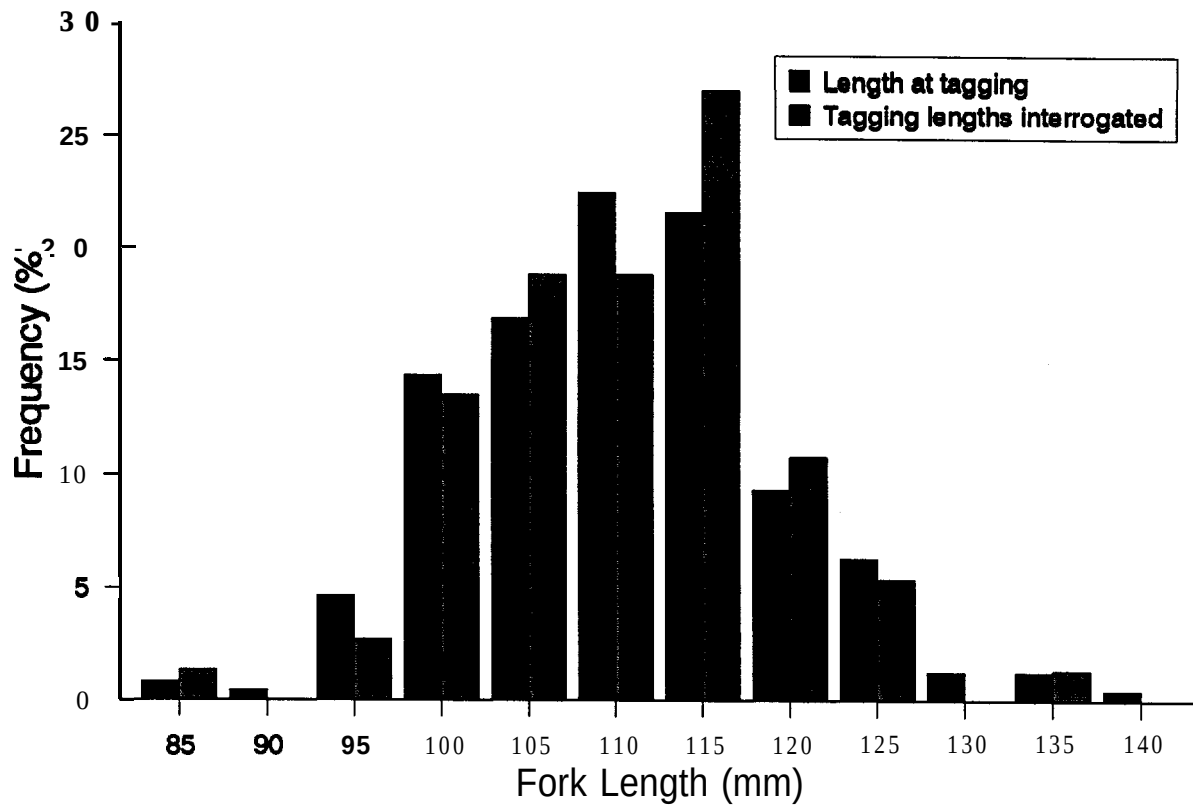


Figure 15. Fork length frequency for PIT tagged natural (upper graph) and hatchery (lower graph) chinook salmon smolts released in the Imnaha River from March 12 - May 9, 1997 and length frequency of fish ultimately detected at Lower Granite Dam in 1997.

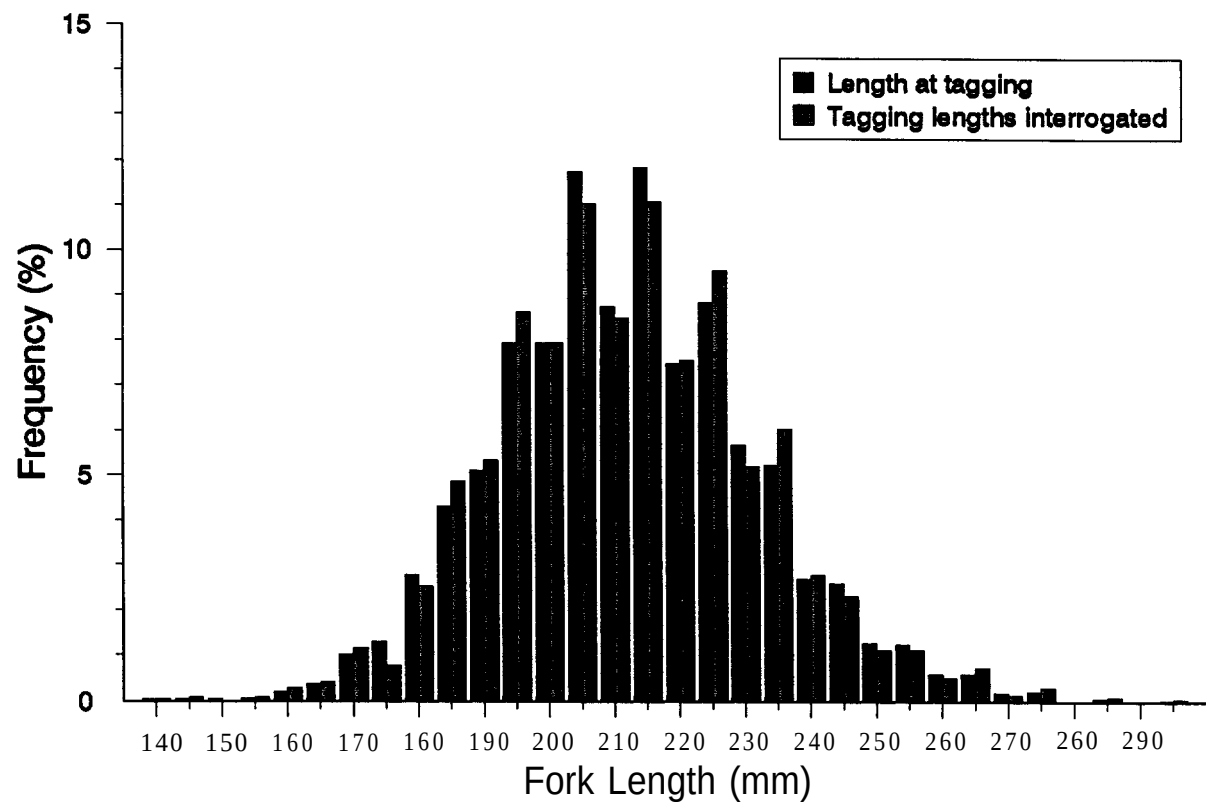
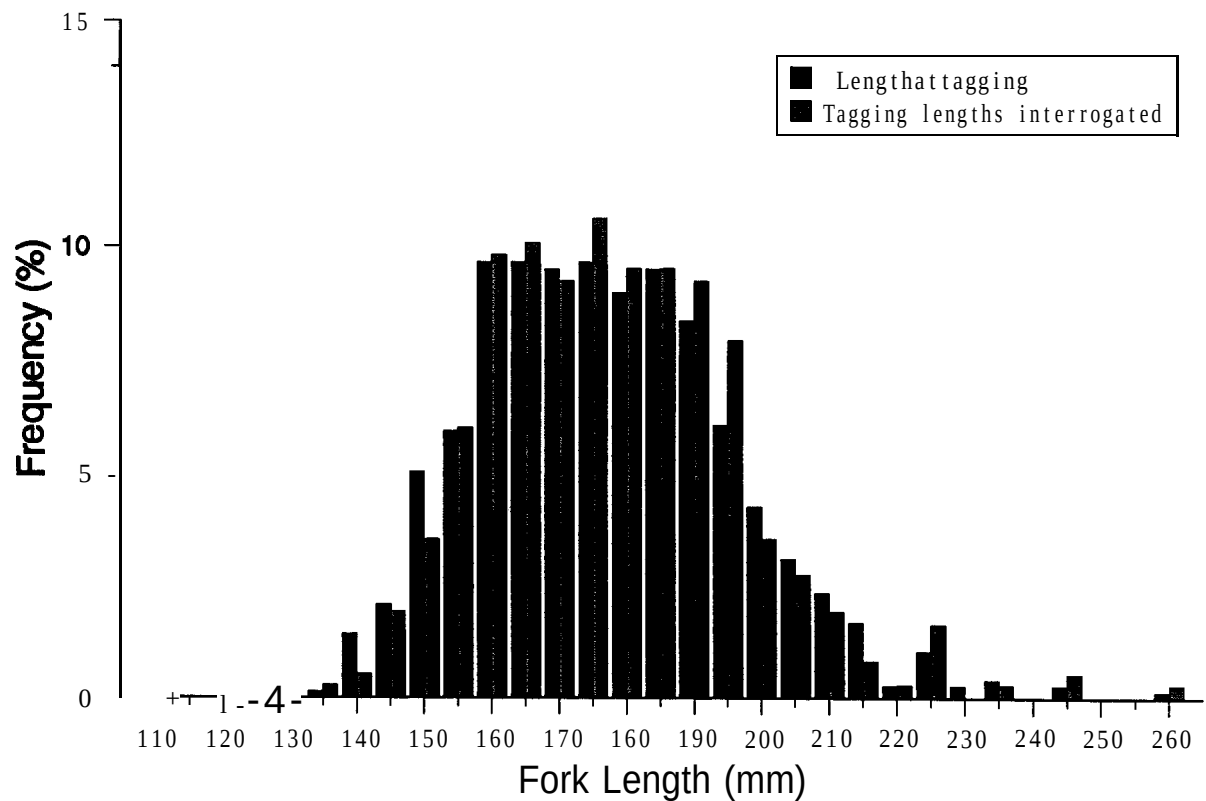


Figure 16. Fork length frequency for PIT tagged natural (upper graph) and hatchery (lower graph) steelhead trout smolts released in the Imnaha River from April 15 - June 27, 1997 and length frequency of fish ultimately detected at Lower Granite Dam in 1997.

Table 19. Comparison of median fork length between weekly PIT tag release groups of Imnaha River natural and hatchery reared steelhead trout smolts detected at Lower Granite Dam in 1997.

Week	<u>Sample Size (n)</u>		<u>Average Fork Length (mm)</u>		Significance Level
	Natural Steelhead	Hatchery Steelhead	Natural Steelhead	Hatchery Steelhead	
April 19	41	290	195	211	p < 0.05
April 26	25	101	184	206	p < 0.05
May 3	89	209	174	209	p < 0.05
May 10	163	205	174	215	p < 0.05
May 17	10	369	158	208	p < 0.05
May 24	17	364	172	209	p < 0.05
May 31	19	400	165	209	p < 0.05

The SURPH survival estimate from the Imnaha River screw trap to Lower Granite Dam for natural chinook salmon smolts released between March 12 and May 7 was 89.8% with a 95% confidence interval of 13.1% (Table 20). SURPH survival estimates for natural chinook salmon smolts from 1993 to 1996 for selected release periods from the Imnaha River screw trap to Lower Granite Dam have ranged from 80.6% to 92.3% (Table 21).

Survival of PIT tagged hatchery chinook smolts, based on the SURPH model, from the Imnaha River acclimation facility to the screw trap was 89.2% in 1997 (Table 22). Estimated post-release survival of hatchery chinook salmon smolts from release to the Imnaha River screw trap in 1997, using the bootstrap method was 44% and is considered an anomaly compared to previous years bootstrap and SURPH model survival estimates. Estimated post-release survival (bootstrap method) of hatchery reared chinook salmon smolts from release to the Imnaha River screw trap, 66 km downstream, ranged from 88.1 to 101.7% in 1994 and 1996 (Table 6). These bootstrap derived point estimates had 95% confidence intervals that ranged from 12 to 26% of the estimate. SURPH model estimated survival ranged from 89 to 101% from release at the acclimation facility to the screw trap from 1994 to 1997 (Table 22). Survival calculated by the two methods provided fairly consistent and comparable estimates across years. Comparatively, the SURPH model survival estimates were 12% higher than bootstrap in 1994 and were 7% lower in 1996 (Kucera and Blenden 1998). In-river post-release mortality of hatchery reared chinook salmon smolts in the Imnaha River was not severe and ranged between 0 to 12% depending on the year. Survival estimates to Lower Granite Dam (LGR) for hatchery reared chinook smolts PIT tagged at the screw trap from April 10 to April 18, 1997, was 80.4% (Table 20). The survival estimate to Lower Granite Dam for hatchery chinook tagged at the screw trap from April 10 to May 9 (season-wide) was 81.1% (Table 20). SURPH survival estimates for

Table 20. Survival estimates with 95% confidence intervals in parenthesis of chinook salmon (CH) and steelhead (RBT) smolts PIT tagged and released at the Imnaha River screw trap (IMN) to Lower Granite (LGR), from Lower Granite Dam to Little Goose Dam (LGO), and from Little Goose Dam to Lower Monumental Dam (LMO) during the spring of 1997.

Species & Origin	Release Dates	Number Released	Survival (%) IMN_LGR	Survival (%) LGR_LGO	Survival (%) LGO_LMO
CH-H	4/10-4/18	937	80.4 (9.4)	87.9 (14.9)	90.3 (28.6)
CH-H	4/10-5/9	1000	81.1 (9.0)	87.8 (14.3)	90.9 (29.0)
CH-N	3/12-5/7	238	89.8 (13.1)	99.5 (24.1)	104.1 (45.5)
RBT-H	4/17-4/25	1135	86.6 (3.3)	103.4 (7.6)	93.4 (16.1)
RBT-H	4/28-5/9	1040	71.4 (4.3)	94.9 (10.0)	91.7 (23.3)
RBT-H	5/12-5/16	1000	86.7 (6.5)	104.1 (16.5)	72.7 (24.3)
RBT-H	5/19-5/23	958	89.1 (5.7)	93.6 (10.4)	80.7 (17.4)
RBT-H	5/27-5/30	925	80.1 (4.9)	90.8 (10.4)	99.6 (41.7)
RBT-H	6/2-6/13	791	84.1 (8.0)	97.1 (19.4)	54.4 (26.8)
RBT-H	6/17-6/27	258	79.1 (6.9)	106.1 (15.7)	63.5 (14.5)
RBT-H	4/15-6/27	6108	81.4 (2.0)	97.8 (4.3)	80.8 (8.0)
RBT-N	4/15-5/9	659	90.2 (3.9)	103.1 (8.4)	84.0 (14.7)
RBT-N	4/15-6/25	782	89.7 (3.9)	103.0 (8.4)	80.2 (13.5)

Table 2 1. Estimated survival of PIT tagged natural chinook salmon smolts, by year and release date, from the Imnaha River screw trap to Lower Granite Dam, from 1993 to 1996.

Year	Date	PIT Tag Release Size	Survival Estimate (%)	95% Confidence Interval (%)
1993	Apr.7-27	234	82.8	12.3
1994	Mar.3 1 -Apr. 12	450	88.0	6.1
1994	Apr. 26-May 4	259	83.5	19.0
1995	Apr. 20-28	284	92.3	8.4
1996	Mar. 26-Apr. 12	330	80.6	10.2
1996	Apr. 15-23	269	87.0	11.0
1996	Apr. 29-May 10	415	82.4	9.8

Table 22. Estimated survival of PIT tagged hatchery reared chinook salmon smolts, by year and release date, from the Imnaha River acclimation facility to the Imnaha River screw trap.

Year	Date	PIT Tag Release Size	Survival Estimate (%)	95% Confidence Interval (%)
1994	April 11	2,973	100.9	14.3
1995	March 28	2,494	92.6	10.0
1996	April 2	4,714	95.0	9.0
1997	April 7	13,378	89.2	2.7

hatchery chinook salmon smolts in 1994, 1996 and 1997, for selected release periods, from the Imnaha River screw trap to Lower Granite Dam have ranged from 65.0% to 80.4% (Table 23). Estimated survival of hatchery reared chinook smolts from release at the acclimation facility to Lower Granite Dam in 1997 was 61.6% and has ranged from 56.8 to 68.5% from 1993 to 1997 (Smith et al. 1998) (Table 24). Survival estimates from release to Lower Monumental Dam (LMO) have ranged from 46.3 to 51.9% from 1993 to 1997. Estimated mortality of hatchery reared chinook salmon smolts was examined in four specific stream reaches from release to Lower Monumental Dam from 1994 to 1997 (Figure 17) by following the same group of PIT tagged fish over 3 14 km of river (Kucera and Blenden 1998). Mortality observed from release at the Imnaha River acclimation facility 66 km downstream to the outmigrant trap site ranged from 0-10.8% over the four year period. The largest portion of mortality was estimated to occur in the 142 km stream reach from the Imnaha River screw trap to Lower Granite Dam (Figure 17). Mortality values in this reach ranged from 26.1 to 38.6%. Estimated mortality in the 60 km

Table 23. Estimated survival of PIT tagged hatchery reared chinook salmon smolts, by year and release date, from the Imnaha River screw trap to Lower Granite Dam in 1994, 1996 and 1997.

Year	Date	PIT Tag Release Size	Survival Estimate (%)	95% Confidence Interval (%)
1994	Apr. 13-23	352	65.0	11.8
1994	Apr. 26-May 6	298	73.8	20.8
1996	Apr. 5-19	502	67.0	10.6
1997	Apr. 10-18	937	80.4	9.4

Table 24. Estimated survival of hatchery reared chinook salmon smolts, by year and release date, from the Imnaha River acclimation facility to Lower Granite Dam (LGR), Lower Granite Dam to Little Goose Dam (LGO), Little Goose Dam to Lower Monumental Dam (LMO), and from release to Lower Monumental Dam (after Smith et al. 1998). Standard error in parenthesis.

Year	Date	PIT Tag Release	Release to LGR	LGR to LGO	LGO to LMO	Release to LMO
1993	Apr. 12	1,991	0.660 (0.025)	0.767 (0.048)		0.507 ¹ (0.025)
1994	Apr. 11	2,973	0.685 (0.021)	0.851 (0.049)	0.876 (0.065)	0.511 (0.029)
1995	Mar. 28	2,494	0.618 (0.015)	0.926 (0.037)	0.908 (0.059)	0.519 (0.029)
1996	Apr. 2	4,714	0.568 (0.014)	0.894 (0.037)	0.912 (0.061)	0.463 (0.028)
1997	Apr. 7	13,378	0.616 (0.017)	0.987 (0.042)	0.775 (0.042)	0.471 (NA)

¹ Estimated survival from release to Little Goose Dam.

stream reach between LGR and Little Goose Dam (LGO) ranged from 2.6 to 10.8% (Figure 17). Mortality from LGO to LMO, in a 46 km stream reach, was estimated to be between 4.4 to 13% from 1994-1997. It is unknown what effect cumulative stress would have on survival of this same group of hatchery chinook salmon smolts as emigration continued past the remaining five hydroelectric dams.

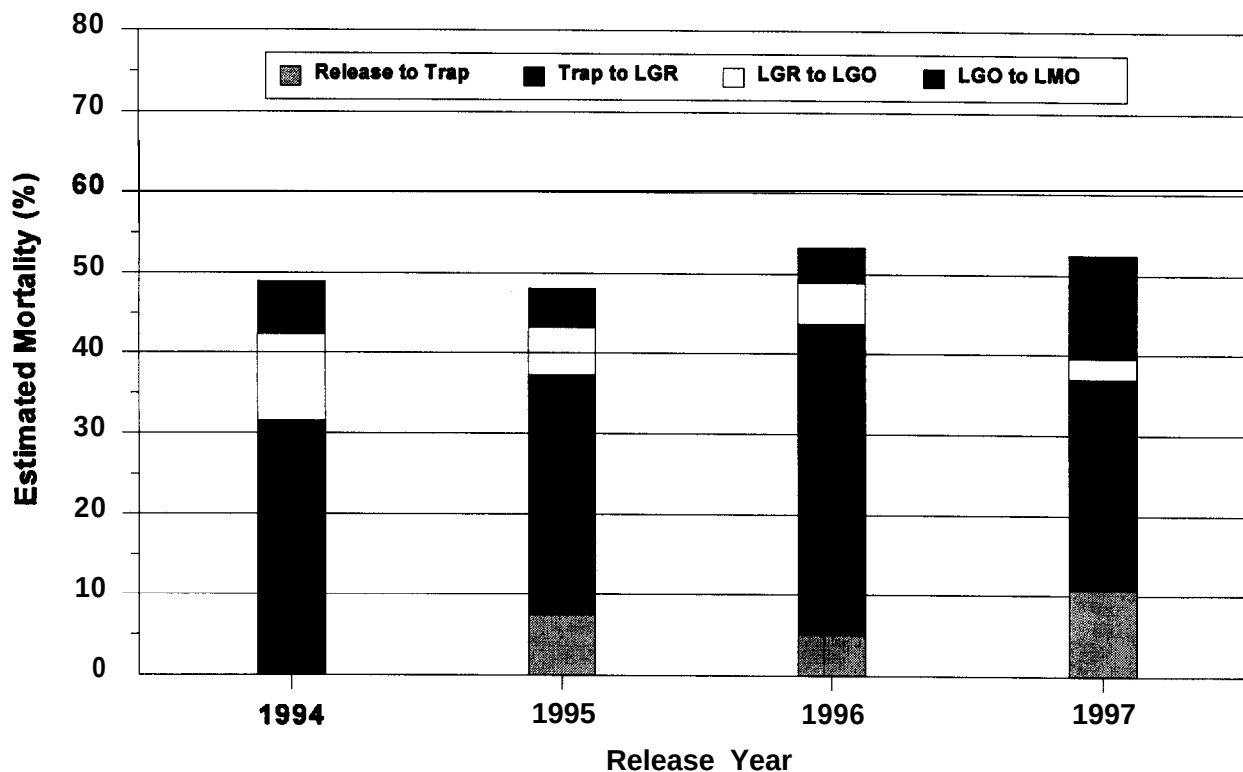


Figure 17. Estimated mortality of hatchery reared chinook salmon smolts, by stream reach, from release at the Imnaha River acclimation facility to Lower Monumental Dam from 1994 to 1997 (after Smith et al. 1998).

Estimated survival of natural steelhead trout smolts from the Imnaha River screw trap to Lower Granite Dam for natural steelhead was 90.2% for a group released from April 15 to May 9 and 89.7% for those released from April 15 to June 25 (Table 20). Survival estimates from the Imnaha River screw trap to Lower Granite Dam have ranged from 73.1 to 93.1% for the years 1994, 1996, and 1997 (Table 25).

Survival estimates, in 1997, for all PIT tag release groups of hatchery steelhead ranged from 79.1 to 89.1% from the Imnaha River screw trap to the Lower Granite Dam, except the estimate for the group released between April 28 and May 9 was 71.4% (Figure 18). Survival estimates of hatchery steelhead trout smolts, released immediately after recovering from anesthesia, from the Imnaha River screw trap to Lower Granite Dam have ranged from 51.4 to 91.4% from 1994 to 1997 (Table 26). The low estimates of 37 to 55.5% in 1993 and 1994 may be due to the extended holding of fish before release at dark and the protocol has been changed to releasing steelhead approximately one hour after tagging.

Table 25. Estimated survival of PIT tagged natural steelhead trout smolts, by year and release date, from the Imnaha River screw trap to Lower Granite Dam in 1994, 1996, and 1997.

Year	Date	PIT Tag Release Size	Survival Estimate (%)	95% Confidence Interval (%)
1994	Apr. 2 1 -May 4	418	73.1'	5.3
1994	May 13-26	334	93.1'	28.0
1994	Apr. 29-May 6	260	75.2	6.9
1994	May 16-25	339	87.9	33.5
1996	Apr. 16-May 2	628	87.4	4.7
1996	May 6-14	644	87.1	6.9
1997	Apr. 15-May 9	659	90.2	3.9

'Fish held and released at dark.

Arrival Timing

Arrival timing at dams of natural chinook in 1997 may not be representative of the run at large due to the low numbers tagged (n = 270). The low numbers collected and tagged is probably due to a large number of natural chinook emigrating from the Imnaha River during a January 1 flood event. PIT tagged Imnaha River natural chinook salmon smolts arrived at Lower Granite Dam (LGR) from April 6 to May 18 with median and 90% passage dates of April 22 and May 11, respectively (Table 27). The 90% passage date for natural chinook at LGR in 1997 (May 11) preceded peak Snake River and LGR flows (May 18) by seven days. Spill at Lower Granite Dam was occurring before the first group of PIT tagged natural chinook was released on March 12. Median arrival dates at LGR have ranged between April 22 and May 4 from 1993 to 1997. The 90% arrival dates for the years 1993-1997 have all fallen within a one week period from May 11-l 8 at Lower Granite Dam. Natural chinook smolts emigrated past Little Goose Dam between April 15 and May 22,1997. The median passage date at Little Goose Dam was April 26 and 90% of natural chinook smolt passage occurred by May 11. The 90% passage date at Little Goose (1994- 1997) has occurred over a two week period from May 7 to May 20. Natural chinook smolt movement past Lower Monumental and McNary dams occurred between April 20 to June 1 and April 22 to May 19, respectively (Table 27). Small sample size at McNary Dam (n=24) may not be representative of the run at large. Passage of 90% of natural chinook smolts at Lower Monumental Dam occurred between May 13 and June 4 from 1993 to 1997. Timing of 90% passage at McNary Dam was observed from May 12 to May 28 (1993-1997). Peaks in arrival occurred in mid to late April at Lower Granite, Little Goose, Lower Monumental and McNary Dams during 1997. These peaks in arrival timing were associated with a substantial increase in river discharge at the dams (Figures 19 - 22).

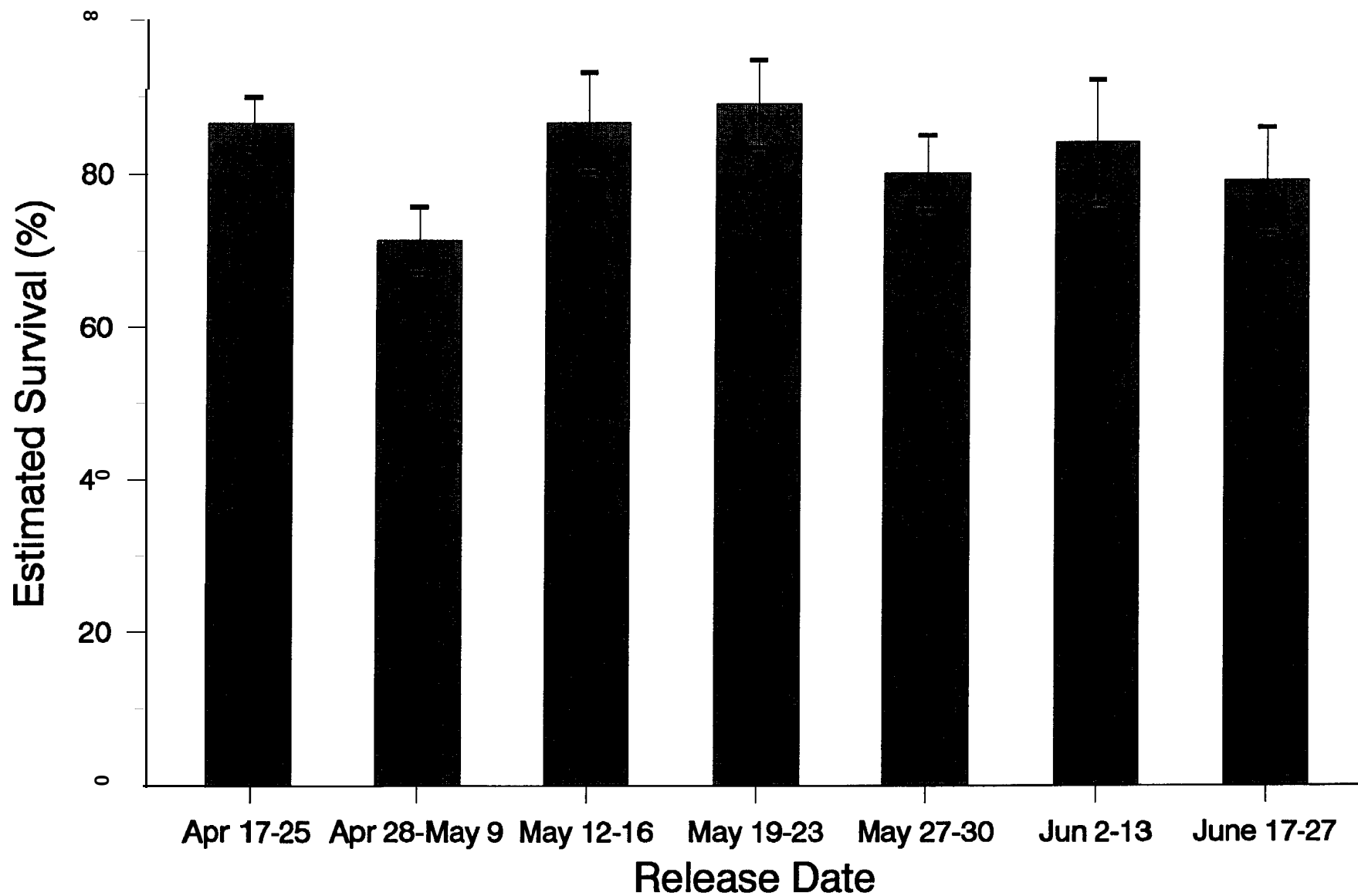


Figure 18. Estimated survival and 95% confidence intervals of PIT tagged hatchery reared steelhead trout smolts from release at the Imnaha River screw trap to Lower Granite Dam in 1997.

Table 26. Estimated survival of PIT tagged hatchery reared steelhead trout smolts, by year and release date, from the Imnaha River screw trap to Lower Granite Dam from 1993 to 1997.

Year	Date	PIT Tag Release Size	Survival Estimate (%)	95% Confidence Interval (%)
1993	May 19-26	294	48.1'	7.2
1994	Apr. 23-May 4	275	37.0'	8.2
1994	May 13-26	316	49.6'	22.5
1994	June 9-21	424	55.5'	13.3
1994	Apr. 26-May 6	456	60.5	9.0
1994	May 13-25	777	91.4	23.1
1995	May 2-3	345	78.7	7.0
1995	May 18-25	546	78.1	4.5
1995	June 1-14	398	76.0	6.1
1996	Apr. 30-May 14	530	69.3	7.1
1996	May 21-June 4	566	51.4	6.7
1996	June 10-24	245	88.0	16.5
1997	Apr. 17-25	1135	86.6	3.3
1997	Apr. 28-May 9	1040	71.4	4.3
1997	May 12-16	1000	86.7	6.5
1997	May 19-23	958	89.1	5.7
1997	May 27-30	925	80.1	4.9
1997	June 2-13	791	84.1	8.0
1997	June 17-27	258	79.1	6.9

'Fish held and released at dark.

Table 27. Arrival timing of PIT tagged Imnaha River natural chinook salmon smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1993 to 1997.

Dam	Year	Sample Size (n)	Arrival Timing		
			Date Range	Median	90%
Lower Granite	1997	74	April 6-May 18	April 22	May 11
	1996	421	April 6-June 12	April 30	May 18
	1995	184	April 11-July 11	May 1	May 11
	1994	348	April 14-June 23	April 24	May 11
	1993	109	April 11-June 12	May 4	May 14
Little Goose	1997	70	April 15-May 22	April 26	May 11
	1996	358	April 12-June 16	April 27	May 20
	1995	144	April 15-July 15	May 7	May 20
	1994	194	April 23-June 17	April 28	May 7
	1993	46	April 27-June 2	May 3	May 16
Lower Monumental	1997	74	April 20-June 1	April 30	May 14
	1996	359	April 13-June 15	May 10	May 22
	1995	142	April 19-August 4	May 8	June 4
	1994	215	April 25-July 26	May 1	May 24
	1993	37	May 3-June 2	May 8	May 13
McNary	1997	24	April 22-May 19	May 1	May 12
	1996	148	April 19-June 8	May 14	May 24
	1995	89	April 28-July 9	May 12	May 21
	1994	229	April 29-July 16	May 12	May 28
	1993	20	May 3-June 15	May 9	May 21

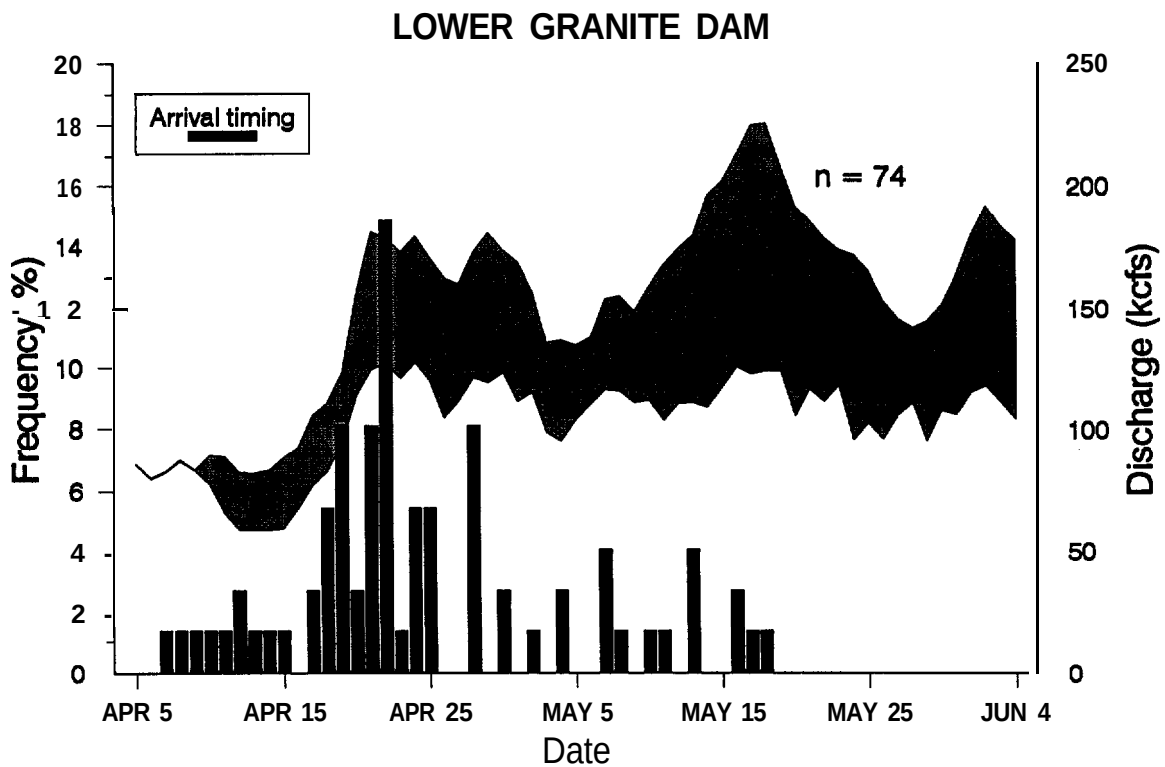


Figure 19. Daily arrival timing frequency of PIT tagged Imnaha River natural chinook salmon smolts at Lower Granite Dam, April 6 to May 18, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line).

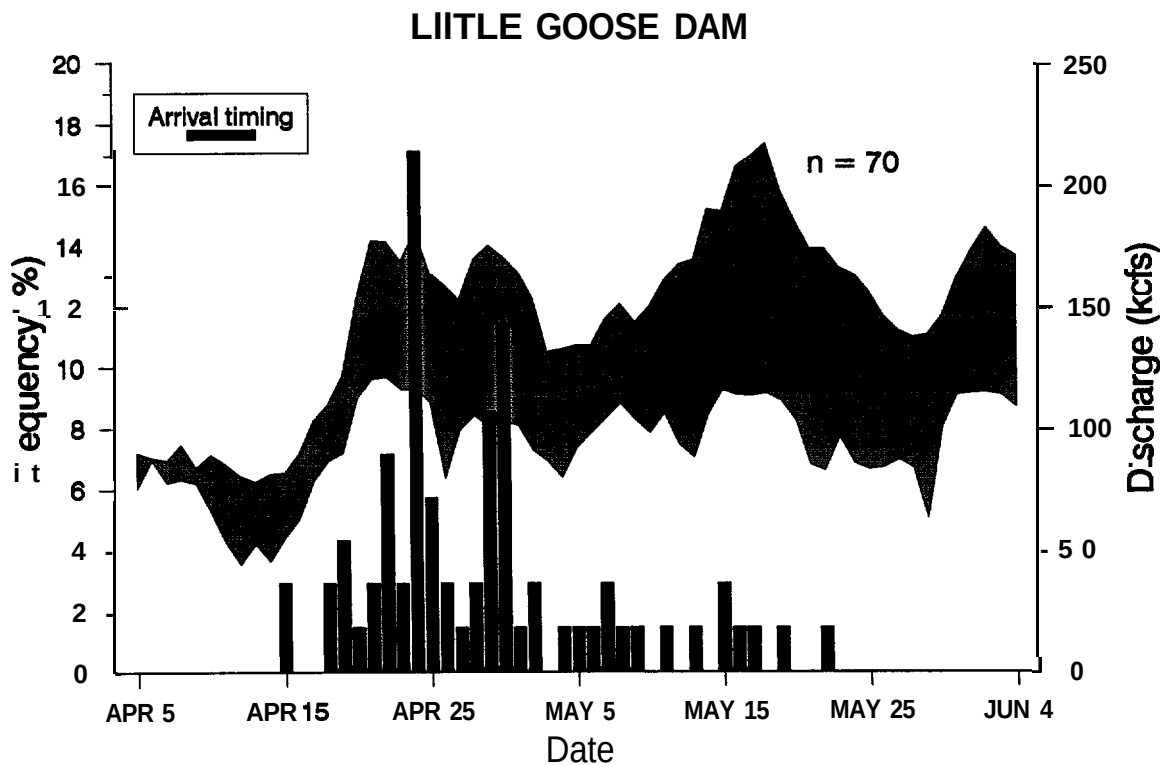


Figure 20. Daily arrival timing frequency of PIT tagged Imnaha River natural chinook salmon smolts at Little Goose Dam, April 15 to May 22, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line).

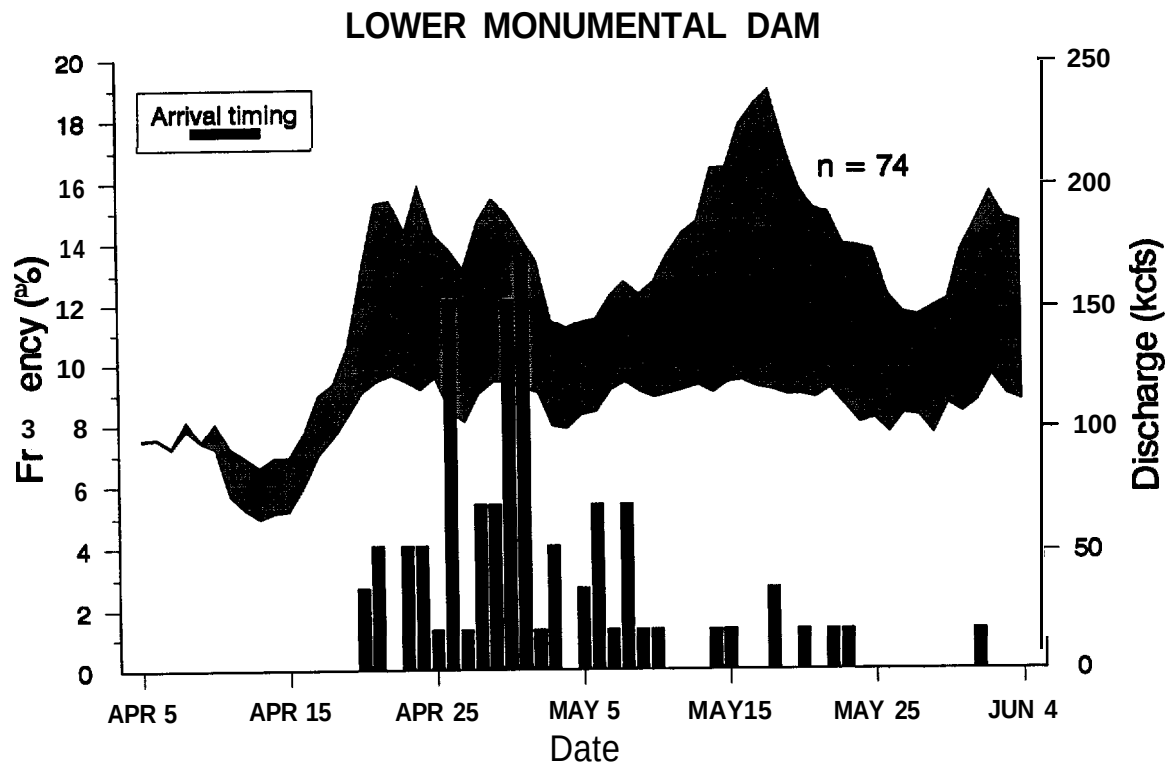


Figure 21. Daily arrival timing frequency of PIT tagged Imnaha River natural chinook salmon smolts at Lower Monumental Dam, April 20 to June 1, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line).

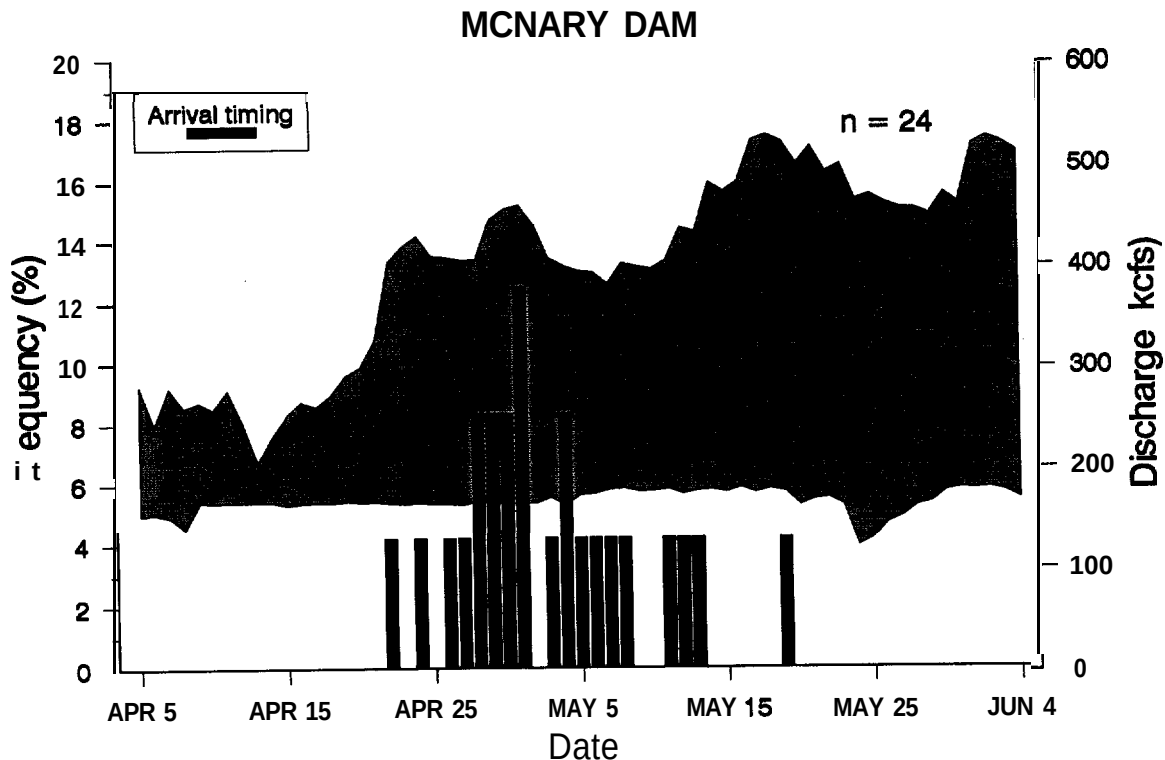


Figure 22. Daily arrival timing frequency of PIT tagged Imnaha River natural chinook salmon smolts at McNary Dam, April 22 to May 19, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line).

Arrival timing of PIT tagged Imnaha River hatchery chinook salmon smolts occurred between April 16 and May 22 at Lower Granite Dam, April 20 and May 27 at Little Goose Dam, April 25 and June 3 at Lower Monumental Dam, and May 1 and June 1 at McNary Dam. Median and 90% arrival dates of hatchery chinook salmon at Lower Granite and Little Goose occurred on May 5 and May 14, and May 9 and May 18, respectively (Table 28). The 90% passage date at Lower Granite Dam of hatchery chinook occurred during a rising hydrograph with increasing spill and preceded peak flows at Lower Granite by four days. May 10 and May 19 were the median and 90% passage dates for hatchery chinook salmon smolts at both Lower Monumental Dam and McNary Dam. Bimodal peaks in arrival of hatchery chinook salmon at Lower Granite and Little Goose Dams occurred approximately a week apart with the second peak occurring during a substantial increase in river discharge in mid-May (Figures 23 and 24). Peak arrival of hatchery chinook smolts at Lower Monumental and McNary dams did not appear to be associated with sharp increases in river discharge (Figures 25 and 26). For the migratory years 1994- 1997 the median and 90% arrival dates at LGR ranged from May 2- 12 and May 12- 16, respectively. The 90% passage date at Little Goose Dam (1994-1 997) has occurred over a five day period from May 18-23. The 90% arrival dates (1994-1997) at Lower Monumental occurred over an eight day period (May 19-26). Hatchery chinook smolts in 1992 were PIT tagged and released over two days after their arrival at the Imnaha River screw trap and are not intended to represent the entire emigration.

PIT tagged natural steelhead trout smolts from the Imnaha River arrived at Lower Granite Dam from April 20 to July 10, at Little Goose Dam from April 20 to June 19, at Lower Monumental Dam from April 21 to June 6, and at McNary Dam from April 24 to June 5 (Table 29). Median and 90% arrival dates of natural steelhead trout occurred on May 8 and May 24 at Lower Granite, May 10 and May 26 at Little Goose, May 11 and May 25 at Lower Monumental, and May 13 and May 18 at McNary Dam (Table 29). The 90% arrival date of May 24 at Lower Granite Dam followed peak river discharge there by 6 days. Peak arrival of natural steelhead trout smolts at Lower Granite, Little Goose, Lower Monumental, and McNary Dams occurred during early to mid May (Figures 27-30). May 2 to May 26 was the median arrival date range at LGR for natural steelhead from 1993 to 1997 while the 90% arrival date range for those years was May 9 to June 8. Natural steelhead smolt arrival timing at Little Goose Dam (90% arrival) transpired, in a more constricted time frame, between May 12 and June 7 (1993-1997). Lower Monumental Dam has experienced a more protracted 90% arrival timing of natural steelhead smolts from May 14 to July 10 in the years from 1993 to 1997. Ninety percent arrival timing at **McNary** Dam (1994 and 1996- 1997) occurred between the dates of May 18 and June 9.

Imnaha River hatchery steelhead trout smolt dam arrival timing was generally very protracted and occurred between April 19 to July 24 at Lower Granite Dam, April 21 to August 23 at Little Goose Dam, April 22 to August 6 at Lower Monumental Dam, and April 23 to August 12 at McNary Dam (Table 30). Median passage for PIT tagged hatchery steelhead trout smolts occurred at Lower Granite Dam on May 23 and 90% passage was observed on June 13 (Table 30). This 90% passage date was observed 26 days after peak river discharge. For the years 1993- 1997 the median and 90% arrival date ranges at LGR were May 17 to May 31 and

Table 28. Arrival timing of PIT tagged Imnaha River hatchery chinook salmon smolts at Lower Granite, Little Goose, Lower Monumental, and McNary Dams from 1992 to 1997.

Dam	Year	Sample Size (n)	Arrival Timing		
			Date Range	Median	90%
Lower Granite	1997	227	April 16-May 22	May 5	May 14
	1996	169	April 13-May 26	May 7	May 16
	1995 ¹	128	April 13-June 7	May 2	May 13
	1995²	83	April 13-May 22	May 8	May 15
	1994	129	April 24-May 18	May 12	May 12
	1992³	273	April 12-June 6	April 21	May 6
Little Goose	1997	267	April 20-May 27	May 9	May 18
	1996	131	April 23-June 6	May 13	May 20
	1995¹	114	April 26-June 11	May 10	May 20
	1995²	67	April 27-June 7	May 12	May 23
	1994	65	April 28-June 2	May 14	May 21
	1992³	116	April 17-May 22	April 27	May 5
Lower Monumental	1997	199	April 25-June 3	May 10	May 19
	1996	136	April 23-May 29	May 15	May 23
	1995¹	106	April 27-June 10	May 12	May 21
	1995²	71	April 29-June 9	May 17	May 26
	1994	73	April 30-June 7	May 14	May 20
McNary	1997	61	May 1-June 1	May 10	May 19
	1996	55	May 1-May 27	May 16	May 23
	1995¹	67	April 29-June 9	May 16	May 23
	1995²	36	May 3-May 30	May 16	May 22
	1994	119	May 6-June 17	May 21	May 26
	1992³	61	April 27-June 1	May 8	May 17

¹ HXW crossed chinook salmon smolts PIT tagged for the Nez Perce Tribe and released at dark.

² HXH crossed chinook salmon smolts PIT tagged for the Fish Passage Center and released one hour after tagging and recovery.

³ Hatchery chinook salmon smolts PIT tagged and released in 1992 were over a two day period only for survival estimation.

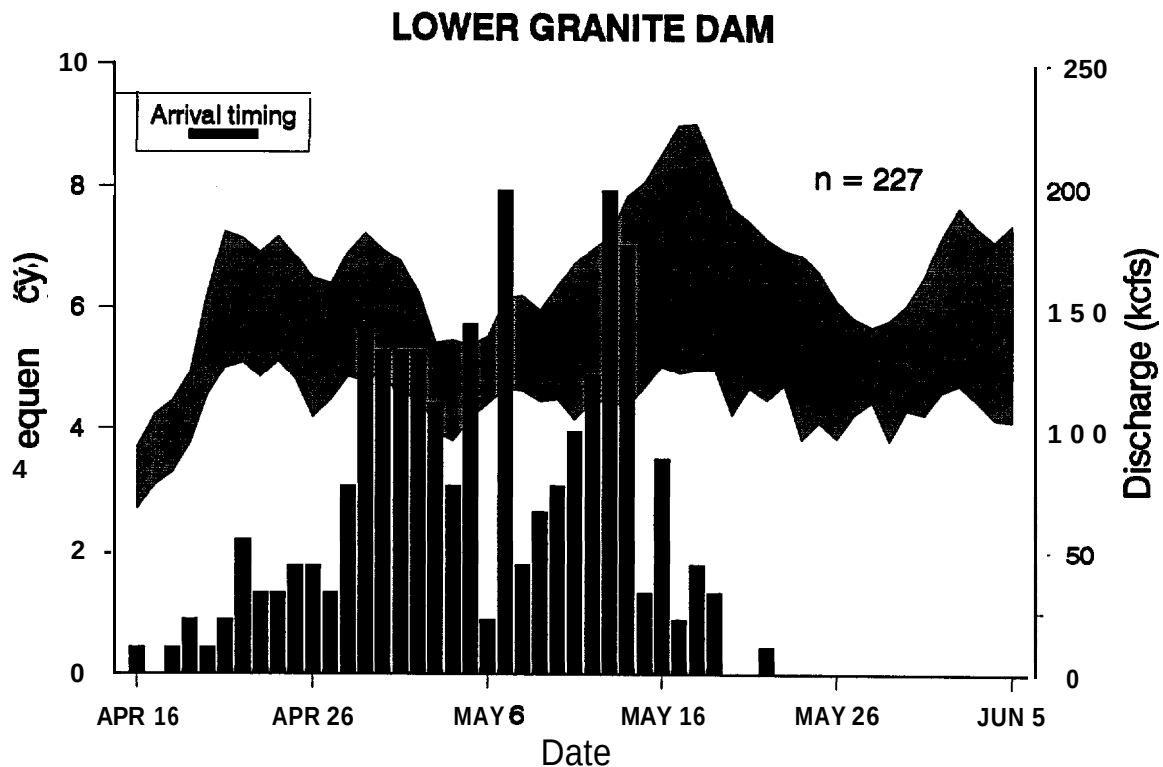


Figure 23. Daily arrival timing frequency of PIT tagged Imnaha River hatchery chinook salmon smolts at Lower Granite Dam, April 16 to May 22, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line).

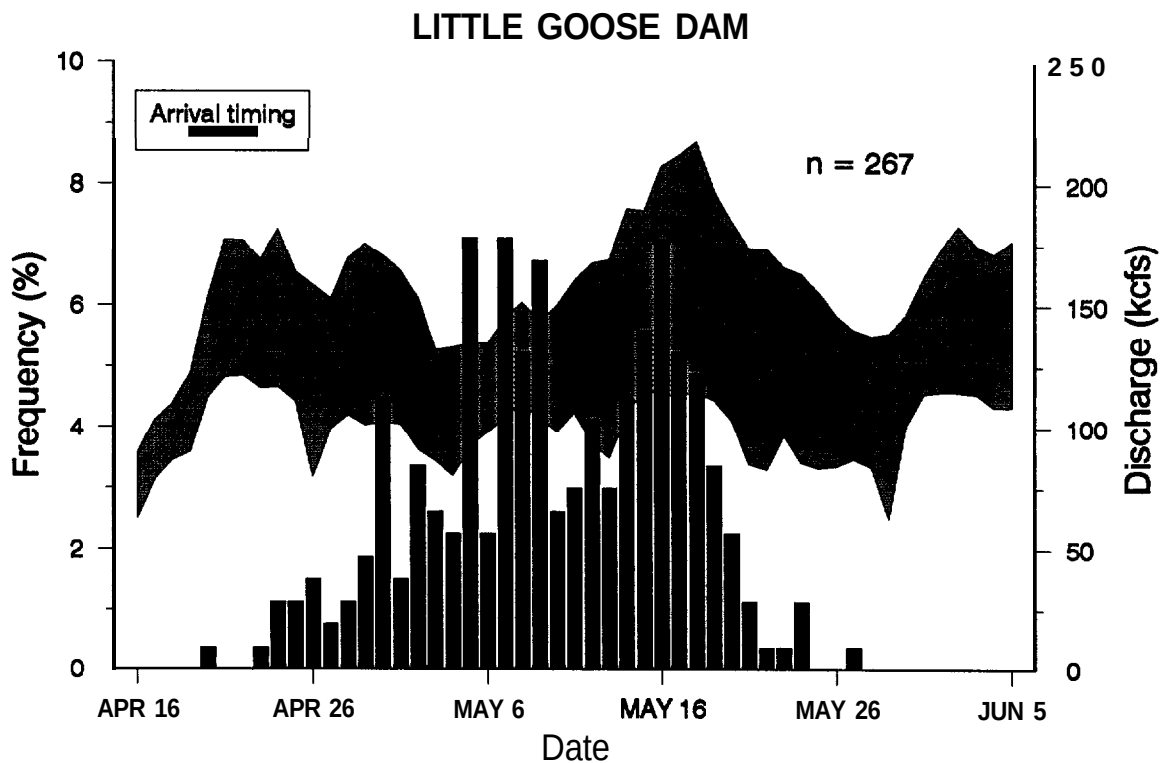


Figure 24. Daily arrival timing frequency of PIT tagged Imnaha River hatchery chinook salmon smolts at Little Goose Dam, April 20 to May 27, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line).

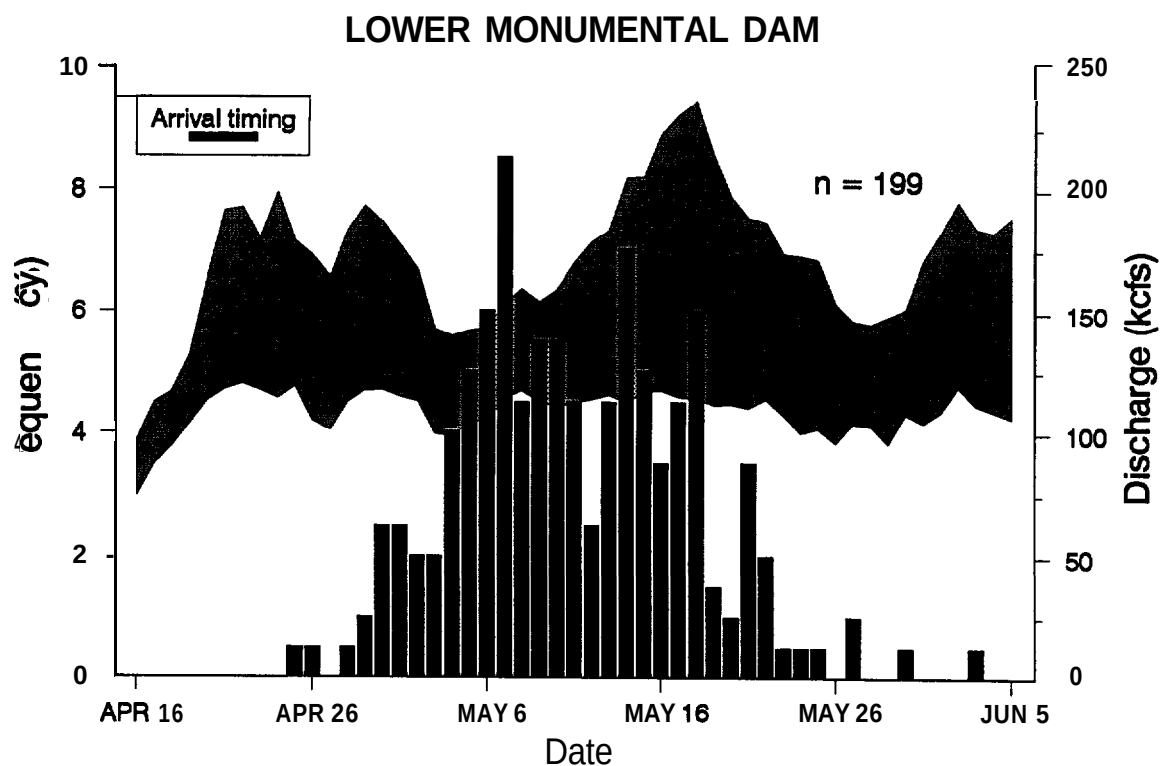


Figure 25. Daily arrival timing frequency of PIT tagged Imnaha River hatchery chinook salmon smolts at Lower Monumental Dam, April 25 to June 3, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line).

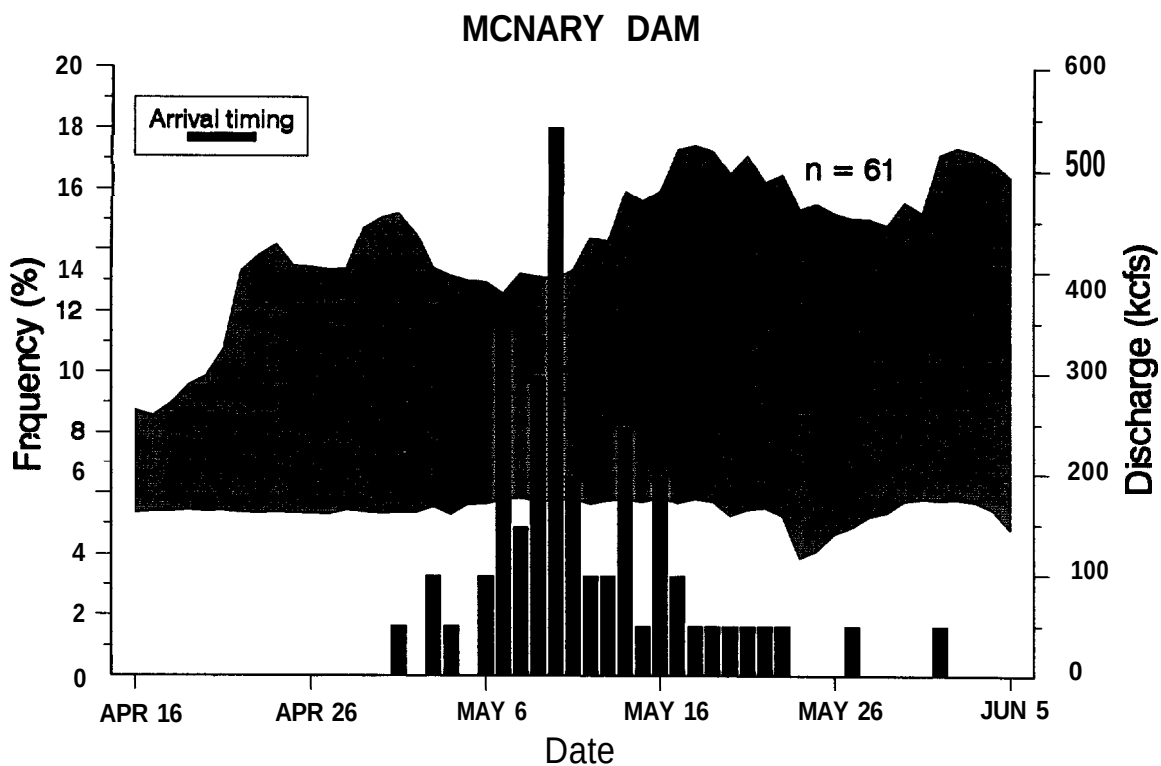


Figure 26. Daily arrival timing frequency of PIT tagged Imnaha River hatchery chinook salmon smolts at McNary Dam, May 1 to June 1, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line).

Table 29. Arrival timing of PIT tagged Imnaha River natural steelhead trout smolts at Lower Granite, Little Goose, Lower Monumental, and McNary Dams from 1993 to 1997.

Dam	Year	Sample Size (n)	Arrival Timing		
			Date Range	Median	90%
Lower Granite	1997	368	April 20-July 10	May 8	May 24
	1996	537	April 19-June 10	May 6	June 4
	1995	128	April 28-June 19	May 2	May 9
	1994¹	332	April 25-August 15	May 8	June 1
	1994²	207	May 3-August 20	May 9	May 30
	1993	101	May 3-June 13	May 26	June 8
Little Goose	1997	319	April 20-June 19	May 10	May 26
	1996	365	April 20-June 14	May 9	May 28
	1995	70	May 1-June 23	May 7	May 12
	1994¹	159	April 29-July 29	May 12	May 31
	1994²	121	May 6-July 26	May 15	June 1
	1993	48	May 6-June 11	May 24	June 7
Lower Monumental	1997	264	April 21-June 6	May 11	May 25
	1996	397	April 22-June 15	May 14	May 29
	1995	81	May 3-May 17	May 9	May 14
	1994'	148	May 1-August 8	May 12	July 8
	1994²	91	May 8-July 31	May 15	July 10
	1993	43	May 6-June 15	May 30	June 11
McNary	1997	62	April 24-June 5	May 13	May 18
	1996	157	April 25-June 11	May 11	May 21
	1995	35	May 5-May 27	May 11	May 17
	1994'	66	May 5-June 22	May 18	June 9
	1994²	42	May 13-June 25	May 18	June 6
	1993	17	May 11-June 13	May 25	May 31

¹ - NPT PIT tagged fish

² - FPC PIT tagged fish

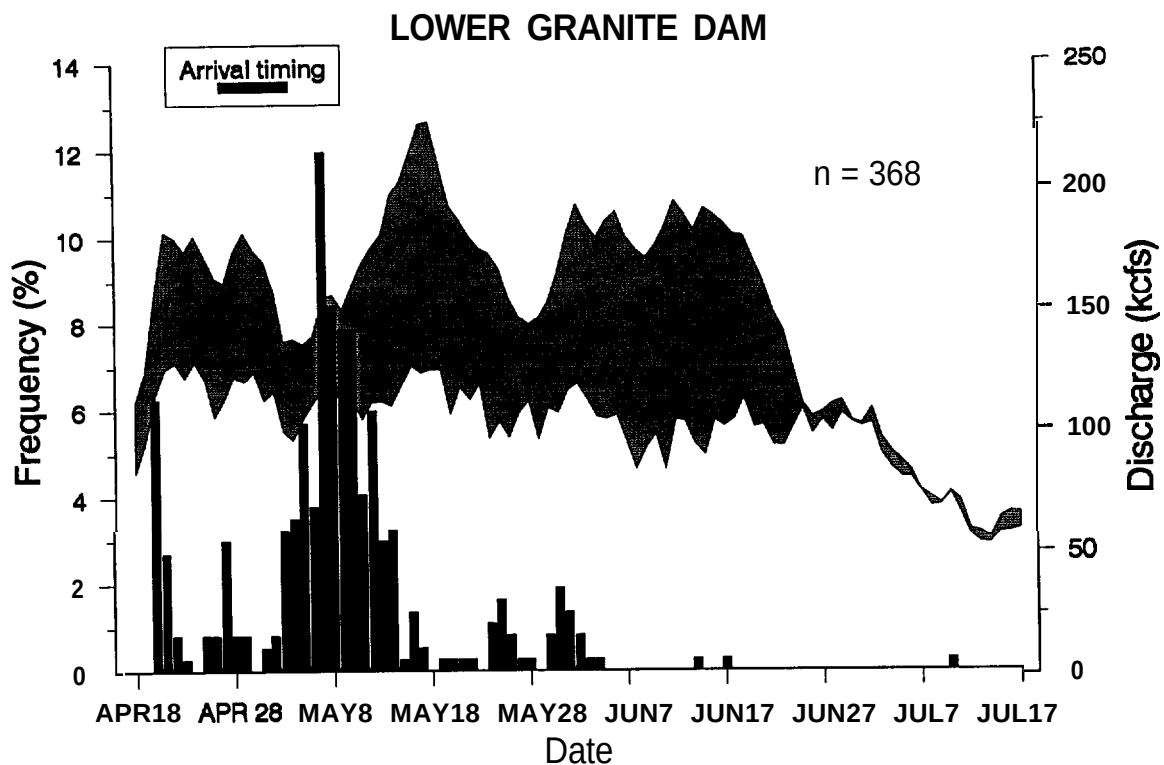


Figure 27. Daily arrival timing frequency of PIT tagged Imnaha River natural steelhead trout smolts at Lower Granite Dam, April 20 to July 10, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line).

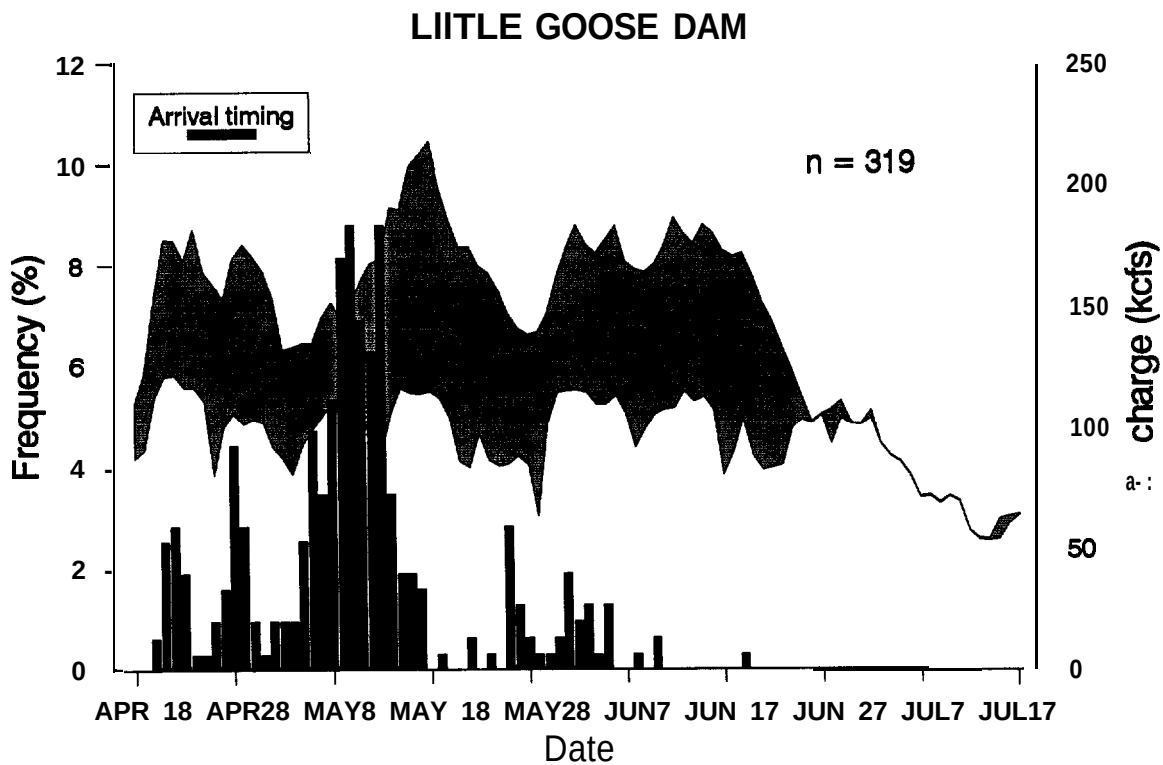


Figure 28. Daily arrival timing frequency of PIT tagged Imnaha River natural steelhead trout smolts at Little Goose Dam, April 20 to June 19, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line).

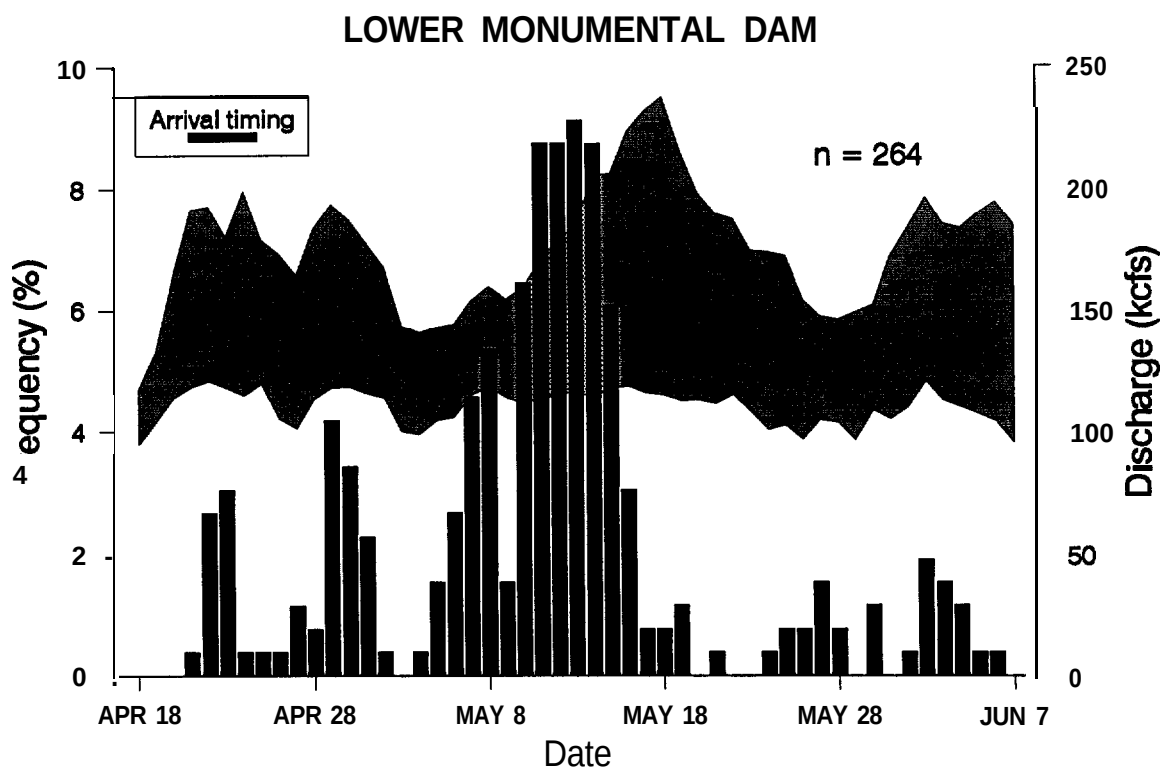


Figure 29. Daily arrival timing frequency of PIT tagged Imnaha River natural steelhead trout smolts at Lower Monumental Dam, April 21 to June 6, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line).

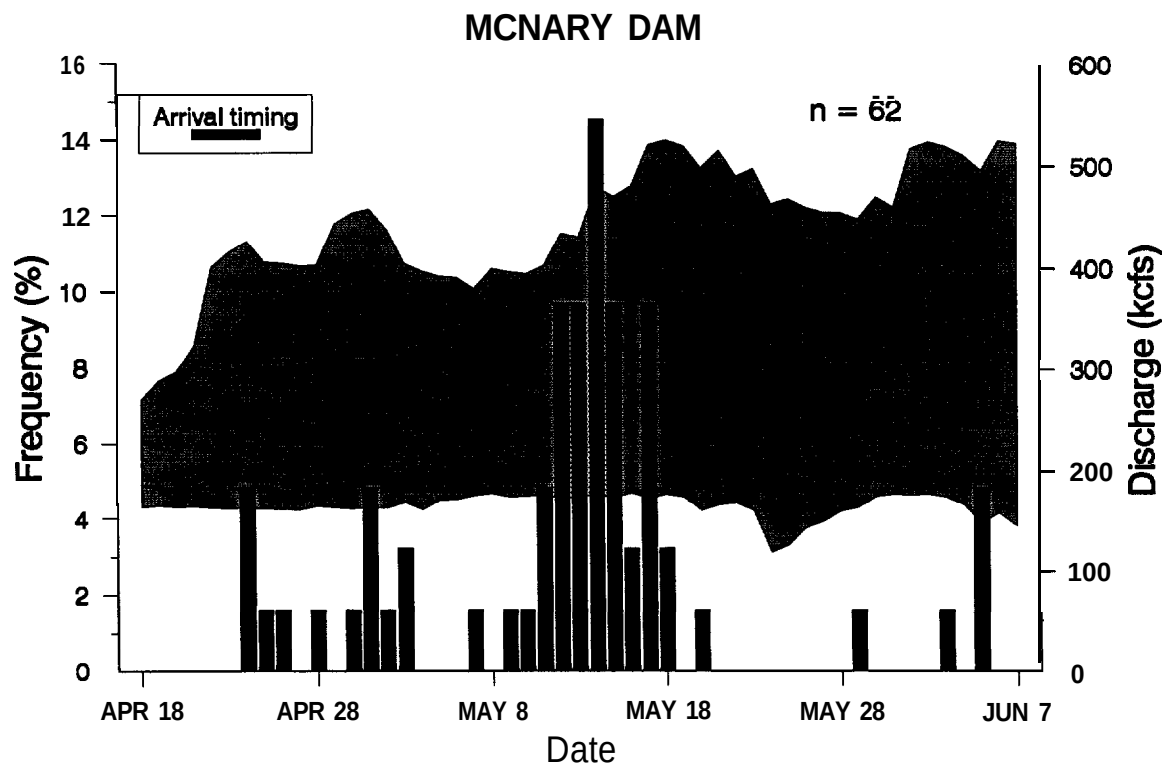


Figure 30. Daily arrival timing frequency of PIT tagged Imnaha River natural steelhead trout smolts at McNary Dam, April 24 to June 5, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line).

Table 30. Arrival timing of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1993 to 1997.

Dam	Year	Sample Size (n)	Arrival Timing		
			Date Range	Median	90%
Lower Granite	1997	2,346	April 19-July 24	May 23	June 13
	1996	440	April 23-July 14	May 28	June 14
	1995	661	May 6-July 12	May 31	June 16
	1994¹	164	April 29-August 20	May 29	July 15
	1994²	306	May 6-August 21	May 25	June 23
	1993	224	May 3-June 28	May 17	May 31
Little Goose	1997	1,844	April 21-August 23	May 26	June 13
	1996	261	April 20-July 11	May 25	June 16
	1995	409	May 8-July 13	June 3	June 20
	1994'	86	May 2-July 30	May 31	July 17
	1994²	165	May 10-August 12	May 27	July 9
	1993	106	May 5-July 8	May 25	June 2
Lower Monumental	1997	1,432	April 22-August 6	May 27	June 15
	1996	232	May 6-July 7	May 27	June 15
	1995	410	May 9-July 13	June 6	June 16
	1994¹	30	May 5-August 5	June 3	July 17
	1994²	75	May 11-August 24	June 18	July 21
	1993	92	May 7-June 14	May 26	June 5
McNary	1997	245	April 23-August 12	May 27	June 18
	1996	30	April 27-July 3	May 23	June 7
	1995	69	May 15-July 17	June 5	June 27
	1994¹	22	May 17-July 14	June 5	July 10
	1994²	56	May 20-July 11	June 17	July 8
	1993	7	May 11-June 5	May 19	May 30

¹ - NPT PIT tagged fish

² - FPC PIT tagged fish

May 31 to July 15, respectively. Median and 90% passage times for hatchery steelhead trout smolts at Little Goose Dam in 1997 occurred on May 26 and June 13, respectively. The 90% passage date at Little Goose Dam (1993-1997) has occurred over a seven week period from June 2 to July 17. Median arrival dates at Little Goose Dam (1993-1997) were more constricted from May 25 to June 3. Median and 90% passage dates for hatchery steelhead trout smolts at Lower Monumental Dam were May 27 and June 15 (Table 30). The median and 90% arrival dates at Lower Monumental Dam (1993- 1997) ranged from May 26 to June 18 and June 5 to July 21, respectively. Three peaks occurred at all dams with the most prominent ones being in late May to early June (Figures 31-34) but the general trend was a protracted emigration.

Die1 Smolt Passage at Hydroelectric Facilities

Average weekly natural and hatchery chinook salmon and steelhead trout smolt die1 passage timing patterns were examined at Lower Granite, Little Goose, Lower Monumental and McNary dams. The data were summarized by three passage times. These passage times included two nighttime (dark) periods, midnight to sunrise and sunset to midnight, and a daytime (light) period of sunrise to sunset. Appendix G contains weekly die1 passage figures for natural and hatchery chinook salmon and steelhead trout smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams provided that a minimum of 30 fish were detected at a site within the week.

Average weekly natural chinook salmon smolt die1 passage timing pattern was examined at Lower Monumental Dam (Appendix G. 1) from April 27-May 3 (Table 31). During this week, sunset to midnight passage was more than four times greater than midnight to sunrise. Daytime passage (sunrise to sunset) was nearly five times greater than the midnight to sunrise passage. Nighttime passage (sunset to sunrise) was 53.2% compared to 46.9% for daylight passage. The majority of fish passed just prior to and after sunset.

Average die1 passage of hatchery chinook salmon at Lower Granite Dam, over a three week period, indicated that 50.7 to 63.8% of the smolts emigrated past the dam during the daytime (Table 31). Die1 passage from midnight to sunrise was 10.5 to 20.9% compared to a range in average die1 passage of 24.6 to 28.4% during the sunset to midnight period (Table 31). Generally, more hatchery chinook smolts emigrated past Lower Granite Dam during the sunset to midnight (dark) period compared to the midnight to sunrise (dark) period (Figure 35). Daytime passage exceeded nighttime passage for all three weeks analyzed. No clear patterns in hourly die1 passage was observed at Lower Granite Dam in the spring of 1997 (Appendix G.2 and 3).

Die1 passage at Little Goose Dam for hatchery chinook salmon smolts was obtained for four weeks from April 27 to May 24. Sunset to midnight passage was three to four times higher than midnight to sunrise passage for the first two weeks and lower for the last two weeks (Figure 35). Peaks in hourly passage were observed at or just after sunset for the first two weeks (Appendix G.4). Hourly passage peaked during daytime for the last two weeks (Appendix G.5). Daytime passage exceeded nighttime passage (sunset to sunrise) for all weeks examined. The high daytime die1 passage (80.6%) that occurred during the week of May 24 was notable because it was the highest hatchery chinook daytime passage observed at any dam in 1997 with no

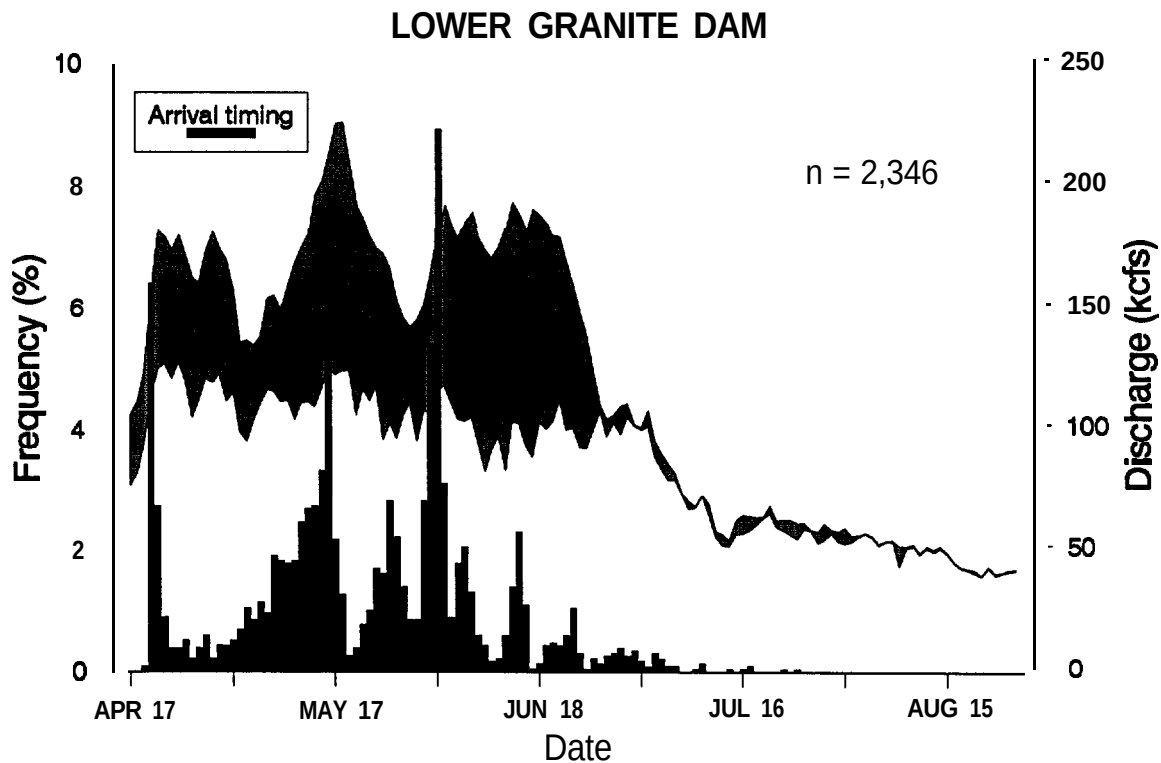


Figure 31 Daily arrival timing frequency of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Granite Dam, April 19 to July 24, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line).

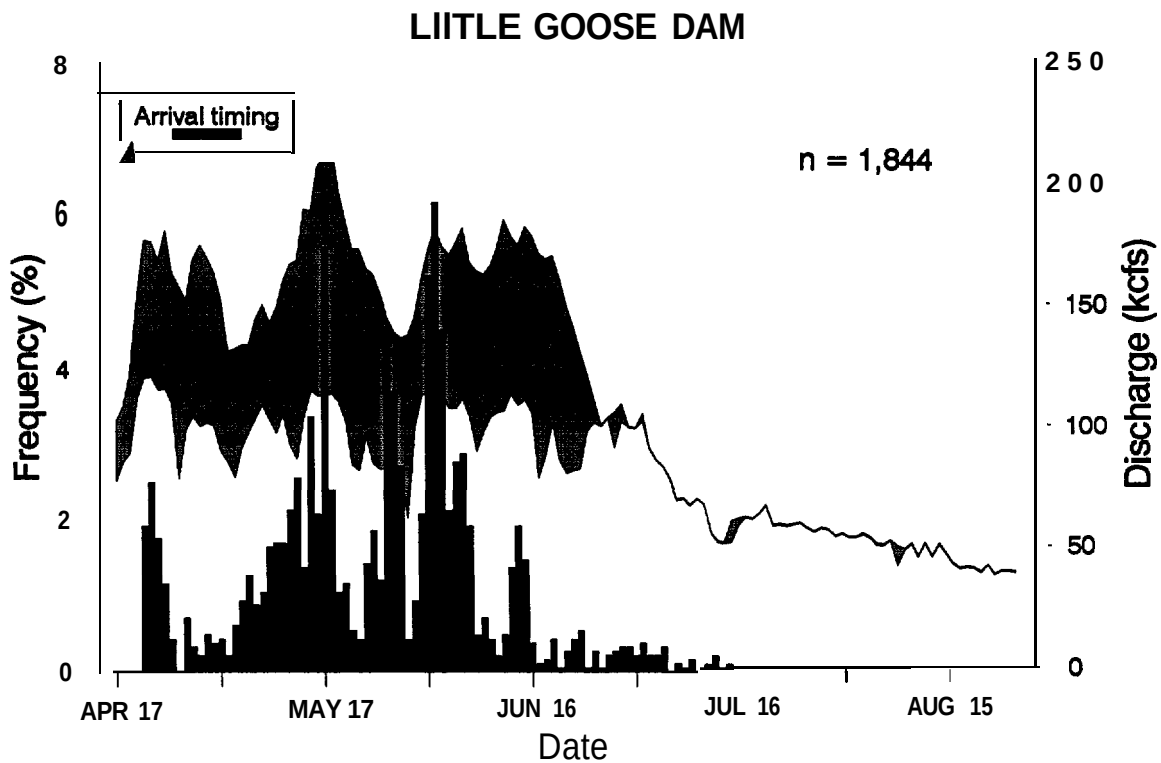


Figure 32. Daily arrival timing frequency of PIT tagged Imnaha River hatchery steelhead trout smolts at Little Goose Dam, April 21 to August 23, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line).

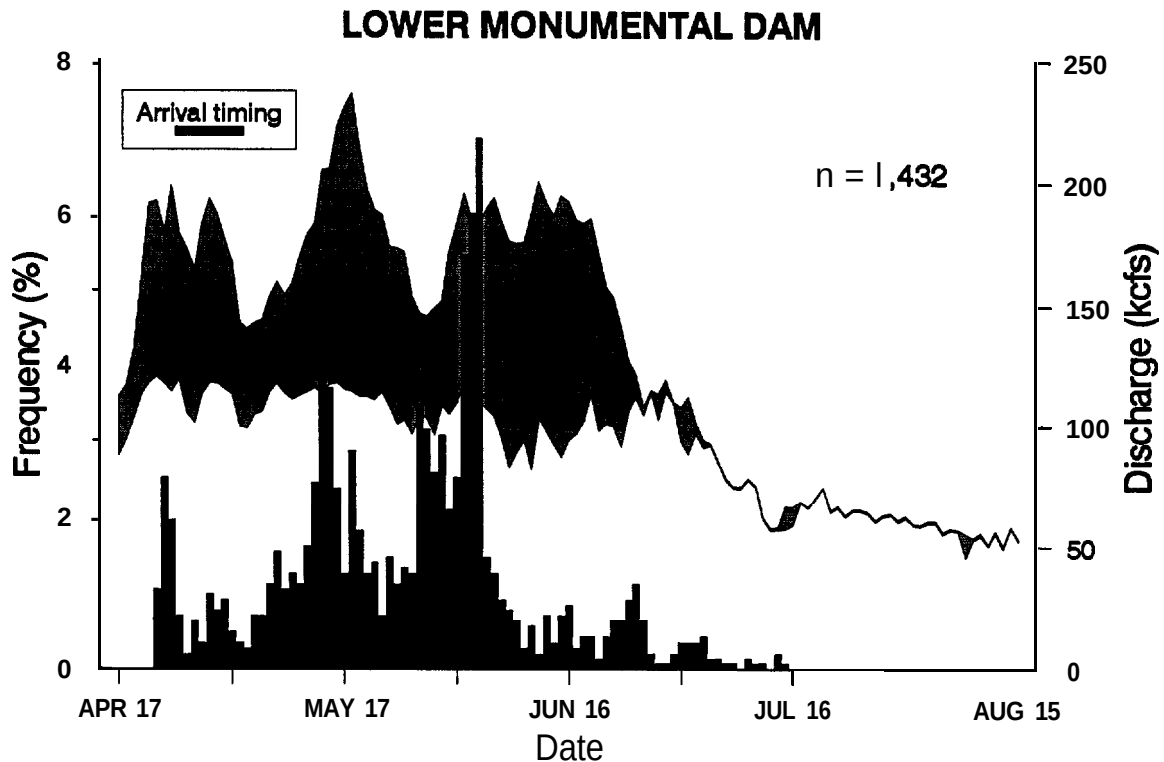


Figure 33. Daily arrival timing frequency of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Monumental Dam, April 22 to August 6, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line).

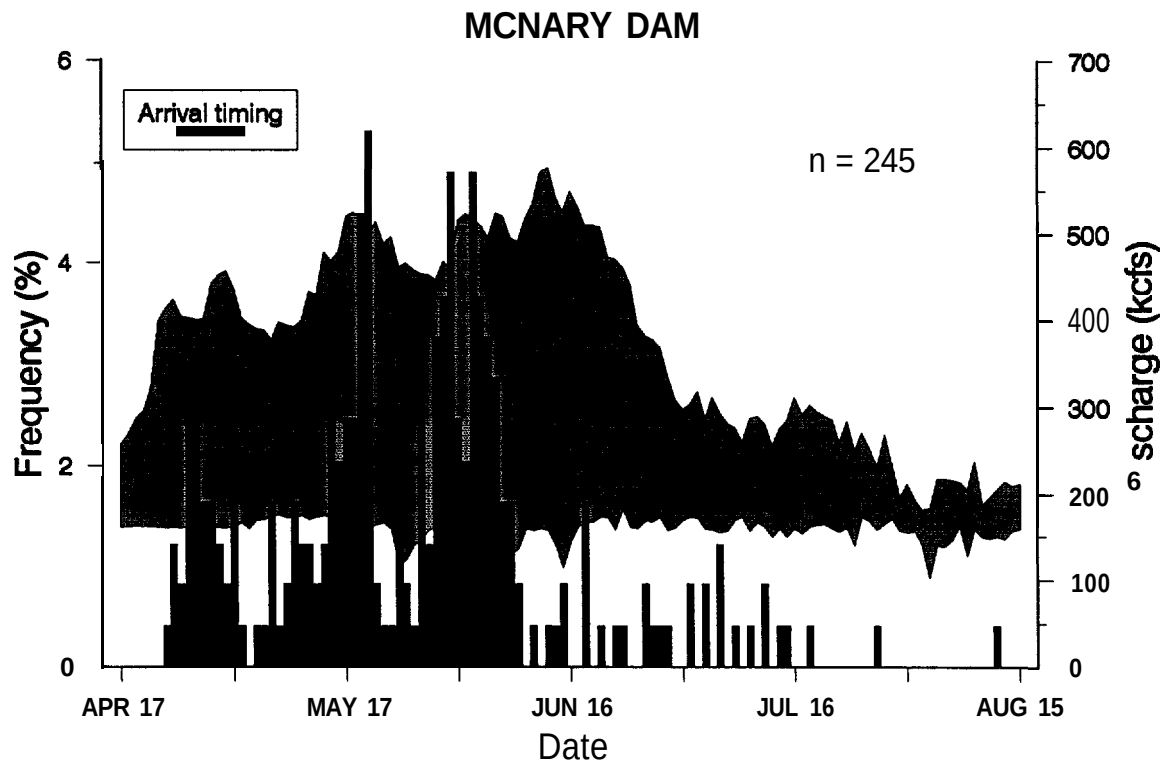


Figure 34 Daily arrival timing frequency of PIT tagged Imnaha River hatchery steelhead trout smolts at McNary Dam, April 23 to August 12, 1997. Total project discharge is represented by top line, spill (shaded) and turbine discharge (lower line).

Table 3 1. Midnight to sunrise, sunrise to sunset and sunset to midnight weekly passage frequency of PIT tagged Imnaha River natural and hatchery chinook salmon smolts at Lower Granite, Little Goose, Lower Monumental and McNary dams in 1997.

Dam	Week	Sample Size (n)	Passage Frequency		
			Midnight to Sunrise (%)	Sunrise to Sunset (%)	Sunset to Midnight (%)
<u>Natural Chinook</u>					
Lower Monumental	April 27-May 3	32	9.4	46.9	43.8
<u>Hatchery Chinook</u>					
Lower Granite	April 27-May 3	69	11.6	63.8	24.6
	May 4-10	57	10.5	63.2	26.3
	May 11-17	67	20.9	50.7	28.4
Little Goose	April 27-May 3	42	9.5	59.5	31.0
	May 4-10	89	7.9	58.4	33.7
	May 11-17	87	19.5	65.5	14.9
	May 18-24	36	19.4	80.6	0
Lower Monumental	May 4- 10	78	16.7	47.4	35.9
	May 11-17	63	22.2	57.1	20.6
	May 18-24	30	23.3	63.3	13.3
McNary	May 4-10	30	13.3	53.3	33.3

passage occurring from sunset to midnight, but was represented by a relatively small sample size (n = 36).

Information on hatchery chinook salmon average weekly diel smolt passage at Lower Monumental Dam, from a three week period, showed that nighttime (dark) passage ranged from 36.6 to 52.6% (Table 3 1). Average daytime diel passage ranged from 47.4 to 63.3% and consistently increased from the week of May 10 through the week of May 24. During the same period the observed midnight to sunrise diel passage percentages increased from 16.7% to 23.3%. Passage percentage during the sunset to midnight period decreased during this period from 35.9 to 13.3% (Figure 36). No observable patterns in hourly movement past Lower Monumental Dam was evident (Appendix G.6 and 7).

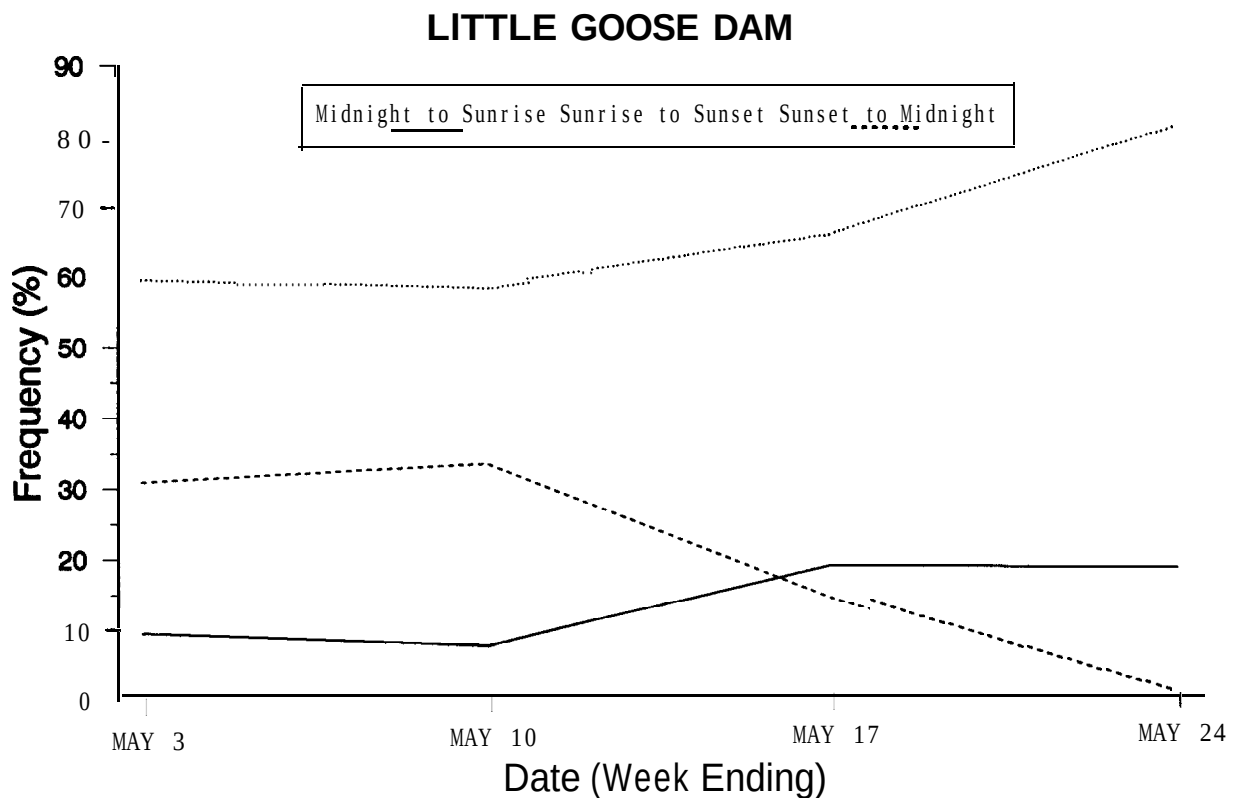
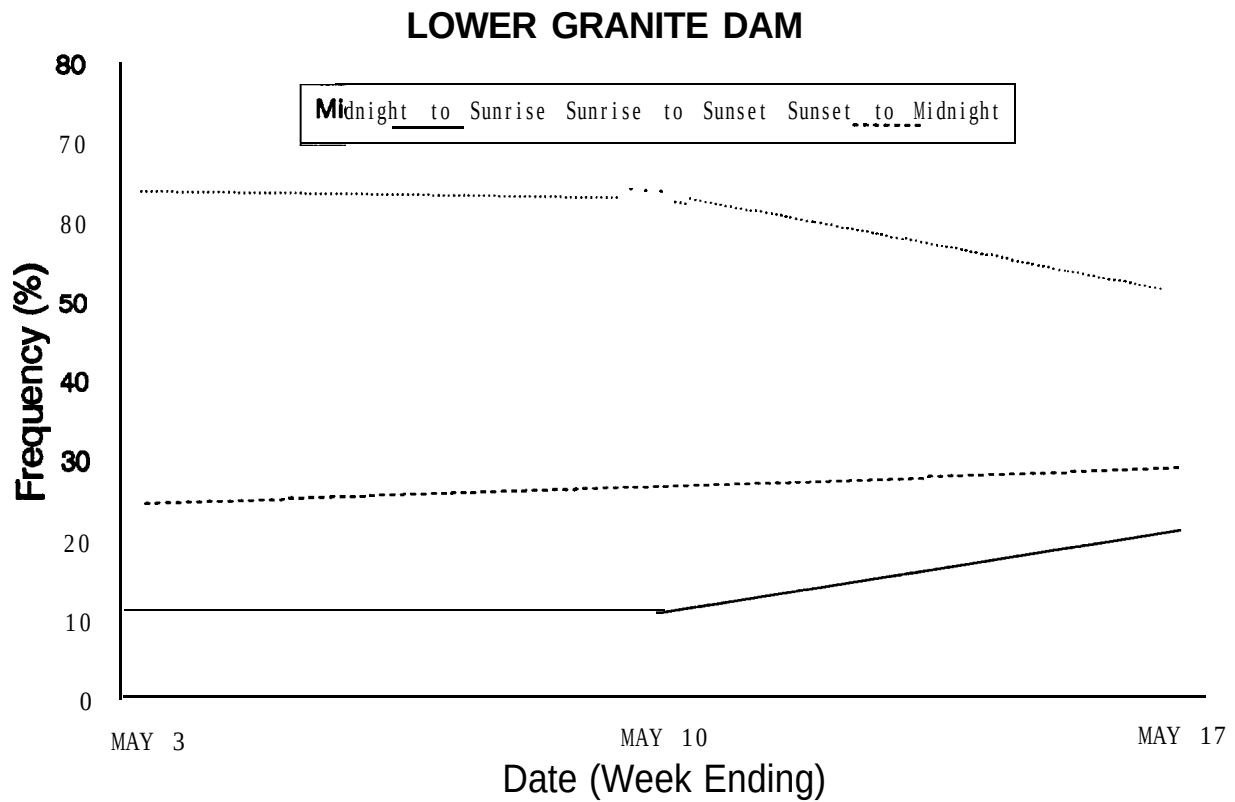


Figure 35. Midnight to sunrise, sunrise to sunset, and sunset to midnight weekly passage frequency of PIT tagged Imnaha River hatchery chinook salmon smolts at Lower Granite (upper graph) and Little Goose (lower graph) dams during the spring of 1997.

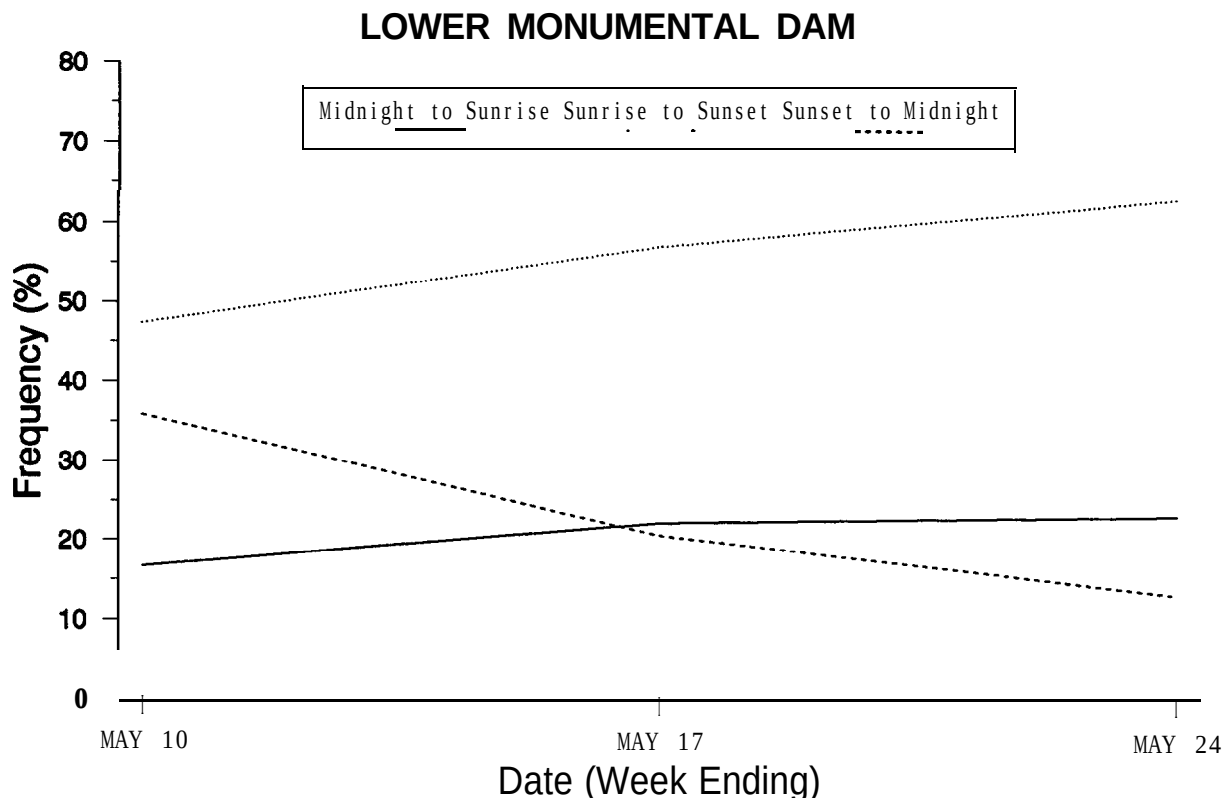


Figure 36. Midnight to sunrise, sunrise to sunset, and sunset to **midnight** weekly **passage** frequency of PIT tagged Imnaha River hatchery chinook salmon smolts at Lower Monumental Dam **during** the spring of 1997.

Only one week worth of information was available on hatchery chinook smolt die1 movement **past McNary** Dam (Appendix G.8). Passage past McNary Dam during the week of May 10 was 53.3% daytime movement 46.6% during dark (sunset to sunrise).

Natural steelhead trout smolt die1 passage was examined over a four week period at Lower Granite Dam (Table 32). The majority of natural steelhead smolts (61.8-80.7%) passed during daytime hours and increased over the first three weeks examined. Nighttime passage, sunset to midnight, ranged from 14.7 to 18.6% compared to midnight to sunrise passage of 5 to 23.5%. Observed passage from sunset to midnight (dark) period was greater than the midnight to sunrise (dark) passage during three out of four weeks (Figure 37). Die1 passage during both dark periods combined ranged between 19.4 to 38.2%. No apparent trend in die1 movement was shown over the four week period (Appendix G.9-10).

Information on die1 passage of natural steelhead trout smolts at Little Goose Dam was available over a four week period from April 20 to May 17. Emigration past the Little Goose Dam facility during the daytime, sunrise to sunset, ranged from 53.3 to 60.5% (Table 32). Passage during nighttime hours, midnight to sunrise and sunset to midnight combined, ranged from 39.5 to 46.6% over the four week period. Die1 passage was higher from sunset to midnight than midnight to sunrise for three of the four weeks examined (Figure 38). Peaks in die1 passage were observed during daytime during three of the four weeks examined (Appendix G.11 and 12).

Table 32. Midnight to sunrise, sunrise to sunset and sunset to midnight weekly passage frequency of PIT tagged Imnaha River natural steelhead trout smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams in 1997.

Dam	Week	Sample Size (n)	Passage Frequency		
			Midnight to Sunrise (%)	Sunrise to Sunset (%)	Sunset to Midnight (%)
<u>Natural Steelhead</u>					
Lower Granite	April 20-26	43	16.3	65.1	18.6
	April 27-May 3	34	8.8	73.5	17.6
	May 4-10	181	5.0	80.7	14.4
	May 11-17	68	23.5	61.8	14.7
Little Goose	April 20-26	30	23.3	53.3	23.3
	April 27-May 3	38	18.4	60.5	21.1
	May 4-10	108	12.0	54.6	33.3
	May 11-17	98	17.3	57.1	25.5
Lower Monumental	April 27-May 3	32	18.8	56.3	25.0
	May 4-10	59	18.6	37.3	44.1
	May 11-17	119	16.8	43.7	39.5
McNary	May 11-17	38	10.5	44.7	44.7

Average weekly diel passage data at Lower Monumental Dam, for natural steelhead smolts, was available for a three week period from April 27 through May 17, 1997. Nighttime passage, midnight to sunrise and sunset to midnight combined, ranged from 43.8 to 62.7% during the three week period. Passage percentages during the sunset to midnight (dark) period exceeded the passage frequency during the midnight to sunrise (dark) period all weeks and was over twice as frequent during the last two weeks (Figure 39). Sunset to midnight passage frequency exceeded the daytime passage for the week ending May 10. Daytime emigration through the Lower Monumental Dam facility ranged from 37.3 to 56.3% (Table 32). Peaks in movement occurred shortly after sunset for all weeks (Appendix G. 13 and 14).

One week of information was available for natural steelhead (n=38) at McNary Dam. Sunrise to sunset and sunset to midnight passage frequencies were both 44.7% with peak passage occurring from sunset to midnight (Appendix G. 15).

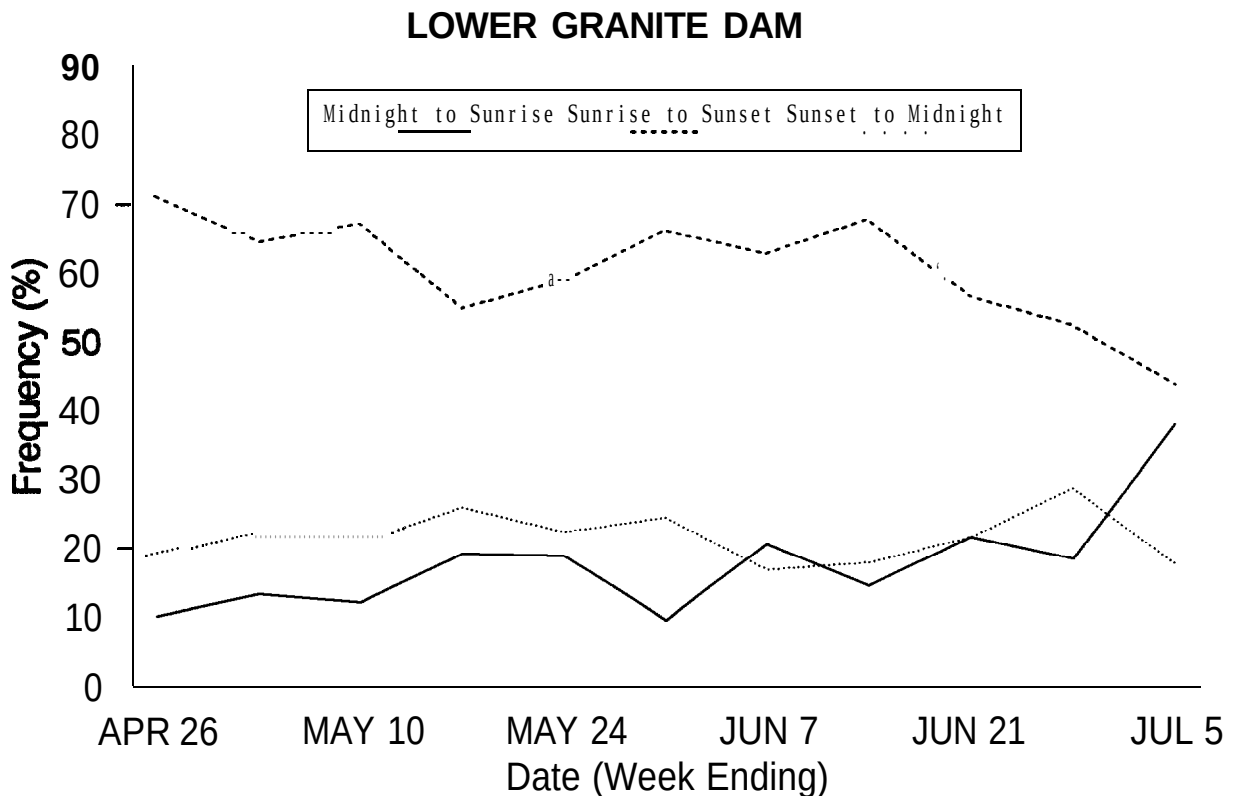
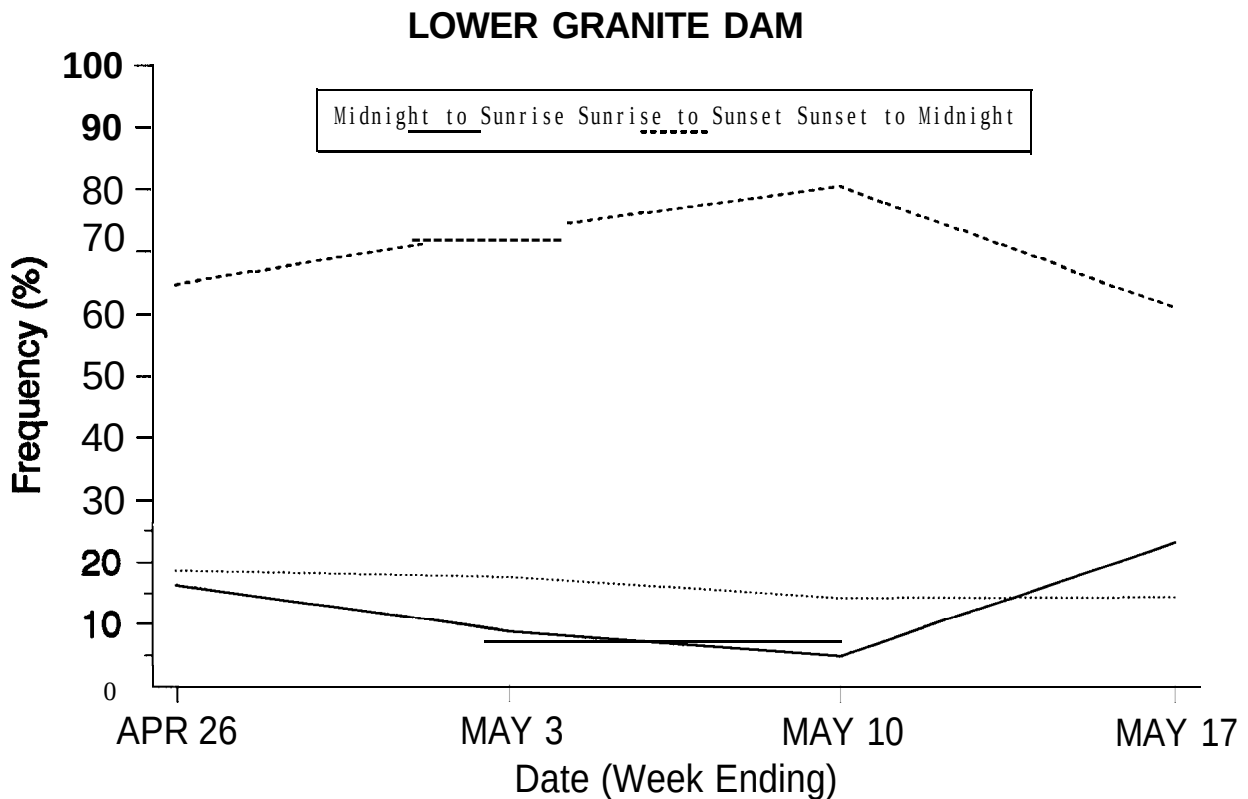


Figure 37. Midnight to sunrise, sunrise to sunset, and sunset to midnight weekly passage frequency of PIT tagged Imnaha River natural (upper graph) and hatchery (lower graph) steelhead trout smolts at Lower Granite Dam during the spring of 1997.

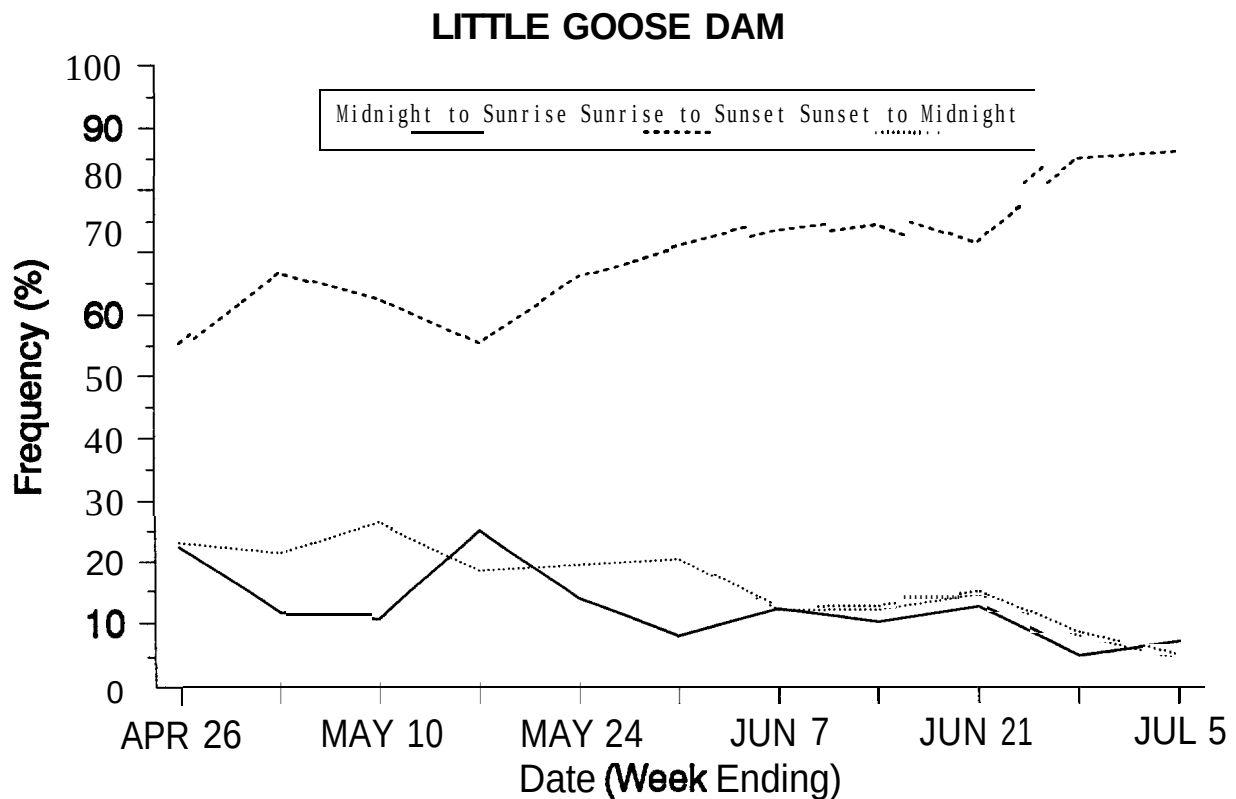
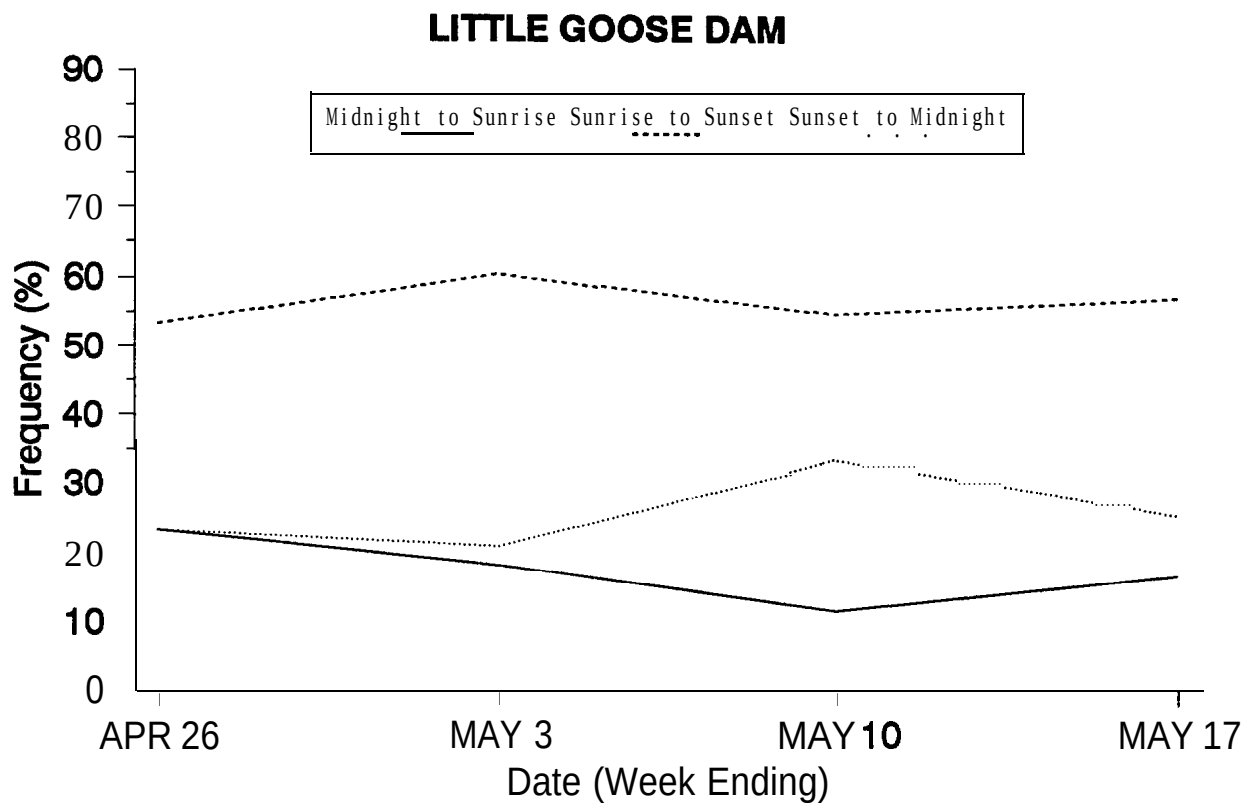


Figure 38. Midnight to sunrise, sunrise to sunset, and sunset to midnight weekly passage frequency of PIT tagged Imnaha River natural (upper graph) and hatchery (lower graph) steelhead trout smolts at Little Goose Dam during the spring of 1997.

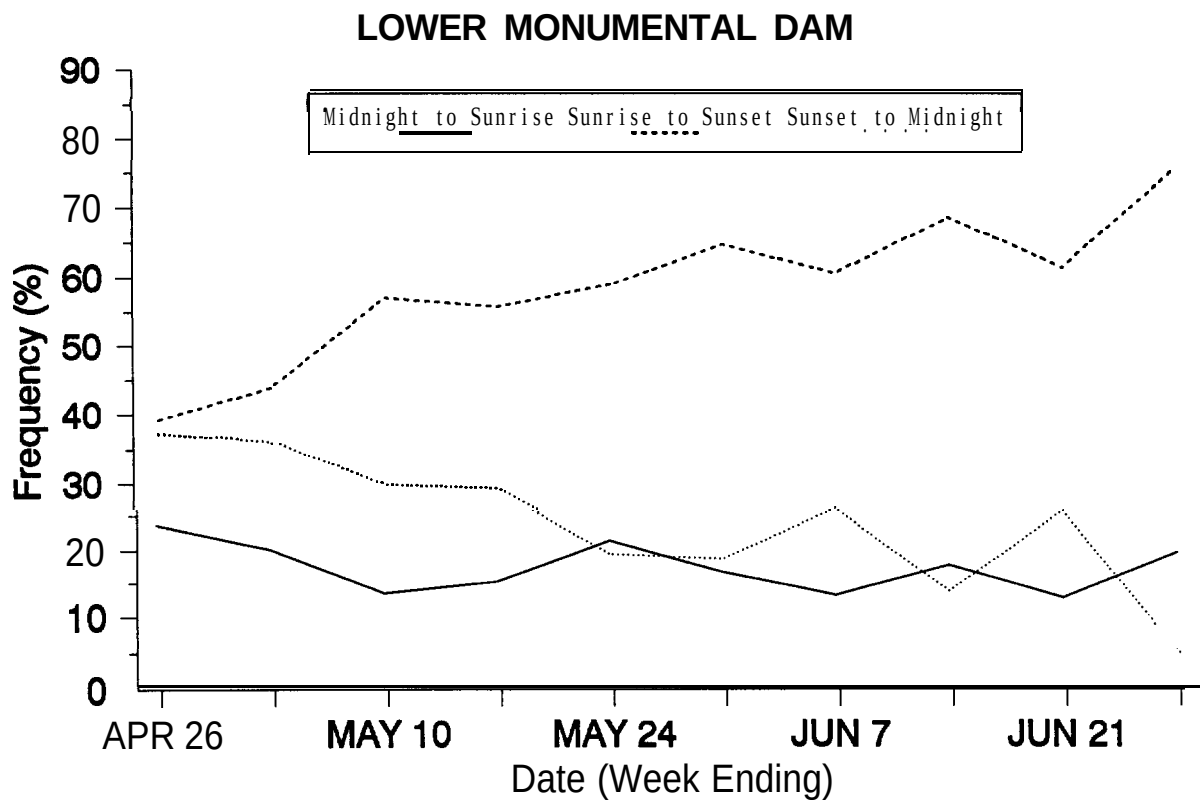
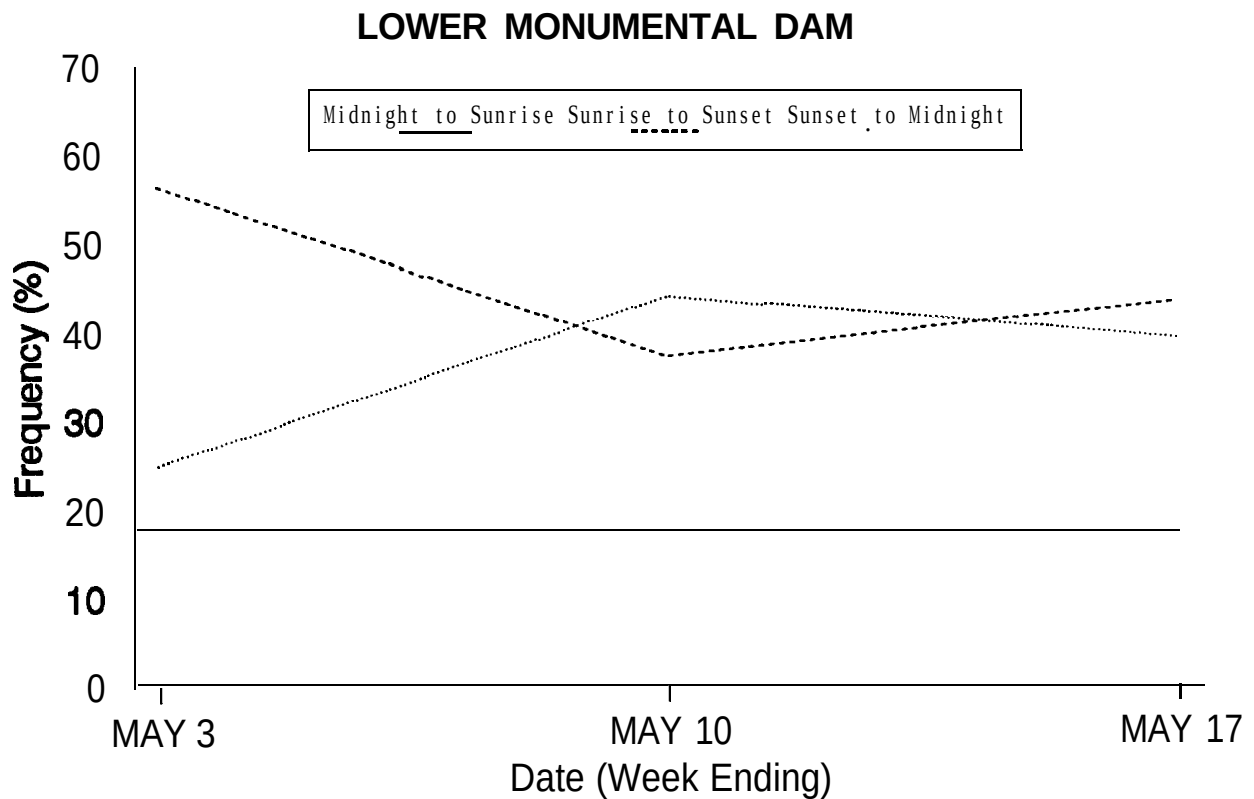


Figure 39. Midnight to sunrise, sunrise to sunset, and sunset to midnight weekly passage frequency of PIT tagged Imnaha River natural (upper graph) and hatchery (lower graph) steelhead trout smolts at Lower Monumental Dam during the spring of 1997.

Hatchery reared steelhead trout smolt die1 passage at Lower Granite Dam was summarized for an eleven week period from April 20 through July 5, 1997 (Appendix G. 16-21). Daytime passage percentages ranged from 44.1 to 71.1%. Daytime passage exceeded 50% during ten of the eleven weeks and generally decreased through the sample period (Table 33). Sunset to midnight passage exceeded the midnight to sunrise passage during eight of eleven weeks with the exceptions being the weeks ending June 7, June 21 and July 5 (Figure 37).

Die1 passage at Little Goose Dam, for hatchery reared steelhead smolts, was evaluated over eleven weeks from April 20 through July 5 (Appendix G.22-27). Daytime passage was a dominant occurrence for all eleven weeks with average frequencies ranging from 54.2 to 86.5% (Table 33). Daytime passage frequency generally increased through the sampling period. Combined nighttime (dark) period passage ranged from 13.5 to 45.7% over the eleven week period and generally decreased over the passage season. Passage from sunset to midnight exceeded the midnight to sunrise passage in eight out of the eleven weeks (Figure 38). Peaks in arrival occurred during daytime hours for eight of the eleven weeks examined.

Data for average weekly die1 passage at Lower Monumental Dam were available for a ten week period from April 20 to June 28 (Appendix G.28-32). Combined nighttime passage for hatchery reared steelhead trout, midnight to sunrise and sunset to midnight, ranged between 25 to 60.9% (Table 33) and exceeded daytime passage during the first two weeks. Daytime passage ranged from 39.1 to 75%. Passage during the daytime increased over the eleven week period to three times as high as the dark period for the week ending June 28 (Figure 39). Peaks in passage occurred between sunset and midnight during five of the ten weeks.

Die1 passage at McNary Dam was examined for three weeks from May 18 to June 7 (Appendix G. 33 and 34). Sample sizes were low and considered useful for trend information only (Table 33). Daytime passage exceeded nighttime passage all three weeks (Figure 40) and ranged from 58.5 to 64.7%. Sunset to midnight passage was higher than midnight to sunrise passage during the three weeks examined. Peaks in arrival occurred during the daytime hours.

Travel Time to Lower Granite Dam

Natural chinook salmon smolts were PIT tagged and released over a nine week period from March 10 to May 7. No natural chinook smolts were tagged and released during the week ending March 22. PIT tag release groups of the weeks ending March 15, March 29, April 26, May 3, and May 12 had less than ten interrogations at Lower Granite Dam and were not used in travel time analysis. Mean travel time of PIT tagged natural chinook salmon smolts from the Imnaha River screw trap to Lower Granite Dam ranged from 5.2 days for the April 19 release group to 18.2 days for the April 5 release group. A consistent trend in decreasing mean travel time was evident between the April 5 weekly release group and the April 19 release group (Figure 41). Mean travel time was lower for natural chinook salmon compared to hatchery chinook salmon PIT tagged and released at the same time (Figure 41).

Table 33. Midnight to sunrise, sunrise to sunset and sunset to midnight weekly passage frequency of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams in 1997.

Dam	Week	Sample Size (n)	Passage Frequency		
			Midnight to Sunrise (%)	Sunrise to Sunset (%)	Sunset to Midnight (%)
<u>Hatchery Steelhead</u>					
Lower Granite	April 20-26	270	10.0	71.1	18.9
	April 27-May 3	76	13.2	64.5	22.4
	May 4-10	225	12.0	67.1	20.9
	May 11-17	482	19.1	55.0	25.9
	May 18-24	165	18.8	58.8	22.4
	May 25-31	384	9.4	66.1	24.5
	June 1-7	438	20.5	62.8	16.7
	June 8-14	146	14.4	67.8	17.8
	June 15-21	74	21.6	56.8	21.6
	June 22-28	38	18.4	52.6	28.9
	June 29-July 5	34	38.2	44.1	17.6
Little Goose	April 20-26	142	22.5	54.2	23.2
	April 27-May 3	51	11.8	66.7	21.6
	May 4-10	147	10.9	62.6	26.5
	May 11-17	345	25.5	55.6	18.8
	May 18-24	162	14.2	66.0	19.8
	May 25-31	282	8.5	70.6	20.9
	June 1-7	471	12.7	74.7	12.5
	June 8-14	103	10.7	76.7	12.6
	June 15-21	53	13.2	71.7	15.1
	June 22-28	34	5.9	85.3	8.8
	June 29-July 5	37	8.1	86.5	5.4

Table 3 3. (Continued).

D a m	Week	Sample Size (n)	Passage Frequency		
			Midnight to Sunrise (%)	Sunrise to Sunset (%)	Sunset to Midnight (%)
Lower Monumental	April 20-26	92	23.9	39.1	37.0
	April 27-May 3	64	20.3	43.8	35.9
	May 4-10	95	13.7	56.8	29.5
	May 11-17	234	15.4	55.6	29.1
	May 18-24	152	21.7	58.6	19.7
	May 25-31	243	16.9	64.2	18.9
	June 1-7	352	13.4	60.2	26.4
	June 8-14	50	18.0	68.0	14.0
	June 15-21	46	13.0	60.9	26.1
	June 22-28	60	20.0	75.0	5.0
McNary	May 18-24	37	8.1	59.5	32.4
	May 25-31	41	19.5	58.5	22.0
	June 1-7	51	9.8	64.7	25.5

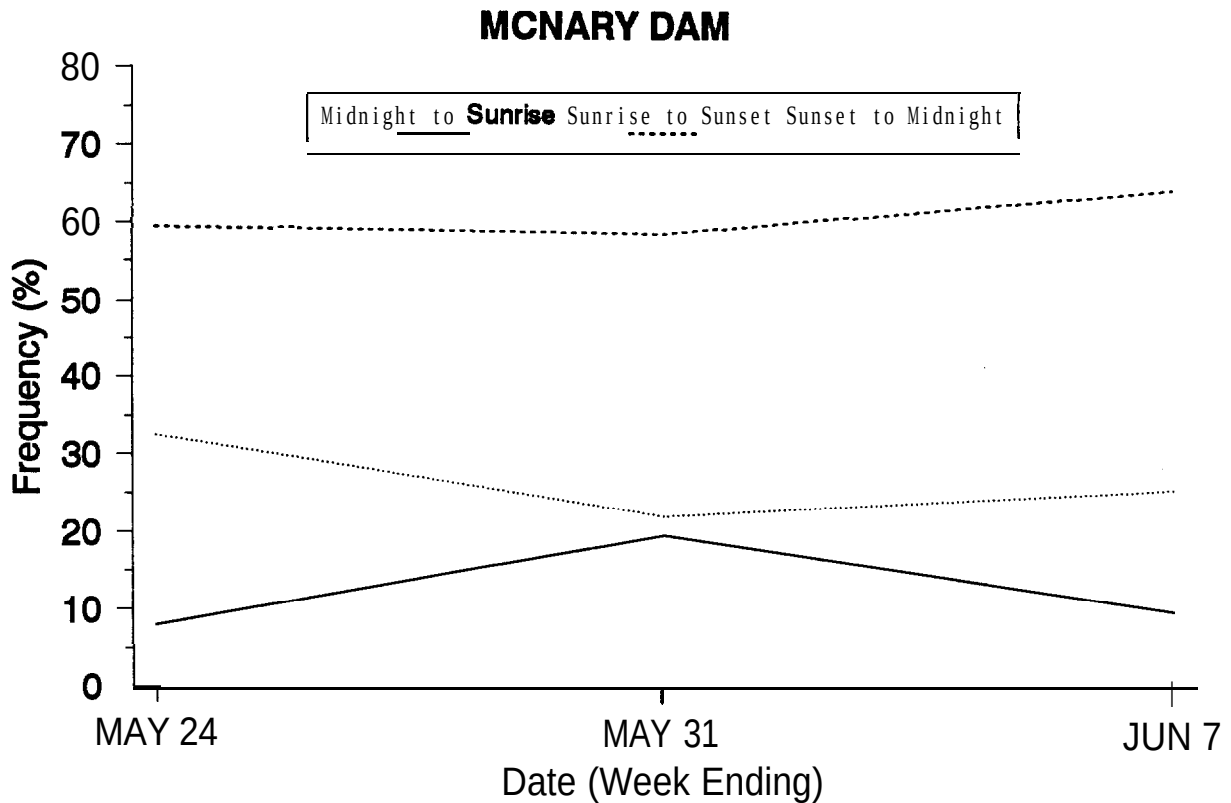


Figure 40. Midnight to sunrise, sunrise to sunset, and sunset to **midnight** weekly **passage** frequency of PIT tagged Imnaha River hatchery steelhead trout smolts at McNary Dam during the spring of 1997.

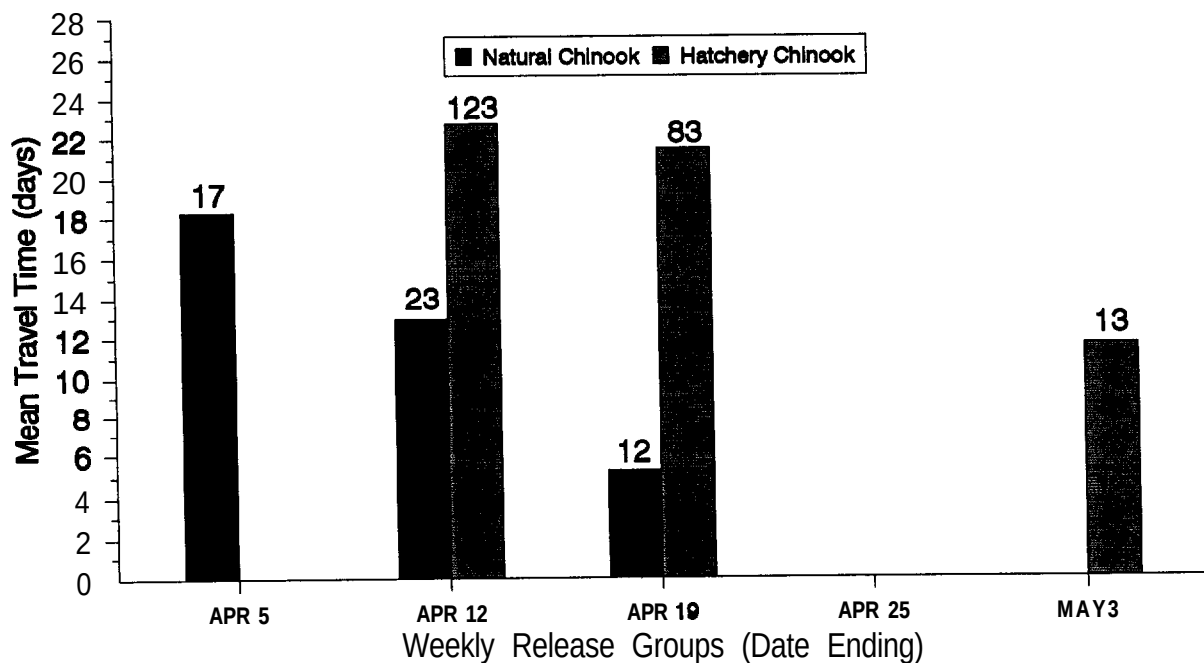


Figure 41. Mean travel time, by weekly PIT tag release group, of natural and hatchery chinook salmon smolts from the Imnaha River to Lower Granite Dam, April 9 to May 22, 1997 (sample size on top).

Hatchery chinook salmon smolts were PIT tagged and released during five weeks of trapping from April 11 to May 9. Mean travel time trends of PIT tagged hatchery chinook salmon to LGR ranged from 11.7 days for the May 3 weekly release group to 22.7 days for those fish released during the week of April 12 (Figure 41). The weekly release groups of April 26 and May 10 had less than ten interrogations and were not used in travel time analysis. Hatchery chinook smolt mean travel time steadily declined throughout the spring emigration season.

Natural chinook salmon smolt mean or median travel time from the Imnaha River to Lower Granite Dam was significantly ($p < 0.05$) faster compared to hatchery chinook smolt movement during two consecutive weeks ending April 12 and April 19 (Table 34). Natural chinook smolts emigrated significantly faster during this time even though they were significantly smaller in fork length ($p < 0.05$) than their hatchery reared counterparts.

Table 34. Comparison of mean and median travel time between weekly PIT tag release groups of **Imnaha River natural** and hatchery reared chinook salmon smolts from the Imnaha River screw trap to Lower Granite Dam in 1997.

Week Ending	<u>Sample Size (n)</u>		<u>Mean Travel Time (days)</u>		Statistical Test	Significance Level
	Natural Chinook	Hatchery Chinook	Natural Chinook	Hatchery Chinook		
April 12	23	123	12.9	22.7	Wilcoxon	$p < 0.05$
April 19	12	83	5.2	21.5	t-test	$p < 0.05$

Natural steelhead trout smolts were PIT tagged and released during nine weeks of trapping from April 15 to June 25. Mean travel time from the screw trap to LGR ranged from 2.2 days for the May 17 release group to 4.7 days for the April 26 and May 3 release groups (Figure 42). Travel time to Lower Granite Dam generally decreased throughout the emigration period. The June 7, June 14 and June 28 PIT tag release groups had less than 10 interrogations which precluded further travel time analysis.

Hatchery steelhead trout smolts were PIT tagged during eleven weeks of trapping. Mean travel time from the screw trap to LGR ranged from 2.9 days for fish released the week ending June 14 to 10.4 days for fish released the week ending April 26 (Figure 42). Mean travel time to LGR from weekly PIT tag release groups of hatchery steelhead fluctuated throughout the spring emigration period, but generally decreased over time.

Natural steelhead trout smolt median travel time, from the Imnaha River to Lower Granite Dam, was significantly faster ($p < 0.05$) than hatchery steelhead smolts during four out of

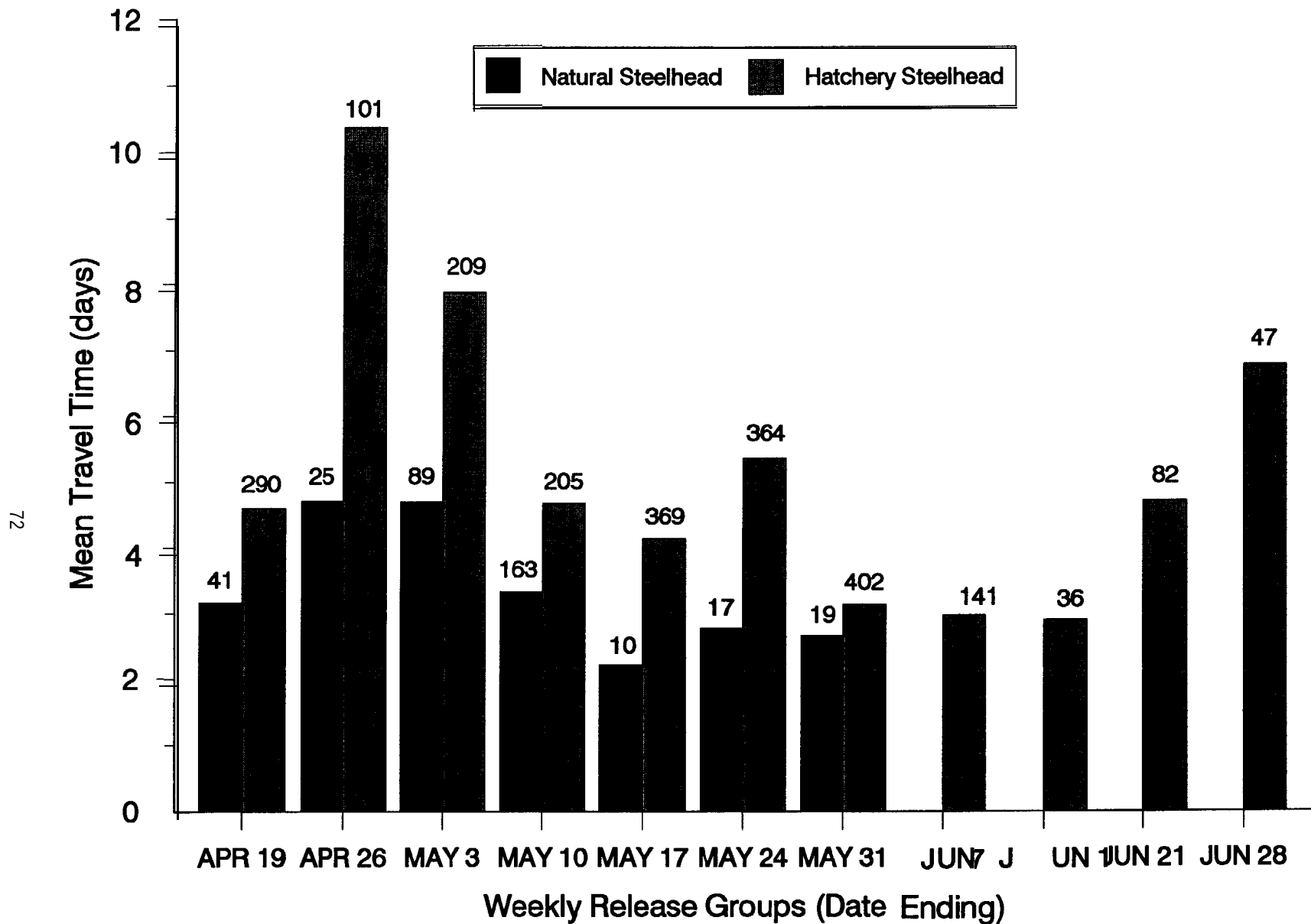


Figure 42. Mean travel time, by weekly PIT tag release group, of natural and hatchery steelheadtrout smolts from the Imnaha River to Lower Granite Dam, April 19 to July 24, 1997 (sample size on top).

the seven weeks when comparisons were made (Table 35). This occurred even though natural steelhead smolts were significantly smaller in fork length ($p < 0.05$) than hatchery reared smolts (Table 19). Natural steelhead smolt average fork length ranged between 158-195 mm compared to 206-215 mm for hatchery smolts during the five week period (Table 19). Natural steelhead smolt emigration was significantly faster for three consecutive weeks ending April 26, May 3, and May 10 and during the week ending **on May 24**. **There** was no significant difference ($p > 0.05$) between hatchery and natural steelhead median travel time for the April 19, May 17, and May 31 release groups (Table 35).

Table 35. Comparison of median travel time (Wilcoxon test) between weekly PIT tag release groups of Imnaha River natural and hatchery reared steelhead trout smolts **from** the Imnaha River screw trap to Lower Granite Dam in 1997.

Week Ending	<u>Sample Size (n)</u>		<u>Mean Travel Time (days)</u>		Statistical Test	Significance Level
	Natural Steelhead	Hatchery Steelhead	Natural Steelhead	Hatchery Steelhead		
April 19	41	290	3.2	4.6	Wilcoxon	$p > 0.05$
April 26	25	101	4.7	10.4	Wilcoxon	$p < 0.05$
May 3	89	209	4.7	7.9	Wilcoxon	$p < 0.05$
May 10	163	205	3.3	4.7	Wilcoxon	$p < 0.05$
May 17	10	369	2.2	4.1	Wilcoxon	$p > 0.05$
May 24	17	364	2.8	5.4	Wilcoxon	$p < 0.05$
May 31	19	402	2.7	3.1	Wilcoxon	$p > 0.05$

SUMMARY

For the fourth consecutive year, the Nez Perce Tribe, in conjunction with the Fish Passage Center, participated in the smolt monitoring program in the Imnaha River. The Nez Perce Tribe's continuing efforts were aimed at providing the Fish Passage Center with in-season information regarding natural and hatchery chinook salmon and steelhead trout smolt emigration from the Imnaha River. This tributary specific information is then used to make flow recommendations and spill requests in the Snake and Columbia River to benefit survival of emigrating anadromous smolts. A screw trap was used to capture emigrating smolts from February 25 to June 27, 1997.

A total of 270 natural chinook salmon, 10,616 hatchery chinook salmon, 864 natural steelhead trout smolts (and 13 natural steelhead parr) and 7,345 hatchery steelhead trout smolts

were captured during the study. Emigrating natural chinook salmon smolts averaged 108 mm in fork length, 13 g in weight and the mean condition factor was 1.02. Weekly mean fork lengths of natural chinook salmon smolts ranged from 103 to 111 mm during the emigration period. Natural chinook smolts were also significantly smaller ($p < 0.05$) in fork length than hatchery reared chinook smolts. Hatchery chinook salmon smolts were noticeably larger than their natural counterparts having a mean length of 131 mm, mean weight of 25.4 g and mean condition factor of 1.12. Natural steelhead trout smolts averaged 175 mm in length, 55.8 g in weight and had a mean condition factor of 1.00. Hatchery steelhead trout were significantly larger than their natural counterparts ($p < 0.05$) averaging 210 mm in length, 88 g in weight and 0.93 in condition factor. Condition factors of hatchery steelhead ranged from 0.91 to 0.98 for the first eight weeks after release and declined to between 0.87 and 0.89 for the remaining three weeks of trap operation.

Peak natural chinook smolt emigration from the Imnaha River, based on number of fish collected, occurred between March 25 and April 30 but it is believed that a large percentage of natural chinook emigrated prior to the start of trapping due to a January 1 flood event. Natural chinook salmon smolts made up 1.4% of the total fish catch.

During six consecutive nights, after hatchery chinook smolts were first captured at the trap, 95.8% of the smolts trapped were collected and 99.2% of the PIT tagged smolts trapped were collected. Hatchery chinook smolts comprised 55.6% of the total target species catch. In 1997, unlike past years, SURPH model survival estimates were relied on solely to estimate post-release survival and smolt yield of hatchery chinook salmon smolts from acclimation facility release to the lower Imnaha River screw trap. Survival for PIT tagged hatchery chinook salmon smolts, from release at the Imnaha River acclimation facility to the screw trap, was estimated at 89.2% using the SURPH model. This represented a smolt yield of 46,384 fish at the screw trap out of approximately 52,000 hatchery chinook smolts released. Based on this estimate of survival 22% of the surviving PIT tagged hatchery chinook smolts should have been interrogated at the screw trap. We interrogated 19.6% ($n=2,624$) of the previously PIT tagged hatchery chinook smolts at the screw trap.

Natural steelhead trout smolt emigration occurred from March 14 until trap operation stopped. Steelhead smolt catch comprised 4.6% of the target species catch. The peak in emigration (from trap catch) occurred from May 1 to May 15. Small numbers of emigrating natural steelhead smolts were captured in June.

ODFW released approximately of 327,460 hatchery reared steelhead trout smolts in Little Sheep Creek. During the study period, 2.2% of the hatchery reared steelhead smolts were captured representing 38.4% of the total target species catch. At the conclusion of the study period hatchery steelhead trout smolts were still being caught at a rate of 8-20 fish per day.

Mortality rates associated with trapping, handling and PIT tagging were low, being 0.37% for natural chinook salmon, 0.11% for hatchery chinook salmon, 0.11% for natural steelhead

trout, and 0.39% for hatchery steelhead trout smolts. Trapping related mortality was the most significant source of mortality.

We interrogated 2,624 (19.6%) of the 13,378 PIT tagged hatchery chinook salmon smolts, released by ODFW from the Imnaha River acclimation pond on April 7 and 8. The majority of observations (55%) were interrogated by April 10. Mean travel time for hatchery chinook salmon smolts to the Imnaha River screw trap was four days with the 90% arrival date occurring on April 13. We also interrogated two of the 8 12 PIT tagged hatchery steelhead trout released from the Little Sheep Creek site on April 15.

Spring runoff water conditions in 1997 provided above average flows for emigrating anadromous salmonid smolts. Imnaha River mean daily discharge during spring emigration ranged from 7.4 cms (260 cfs) on March 9 to 96.6 cms (3,410 cfs) on April 20 at USGS gauge 13292000, Imnaha, OR. Snake River discharge measured at the Anatone gauge station, ranged from 61.1 to 152 kcfs from April 15 to May 18. River discharge at LGR ranged from 79.6 kcfs on March 6 to 225.3 kcfs on May 18. Flows at LGR were generally greater than 100 kcfs during most of the spring runoff period, and discharge exceeded 120 kcfs from March 20 - 31 and April 19 to June 24. The water spill period at LGR occurred continuously from April 10 to June 29 with peak spill of 101.9 kcfs occurring on May 17.

We PIT tagged and released 238 natural chinook salmon smolts during the study period but they may not be representative of the population at large because of a January 1 flood event. Cumulative interrogations at Snake River and Columbia River dams were 67.2% ($n = 160$). Cumulative interrogations ($n > 30$) ranged from 67.5% for the April 19 release group to 70.2% for fish released the week ending April 12. Survival from the Imnaha River screw trap to Lower Granite Dam was estimated to be 89.8% for PIT tagged natural chinook salmon smolts. Imnaha River natural chinook salmon smolts arrived at LGR between April 6 and May 18 with median and 90% passage dates of April 22 and May 11, respectively. Natural chinook smolts emigrated past Little Goose Dam between April 15 and May 22. The median passage date at LGO was April 26 and 90% of natural chinook smolt passage occurred by May 11. Peaks in arrival timing occurred in late April at the three Snake River dams. Natural chinook smolt diel passage at Lower Monumental Dam indicated that nighttime passage was 53.1% during the one week period examined with sunset to midnight passage being four times greater than midnight to sunrise. Mean travel time of PIT tagged natural chinook salmon from the Imnaha River screw trap to LGR ranged from 5 days for the April 19 release group to 18 days for fish tagged and released by April 5. Natural chinook salmon smolt mean or median travel time to LGR was significantly faster ($p < 0.05$) than hatchery chinook smolt travel time even though natural chinook were significantly smaller in fork length ($p < 0.05$) than their hatchery counterparts.

A total of 1,000 hatchery chinook salmon smolts were PIT tagged and released in the Imnaha River during the study period. Of the 1,000 PIT tagged hatchery chinook salmon smolts released at the Imnaha River screw trap, 53.8% ($n=538$) of the fish were cumulatively interrogated at Snake River and Columbia River dams. Cumulative interrogation percentages for

weekly release groups with sufficient sample sizes (April 12 and 19) were both 53%. The estimated survival of PIT tagged hatchery chinook salmon smolts released between April 10 and April 18 from the Imnaha River screw trap to Lower Granite Dam was 80.4%. This estimate was the highest survival observed for hatchery chinook smolts since 1994. Survival of PIT tagged hatchery chinook smolts from the Imnaha River acclimation facility to the screw trap was 89.2%.

Hatchery chinook salmon smolts arrived at Lower Granite Dam from April 16 to May 22, at Little Goose Dam from April 20 to May 27, at Lower Monumental Dam from April 25 to June 3, and McNary Dam from May 1 to June 1. Median and 90% passage dates for hatchery reared chinook occurred at Lower Granite on May 5 and May 14 and at Little Goose Dams on May 9 and May 18. May 10 and May 19 were the median and 90% passage dates for hatchery chinook smolts at Lower Monumental Dam and McNary Dam in 1997. Peak in arrival of hatchery chinook salmon at Lower Granite, Little Goose, Lower Monumental, McNary dams occurred in early May. Daytime diel passage frequency at Lower Granite Dam ranged from 50.7 to 63.8% over a three week period. The majority of nighttime passage occurred from sunset to midnight as compared to passage between midnight to sunrise. Mean travel time of PIT tagged hatchery chinook salmon smolts to Lower Granite Dam ranged from 11.7 days for the May 3 weekly release group to 22.7 days for those fish released the week of April 12. Hatchery chinook smolt mean travel time to LGR steadily declined throughout the spring emigration season.

A total of 588 (75.2%) of the 782 PIT tagged natural steelhead trout smolts released at the Imnaha River screw trap were interrogated at mainstem dams. Cumulative interrogation of weekly release groups ranged from 62.2% for the April 19 release group to 80% for the May 3 1 release group. Survival of natural steelhead trout smolts PIT tagged and released at the Imnaha River screw trap, from April 16 to May 9, to Lower Granite Dam was 90.2% and fell within the range observed in 1994 and 1996. Natural steelhead trout smolts arrived at Lower Granite Dam from April 20 to July 10 with median and 90% passage dates of May 8 and May 24, respectively. Natural steelhead smolt arrival occurred at Little Goose from April 20 to June 19, at Lower Monumental from April 21 to June 6 and at McNary Dam from April 24 to June 5. The 90% passage date at Little Goose was on May 26, at Lower Monumental was May 25 and at McNary Dam occurred by May 18. Daytime passage at Lower Granite Dam ranged from 61.8 to 80.7% over a four week period. Nighttime diel passage occurred at a 19.4 to 38.2% rate. Passage from sunset to midnight was greater than passage from midnight to sunrise during three out of four weeks. Diel emigration past Little Goose Dam during daytime hours ranged from 53.3 to 60.5% over a four week period. Nighttime passage at LGO ranged from 39.5 to 46.6%. Average weekly diel passage of natural steelhead smolts at Lower Monumental Dam ranged from 43.8 to 62.7% during the nighttime for a three week period. Sunset to midnight passage exceeded the midnight to sunrise passage for all three weeks with peaks in movement occurring shortly after sunset. Mean travel time from the Imnaha River screw trap to Lower Granite Dam for natural steelhead smolts ranged from 2.2 days for the May 17 release group to 4.7 days for the April 26 and May 3 release groups. Natural steelhead trout smolt median travel time was significantly faster ($p < 0.05$) than hatchery steelhead smolts during four out of seven weeks when comparisons were made. This occurred even though natural steelhead smolts were significantly smaller in fork length ($p < 0.05$) than hatchery reared smolts.

We PIT tagged 6,117 hatchery steelhead trout smolts in the Imnaha River during the study period. Cumulative interrogations observed at Snake River and Columbia River dams represented 62% (**n=3,794**) of the PIT tagged hatchery steelhead trout. Cumulative interrogations of weekly PIT tag release groups for hatchery steelhead trout smolts ranged from 49.1% to 75.3% over an eleven week period. Survival for seven groups of hatchery steelhead trout smolts from the Imnaha River screw trap to Lower Granite Dam ranged from 71.4% to 89.1% in 1997. From 1994 to 1996 the survival of PIT tagged hatchery steelhead trout smolts to Lower Granite Dam has ranged from 51.4% to 91.4%. Imnaha River hatchery steelhead trout smolts arrived at Lower Granite Dam from April 19 to July 24, at Little Goose Dam from April 21 to August 23, at Lower Monumental Dam from April 22 to August 6, and at McNary Dam from April 23 to August 12. The median and 90% passage dates for hatchery steelhead smolts at LGR occurred on May 23 and June 13. The 90% passage date for PIT tagged hatchery steelhead trout at Little Goose Dam, Lower Monumental Dam, and McNary occurred on June 13, June 15, and June 18, respectively. Three peaks occurred at all dams with the most prominent ones being in late May to early June. The general trend at each dam was a long protracted emigration. Diel daytime passage at LGR ranged from 44.1 to 71.1% and exceeded 50% during ten of the eleven weeks. Sunset to midnight passage was more prominent at LGR than midnight to sunrise passage for hatchery steelhead smolts for eight of eleven weeks. Diel passage at Little Goose Dam was largely daytime passage (54.2-86.5%) for the eleven weeks between April 20 and July 5 with peaks in passage occurring during the day for eight weeks. Combined nighttime passage ranged from 13.5 to 45.7% and generally decreased over the passage season. Diel passage at Little Goose Dam from sunset to midnight exceeded the midnight to sunrise passage during eight out of eleven weeks. Daytime diel passage at Lower Monumental Dam ranged between 39.1 to 75% over a ten week period and increased over that period to three times as high as the dark period for the week ending June 28. Diel passage at McNary Dam was examined for a three week period from May 18 to June 1 with sample sizes used for trend information only, Daytime passage exceeded nighttime passage for all three weeks and ranged from 58.5 to 64.7%. Mean travel time of hatchery steelhead trout smolts from the Imnaha River screw trap to Lower Granite Dam ranged from 2.9 days for the June 14 weekly release group to 10.4 days for fish released the week ending April 26.

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Table A. 1. Imnaha River daily minimum, maximum, and mean water temperatures in degrees Celsius from February 23 to June 25,1997.

DATE	MEAN	MAX	MIN	DATE	MEAN	MAX	MIN
02/23/97	4.2	5.7	2.9	03/17/97	8.8	10.1	7.6
02/24/97	3.9	5.3	2.1	03/18/97	9.1	10.6	7.6
02/25/97	4.0	5.1	3.0	03/19/97	9.7	10.7	8.7
02/26/97	4.9	5.7	4.4	03/20/97	8.5	9.6	7.6
02/27/97	5.0	6.0	4.3	03/21/97	8.5	7.4	5.3
02/28/97	3.9	4.9	2.7	03/22/97	6.7	7.8	5.7
03/01/97	4.1	4.8	3.4	03/23/97	7.7	8.9	6.9
03/02/97	4.8	5.8	4.2	03/24/97	7.3	8.5	6.0
03/03/97	4.8	5.4	4.2	03/25/97	7.5	9.4	6.0
03/04/97	3.9	4.6	3.0	03/26/97	8.6	9.8	7.6
03/05/97	4.1	5.3	2.9	03/27/97	8.0	9.3	8.9
03/06/97	5.2	7.0	4.2	03/28/97	6.9	7.4	6.2
03/07/97	8.1	7.3	5.1	03/29/97	8.3	7.8	4.8
03/08/97	6.2	7.6	5.3	03/30/97	6.9	7.9	6.0
03/09/97	5.6	6.4	4.9	03/31/97	7.5	8.1	6.7
03/10/97	6.2	6.7	6.0	04/01/97	5.9	6.6	5.2
03/11/97	6.5	8.5	5.3	04/02/97	5.4	7.4	3.5
03/12/97	7.4	8.4	8.4	04/03/97	6.6	8.4	5.2
03/13/97	5.4	7.1	4.2	04/04/97	6.5	7.4	5.5
03/14/97	4.4	5.1	3.3	04/05/97	5.5	7.0	4.1
03/15/97	4.5	6.7	3.2	04/06/97	6.1	8.1	4.1
03/16/97	7.3	9.0	5.9	04/07/97	7.2	8.8	5.8

Table A.1 (continued).

DATE	MEAN	MAX	MIN	DATE	MEAN	MAX	MIN
04/08/97	7.7	8.5	7.0	05/04/97	10.2	11.2	9.3
04/09/97	7.9	9.5	6.5	05/05/97	9.9	10.6	9.0
04/10/97	7.8	8.8	6.9	05/06/97	9.8	10.4	9.0
04/11/97	8.9	8.8	5.1	05/07/97	9.1	10.5	7.8
04/12/97	7.1	9.4	5.0	05/08/97	9.6	10.9	8.0
04/13/97	7.7	8.5	6.5	05/09/97	10.5	11.8	9.1
04/14/97	7.9	8.7	7.2	05/10/97	10.8	11.8	9.6
04/15/97	9.7	11.8	8.1	05/11/97	10.6	11.8	9.2
04/16/97	10.4	11.4	9.4	05/12/97	10.5	11.8	9.0
04/17/97	10.3	11.0	9.5	05/13/97	10.9	12.1	9.6
04/18/97	8.7	9.3	7.8	05/14/97	10.7	11.8	9.1
04/19/97	8.9	9.3	8.5	05/15/97	11.1	12.3	9.6
04/20/97	8.5	8.9	8.1	05/16/97	10.9	12.0	9.6
04/21/97	7.6	8.5	6.3	05/17/97	10.8	11.8	9.8
04/22/97	8.3	9.5	7.0	05/18/97	10.0	11.0	8.6
04/23/97	7.9	8.9	7.4	05/19/97	10.1	11.5	8.5
04/24/97	7.0	7.3	6.7	05/20/97	10.8	11.6	9.8
04/25/97	8.1	9.5	6.8	05/21/97	10.2	11.2	8.9
04/26/97	9.5	10.9	8.1	05/22/97	10.8	11.5	9.5
04/27/97	9.4	10.6	8.5	05/23/97	10.4	11.2	9.8
04/28/97	7.8	8.4	7.3	05/24/97	9.4	9.8	9.2
04/29/97	8.0	8.9	7.1	05/25/97	8.8	9.2	8.2
04/30/97	7.6	8.2	7.1	05/26/97	9.5	10.6	8.2
05/01/97	7.0	7.6	6.4	05/27/97	10.5	11.8	9.2
05/02/97	7.1	8.5	5.6	05/28/97	11.1	12.0	10.0
05/03/97	8.9	10.4	7.6	05/29/97	11.8	12.8	11.0

Table A. 1 (continued).

DATE	MEAN	MAX	MIN	DATE	MEAN	MAX	MIN
05/30/97	12.3	13.3	11.2	06/13/97	10.5	11.3	10.0
05/31/97	13.1	14.4	11.8	06/14/97	12.3	13.9	10.8
06/01/97	12.1	13.1	11.2	06/15/97	13.1	14.2	11.8
06/02/97	12.0	13.4	10.6	06/16/97	13.0	13.9	12.1
06/03/97	11.9	12.5	11.5	06/17/97	12.5	13.2	11.8
06/04/97	11.5	12.2	10.6	06/18/97	12.9	13.7	12.3
06/05/97	10.3	10.9	9.8	06/19/97	12.8	13.9	11.8
06/06/97	11.2	12.5	10.2	06/20/97	12.5	13.7	11.2
06/07/97	12.0	13.2	10.6	06/21/97	11.9	12.6	10.9
06/08/97	12.9	14.4	11.5	06/22/97	12.5	14.1	11.1
06/09/97	13.0	14.0	11.8	06/23/97	12.4	13.6	11.5
06/10/97	12.1	13.4	11.1	06/24/97	12.5	14.7	10.5
06/11/97	11.8	12.8	11.0	06/25/97	12.4	12.9	12.0
06/12/97	11.0	12.3	10.2				

Table A.2. Imnaha River daily staff gauge measurements and discharge readings from USGS gauge 1329200 at Imnaha, OR. February 25 - June 27, 1997.
(NR = No reading, Q = discharge (cfs), staff measure in meters).

DATE	STAFF	Q	DATE	STAFF	Q
02/25/97	NR	276	04/03/97	0.68	723
02/26/97	NR	279	04/04/97	0.68	733
02/27/97	NR	287	04/05/97	NR	697
02/28/97	NR	280	04/06/97	0.63	645
03/01/97	NR	274	04/07/97	0.64	623
03/02/97	NR	290	04/08/97	0.68	623
03/03/97	NR	285	04/09/97	0.62	611
03/04/97	NR	259	04/10/97	0.60	606
03/05/97	NR	260	04/11/97	0.61	566
03/06/97	NR	264	04/12/97	0.59	545
03/07/97	NR	261	04/13/97	0.60	556
03/08/97	NR	269	04/14/97	0.59	566
03/09/97	NR	260	04/15/97	0.61	591
03/10/97	0.44	281	04/16/97	0.66	718
03/11/97	0.48	309	04/17/97	0.82	1100
03/12/97	0.44	335	04/18/97	0.96	1450
03/13/97	0.49	332	04/19/97	NR	2120
03/14/97	0.48	332	04/20/97	1.50	3410
03/15/97	NR	343	04/21/97	1.50	3370
03/16/97	0.48	354	04/22/97	1.20	2560
03/17/97	0.56	497	04/23/97	1.22	2520
03/18/97	0.61	552	04/24/97	1.14	2250
03/19/97	0.70	783	04/25/97	1.10	2030
03/20/97	NR	1240	04/26/97	NR	2010
03/21/97	0.95	1390	04/27/97	1.15	2340
03/22/97	NR	1240	04/28/97	1.19	2320
03/23/97	0.84	1190	04/29/97	1.10	2110
03/24/97	0.80	1090	04/30/97	1.06	1940
03/25/97	0.79	1020	05/01/97	1.01	1760
03/26/97	0.86	1110	05/02/97	0.98	1570
03/27/97	0.86	1340	05/03/97	NR	1460
03/28/97	0.88	1220	05/04/97	0.94	1560
03/29/97	NR	1060	05/05/97	0.98	1650
03/30/97	0.74	975	05/06/97	1.02	1800
03/31/97	0.74	937	05/07/97	1.01	1810
04/01/97	0.72	851	05/08/97	1.05	1840
04/02/97	0.68	760	05/09/97	1.07	1980

Table A.2 (continued).

DATE	STAFF	Q	DATE	STAFF	Q
05/10/97	NR	2190	06/04/97	1.06	2120
05/11/97	1.14	2460	06/05/97	1.06	2110
05/12/97	1.24	2530	06/06/97	1.01	1860
05/13/97	1.20	2630	06/07/97	NR	1750
05/14/97	1.32	2740	06/08/97	NR	1660
05/15/97	1.28	2790	06/09/97	NR	1890
05/16/97	NR	3000	06/10/97	0.96	1680
05/17/97	NR	2940	06/11/97	0.98	1780
05/18/97	1.20	2710	06/12/97	1.08	2100
05/19/97	1.20	2360	06/13/97	1.07	2010
05/20/97	1.15	2220	06/14/97	NR	2020
05/21/97	1.09	2110	06/15/97	NR	2030
05/22/97	1.04	1940	06/16/97	1.02	1990
05/23/97	1.04	1890	06/17/97	1.00	1960
05/24/97	NR	1950	06/18/97	1.04	1960
05/25/97	NR	2730	06/19/97	0.99	1790
05/26/97	0.90	1560	06/20/97	0.97	1590
05/27/97	0.89	1460	06/21/97	NR	1460
05/28/97	0.91	1440	06/22/97	0.85	1340
05/29/97	0.90	1520	06/23/97	0.83	1270
05/30/97	NR	1700	06/24/97	0.80	1140
05/31/97	NR	1880	06/25/97	0.80	1110
06/01/97	1.06	2150	06/26/97	0.80	1160
06/02/97	1.07	1960	06/27/97	0.84	1230
06/03/97	1.03	1900			

Table B.1 Fish composition of Imnaha River screw trap February, 1997

Date	Chinook			Steelhead			Total Catch
	Natural	Hatchery	Total	Natural	Hatchery	Total	
25	1	0	1	0	0	0	1
26*							
27*							
28*							
Total	1	0	1	0	0	0	1

* Trap not operated. See details in Table 4.

Table B.2. Fish composition of Imnaha River screw trap, March, 1997.

Date	Chinook			Steelhead			Total Catch
	Natural	Hatchery	Total	Natural	Hatchery	Total	
1*							
2*							
3*							
4*							
5*							
6*							
7*							
8*							
9*							
10	1	0		0	0		1
11	0	0		0	0		0
12	4	0		0	0		4
13	1	0		0	0		1
14	0	0		1	0		1
15*							
16*							
17	0	0		0	0		0
18~	0	0		1	0		1
19~	2	0		0	0		2
20~	2	0		0	0		2
21~	0	0		0	1		1
22*							
23*							
24	1	0		2	0		3
25	9	0		1	0		10
26	2	0		5	0		7
27	6	0		2	0		8
28	2	0		3	0		5
29*							
30*							
31	1	0		0	0		1
Total	31	0		15	1		47

* Trap not operated. See details in Table 4.

~ Irregular trap operation.

Table B.3 Fish composition of Imnaha River screw trap April, 1997

Date	Chinook			Steelhead			Total Catch
	Natural	Hatchery	Total	Natural	Hatchery	Total	
1	7	0	7	2	0	2	9
2	32	0	32	6	0	6	38
3~	14	0	14	5	0	5	19
4	17	0	17	1	0	1	18
5*							
6*							
7	7	0	7	6	0	6	13
8	11	0	11	3	0	3	14
9	7	95	102	1	0	1	103
10	15	3,978	3,993	3	0	3	3,996
11	10	2,785	2,795	6	0	6	2,801
12	14	1,729	1,743	4	1	5	1,748
13	8	974	982	13	0	13	995
14	7	420	427	16	0	16	443
15	5	287	292	9	1	10	302
16	7	106	113	26	251	277	390
17~	9	75	84	9	124	133	217
18	4	78	82	71	563	634	716
19*							
20*							
21*							
22*							0
23	3	2	5	27	77	104	109
24~	7	0	7	16	62	78	85
25~	12	12	24	28	107	135	159
26*							0
27*							0
28	0	0	0	13	12	25	25
29	10	5	15	12	61	73	88
30	7	27	34	19	87	106	140
Total	213	10,573	10,786	296	346	642	12,428

* Trap not operated. See details in Table 4

~ Irregular trap operation.

Table B.4. Fish composition of Imnaha River screw trap, May, 1997.

Date	Chinook			Steelhead			Total Catch
	Natural	Hatchery	Total	Natural	Hatchery	Total	
1	12	23	35	51	178	229	264
2	1	1	2	65	128	193	195
3*							
4*							
5	3	15	18	121	133	254	272
6~	0	1	1	21	43	64	65
7~	1	0	1	67	147	214	215
8	0	1	1	61	200	261	262
9	1	2	3	52	231	283	286
10*							
11*							
12	0	0	0	14	218	232	232
13~	0	0	0	0	0	0	0
14	0	0	0	3	997	1000	1000
15	0	0	0	3	524	527	527
16	0	0	0	2	200	202	202
17*							
18*							
19	0	0	0	1	93	94	94
20~	0	0	0	0	54	54	54
21~	0	0	0	2	67	69	69
22~	1	0	1	27	266	293	294
23	1	0	1	19	490	509	510
24*							
25*							
26*							
27	0	0	0	4	100	104	104
28	0	0	0	16	239	255	255
29	1	0	1	10	190	200	201
30	2	0	2	15	401	416	418
31*							
Total	23	43	66	554	4,899	5,453	5,519

* Trap not operated. See details in Table 4.

~ Irregular trap operation.

Table B.5. Fish composition of Imnaha River screw trap, June, 1997.

Date	Chinook			Steelhead			Total Catch
	Natural	Hatchery	Total	Natural	Hatchery	Total	
1*							
2	0	0	0	5	140	145	145
3~	1	0	1	2	217	219	220
4	0	0	0	1	90	91	91
5	0	0	0	0	2	2	2
6	0	0	0	1	52	53	53
7*							
8*							
9~	0	0	0	0	69	69	69
10	1	0	1	0	100	100	101
11	0	0	0	0	120	120	120
12~	0	0	0	1	39	40	40
13	0	0	0	1	10	10	11
14*	0	0					
15*							
16*							
17	0	0	0	0	34	34	34
18	0	0	0	0	35	35	35
19	0	0	0	0	106	106	106
20	0	0	0	0	7	7	7
21*							
22*							
23	0	0	0	0	13	13	13
24	0	0	0	0	23	23	23
25	0	0	0	1	14	15	15
26	0	0	0	0	8	8	8
27	0	0	0	0	20	20	20
Total	2	0	2	12	1,099	1,111	1,113

* Trap not operated. See details in Table 4.

~ Irregular trap operation.

Table C. Releases of hatchery chinook salmon and steelhead trout smolts by ODFW in the Imnaha River, 1997.

Date	Species	Number Released	Fin Mark	Release Strategy	Location
04/7-8/97	CH	52,000	Ad + CWT	Acclimated	Imnaha Acclimation Pond (RKM 74)
	Total	52,000			
04/15/97	RBT	208,936	AdLV + CWT (23%) Ad (77%)	Acclimated	Little Sheep Acclimation Pond (RKM 8)
05/13/97	RBT	118,524	Ad	Acclimated	Little Sheep Acclimation Pond (RKM 8)
	Total	327,460			

Table D.1. Mean daily length, weight, and condition factor of natural chinook salmon smolts sampled at the Imnaha screw trap, February 25 to June 27, 1997.

Date	Number Sampled (n)	Mean Length	Standard Deviation	Mean Weight	Standard Deviation	Mean Condition	Standard Deviation
2/25	1	91	0.0	na	na	na	na
3/10	1	110	0.0	na	na	na	na
3/12	4	110	12.3	13.5	4.8	0.97	0.05
3/13	1	91	0.0	7.9	0.0	1.05	0.00
3/19	2	101	2.8	na	na	na	na
3/20	2	111	2.1	na	na	na	na
3/24	1	100	0.0	15.5	0.0	1.55	0.00
3/25	8	103	4.8	11.4	1.6	1.06	0.06
3/26	2	112	2.1	16.4	4.5	1.17	0.25
3/27	6	102	8.8	11.5	3.9	1.05	0.07
3/28	2	101	0.7	10.1	0.5	0.99	0.07
3/31	1	na	na	na	na	na	na
4/01	7	105	5.3	11.5	1.7	0.98	0.06
4/02	32	113	7.6	12.9	3.6	0.89	0.12
4/03	14	110	5.1	11.8	1.7	0.88	0.03
4/04	16	111	7.5	12.9	2.5	0.93	0.08
4/07	7	111	11.9	11.8	3.7	0.84	0.05
4/08	11	110	5.8	12.9	2.0	0.96	0.09
4/09	5	108	12.8	11.6	2.5	0.93	0.18
4/10	13	104	8.7	12.1	2.4	1.08	0.14
4/11	10	107	11.9	14.1	5.5	1.11	0.09
4/12	14	106	10.4	13.8	4.7	1.11	0.07
4/13	8	107	3.1	13.4	1.2	1.10	0.10
4/14	7	111	14.1	14.9	6.9	1.04	0.11
4/15	5	112	7.3	15.3	3.2	1.07	0.09
4/16	7	112	8.9	15.1	2.3	1.07	0.11
4/17	9	112	8.3	14.9	3.9	1.03	0.13
4/18	4	112	4.1	11.7	1.6	0.84	0.04
4/23	3	103	8.5	11.3	2.6	1.03	0.07
4/24	7	106	15.2	15.0	7.8	na	na
4/25	12	105	7.7	13.1	2.6	1.12	0.07
4/29	10	106	7.1	12.9	2.4	1.09	0.10
4/30	7	102	9.1	11.0	2.6	1.01	0.08
5/01	12	107	6.7	13.9	2.7	1.15	0.08
5/02	1	na	na	na	na	na	na
5/05	3	113	5.1	16.2	2.6	1.11	0.05
5/07	1	116	0.0	16.2	0.0	1.04	0.00
5/09	1	na	na	na	na	na	na
5/22	1	112	0.0	17.1	0.0	1.22	0.00

Table D.1 (continued).

Date	Number Sampled (n)	Mean Length	Standard Deviation	Mean Weight	Standard Deviation	Mean Condition	Standard Deviation
5/23	1	145	0.0	na	na	na	na
5/30	2	141	15.6	16.2	7.8	1.14	0.09
6/03	1	128	0.0	23.8	0.0	1.13	0.00
6/10	1	116	0.0	17.6	0.0	1.13	0.00

Table D.2. Mean daily length, weight, and condition factor of hatchery chinook salmon smolts sampled at the Imnaha screw trap, February 25 to June 27, 1997.

Date	Number Sampled (n)	Mean Length	Standard Deviation	Mean Weight	Standard Deviation	Mean Condition	Standard Deviation
4/09	94	133	10.2	25.4	5.8	1.07	0.16
4/10	1,572	132	10.3	25.7	7.2	1.09	0.10
4/11	795	132	10.7	26.4	6.6	1.21	0.14
4/12	500	131	10.7	25.9	7.1	1.19	0.10
4/13	332	130	11.4	25.3	6.2	1.20	0.13
4/14	209	130	10.0	24.5	6.6	1.11	0.10
4/15	235	131	10.0	23.4	6.5	1.07	0.12
4/16	103	131	11.8	86.9	0.0	1.09	0.00
4/17	74	131	10.6	12.3	0.0	1.09	0.00
4/18	78	131	12.7	12.3	0.0	1.09	0.00
4/23	2	117	2.8	16.7	0.7	1.05	0.04
4/25	12	126	9.0	22.0	4.7	1.07	0.08
4/29	5	134	5.1	26.3	4.2	1.09	0.06
4/30	27	130	9.9	23.4	7.4	1.03	0.10
5/01	22	127	10.7	23.4	5.8	1.11	0.07
5/05	11	128	0.0	20.1	5.6	1.08	0.09
5/06	1	135	0.0	24.9	0.0	1.01	0.00
5/08	1	127	0.0	17.6	0.0	0.86	0.00
5/09	2	127	14.1	21.5	6.1	1.04	0.05

Table D.3. Mean daily length, weight, and condition factor of natural steelhead smolts sampled at the Imnaha screw trap, February 25 to June 27, 1997.

Date	Number Sampled (n)	Mean Length	Standard Deviation	Mean Weight	Standard Deviation	Mean Condition	Standard Deviation
3/14	1	94	0.0	na	na	na	na
3/18	1	140	12.0	28.9	0.0	1.05	0.00
3/24	2	147	12.0	34.6	8.2	1.09	0.01
3/26	5	199	28.1	76.3	25.3	0.95	0.10
3/27	1	138	0.0	27.6	0.0	1.05	0.00
3/28	3	163	28.8	43.8	19.1	0.98	0.06
4/01	2	121	0.0	18.5	0.0	1.04	0.00
4/02	6	189	29.4	70.8	24.0	1.02	0.12
4/03	5	184	26.0	66.0	22.0	1.03	0.10
4/04	1	209	0.0	87.6	0.0	0.96	0.00
4/07	6	183	19.9	61.9	20.7	0.99	0.08
4/08	3	216	6.7	86.7	16.5	0.89	0.08
4/09	1	157	0.0	40.3	0.0	1.04	0.00
4/10	3	187	6.1	60.4	5.2	0.95	0.04
4/11	5	173	8.8	50.1	8.5	0.92	0.02
4/12	4	177	20.1	56.7	16.7	1.01	0.15
4/13	12	173	23.3	52.0	26.2	0.96	0.11
4/14	16	183	16.3	60.8	20.0	0.96	0.08
4/15	7	170	12.9	53.5	10.0	1.08	0.17
4/16	23	177	20.9	58.2	18.5	1.02	0.12
4/17	8	194	23.0	65.9	18.4	1.05	0.04
4/18	70	190	24.1	70.4	28.4	0.97	0.08
4/23	26	179	18.0	59.8	15.3	1.02	0.10
4/24	15	170	13.0	54.5	12.1	1.09	0.08
4/25	27	183	20.7	62.4	19.4	0.99	0.07
4/28	13	177	24.2	61.7	21.9	1.09	0.16
4/29	12	161	17.8	47.4	13.3	1.11	0.12
4/30	19	170	19.1	50.8	15.6	1.00	0.08
5/01	51	175	15.4	55.6	13.8	1.03	0.06
5/02	65	180	17.4	61.1	17.4	1.02	0.07
5/05	121	174	17.3	54.2	16.1	1.00	0.09
5/06	21	170	18.8	51.6	17.7	1.01	0.08
5/07	66	176	18.0	55.3	18.8	0.98	0.08
5/08	61	173	17.8	52.8	15.5	0.99	0.07
5/09	51	173	18.3	53.8	20.6	0.99	0.08
5/12	14	165	20.3	47.9	16.4	1.03	0.11
5/14	3	175	14.0	53.4	13.2	1.00	0.14
5/15	3	174	13.7	51.6	7.1	0.98	0.09
5/16	2	155	2.8	38.0	0.4	1.02	0.07
5/19	1	166	0.0	42.7	0.0	0.93	0.00
5/21	2	174	20.5	51.9	17.2	0.98	0.02
5/22	27	163	10.5	43.3	8.7	0.99	0.05

Table D.3 (continued).

Date	Number Sampled (n)	Mean Length	Standard Deviation	Mean Weight	Standard Deviation	Mean Condition	Standard Deviation
5/23	17	189	14.0	48.0	11.9	0.97	0.08
5/27	2	186	17.0	63.7	10.5	1.00	0.11
5/28	16	164	15.4	45.4	11.0	1.03	0.09
5/29	8	161	10.9	46.8	10.7	1.10	0.10
5/30	14	166	12.2	48.2	10.6	0.99	0.11
6/02	5	166	9.8	51.4	8.5	1.10	0.06
6/03	2	164	3.5	44.9	4.2	1.02	0.03
6104	1	170	0.0	46.0	0.0	0.94	0.00
6/06	1	148	0.0	34.4	0.0	1.06	0.00
6/12	1	171	0.0	51.2	0.0	1.02	0.00
6/13	1	165	0.0	49.8	0.0	1.11	0.00
6/25	1	178	0.0	58.0	0.0	0.99	0.00

Table D.4. Mean daily length, weight, and condition factor of hatchery steelhead smolts sampled at the Imnaha screw trap, February 25 to June 27, 1997.

Date	Number Sampled (n)	Mean Length	Standard Deviation	Mean Weight	Standard Deviation	Mean Condition	Standard Deviation
3/21	1	269	0.0	na	na	na	na
4/12	1	178	0.0	69.8	0.0	1.24	0.00
4/15	1	274	0.0	200.0	0.0	0.97	0.00
4/16	249	211	17.8	93.3	23.4	0.98	0.85
4/17	121	210	14.1	86.6	25.7	1.01	0.05
4/18	556	211	16.8	62.4	34.4	1.00	0.01
4/23	76	207	16.7	87.4	21.2	0.96	0.07
4/24	60	207	19.3	92.8	30.1	1.02	0.12
4/25	104	209	16.6	90.6	22.3	0.97	0.07
4/28	12	207	15.6	91.3	17.2	1.02	0.09
4/29	61	205	18.9	88.7	22.8	1.01	0.06
4/30	86	207	17.2	84.6	20.1	0.94	0.06
5/01	174	208	18.5	87.3	25.5	0.98	0.06
5/02	124	209	18.5	92.8	26.5	1.00	0.06
5/05	131	215	20.0	97.7	28.5	0.96	0.06
5/06	43	217	21.6	101.0	34.9	0.96	0.05
5/07	144	212	18.3	97.0	26.9	0.95	0.05
5/08	199	217	19.1	91.8	24.7	0.96	0.13
5/09	65	213	19.4	92.3	24.5	0.94	0.06
5/12	198	204	17.1	83.1	20.8	0.96	0.10
5/14	804	210	19.3	83.3	22.1	0.92	0.08
5/15	30	212	22.8	na	na	na	na
5/16	30	208	20.0	na	na	na	na
5/19	92	206	18.0	82.7	23.6	0.92	0.07
5/20	49	209	18.6	85.8	23.9	0.92	0.05
5/21	66	208	16.4	89.6	22.2	0.96	0.08
5/22	266	209	20.1	86.6	27.5	0.90	0.05
5/23	479	208	19.1	75.9	22.8	0.84	0.07
5/27	95	216	20.1	91.7	27.2	0.89	0.12
5/28	237	210	21.6	83.1	24.3	0.93	0.09
5/29	190	208	21.2	85.4	27.9	0.92	0.09
5/30	396	208	24.6	86.1	31.3	0.90	0.11
6/02	111	208	18.7	86.5	26.4	0.94	0.10
6/03	23	208	22.5	82.9	32.5	0.90	0.07
6/04	87	211	21.7	84.8	28.9	0.90	0.10
6/05	2	201	14.9	77.8	24.7	0.95	0.09
6106	52	202	19.5	76.4	24.8	0.93	0.08
6/09	68	209	25.6	81.9	28.3	0.86	0.08
6/10	100	216	20.0	94.4	28.2	0.90	0.06

Table D.4 (continued).

Date	Number Sampled (n)	Mean Length	Standard Deviation	Mean Weight	Standard Deviation	Mean Condition	Standard Deviation
6/11	120	215	17.6	91.4	21.3	0.86	0.08
6/12	39	221	26.0	na	na	na	na
6/13	10	215	14.4	92.7	17.0	0.92	0.05
6/17	34	208	25.6	81.0	32.0	0.85	0.04
6/18	35	213	19.3	89.4	27.4	0.90	0.05
6/19	104	209	21.9	81.4	25.6	0.87	0.07
6/20	7	225	28.0	102.9	35.5	0.88	0.04
6/23	13	205	23.2	79.4	26.5	0.89	0.05
6/24	23	210	19.4	82.1	23.9	0.86	0.06
6/25	14	209	21.7	86.4	31.9	0.90	0.09
6/26	8	220	29.0	102.6	43.6	0.91	0.05
6/27	20	222	19.7	98.3	25.4	0.88	0.05

Table E.I . Composition of incidental fish species captured in the Imnaha River screw trap, February, 1997.

Date	Species								Total
	STHD	BT	MWF	RSS	LND	NSF	BLS	SC	Catch
									0
25									0
26									0
27									0
28									0
Total	0	0	0	0	0	0	0	0	0

STHD Adult Steelhead Trout

BT Bull Trout

MWF Mountain Whitefish

RSS Redside Shiner

LND

NSF

BLS

SC

Longnose Dace

Northern Squawfish

Bridgelip Sucker

Sculpin

Table E.2. Composition of incidental fish species captured in the Imnaha River screw trap, March, 1997.

Date	Species								Total Catch
	STHD	BT	MWF	RSS	LND	NSF	BLS	SC	
1									0
2									0
3									0
4									0
5									0
6									0
7									0
a									0
9									0
10					1			3	4
11							4	3	7
12							10		10
13							11		11
14	1						3		4
15									0
16									0
17							14		14
1a							2		2
19					1		3		5
20					2				2
21									0
22									0
23					2				2
24									0
25									0
26					5				5
27					6			7	13
28					3				3
29									0
30									0
31					1				1
Total	1	0	1	0	21	0	47	13	83

STHD Adult Steelhead Trout

BT Bull Trout

MWF Mountain Whitefish

RSS Redside Shiner

LND Longnose Dace

NSF Northern Squawfish

BLS Bridgelip Sucker

SC Sculpin

Table E.3. Composition of incidental fish species captured in the Imnaha River screw trap, April, 1997.

Date	Species								Total Catch
	STHD	BT	MWF	RSS	LND	NSF	BLS	SC	
1				1	1				2
2									0
3									0
4	1				1			1	3
5									0
6									0
7					1				1
a	1							1	2
9									0
10									0
11									0
12									0
13									0
14									0
15									1
16					3			1	4
17					2				2
18	1								1
19									0
20									0
21									0
22									0
23									0
24									0
25									0
26									0
27									0
28					1			2	3
29									0
30	1								1
Total	4	1	0	1	9	0	0	5	20

STHD Adult Steelhead Trout
 BT Bull Trout
 MWF Mountain Whitefish
 RSS **Redside** Shiner

LND **Longnose Dace**
 NSF Northern Squawfish
 BLS Bridgelip Sucker
 SC Sculpin

Table E.4. Composition of incidental fish species captured in the Imnaha River screw trap, May, **1997**.

Date	Species								Total Catch
	STHD	BT	MWF	RSS	LND	NSF	BLS	SC	
1	1								1
2									0
3									0
4									0
5	2								2
6									0
7	1								1
8									0
9									0
10									0
11									0
12	1	1							2
13									0
14									0
15									0
16									0
17									0
18									0
19									0
20									0
21	4								4
22	1								1
23	1								1
24									0
25									0
26									0
27									0
28									0
29									0
30					2				2
31									0
Total	11	1	0	0	2	0	0	0	14

STHD Adult Steelhead Trout

BT Bull Trout

MWF Mountain Whitefish

RSS Redside Shiner

LND Longnose **Dace**

NSF Northern Squawfish

BLS Bridgelip Sucker

SC Sculpin

Table **E.5.** Composition of incidental fish species captured in the Imnaha River screw trap, June, 1997.

Date	STHD	BT	MWF	Species k s s	LND	NSF	BLS	SC	Total Catch
1	1								1
2									0
3							1	1	2
4							3		3
5	2						a		10
6	1						1		2
7									0
a									0
9							1		1
10	1						1		2
11							4		4
12							3		3
13						1	21		22
14									0
15									0
16									0
17							4		4
18					2		9		11
19					1		5		6
20	1						2		3
21									0
22									0
23							11		11
24					a		5		13
25					14		5		19
26									0
27					3		3		6
Total	6	0	0	0	28	1	a7	1	123

STHD Adult Steelhead Trout
 BT Bull Trout
 MWF Mountain Whitefish
 RSS Redside Shiner

LND Longnose **Dace**
 NSF Northern Squawfish
 BLS Bridgelip Sucker
 SC Sculpin

Table F.1 . Summary of natural and hatchery chinook smolt PIT tag groups released at the Imnaha River screw trap, February 25 to June 27, 1997.

Release Date	Tag File	Species	Origin	Release Strategy	Number Released	Mean Length	Mean Weight
03/12/97	PAK97071.NT1	CH	N	NPT	4	110	13.5
03/13/97	PAK97072.NT1	CH	N	NPT	1	91	7.9
03/25/97	PAK97084.NT1	CH	N	NPT	8	102	11.4
03/27/97	PAK97086.NT1	CH	N	NPT	6	102	11.5
04/01/97	PAK97091.NT1	CH	N	NPT	7	105	11.5
04/02/97	PAK97092.NT1	CH	N	NPT	32	112	12.9
04/03/97	PAK97093.NT1	CH	N	NPT	14	110	11.8
04/04/97	PAK97094.NT1	CH	N	NPT	15	111	13.0
04/07/97	PAK97097.NT1	CH	N	NPT	7	111	11.8
04/08/97	PAK97098.NT1	CH	N	NPT	10	110	12.9
04/09/97	PAK97099.NT1	CH	N	NPT	5	108	11.6
04/10/97	PAK97100.NT1	CH	N	NPT	10	106	12.8
04/10/97	PAK97100.NT4	CH	N	NPT	1	94	8.8
04/10/97	PAK97100.NT5	CH	N	NPT	1	100	12.3
04/11/97	PAK97101.NT1	CH	N	NPT	4	104	12.2
04/11/97	PAK97101.NT2	CH	N	NPT	5	110	15.8
04/12/97	PAK97102.NT1	CH	N	NPT	14	106	13.8
04/13/97	PAK97103.NT1	CH	N	NPT	8	107	13.4
04/14/97	PAK97104.NT1	CH	N	NPT	2	126	23.0
04/14/97	PAK97104.NT2	CH	N	NPT	5	103	10.9
04/15/97	PAK97105.NT2	CH	N	NPT	5	112	15.3
04/16/97	PAK97106.NT1	CH	N	NPT	7	112	15.1
04/17/97	PAK97107.NT1	CH	N	NPT	9	112	14.9
04/18/97	PAK97108.NT1	CH	N	NPT	4	112	11.7
04/23/97	PAK97113.NT1	CH	N	NPT	3	103	11.3
04/24/97	PAK97114.NT1	CH	N	NPT	7	106	15.0
04/25/97	PAK97115.NT2	CH	N	NPT	12	105	13.1
04/29/97	PAK97119.NT1	CH	N	NPT	10	106	12.8
04/30/97	PAK97120.NP1	CH	N	NPT	7	102	11.0
05/01/97	PAK97121.NT1	CH	N	NPT	11	106	13.9
05/05/97	PAK97125.NT1	CH	N	NPT	3	113	16.2
05/07/97	PAK97127.NT1	CH	N	NPT	1	116	16.2
Subtotal		CH	N		238		

Table F.1. (continued)

Release Date	Tag File	Species	Origin	Release Strategy	Number Released	Mean Length	Mean Weight
04/10/97	PAK971 00.NT1	CH	H	NPT	258	132	25.1
04/10/97	PAK97100.NT3	CH	H	NPT	47	133	25.5
04/10/97	PAK97100.NT4	CH	H	NPT	269	131	na
04/15/97	PAK97105.NT2	CH	H	NPT	174	132	24.0
04/16/97	PAK97106.NT1	CH	H	NPT	77	131	na
04/17/97	PAK97107.NT1	CH	H	NPT	58	131	na
04/18/97	PAK97108.NT1	CH	H	NPT	56	133	na
<i>04123197</i>	PAK97113.NT1	CH	H	NPT	1	119	17.2
04/25/97	PAK97115.NT2	CH	H	NPT	11	126	21.7
04/29/97	PAK97119.NT1	CH	H	NPT	3	138	27.9
04/30/97	PAK97120.NP1	CH	H	NPT	19	131	23.6
05/01/97	PAK97121 .NT1	CH	H	NPT	16	128	23.7
05/05/97	PAK97125.NT1	CH	H	NPT	8	129	23.7
<i>05108197</i>	PAK97128.NT1	CH	H	NPT	1	127	17.6
05/09/97	PAK97129.NT1	CH	H	NPT	2	127	21.5
Subtotal		CH	H		1,000		
TOTAL		CH	All		1,238		

Table F.2. Summary of natural and hatchery steelhead trout smolt **PIT** tag groups released at the Imnaha River screw trap, February 25 to June 27, 1997.

Release Date	Tag File	Species	Origin	Release Strategy	Number Released	Mean Length	Mean Weight
04/15/97	PAK97105.FP1	RBT	N	FPC	9	170	53.5
04/16/97	PAK97106.FP1	RBT	N	FPC	13	176	55.9
04/16/97	PAK97107.FP1	RBT	N	FPC	19	185	61.9
04/18/97	PAK97108.FP1	RBT	N	FPC	43	190	71.4
04/18/97	PAK97108.NT1	RBT	N	FPC	27	190	69.0
04/23/97	PAK97113.FP1	RBT	N	FPC	27	177	58.1
04/24/97	PAK97114.FP1	RBT	N	FPC	16	166	52.1
04/25/97	PAK97115.FP2	RBT	N	FPC	25	184	63.2
04/25/97	PAK97115.FP3	RBT	N	FPC	1	154	41.6
04/28/97	PAK97118.FP1	RBT	N	FPC	13	177	61.7
04/29/97	PAK97119.FP1	RBT	N	FPC	10	164	49.7
04/29/97	PAK97119.FP2	RBT	N	FPC	2	148	36.2
04/30/97	PAK97120.FP1	RBT	N	FPC	18	171	50.8
05/01/97	PAK97121.FP1	RBT	N	FPC	51	175	55.6
05/02/97	PAK97122.FP1	RBT	N	FPC	65	180	61.1
05/05/97	PAK97125.FP1	RBT	N	FPC	121	174	54.0
05/06/97	PAK97126.FP1	RBT	N	FPC	20	171	52.6
05/07/97	PAK97127.FP1	RBT	N	FPC	66	176	55.3
05/08/97	PAK97128.FP2	RBT	N	FPC	19	170	51.1
05/08/97	PAK97128.FP3	RBT	N	FPC	6	182	57.9
05/08/97	PAK97128.FP4	RBT	N	FPC	36	173	52.8
05/09/97	PAK97129.FP1	RBT	N	FPC	40	175	54.2
05/09/97	PAK97129.FP2	RBT	N	FPC	12	166	52.0
05/12/97	PAK97132.FP1	RBT	N	FPC	14	165	47.9
05/14/97	PAK97134.FP1	RBT	N	FPC	3	175	53.4
05/15/97	PAK97135.FP1	RBT	N	FPC	3	174	51.6
05/16/97	PAK97136.FP3	RBT	N	FPC	2	155	38.0
05/19/97	PAK97139.FP1	RBT	N	FPC	1	166	42.7
05/21/97	PAK97141.FP1	RBT	N	FPC	2	174	51.8
05/22/97	PAK97142.FP1	RBT	N	FPC	27	163	43.3
05/23/97	PAK97143.FP1	RBT	N	FPC	2	144	32.0
05/23/97	PAK97143.FP2	RBT	N	FPC	17	169	47.7
05/27/97	PAK97147.FP1	RBT	N	FPC	2	186	63.6
05/28/97	PAK97148.FP1	RBT	N	FPC	16	164	45.4
05/29/97	PAK97149.FP1	RBT	N	FPC	8	161	46.6
05/30/97	PAK97150.FP1	RBT	N	FPC	5	172	49.0
05/30/97	PAK97150.NT1	RBT	N	NPT	9	163	44.7
06/02/97	PAK97153.FP2	RBT	N	FPC	5	166	51.4
06/03/97	PAK97154.FP1	RBT	N	FPC	1	166	47.8
06/03/97	PAK97154.FP2	RBT	N	FPC	1	161	41.9
06/04/97	PAK97155.NT1	RBT	N	NPT	1	170	46.0
06/06/97	PAK97157.NT1	RBT	N	NPT	1	148	34.4
06/12/97	PAK97163.NT1	RBT	N	NPT	1	171	51.2
06/13/97	PAK97164.NT1	RBT	N	NPT	1	165	49.8
06/25/97	PAK97176.NT1	RBT	N	NPT	1	178	56.0
Subtotal		RBT	N		782		

Table F.2. (continued)

Release Date	Tag File	Species	Origin	Release Strategy	Number Released	Mean Length	Mean Weight
04/15/97	PAK97105.FP1	RBT	H	FPC	1	274	199.9
04/16/97	PAK97106.FP1	RBT	H	FPC	1	182	59.1
04/16/97	PAK97107.FP1	RBT	H	FPC	335	211	93.4
04/16/97	PAK97107.FP2	RBT	H	FPC	5	217	na
04/18/97	PAK97108.FP1	RBT	H	FPC	306	211	na
04/18/97	PAK97108.NT1	RBT	H	NPT	247	212	38.1
04/23/97	PAK97113.FP1	RBT	H	FPC	77	205	87.4
04/24/97	PAK97114.FP1	RBT	H	FPC	62	201	92.8
04/25/97	PAK97115.FP2	RBT	H	FPC	98	205	90.6
04/25/97	PAK97115.FP3	RBT	H	FPC	8	211	89.9
04/28/97	PAK97118.FP1	RBT	H	FPC	12	207	91.3
04/29/97	PAK97119.FP1	RBT	H	FPC	61	205	88.7
04/30/97	PAK97120.FP1	RBT	H	FPC	86	205	84.6
05/01/97	PAK97121.FP1	RBT	H	FPC	175	206	87.3
05/02/97	PAK97122.FP1	RBT	H	FPC	124	209	92.8
05/05/97	PAK97125.FP1	RBT	H	FPC	131	215	97.7
05/06/97	PAK97126.FP1	RBT	H	FPC	40	217	101.0
05/07/97	PAK97127.FP1	RBT	H	FPC	144	212	97.0
05/08/97	PAK97128.FP2	RBT	H	FPC	65	210	91.8
05/08/97	PAK97128.FP3	RBT	H	FPC	18	214	na
05/08/97	PAK97128.FP4	RBT	H	FPC	116	222	na
05/09/97	PAK97129.FP1	RBT	H	FPC	66	210	92.3
05/12/97	PAK97132.FP1	RBT	H	FPC	200	202	83.1
05/14/97	PAK97134.FP1	RBT	H	FPC	402	209	83.3
05/14/97	PAK97134.NT1	RBT	H	NPT	401	212	na
05/19/97	PAK97139.FP1	RBT	H	FPC	93	204	82.7
05/20/97	PAK97140.FP1	RBT	H	FPC	49	187	85.0
05/20/97	PAK97140.FP2	RBT	H	FPC	5	211	93.4
05/21/97	PAK97141.FP1	RBT	H	FPC	67	205	89.6
05/22/97	PAK97142.FP1	RBT	H	FPC	266	209	86.6
05/23/97	PAK97143.FP1	RBT	H	FPC	122	209	75.9
05/23/97	PAK97143.NT1	RBT	H	NPT	213	207	na
05/23/97	PAK97143.NT2	RBT	H	NPT	145	211	na
05/27/97	PAK97147.FP1	RBT	H	FPC	96	216	91.7
05/28/97	PAK97148.FP1	RBT	H	FPC	239	208	83.1
05/29/97	PAK97149.FP1	RBT	H	FPC	190	208	85.4
05/30/97	PAK97150.FP1	RBT	H	FPC	205	203	43.1
05/30/97	PAK97150.NT1	RBT	H	NPT	196	207	87.0
06/02/97	PAK97153.FP2	RBT	H	FPC	112	204	86.5
06/03/97	PAK97154.FP1	RBT	H	FPC	82	204	87.5
06/03/97	PAK97154.FP2	RBT	H	FPC	121	210	80.5
06/04/97	PAK97155.NT1	RBT	H	NPT	90	204	84.8
06/06/97	PAK97157.NT1	RBT	H	NPT	51	202	76.4
06/09/97	PAK97160.NT1	RBT	H	NPT	69	206	81.9
06/10/97	PAK97161.NT1	RBT	H	NPT	100	216	94.4

Table F.2. (continued)

Release Date	Tag File	Species	Origin	Release Strategy	Number Released	Mean Length	Mean Weight
6/11/97	PAK97162.NT3	RBT	H	NPT	120	215	91.0
6/12/97	PAK97 163. NT1	RBT	H	NPT	38	221	na
06/13/97	PAK97164.NT1	RBT	H	NPT	10	215	92.7
06/17/97	PAK97168.NT1	RBT	H	NPT	34	208	81.0
06/18/97	PAK97169.NT1	RBT	H	NPT	35	213	89.4
06/19/97	PAK97 170. NT1	RBT	H	NPT	97	207	81.2
06/19/97	PAK97170. NT2	RBT	H	NPT	8	208	83.4
06/20/97	PAK97171.NT1	RBT	H	NPT	7	225	102.9
06/23/97	PAK97174.NT2	RBT	H	NPT	13	205	79.4
06/24/97	PAK97175.NT1	RBT	H	NPT	22	210	82.1
06/25/97	PAK97176.NT1	RBT	H	NPT	14	209	86.4
06/26/97	PAK97177.NT2	RBT	H	NPT	7	220	102.6
06127197	PAK97178.NT1	RBT	H	NPT	20	222	98.3
Subtotal		RBT	H		6.117		
TOTAL		RBT	All		6,901		

**LOWER MONUMENTAL DAM
APRIL 27-MAY 3**

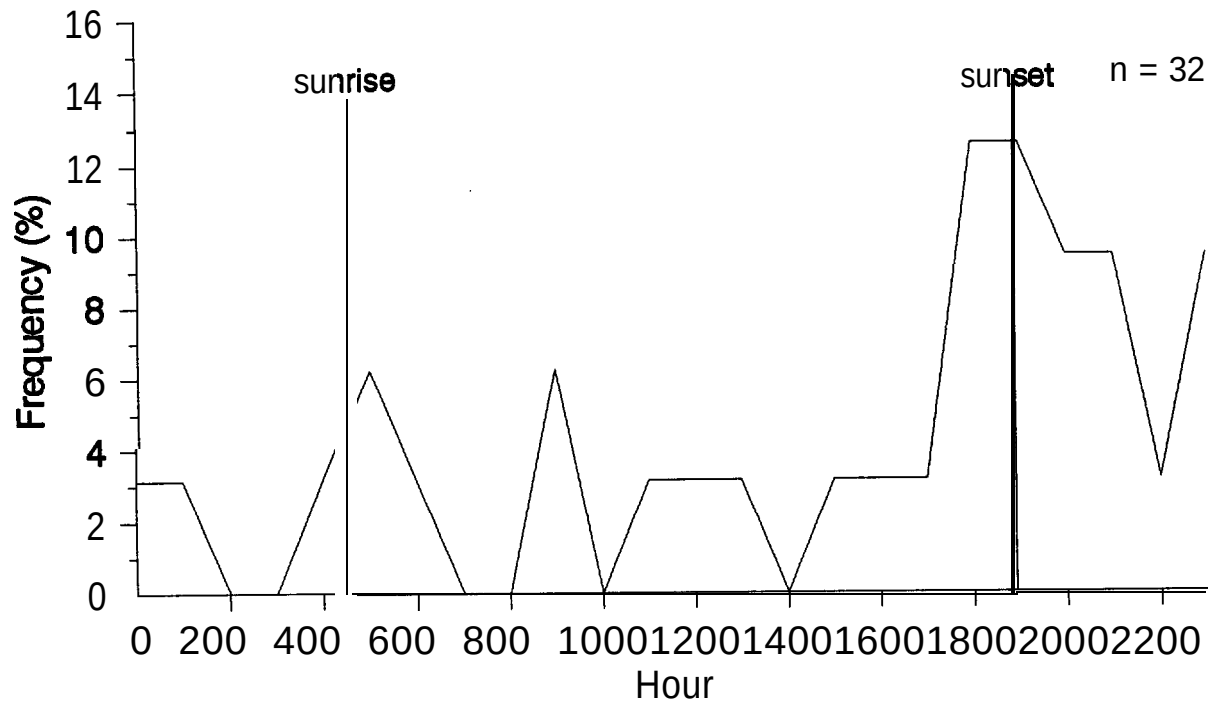


Figure G.1. Average weekly diel passage of PIT tagged Imnaha River natural chinook salmon smolts at Lower Monumental Dam during the week of April 27-May 3, 1997.

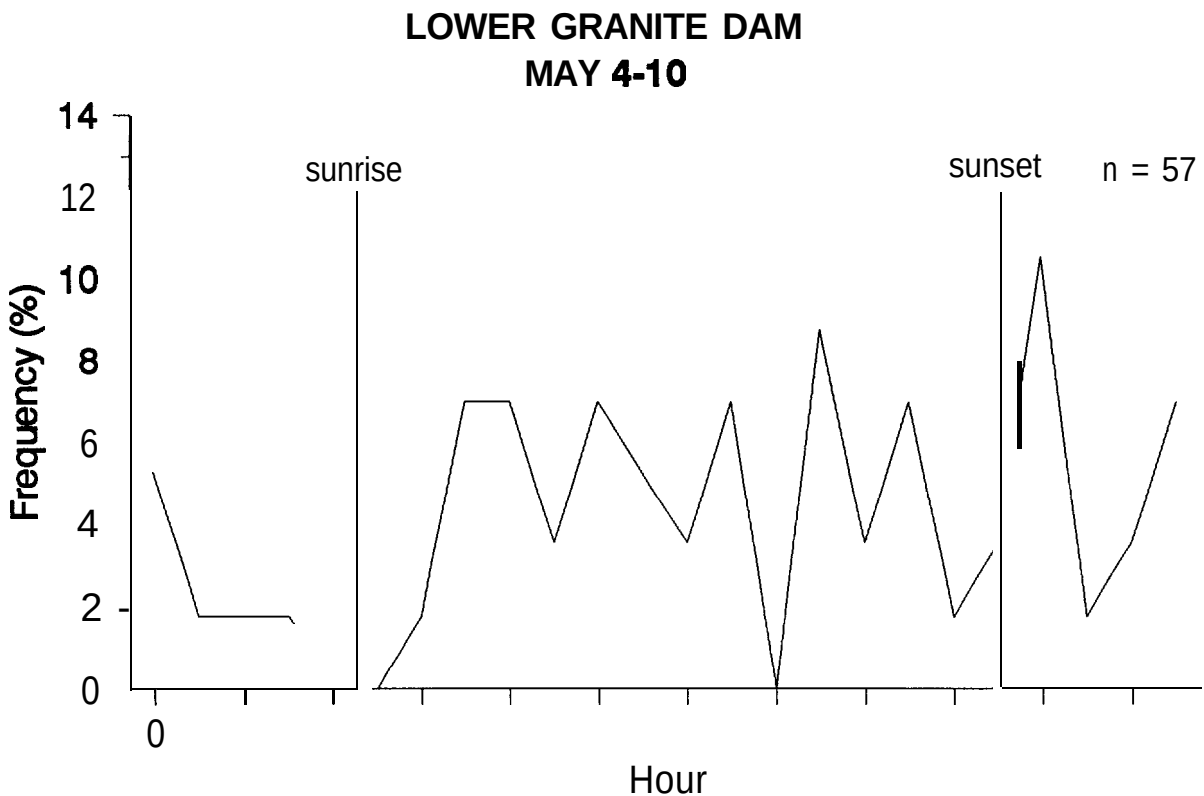
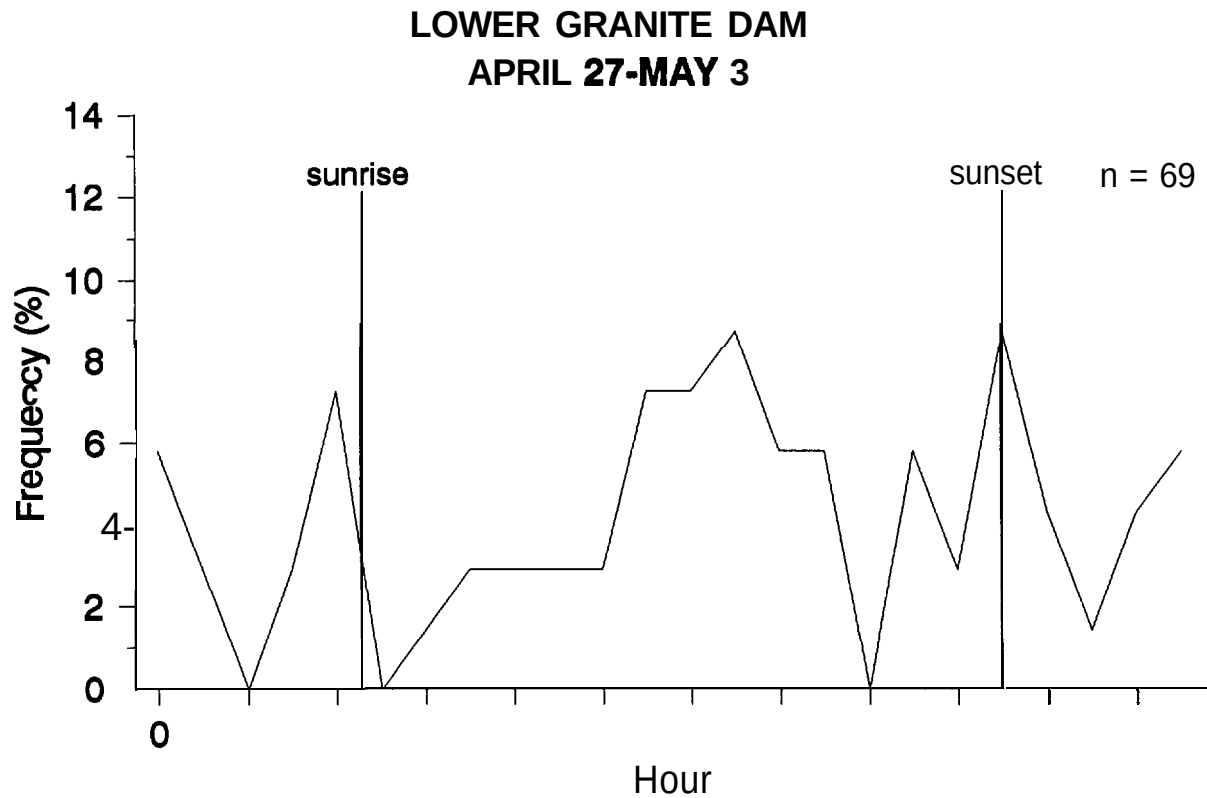


Figure G.2. Average weekly diel passage of PIT tagged Imnaha River hatchery chinook salmon smolts at Lower Granite Dam during the weeks of April 27-May 3 (upper) and May 4-10, 1997 (lower).

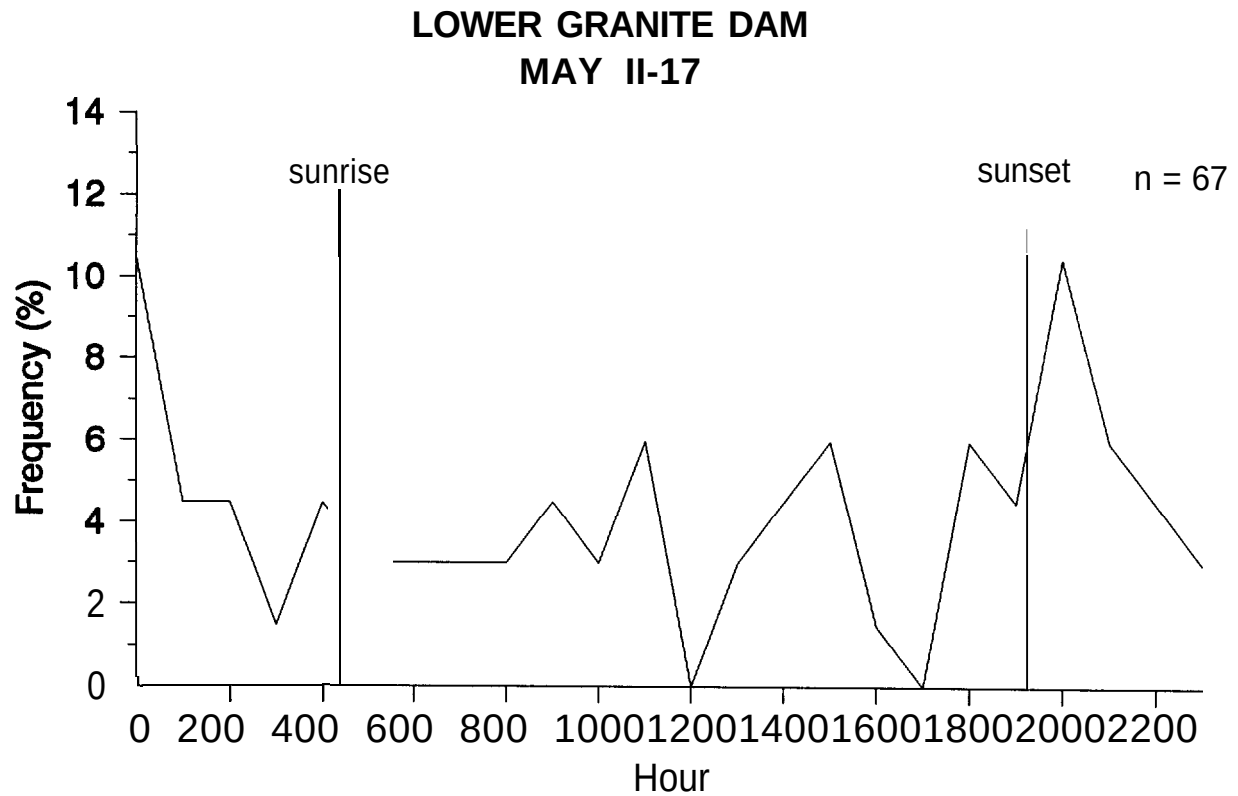


Figure G.3. Average weekly diel passage of PIT tagged Imnaha River hatchery chinook salmon smolts at Lower Granite Dam during the week of May 1-17, 1997.

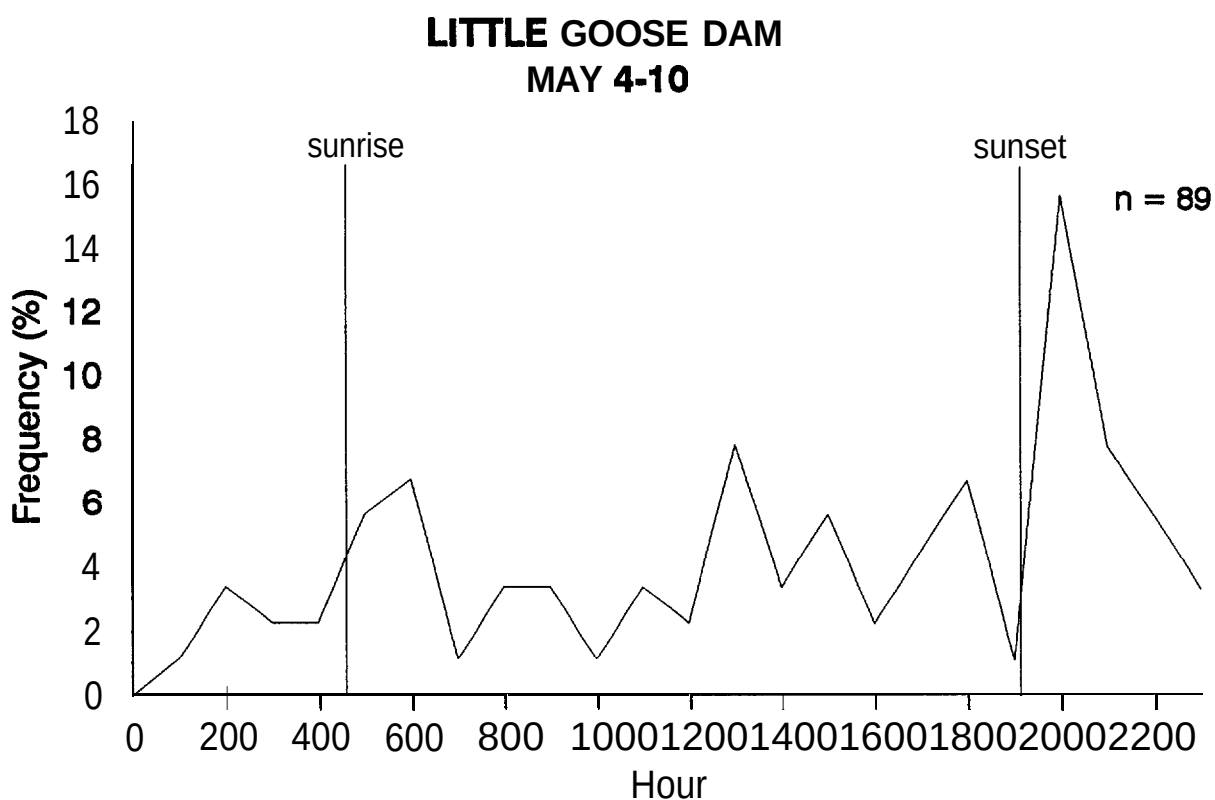
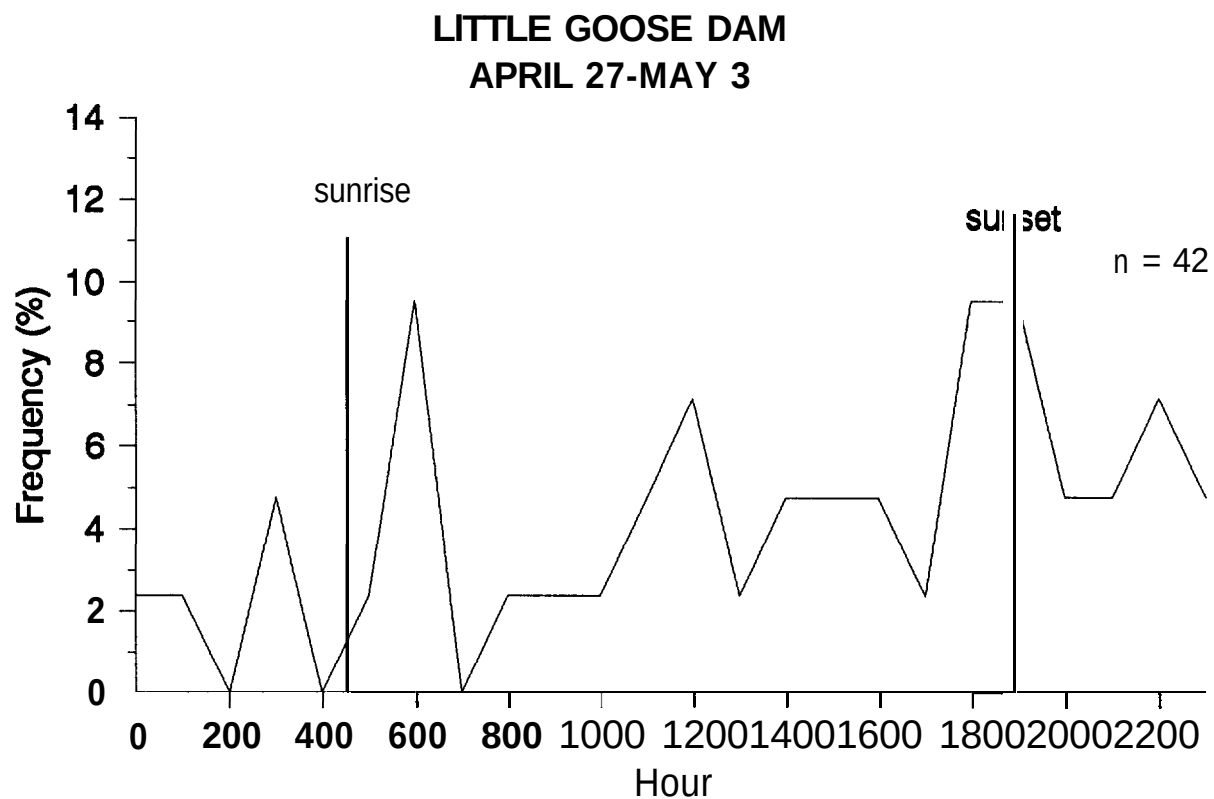


Figure G.4. Average weekly diel passage of PIT tagged Imnaha River hatchery chinook salmon smolts at Little Goose Dam during the weeks of April ~~27-May~~ 3 (upper) and May 4-10, 1997 (lower).

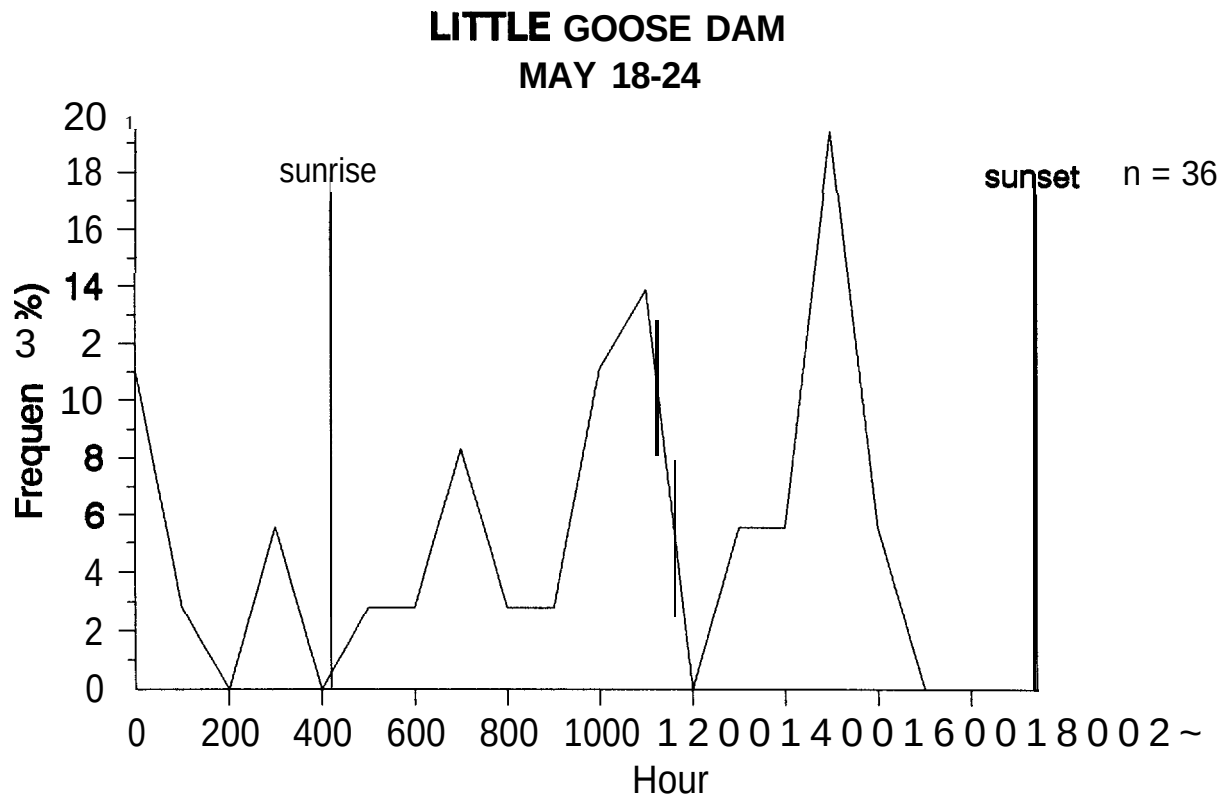
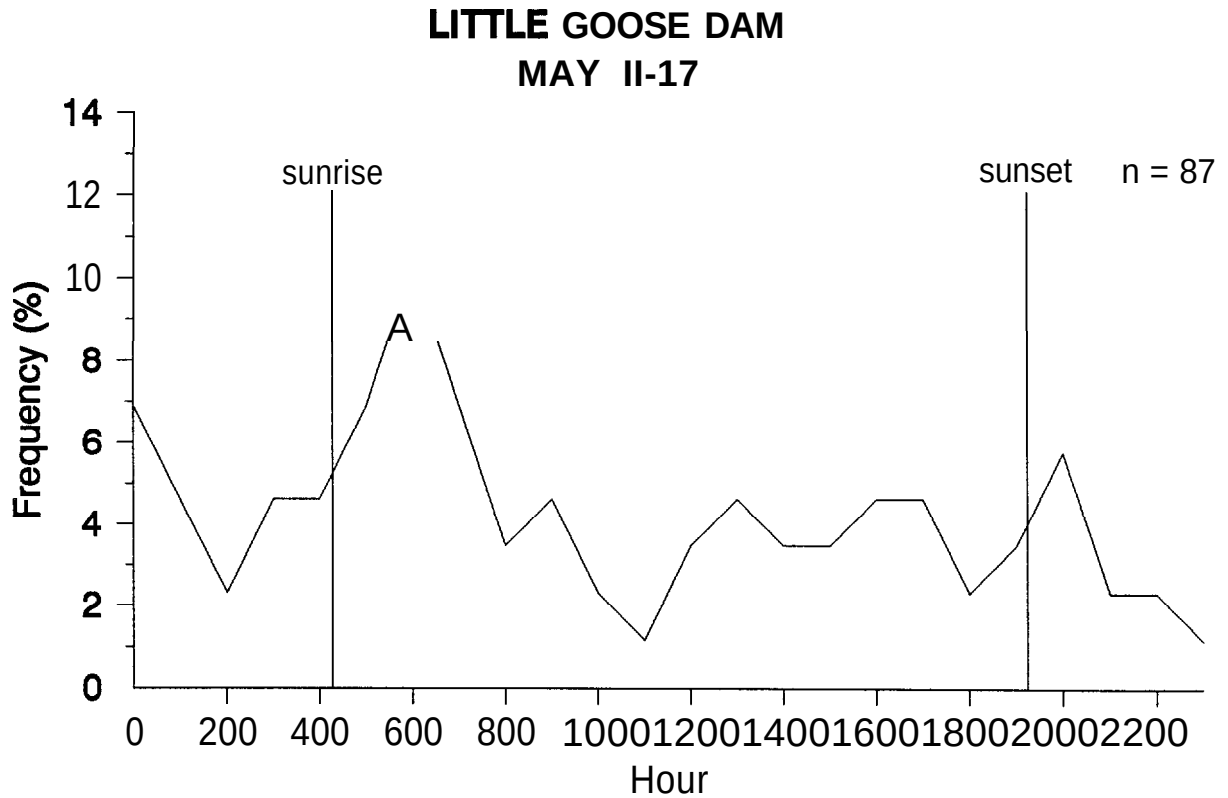


Figure G.5. Average weekly diel passage of PIT tagged Imnaha River hatchery chinook salmon smolts at Little Goose Dam during the weeks of May 11-17 (upper) and May 18-24, 1997 (lower).

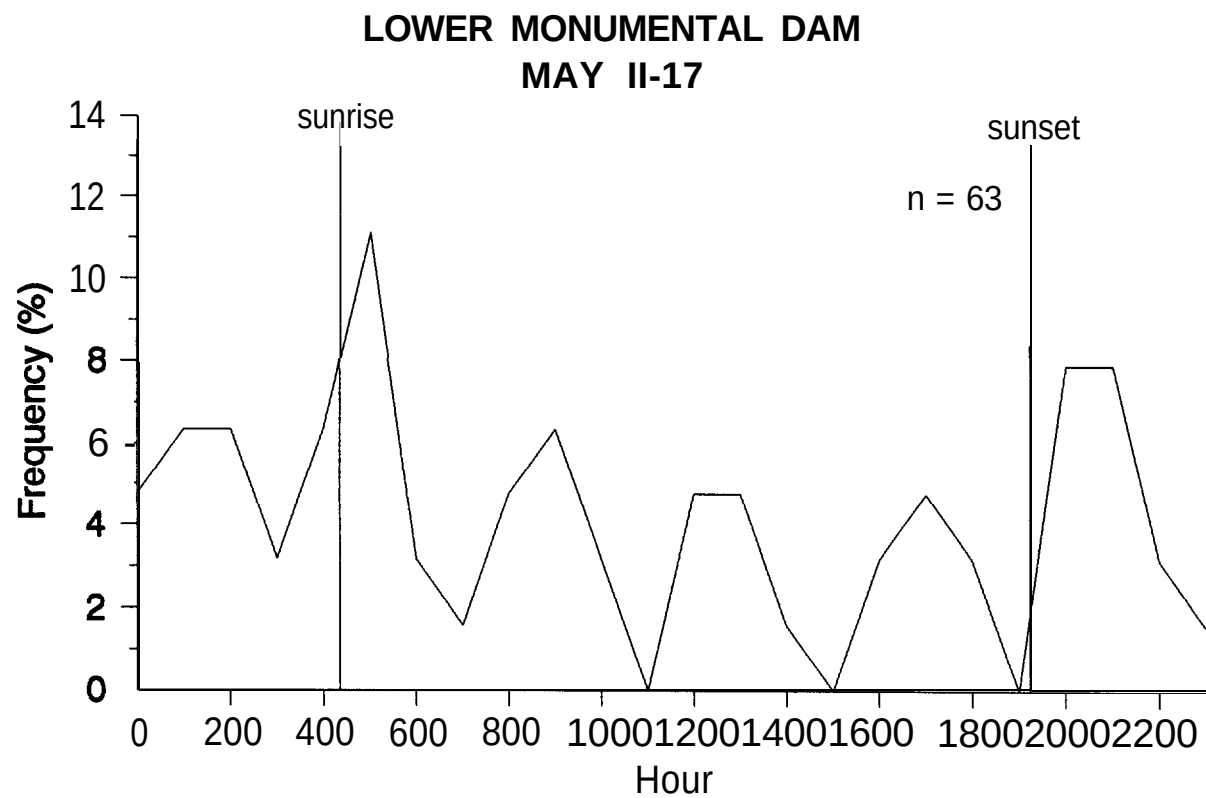
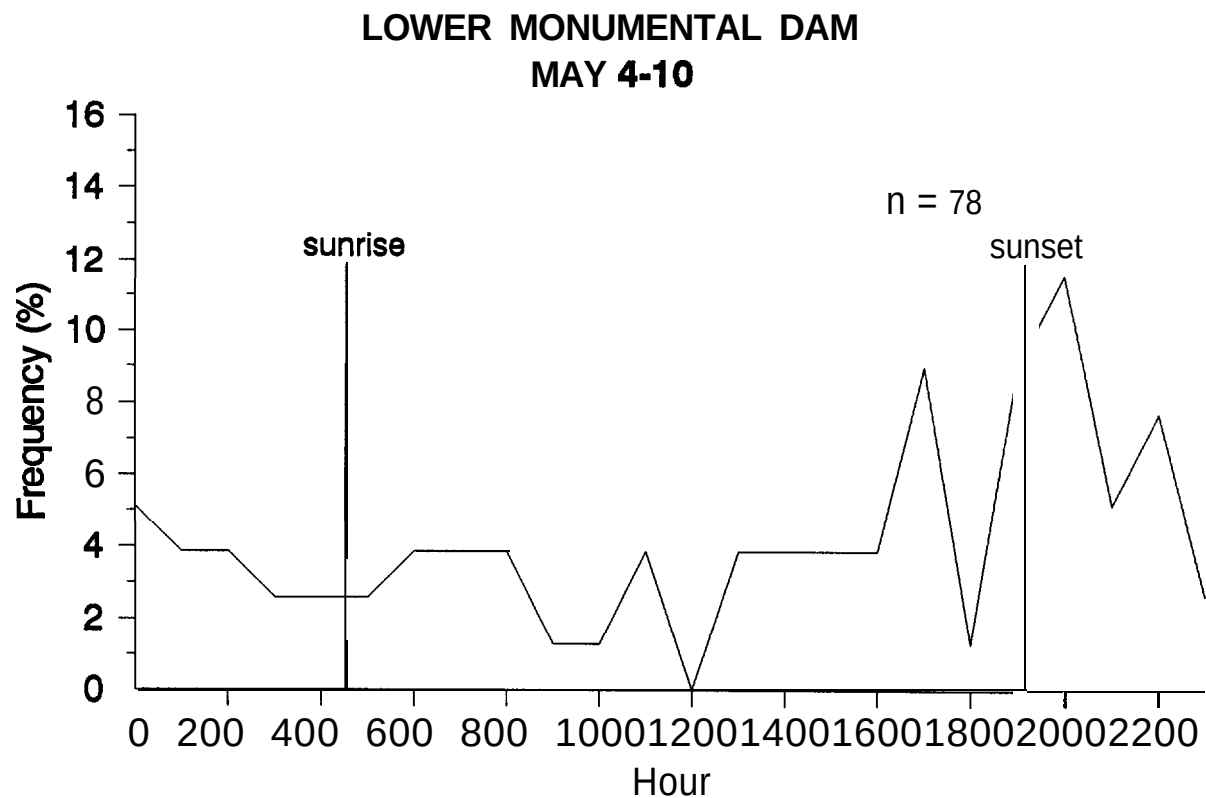


Figure G.6. Average weekly diel passage of PIT tagged Imnaha River hatchery chinook salmon smolts at Lower Monumental Dam during the weeks of May 4-10 (upper) and May 11-17, 1997 (lower).

LOWER MONUMENTAL DAM
MAY 18-24

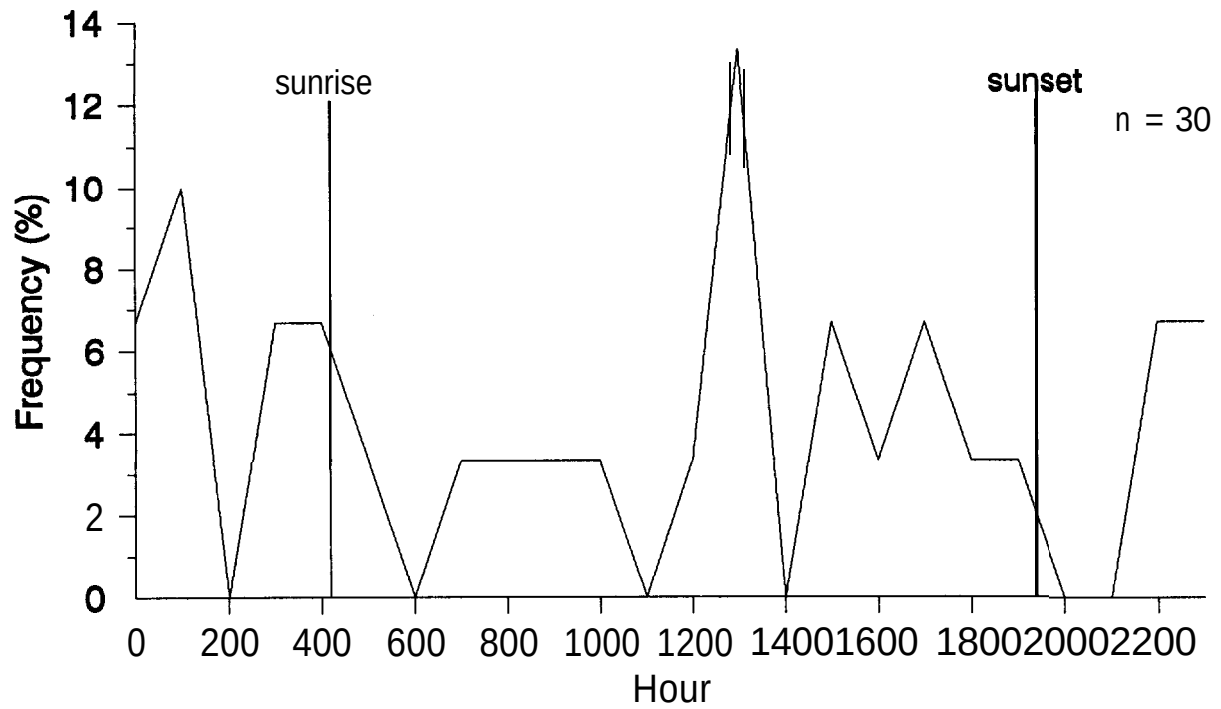


Figure G.7. Average weekly **diel** passage of PIT tagged Imnaha River hatchery chinook salmon smolts at Lower Monumental Dam during the week of May 18-24, 1997.

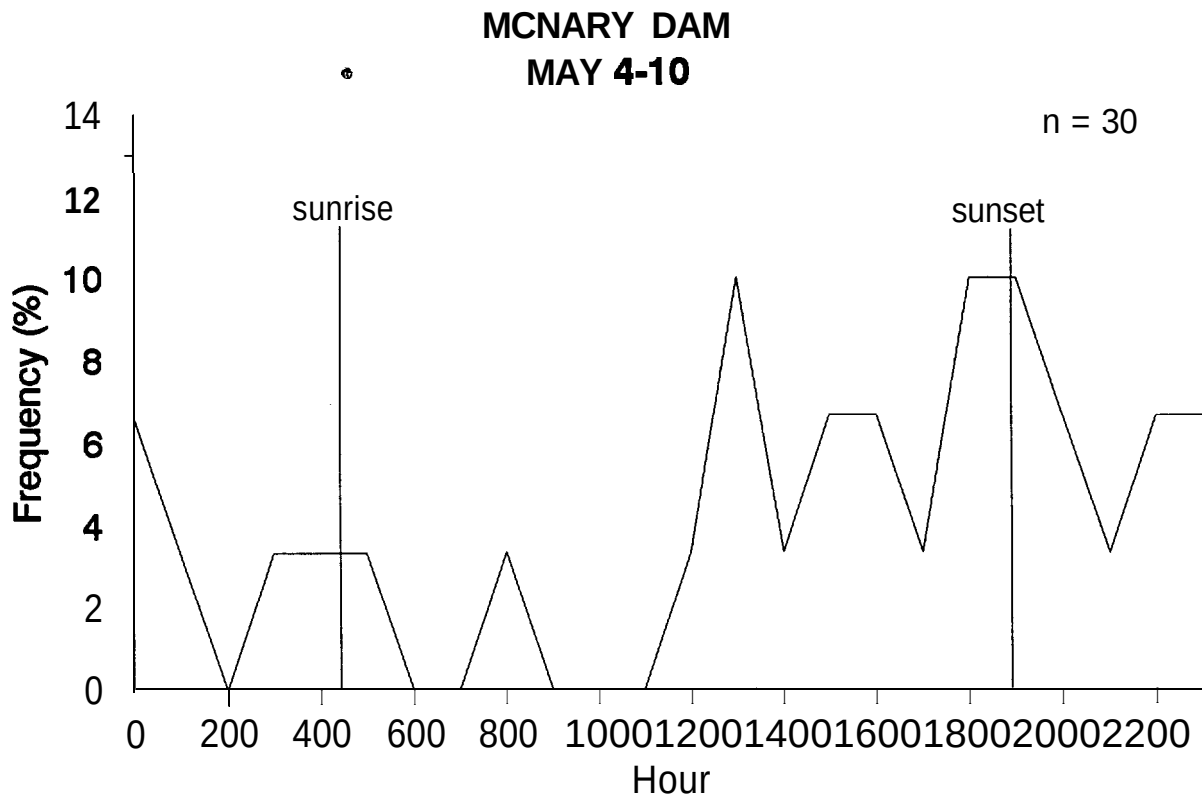


Figure G.8. Average weekly diel passage of PIT tagged Imnaha River hatchery chinook salmon smolts at McNary Dam during the week of May 4-10, 1997.

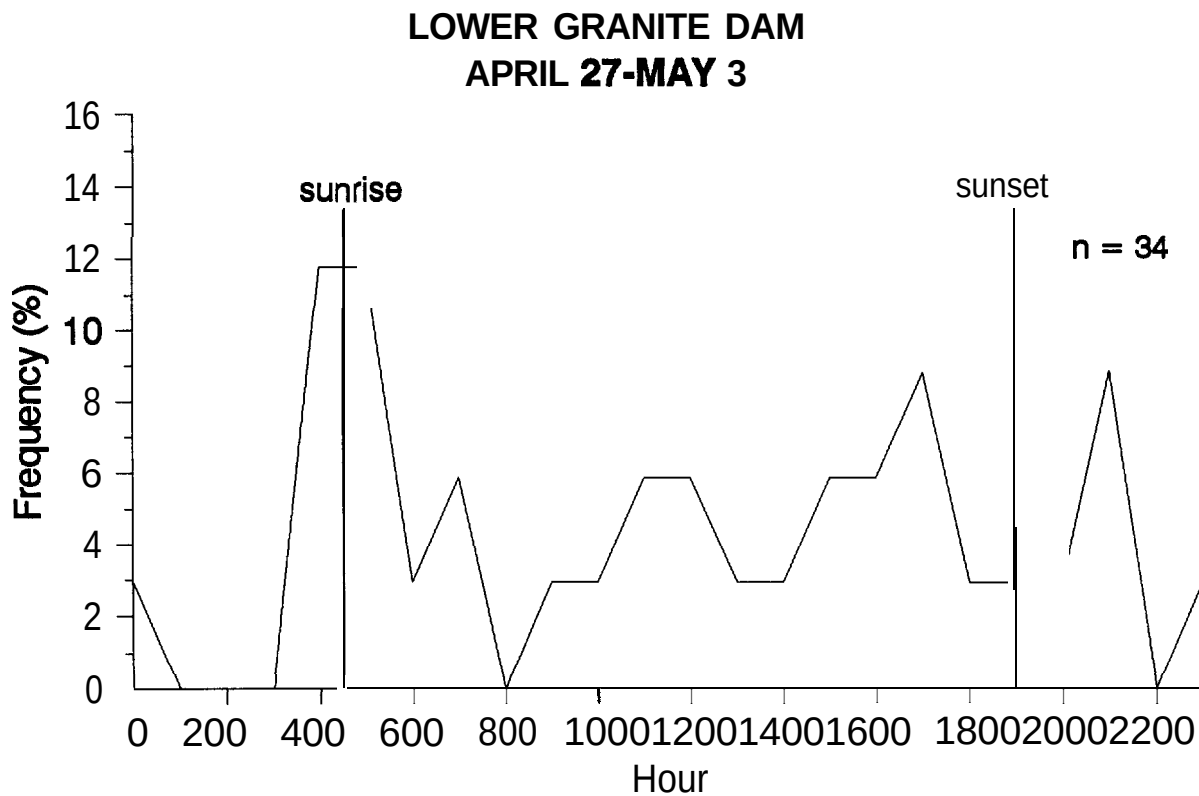
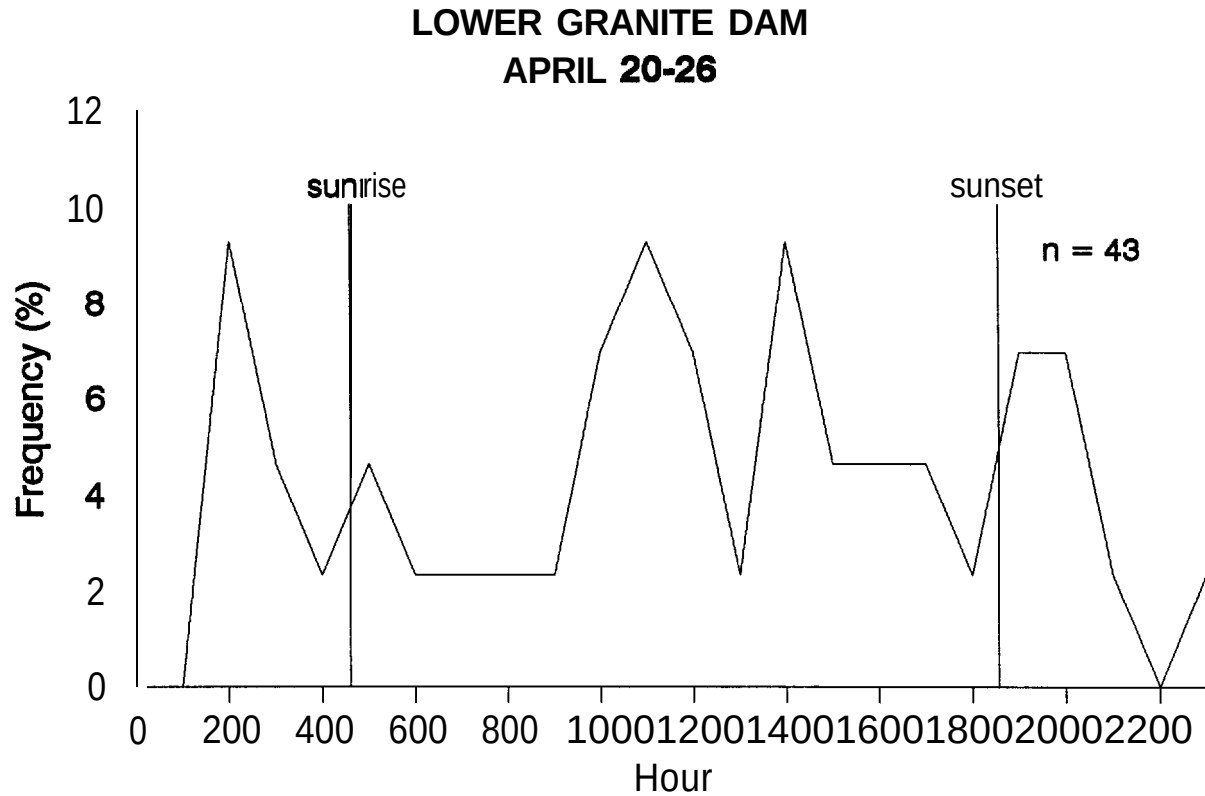


Figure G.9. Average weekly diel passage of PIT tagged Imnaha River natural steelhead trout smolts at Lower Granite Dam during the weeks of April 20-26 (upper) and April 27-May 3, 1997 (lower).

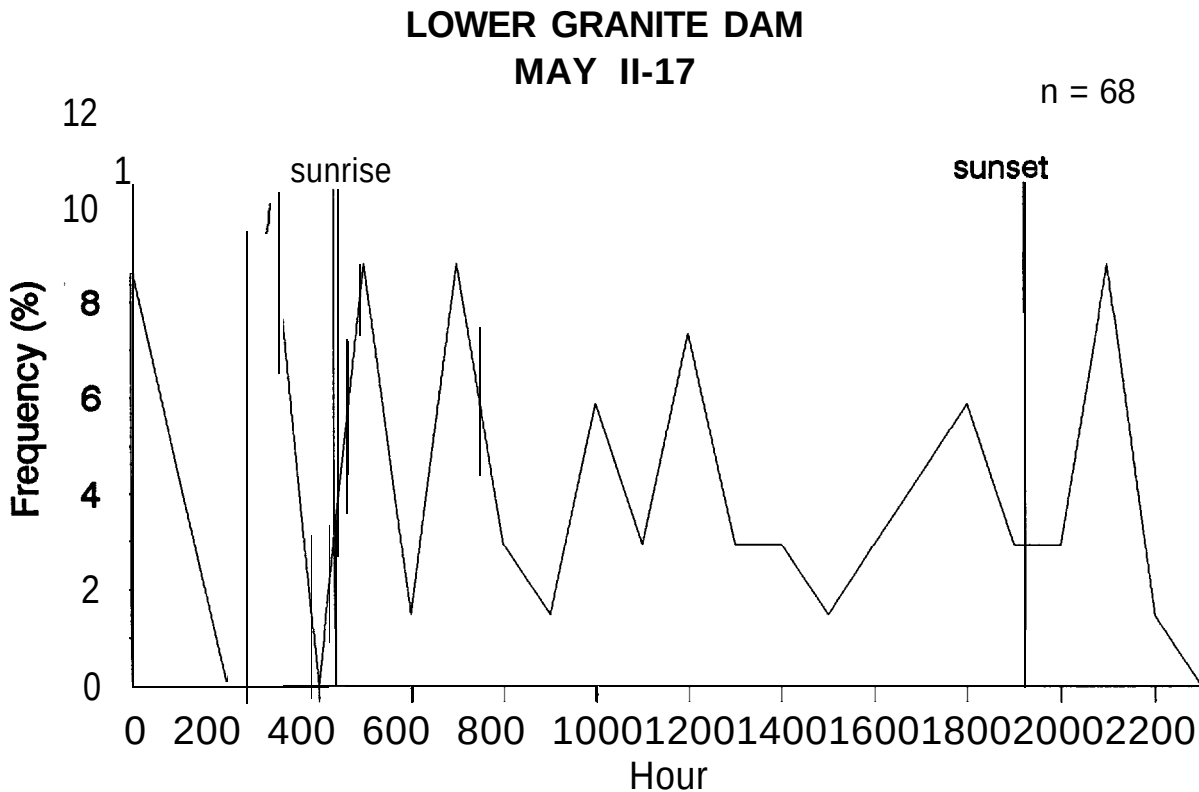
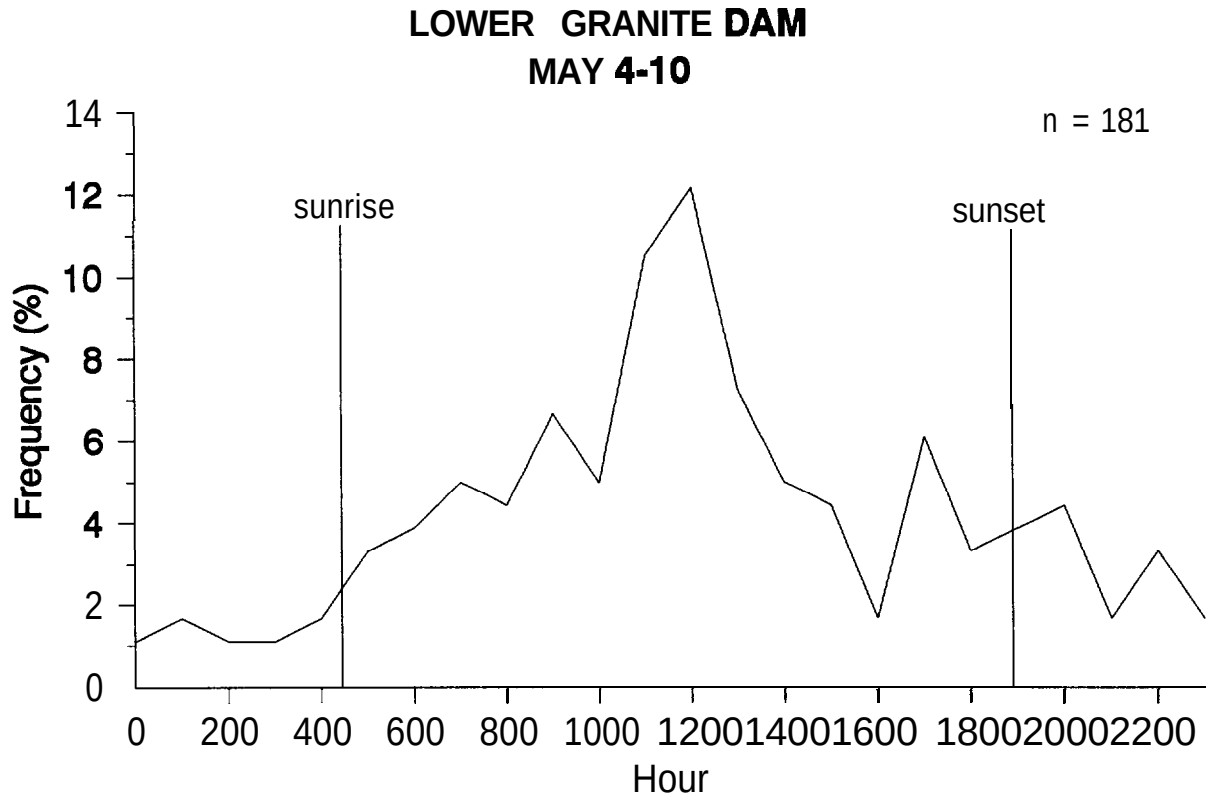


Figure G.10. Average weekly diel passage of PIT tagged Imnaha River natural steelhead trout smolts at Lower Granite Dam during the weeks of May 4-10 (upper) and May 11-17, 1997 (lower).

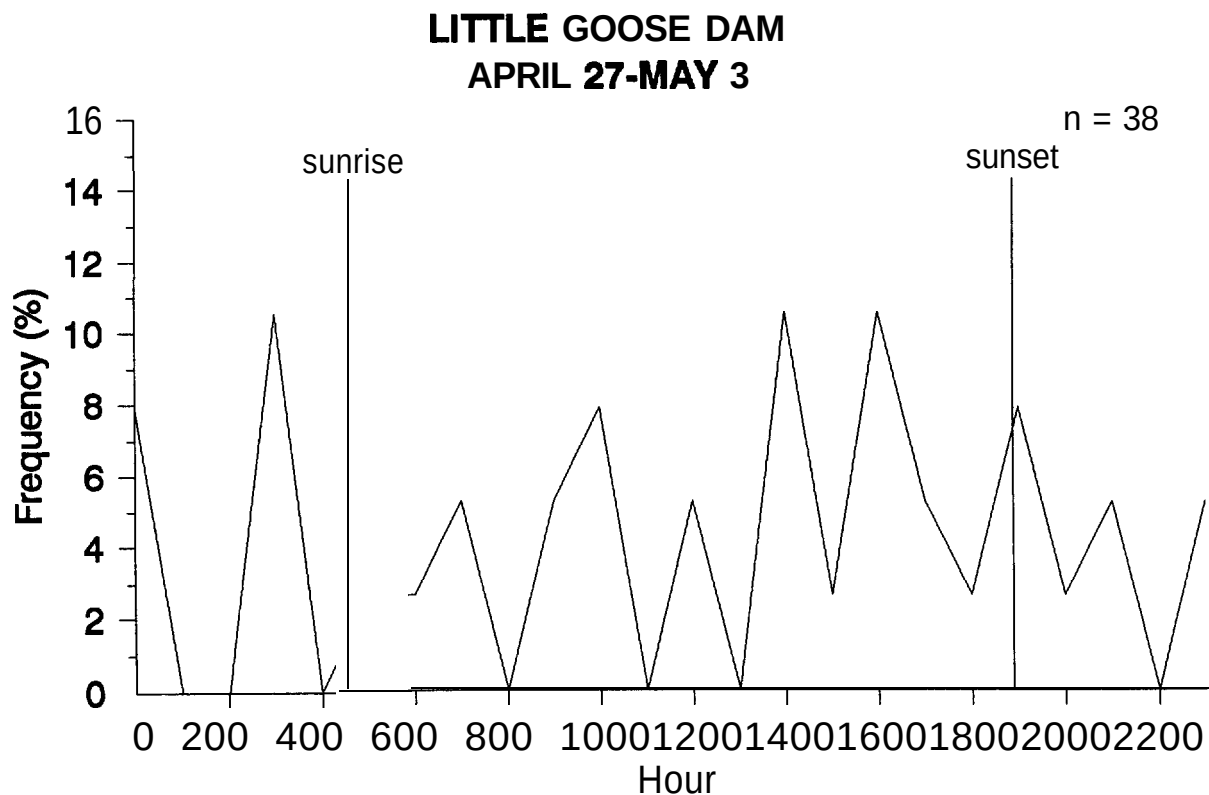
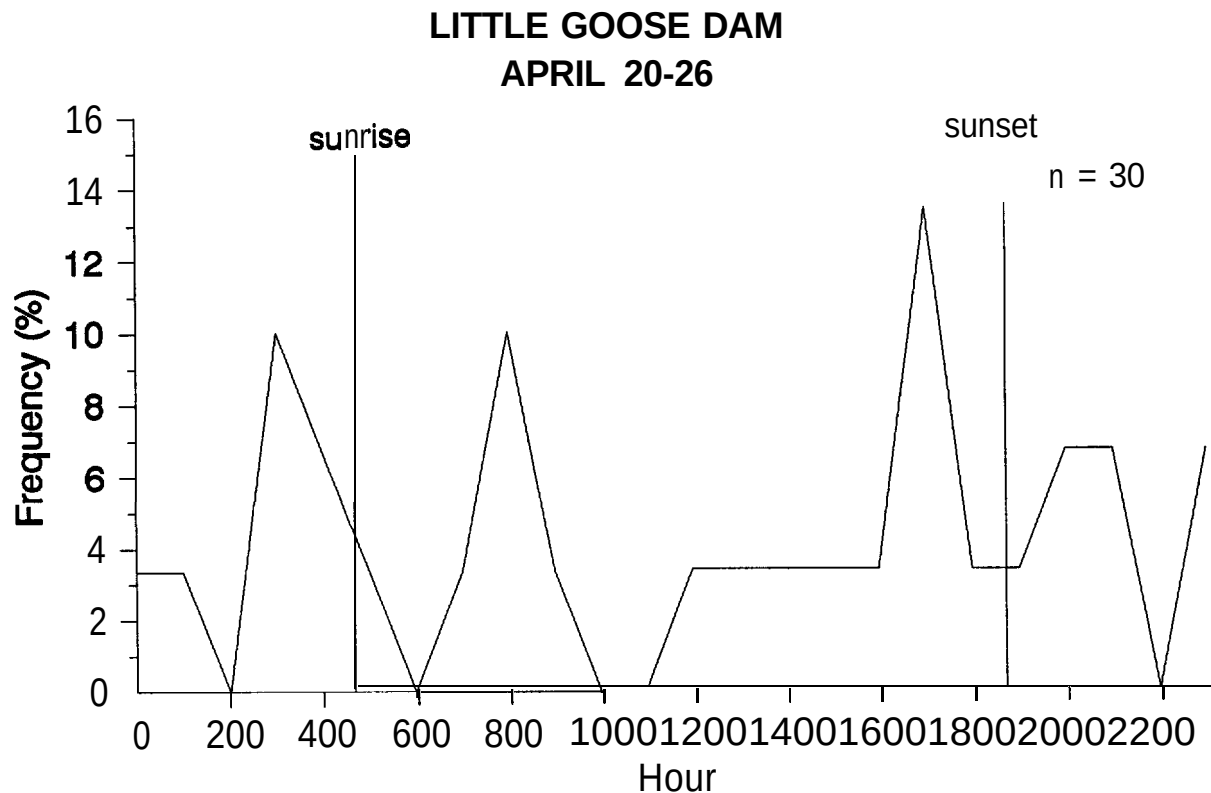


Figure G.11. Average weekly diel passage of PIT tagged Imnaha River natural steelhead trout smolts at Little Goose Dam during the weeks of April 20-26 (upper) and April 27-May 3, 1997 (lower).

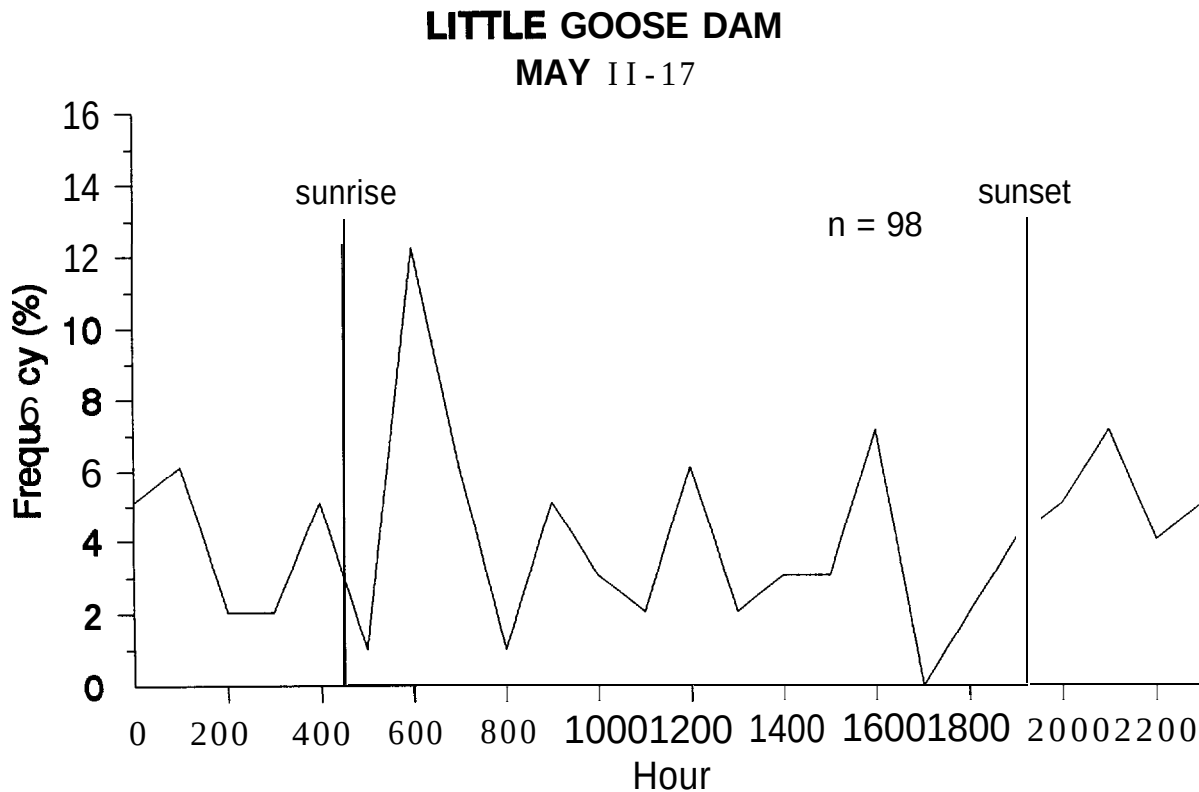
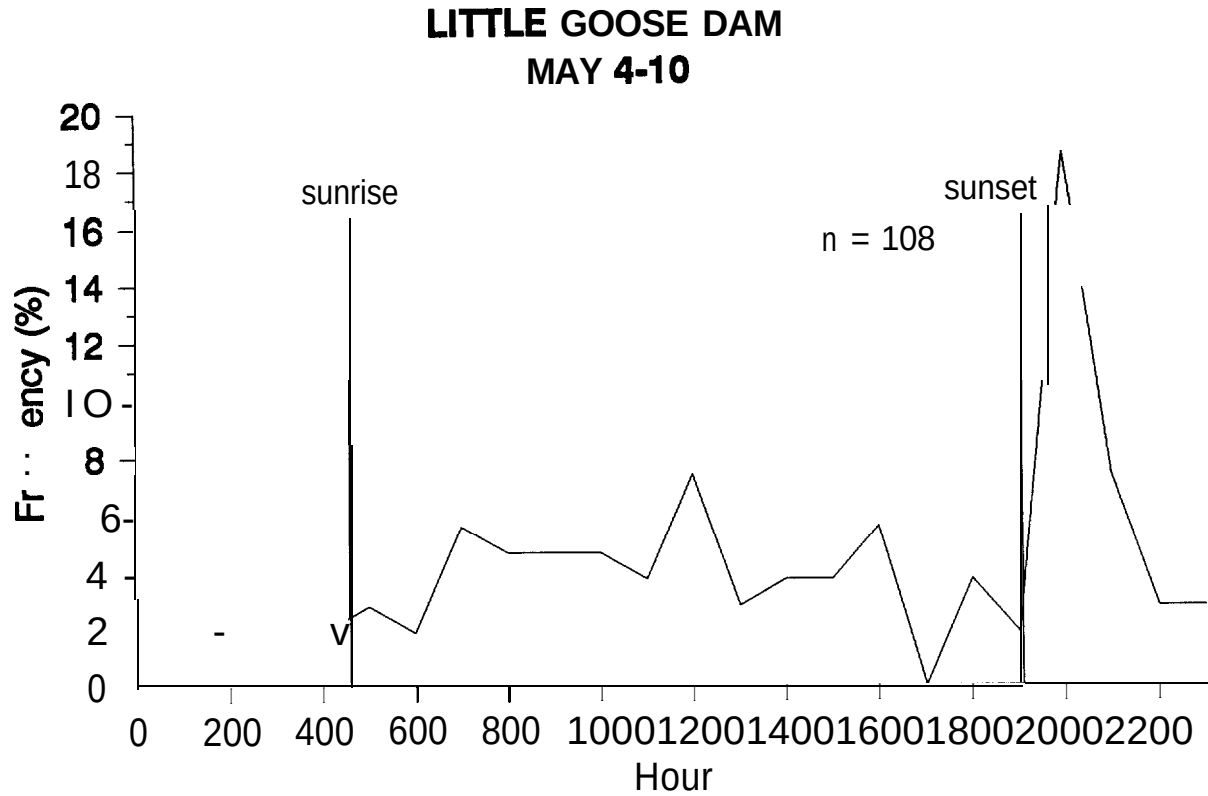


Figure G.12. Average weekly diel passage of PIT tagged Imnaha River natural steelhead trout smolts at Little Goose Dam during the weeks of May 4-10 (upper) and May 11-17, 1997 (lower).

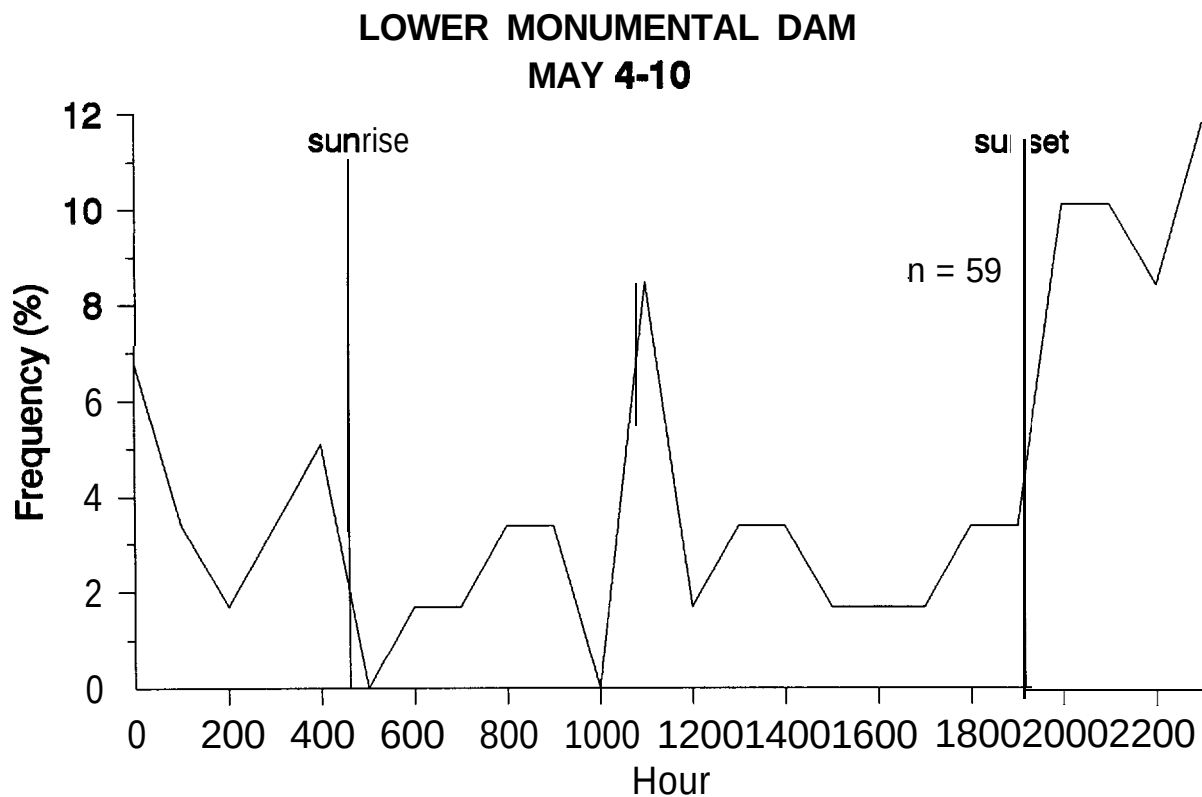
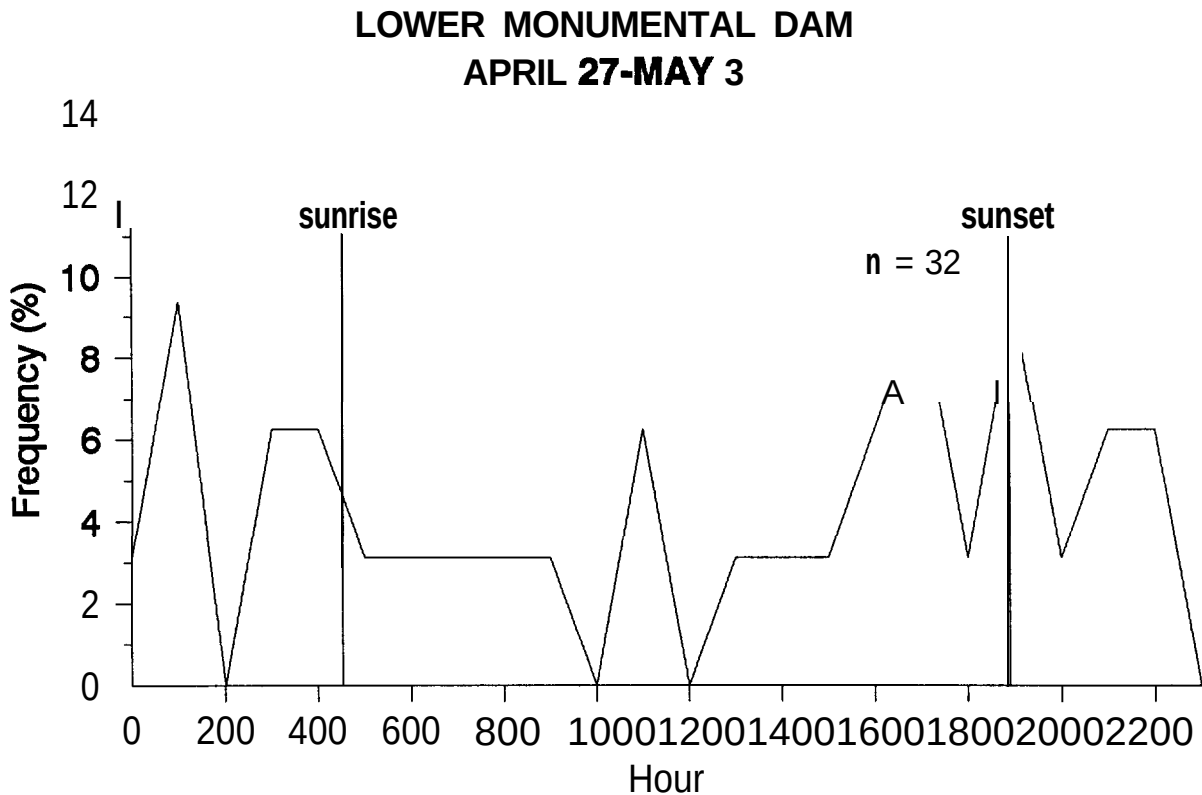


Figure G.13. Average weekly diel passage of PIT tagged Imnaha River natural steelhead trout smolts at Lower Monumental Dam during the weeks of April 27-May 3 (upper) and May 4-10, 1997 (lower).

LOWER MONUMENTAL DAM MAY 11-17

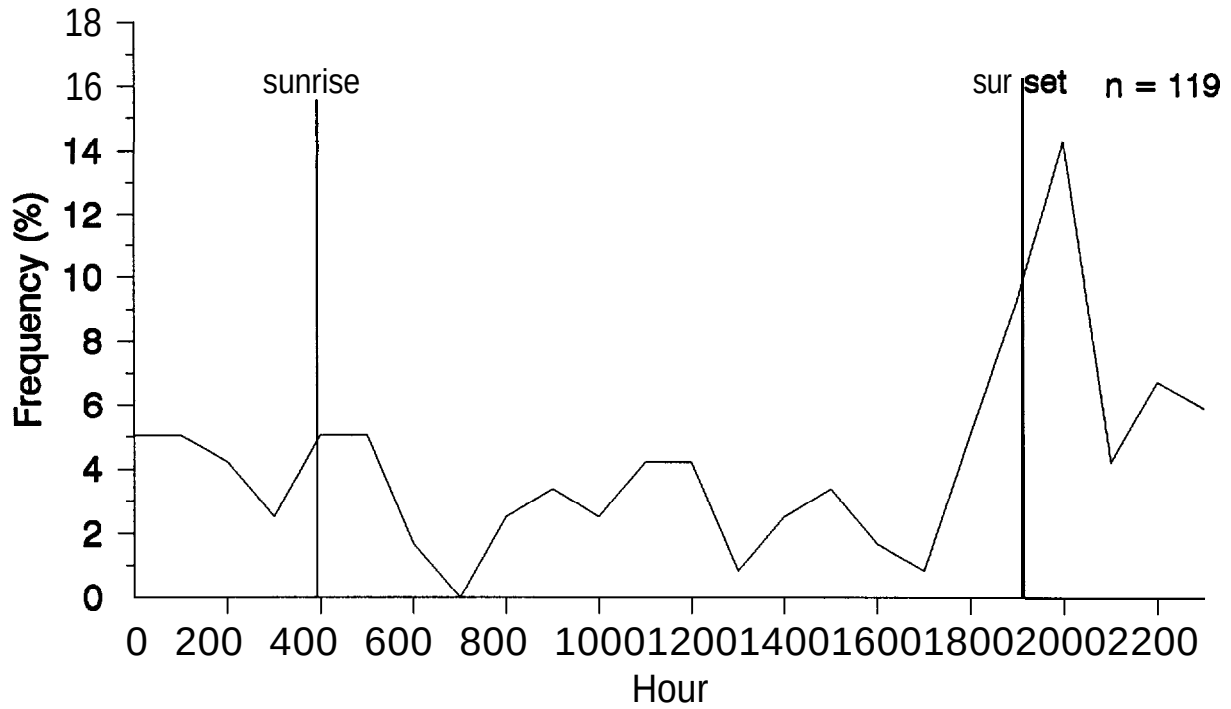


Figure G.14. Average weekly diel passage of PIT tagged Imnaha River natural steelhead trout smolts at Lower Monumental Dam during the week of May 11-17, 1997.

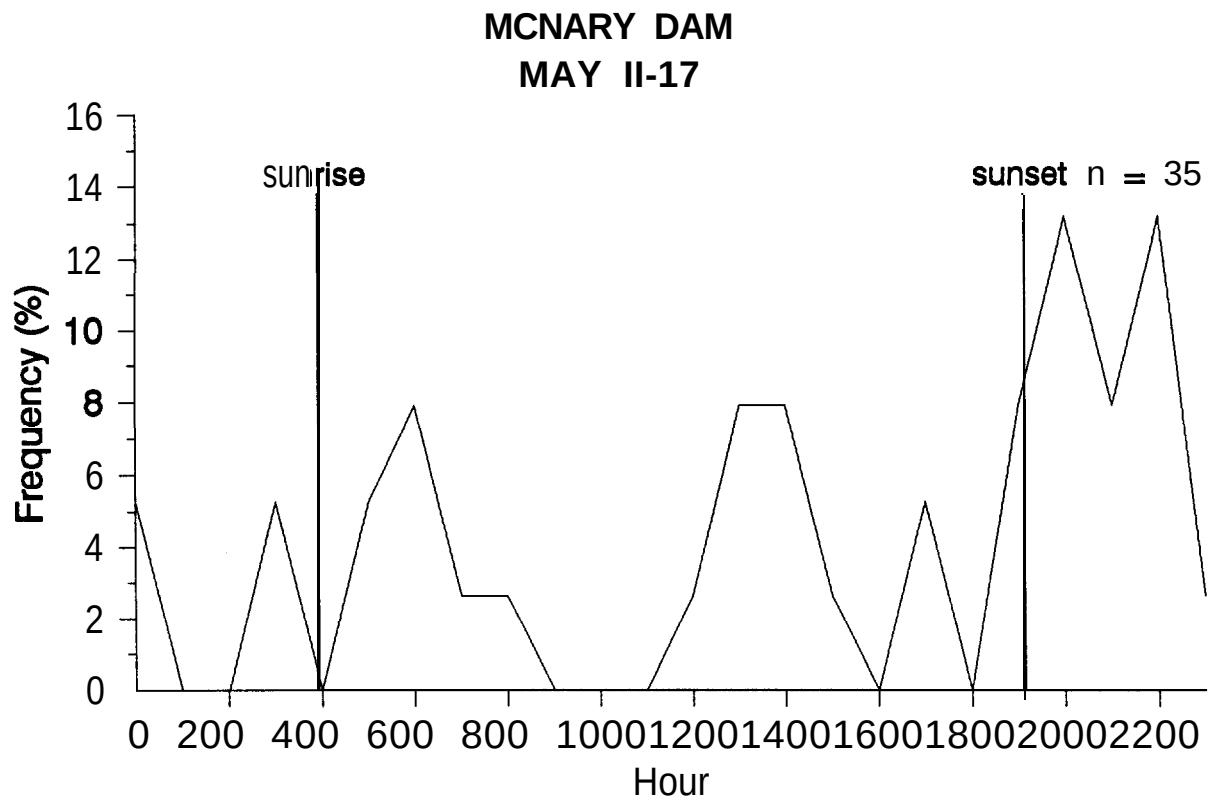


Figure G.15. Average weekly **diel** passage of PIT tagged Imnaha River natural steelhead trout smolts at McNary Dam during the week of May 11-17, 1997.

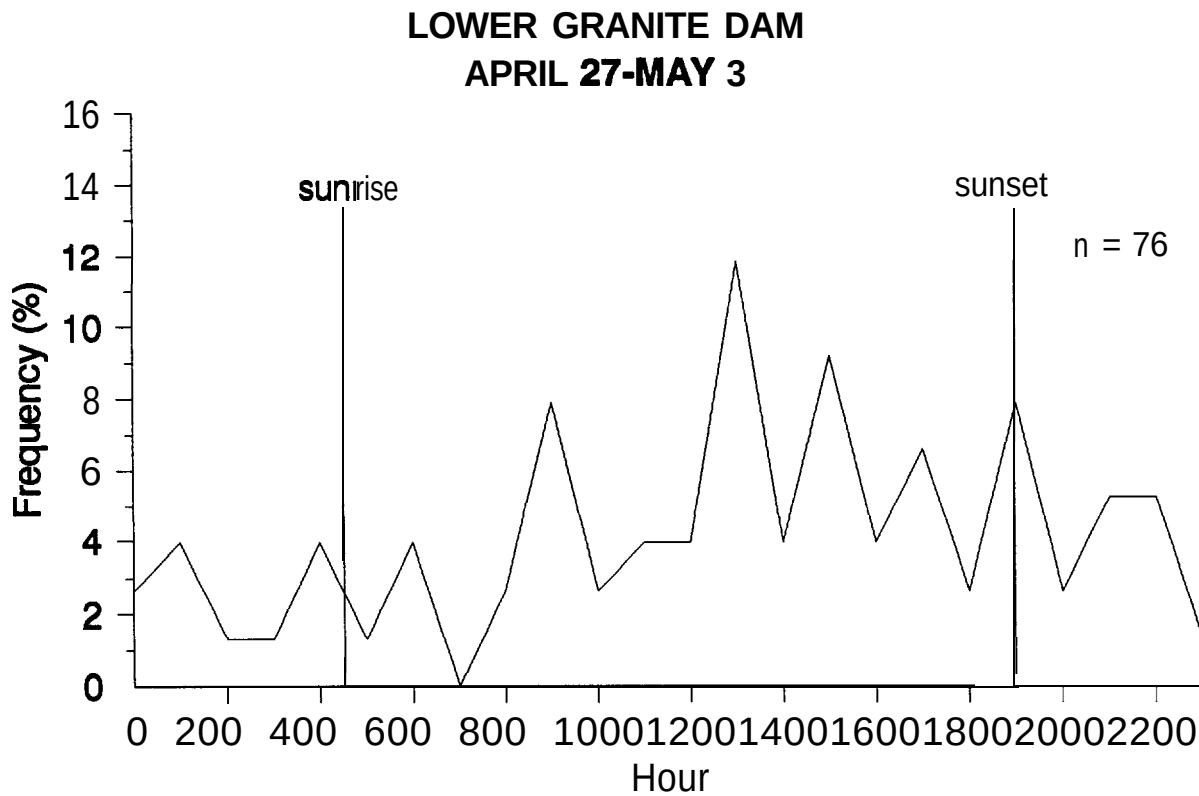
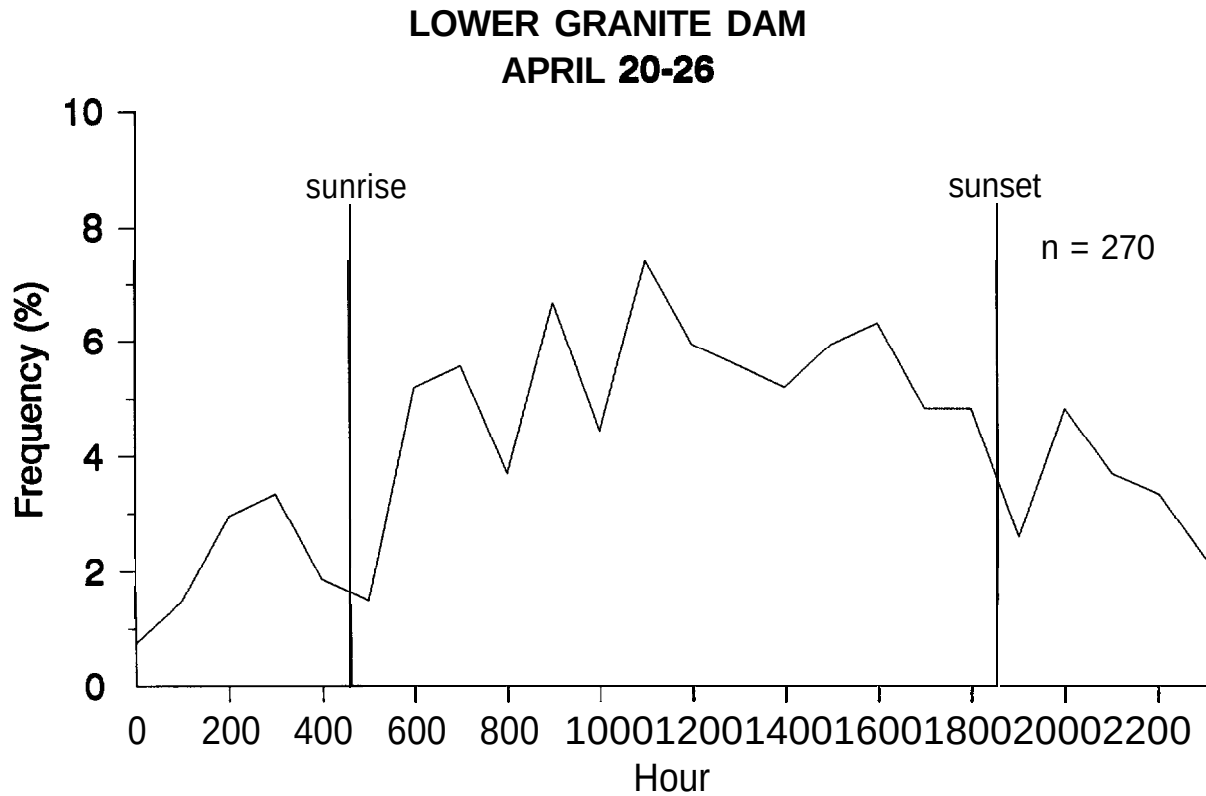


Figure G.16. Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Granite Dam during the weeks of April 20-26 (upper) and April 27-May 3, 1997 (lower).

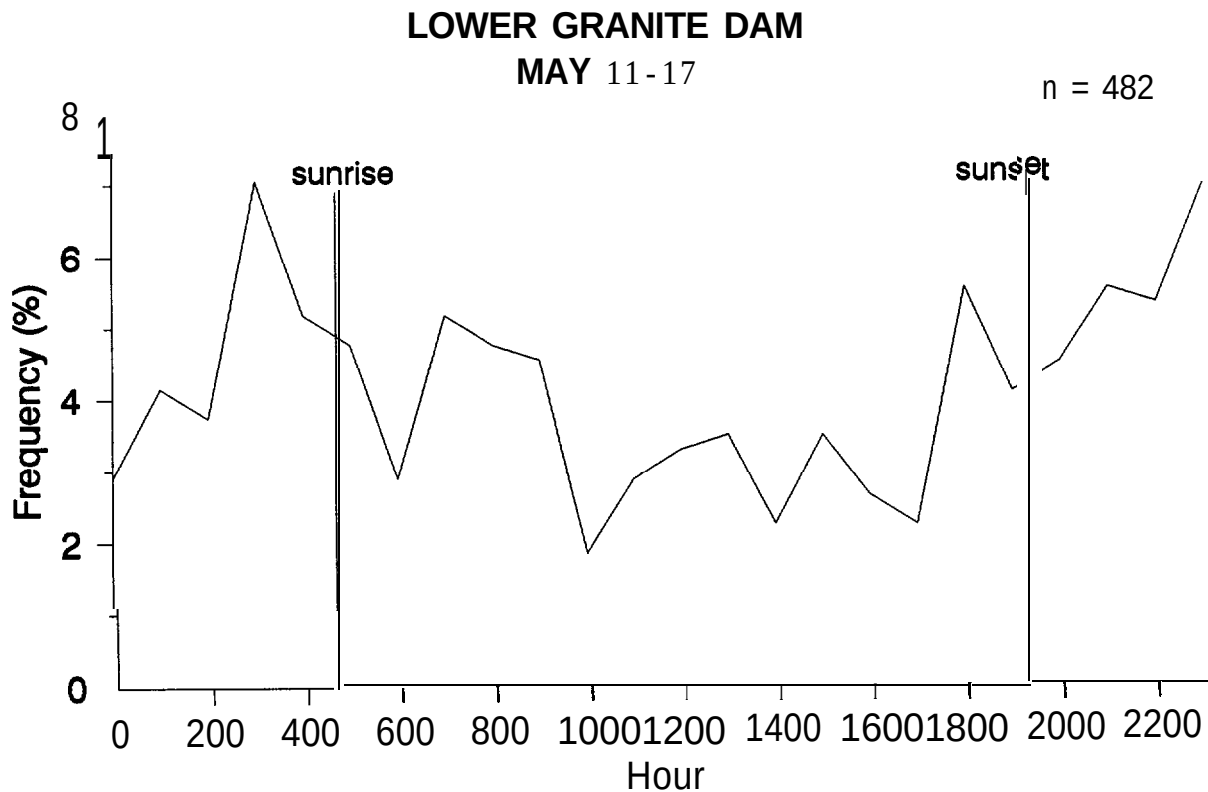
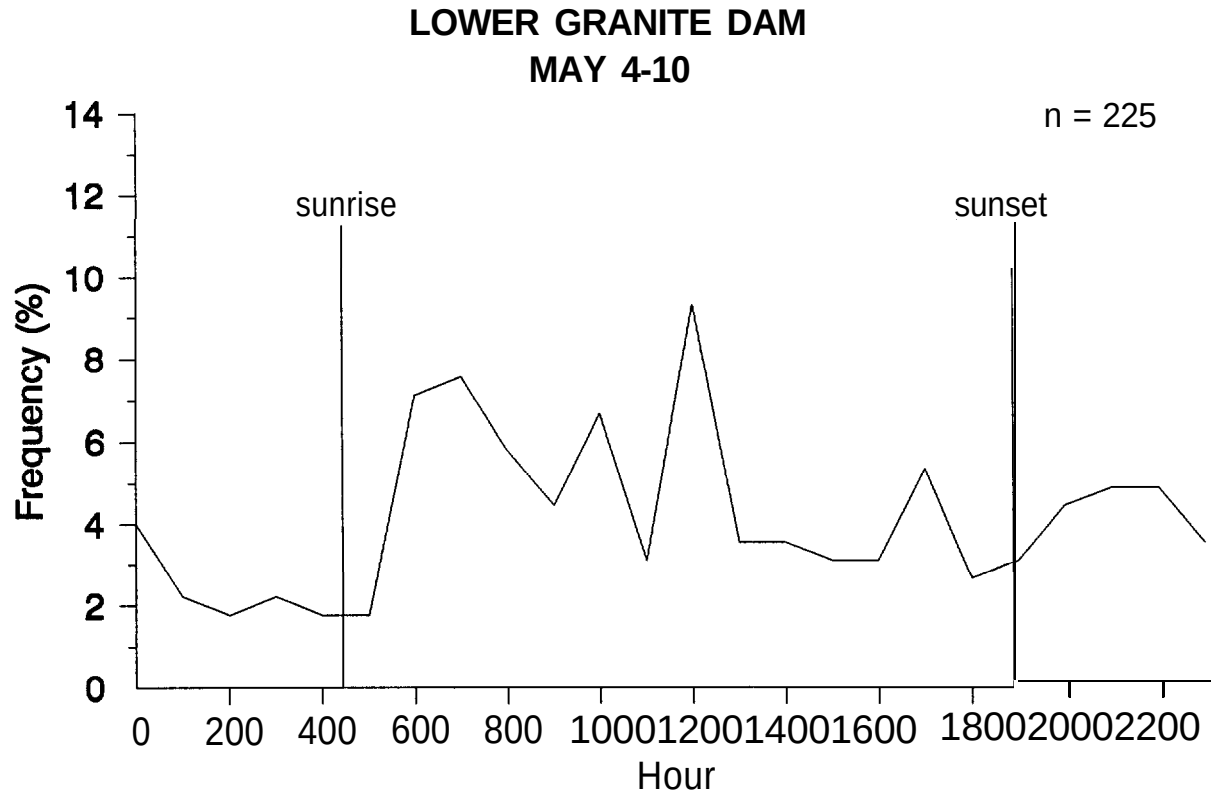


Figure **G.17**. Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Granite Dam during the weeks of May 4-10 (upper) and May 11-17, 1997 (lower).

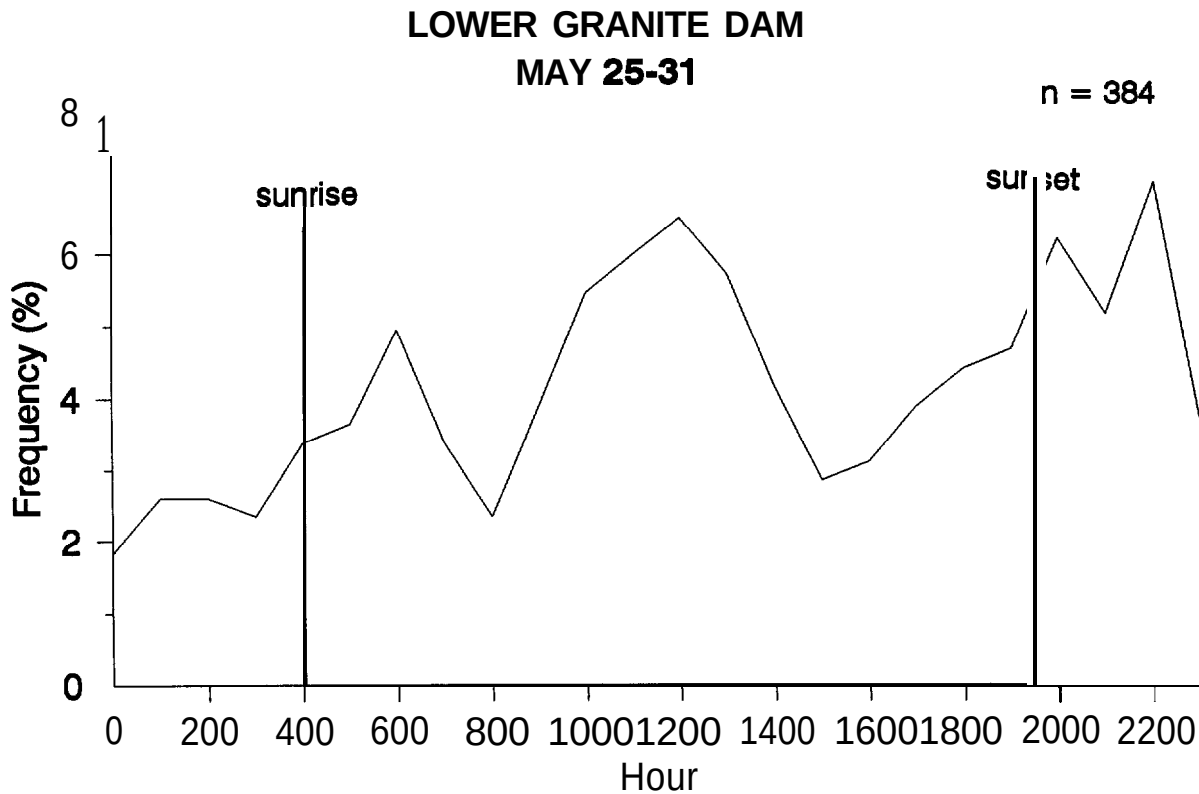
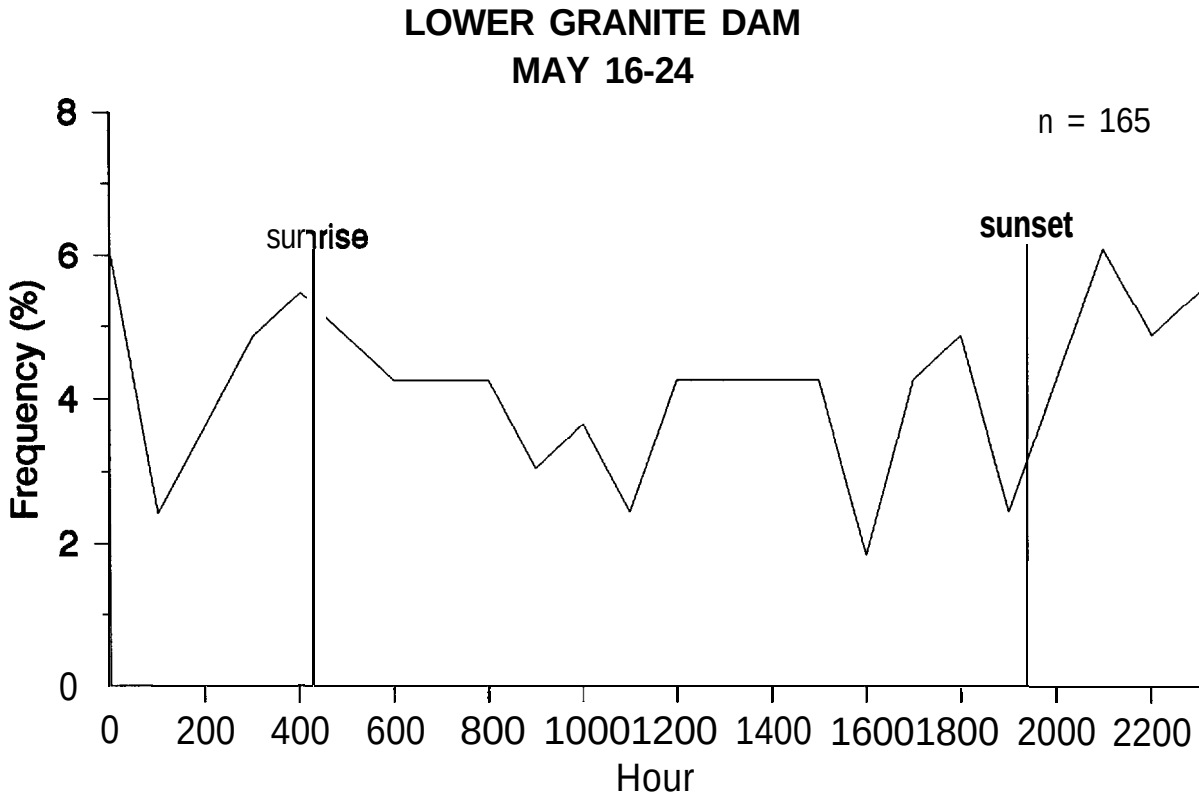


Figure G. 18. Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Granite Dam during the weeks of May 18-24 (upper) and May 25-31, 1997 (lower).

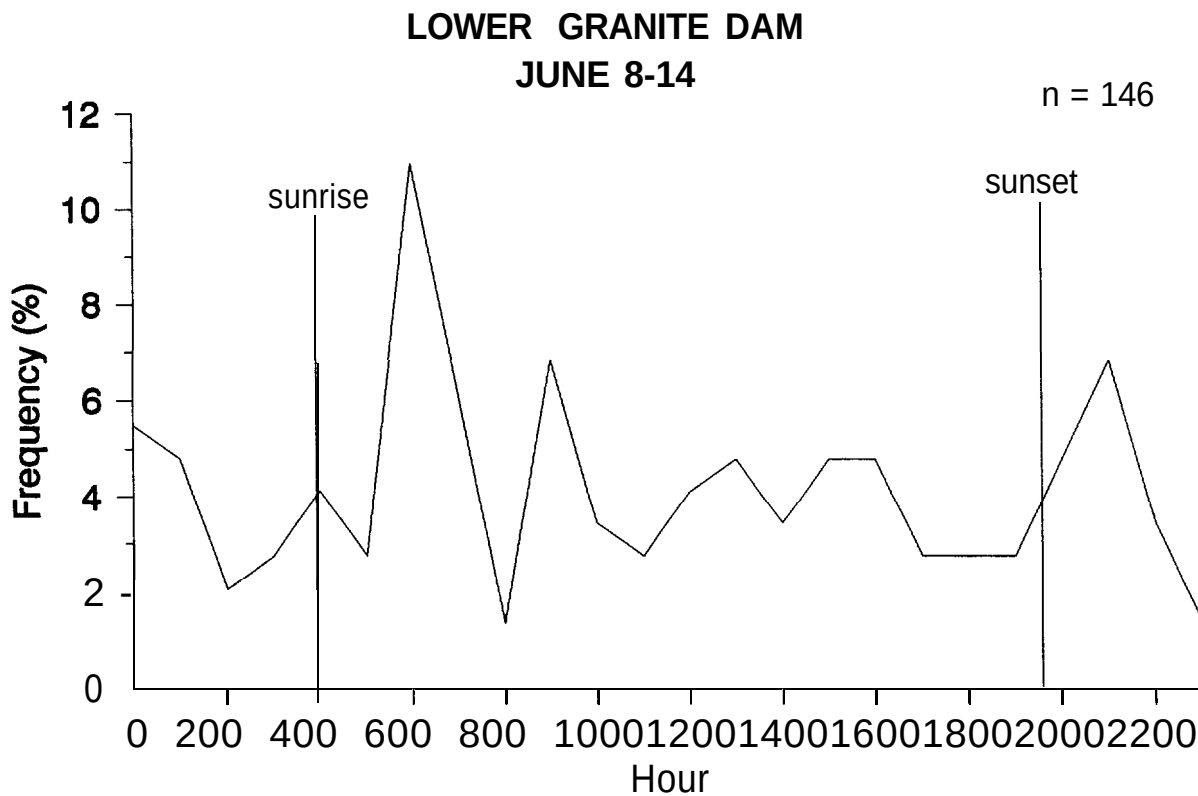
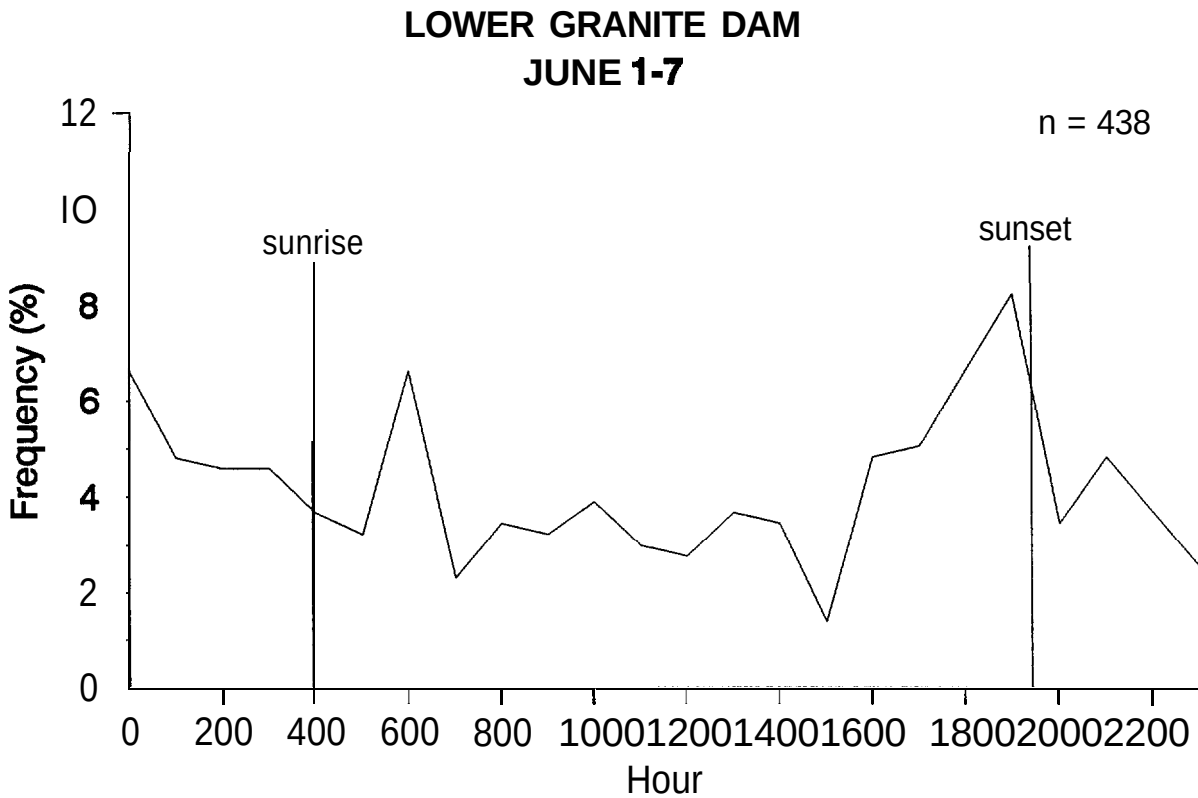


Figure G. 19. Average weekly **diel** passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Granite Dam during the weeks of June 1-7 (upper) and June 8-14, 1997 (lower).

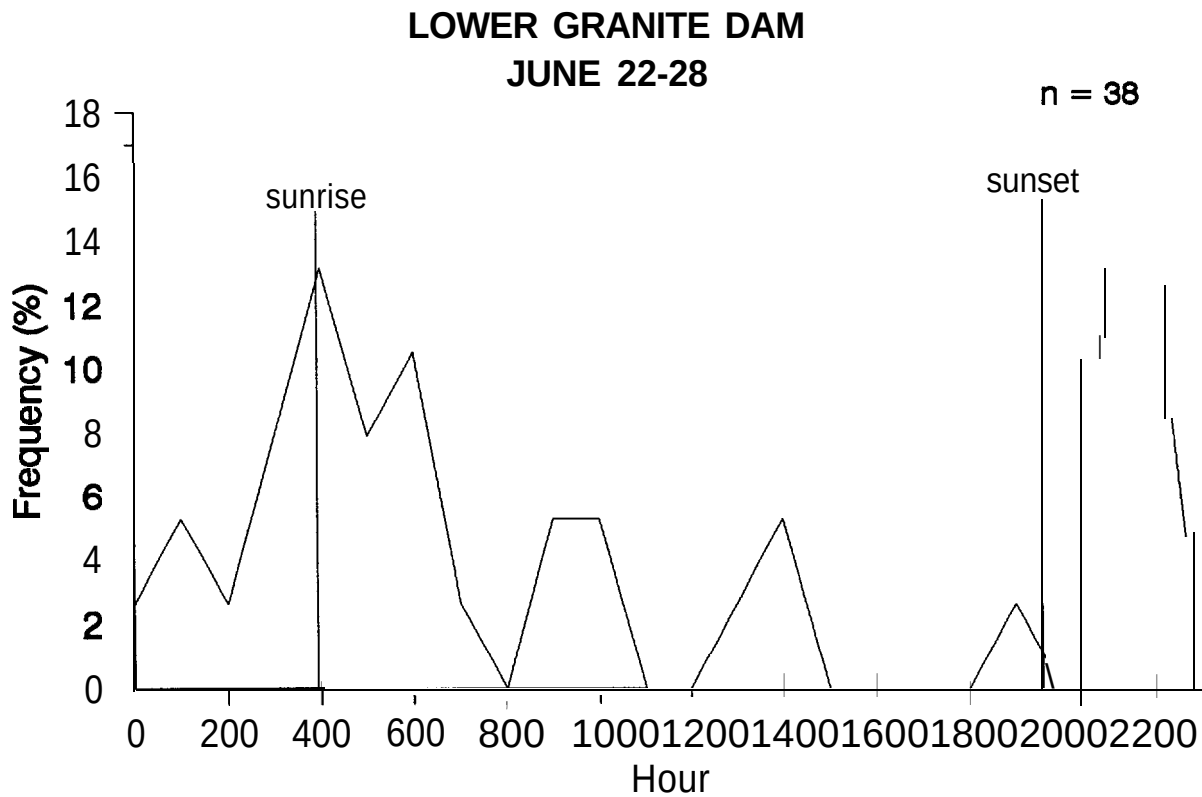
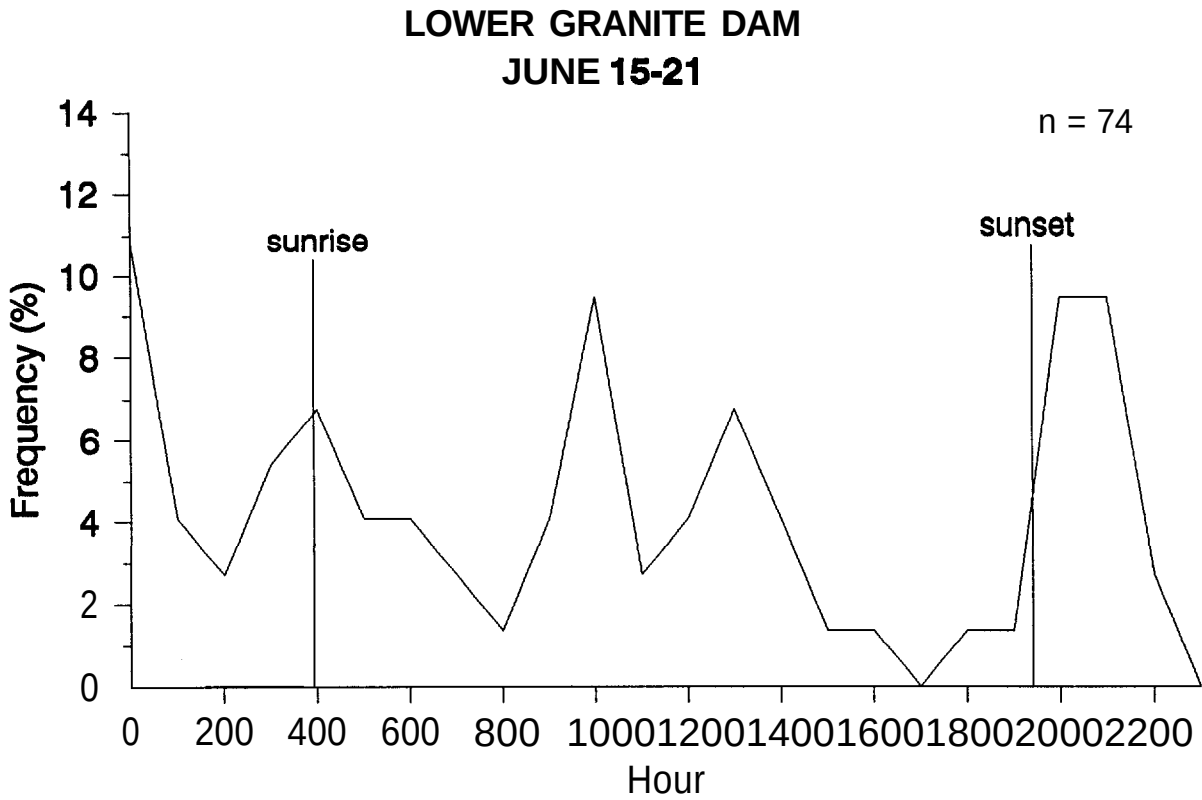


Figure G.20. Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Granite Dam during the weeks of June 15-21 (upper) and June 22-28, 1997 (lower).

LOWER GRANITE DAM JUNE 29JULY 5

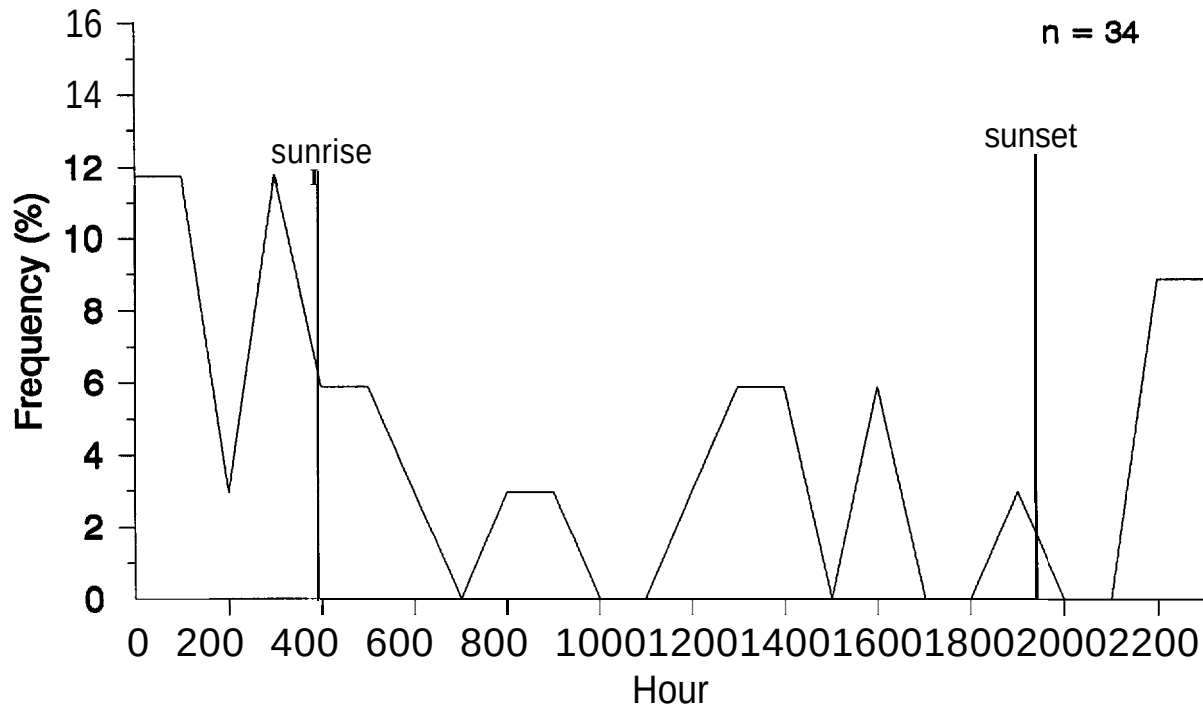


Figure G.21. Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Granite Dam during the week of June 29-July 5.

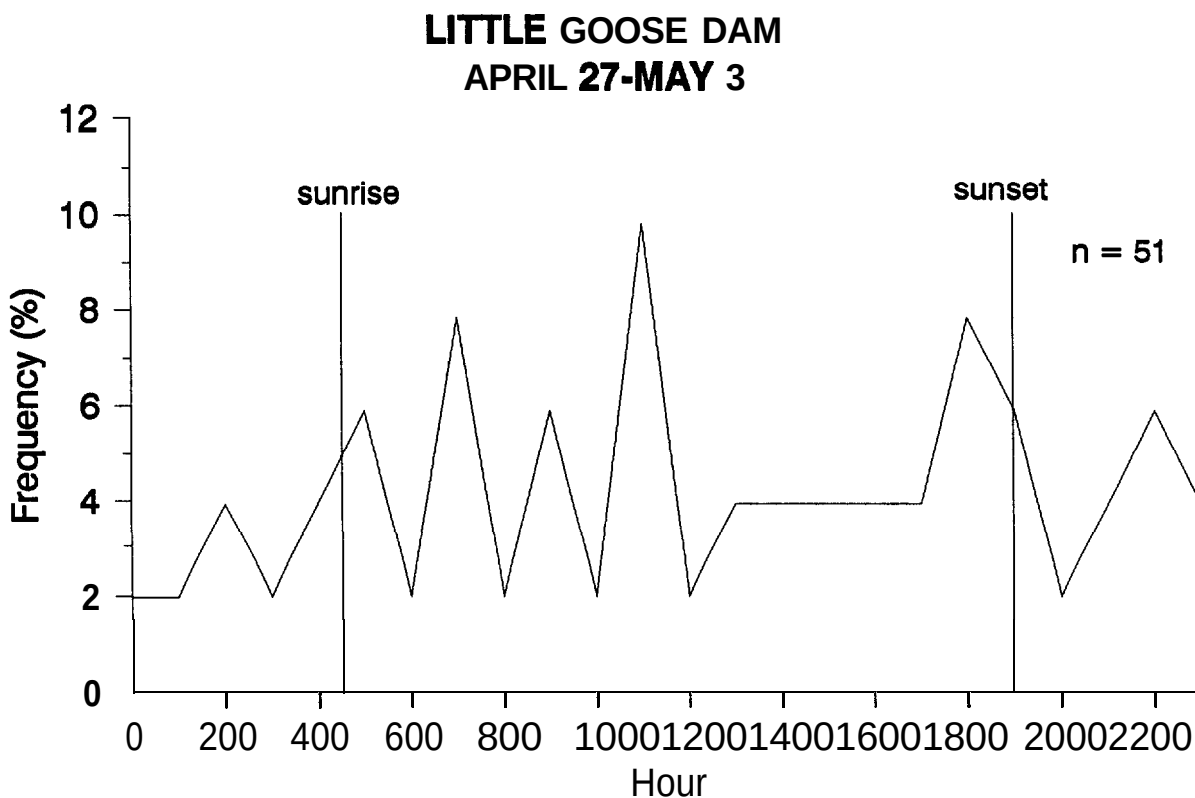
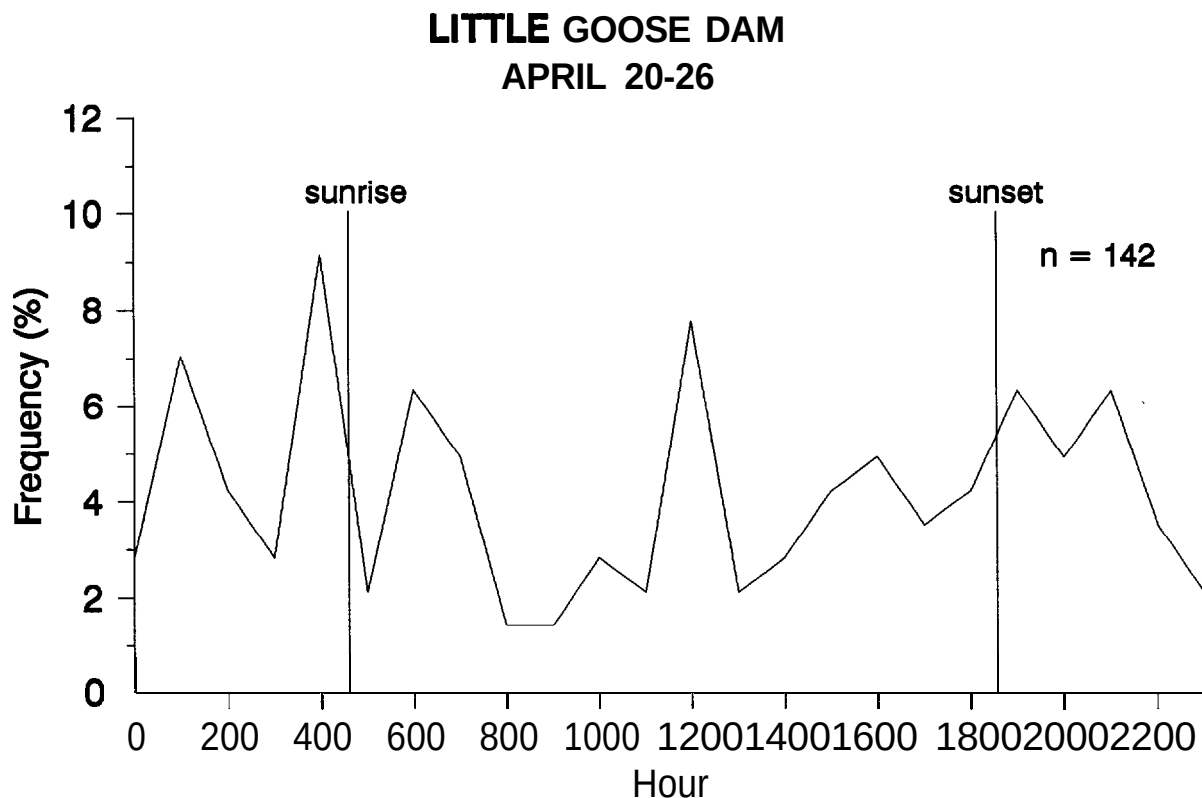


Figure G.22. Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Little Goose Dam during the weeks of April 20-26 (upper) and April 27-May 3, 1997 (lower).

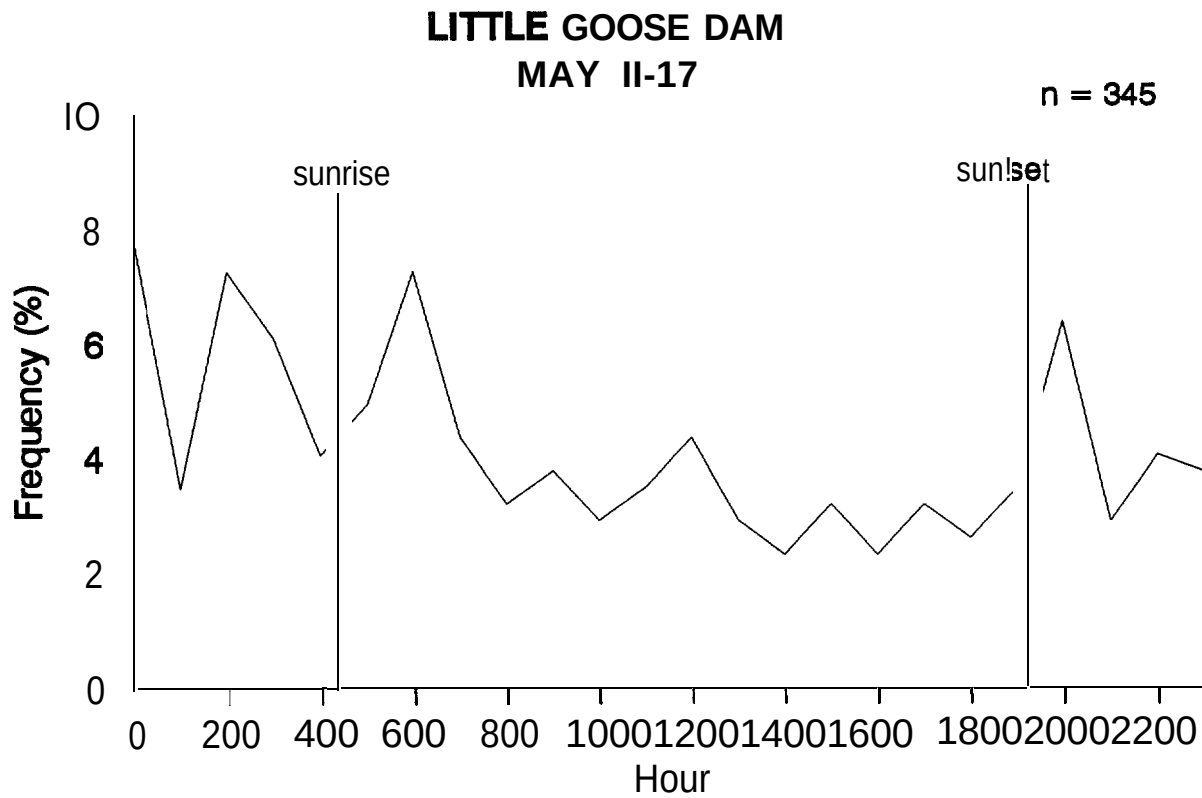
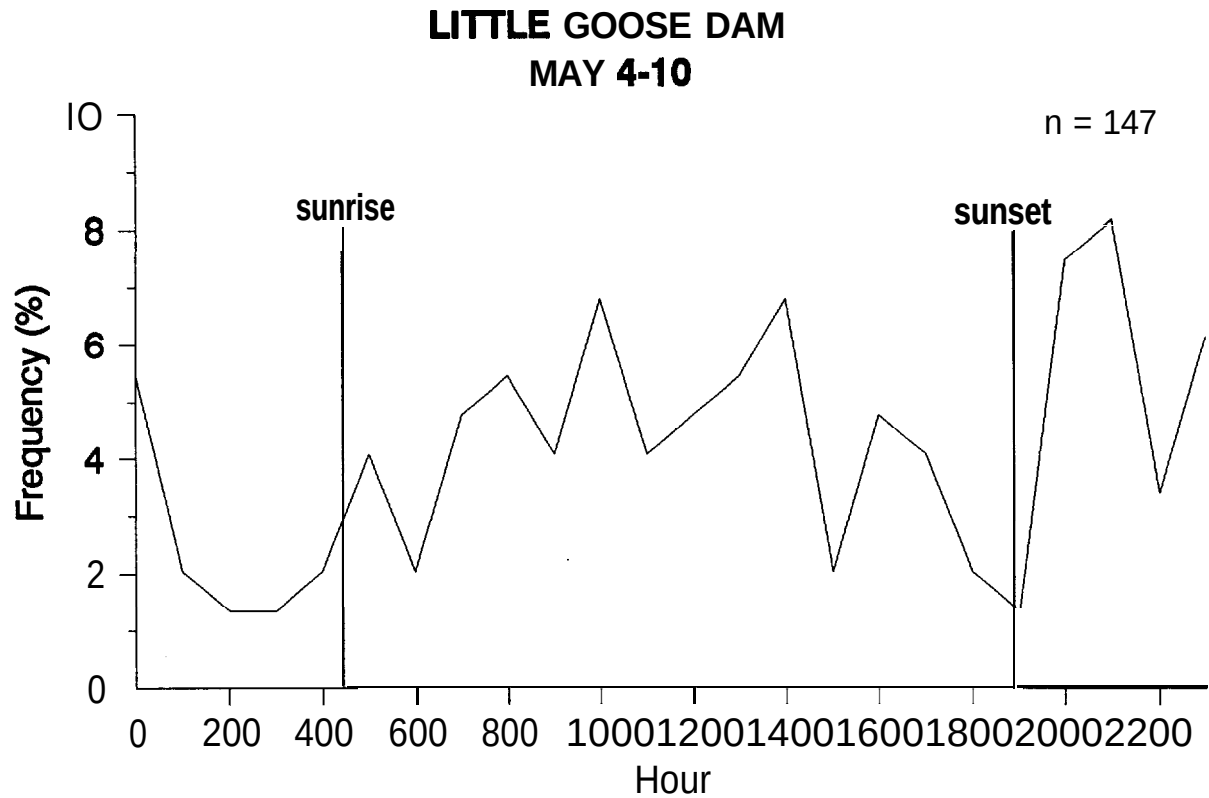


Figure G.23. Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Little Goose Dam during the weeks of May 4-10 (upper) and May 11-17, 1997 (lower).

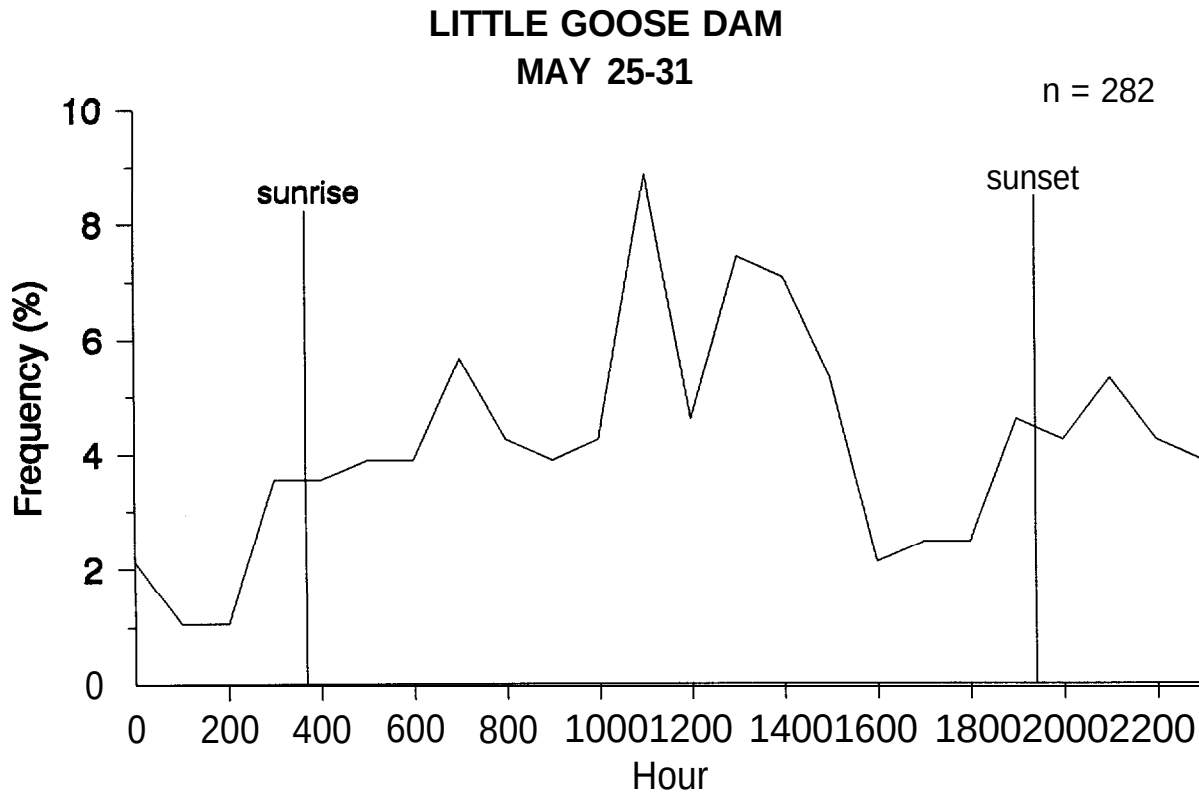
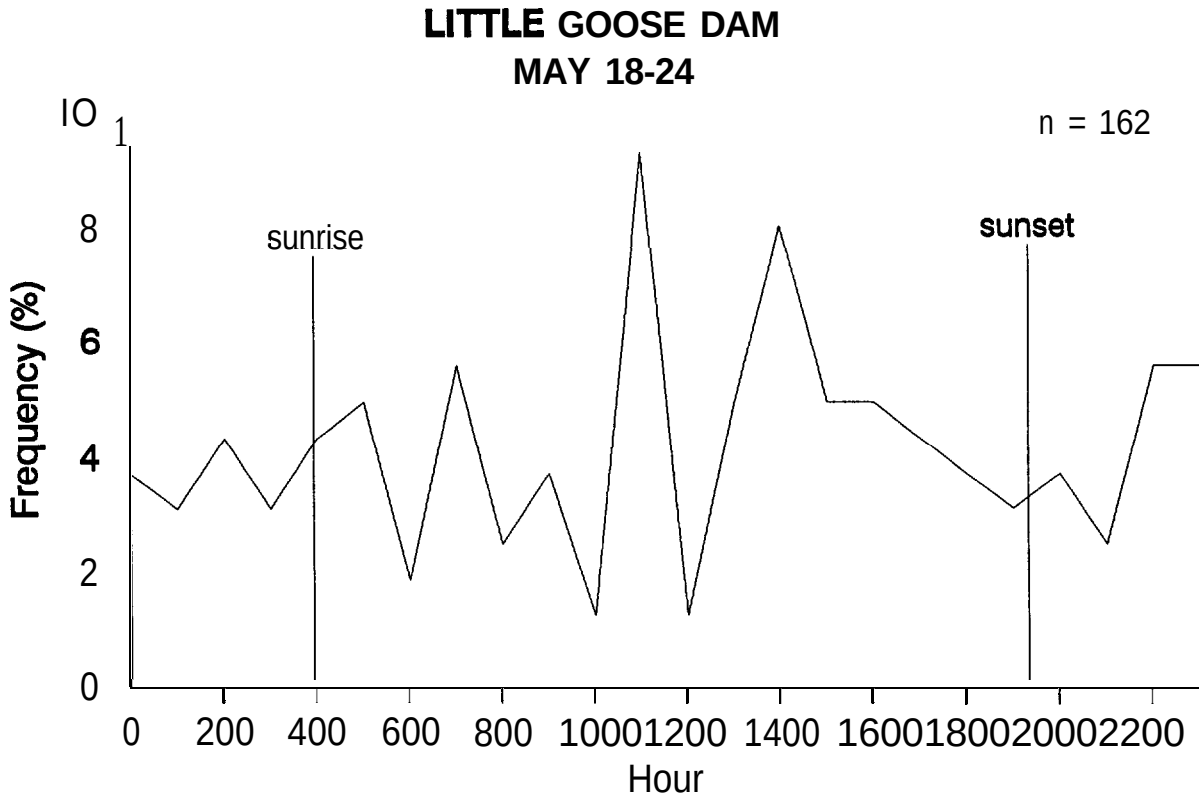


Figure G.24. Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Little Goose Dam during the weeks of May 18-24 (upper) and May 25-31, 1997 (lower).

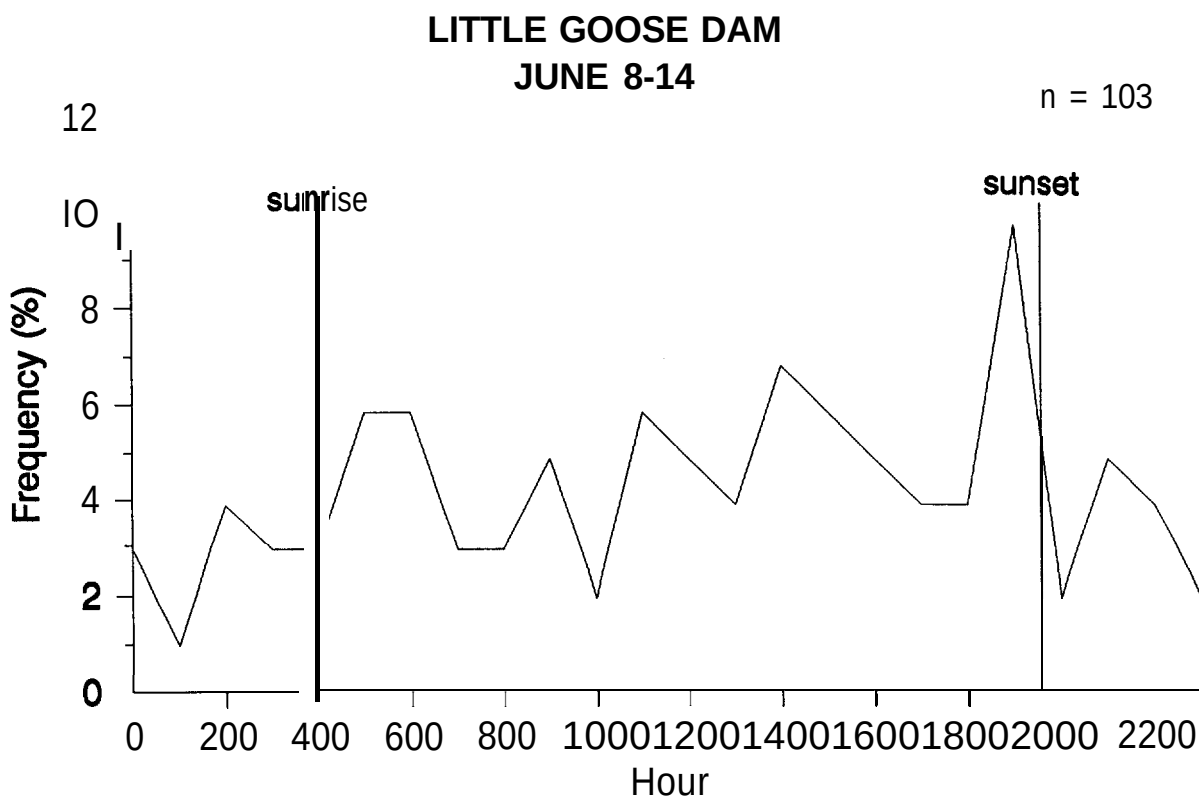
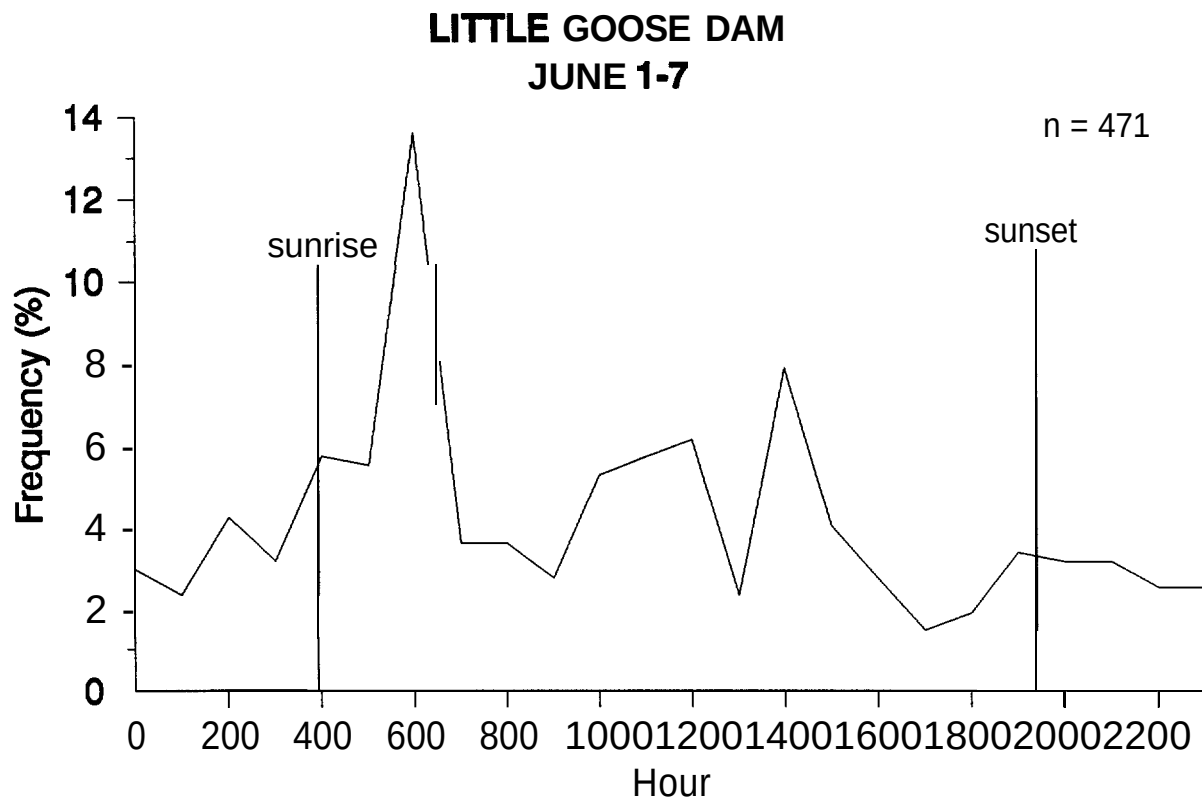


Figure G.25. Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Little Goose Dam during the weeks of June 1-7 (upper) and June 8-14, 1997 (lower).

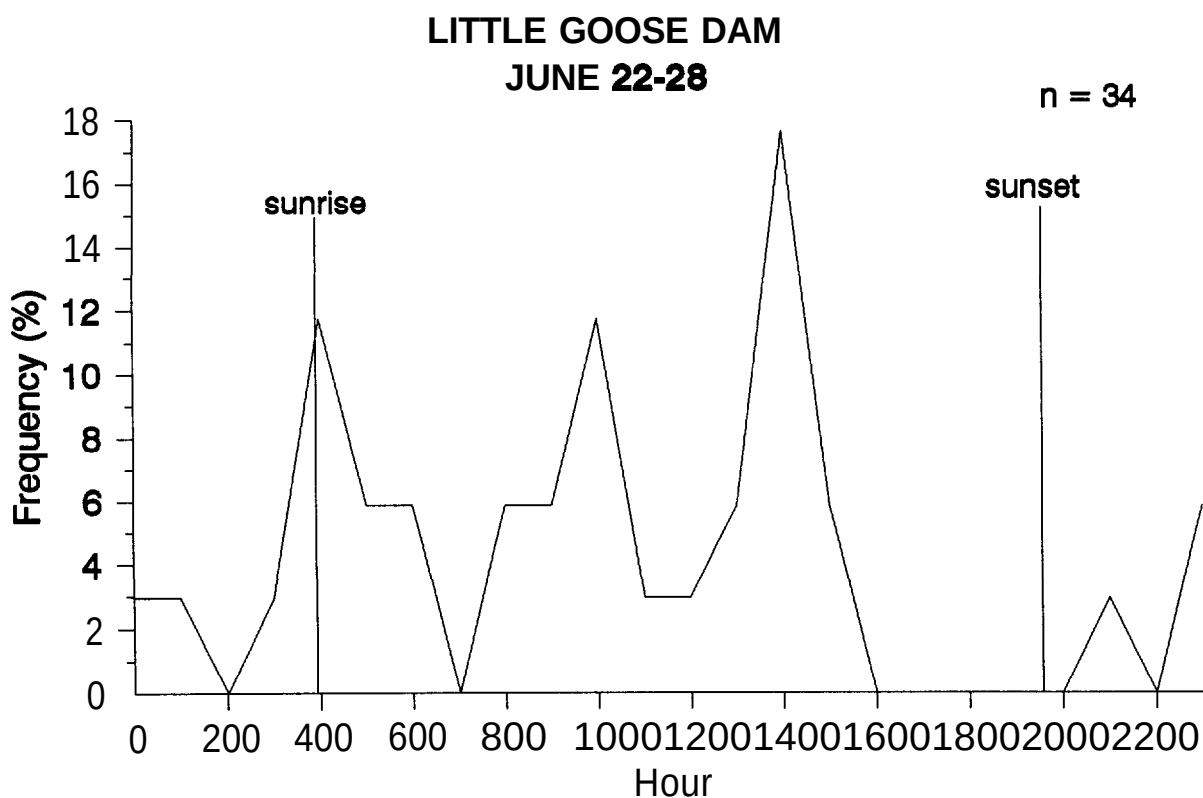
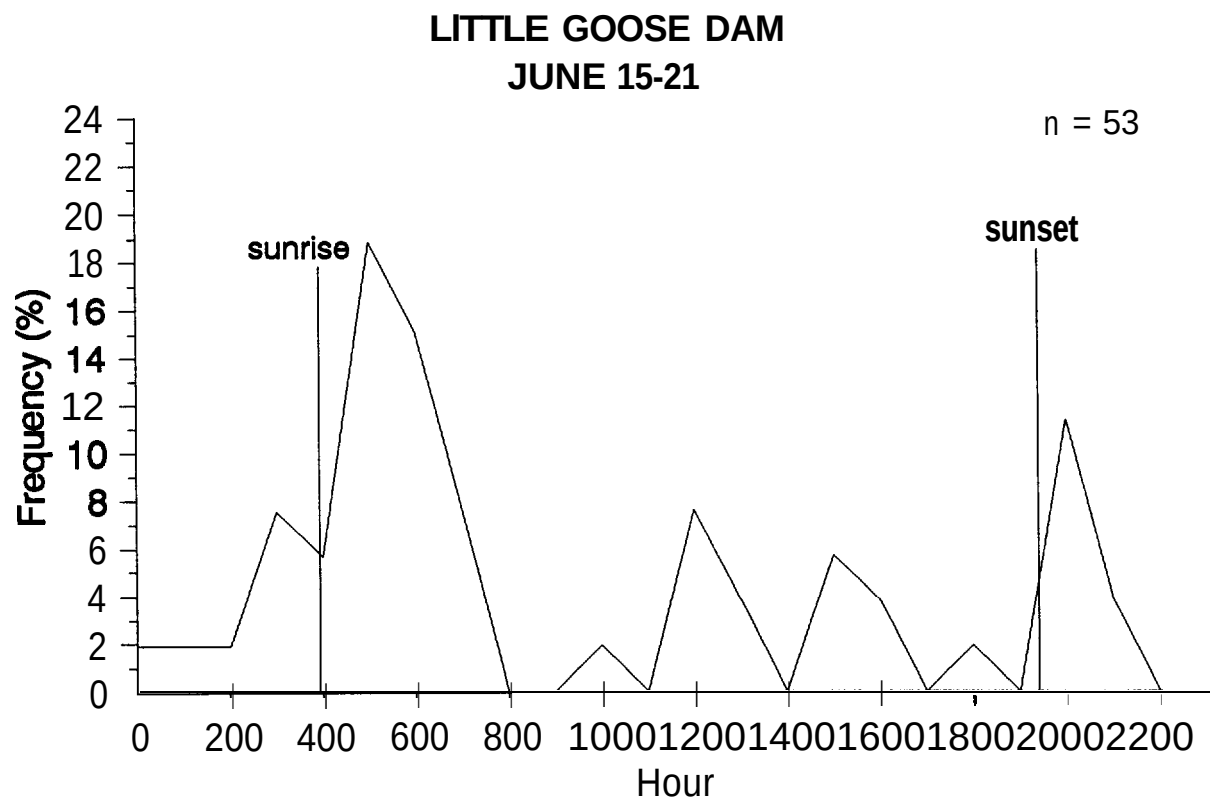


Figure **G.26**. Average weekly **diel** passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Little Goose Dam during the weeks of June 15-21 (upper) and June 22-28, 1997 (lower).

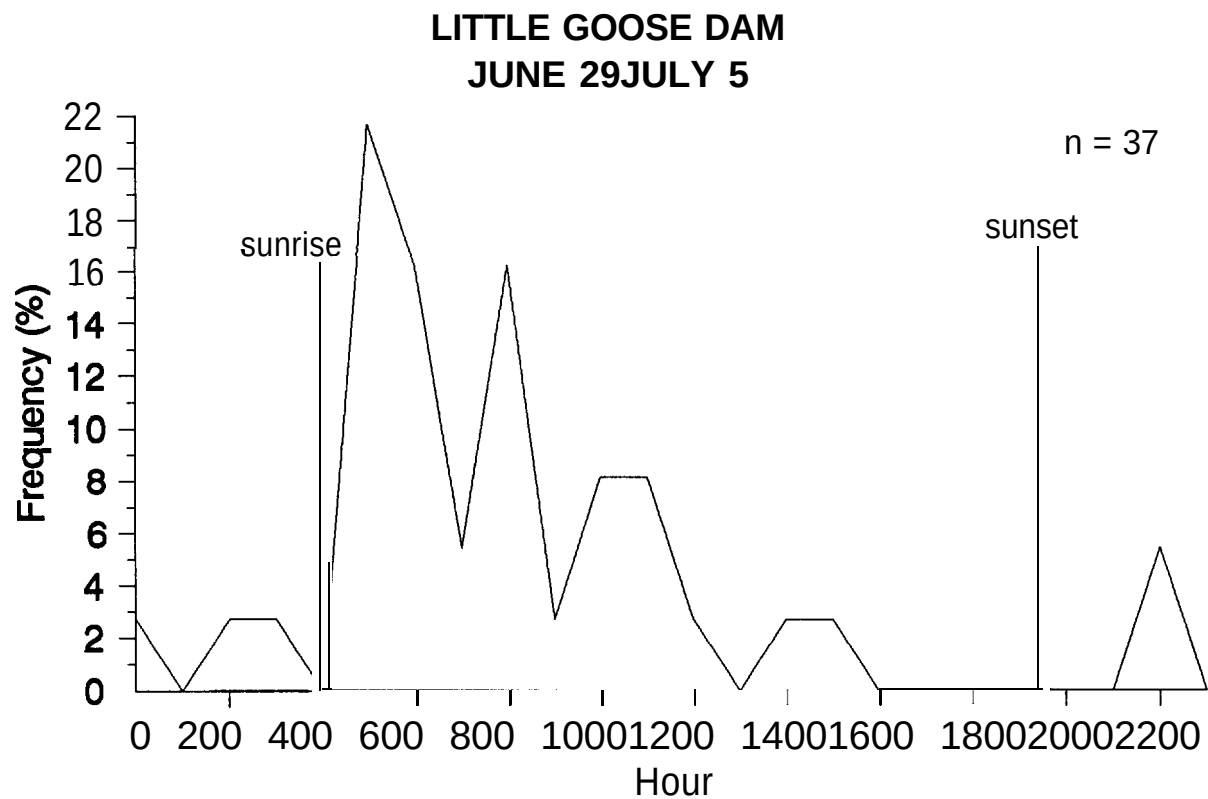


Figure G.27. Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Little Goose Dam during the week of June 29-July 5, 1997.

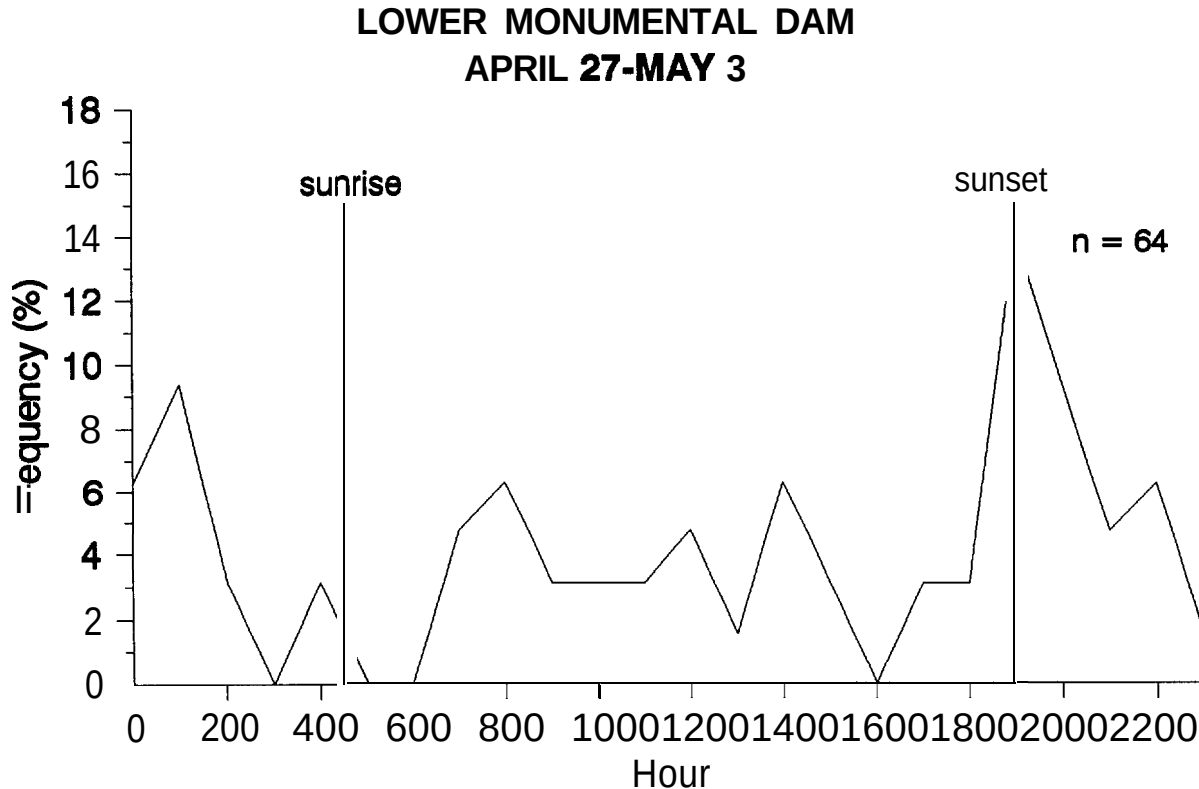
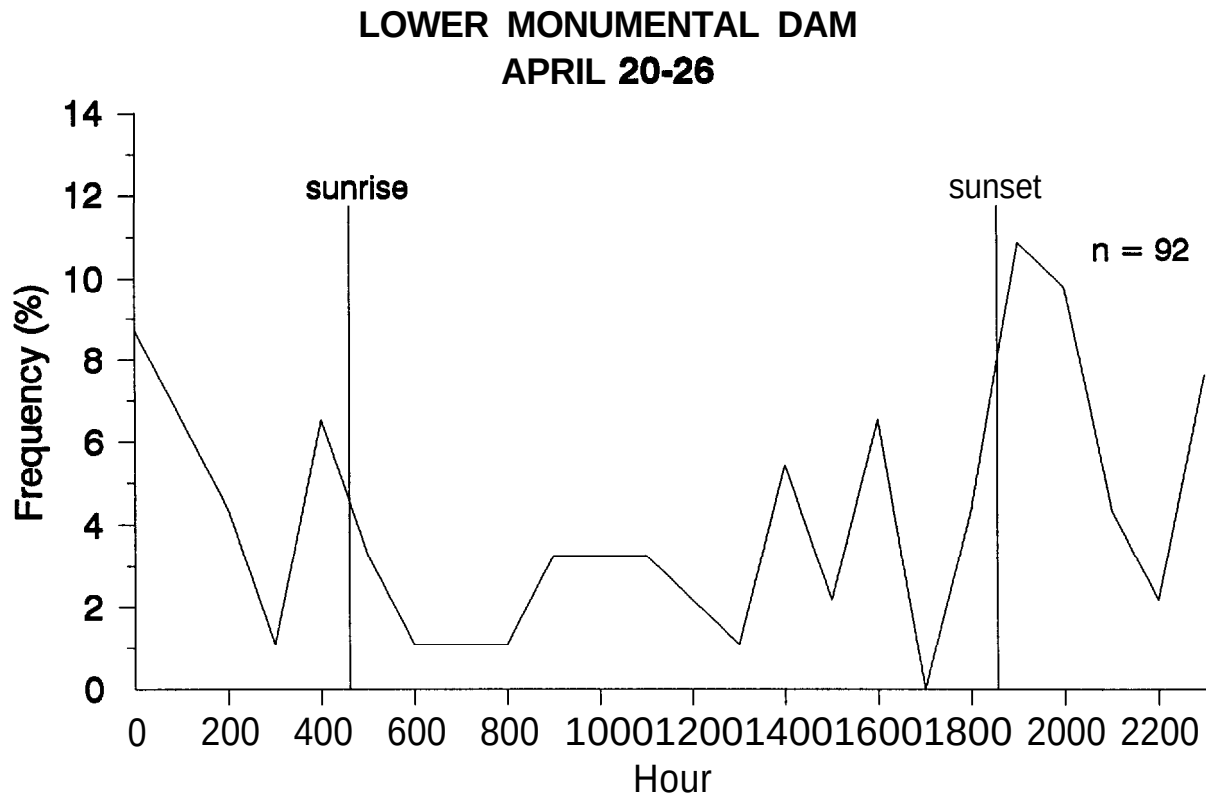


Figure G.28. Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Monumental Dam during the weeks of April 20-26 (upper) and April 27-May 3, 1997 (lower).

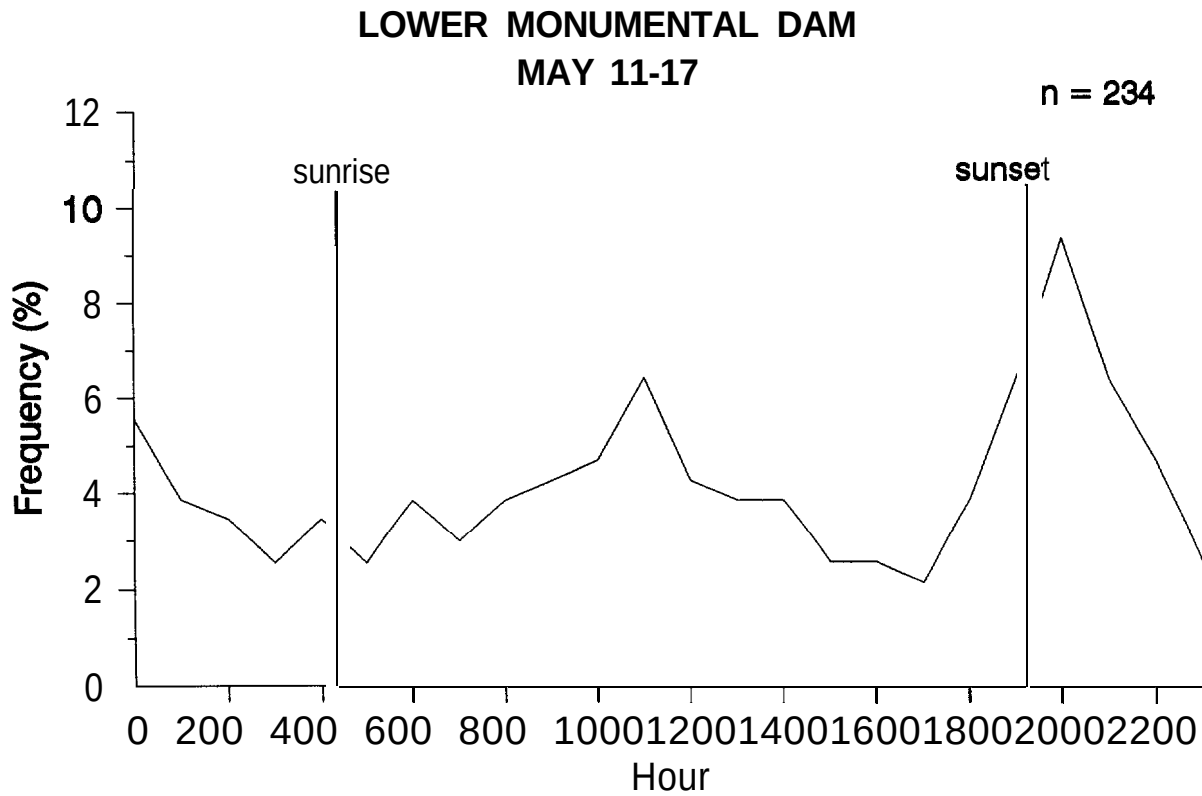
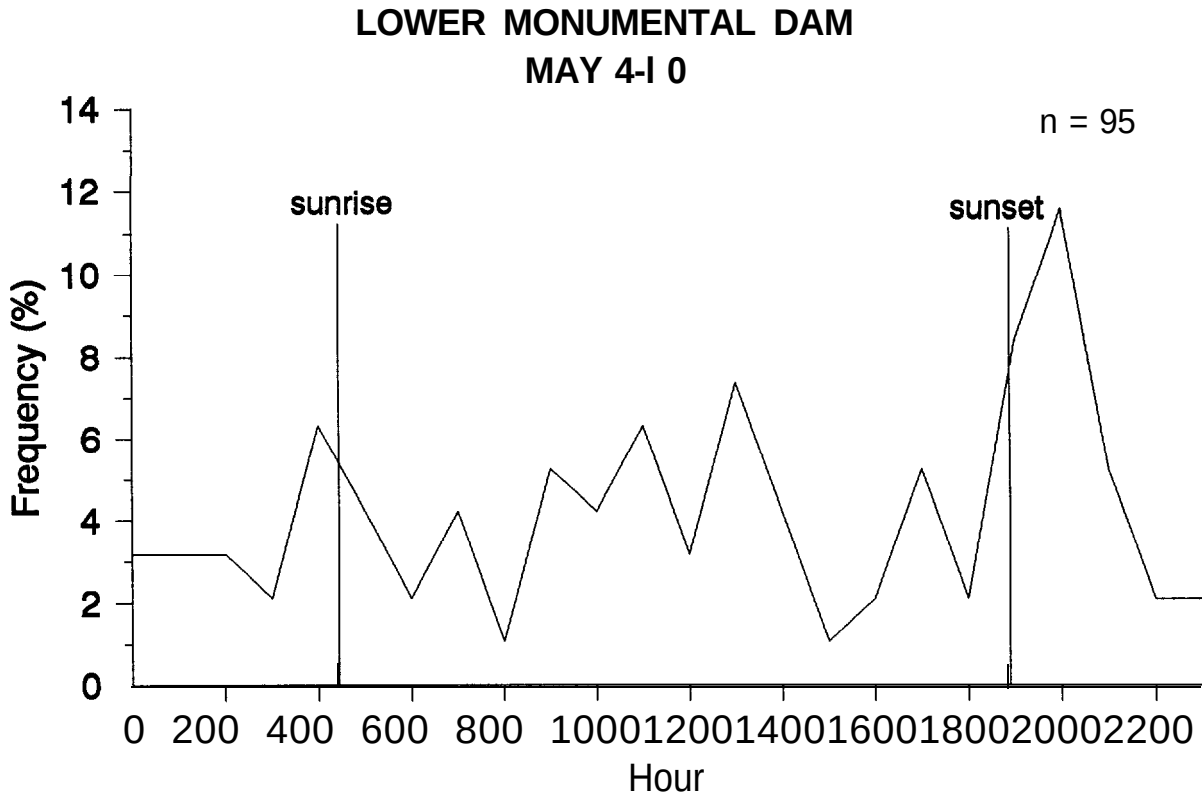


Figure **G.29**. Average weekly **diel** passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Monumental Dam during the weeks of May 4-10 (upper) and May 11-17, 1997 (lower).

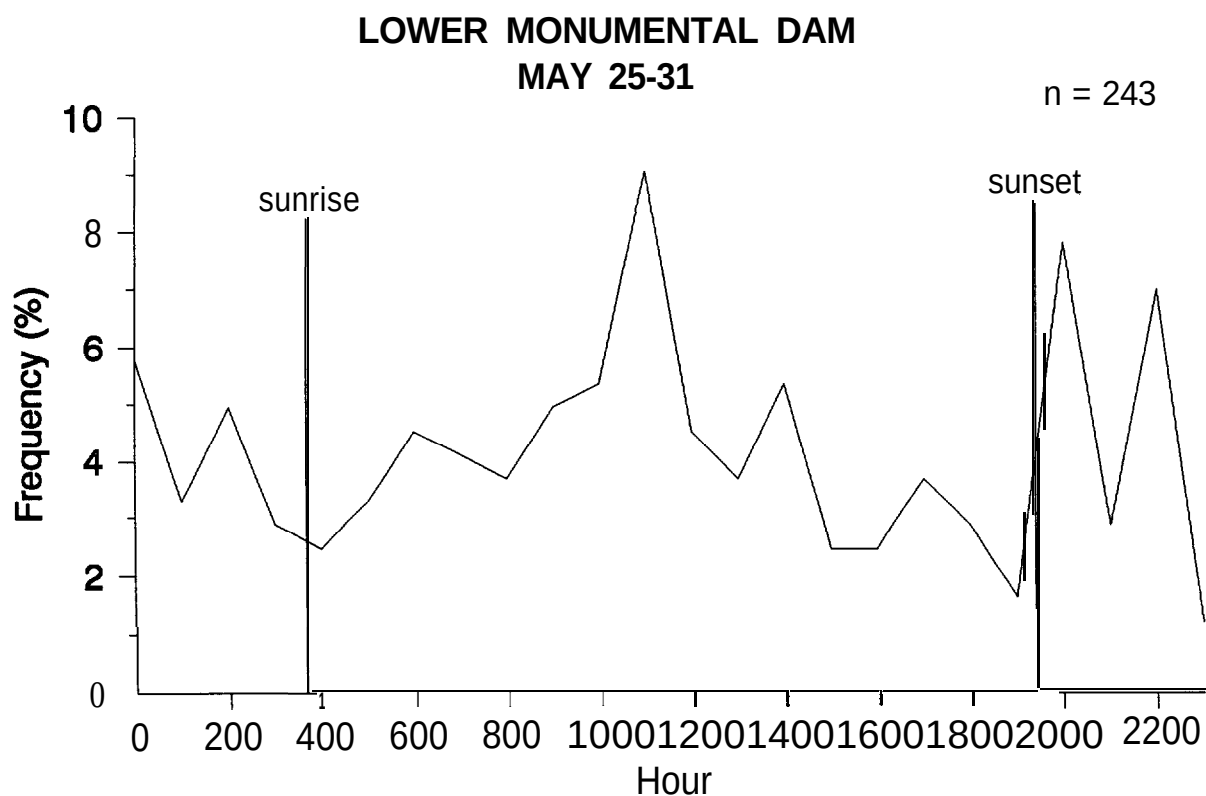
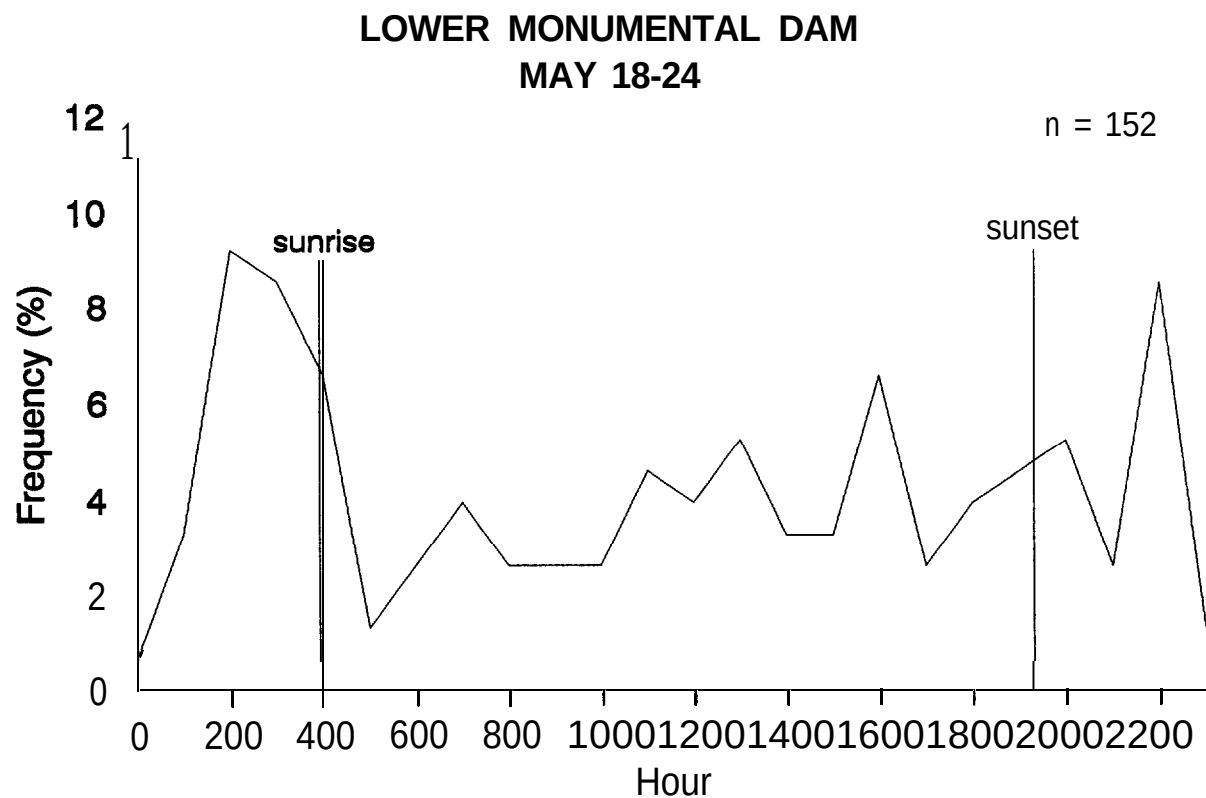


Figure G.30. Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Monumental Dam during the weeks of May 18-24 (upper) and May 25-31, 1997 (lower).

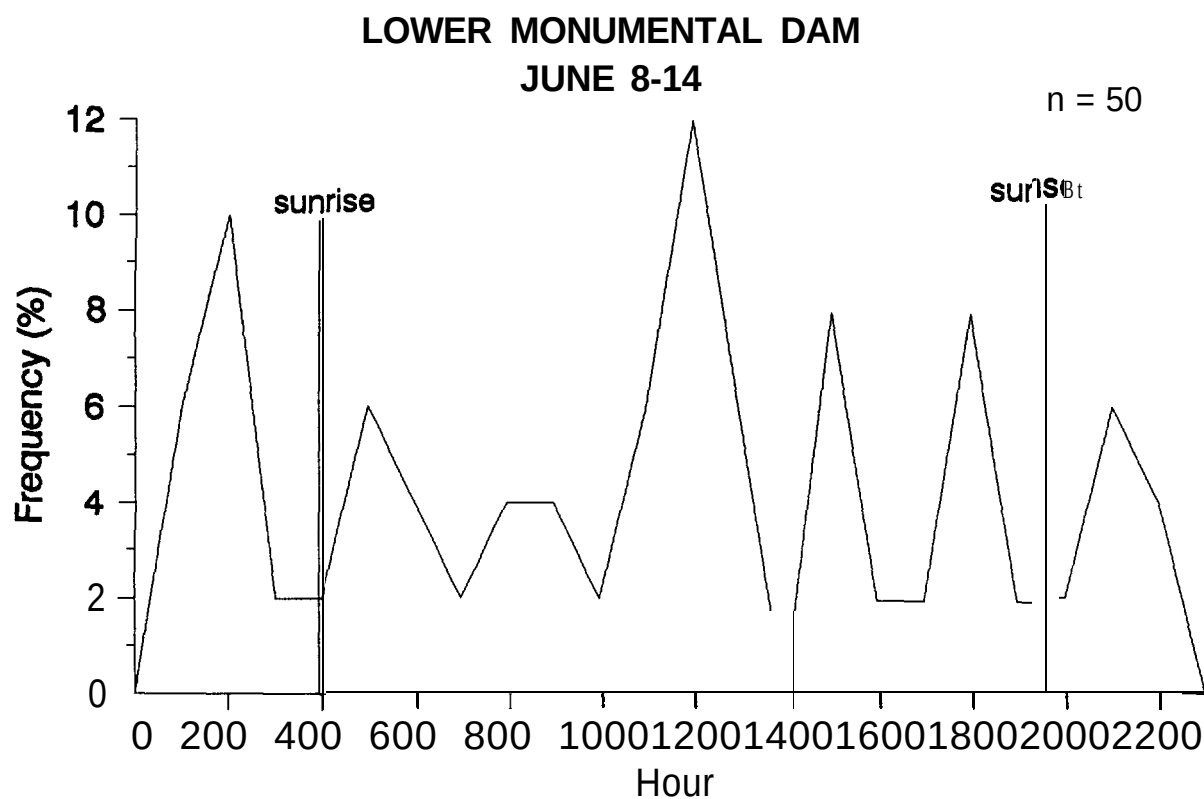
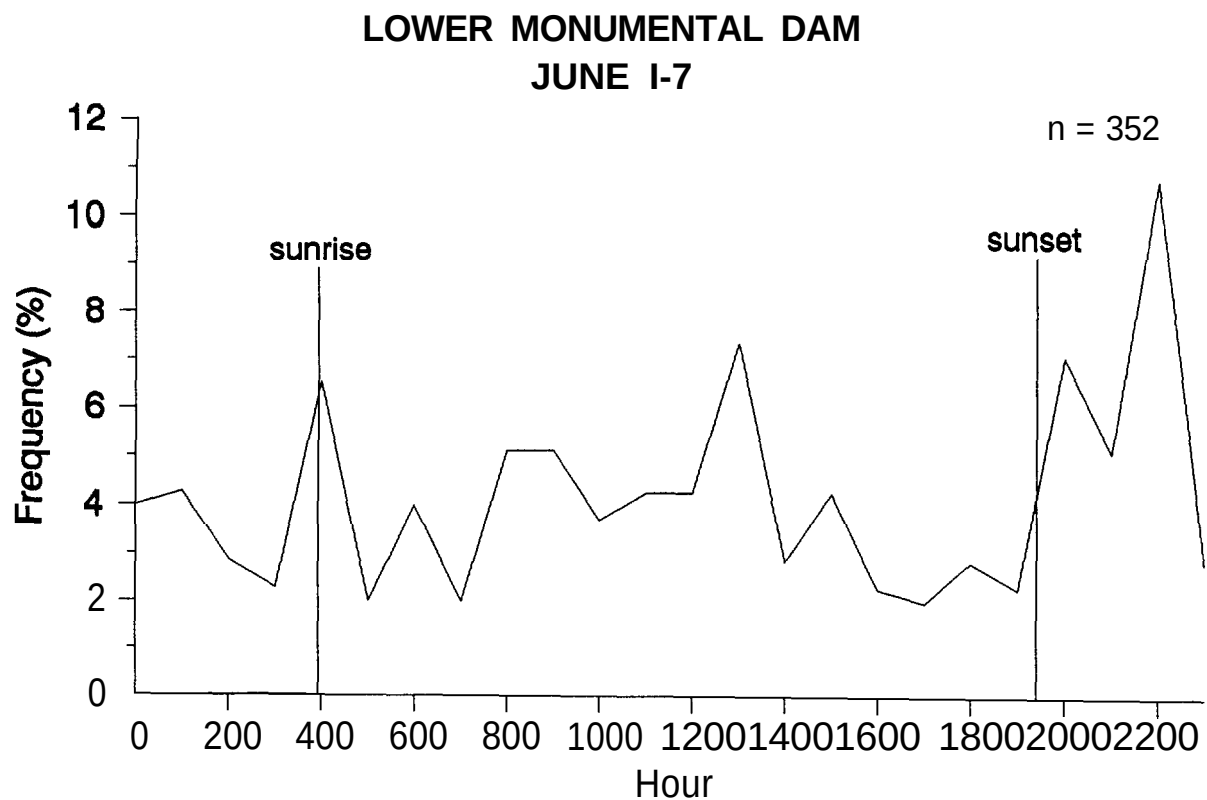


Figure G.31. Average weekly diel passage of PIT tagged Innaha River hatchery steelhead trout smolts at Lower Monumental Dam during the weeks of June 1-7 (upper) and June 8-14, 1997 (lower).

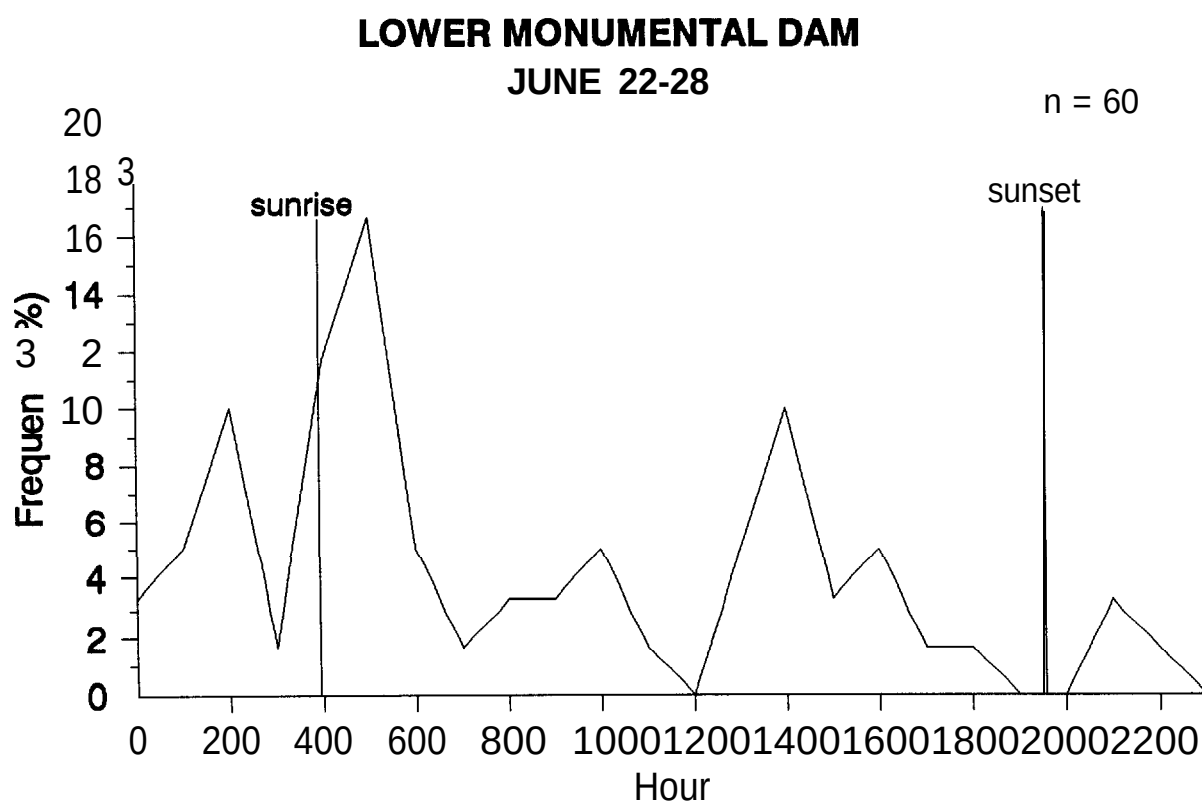
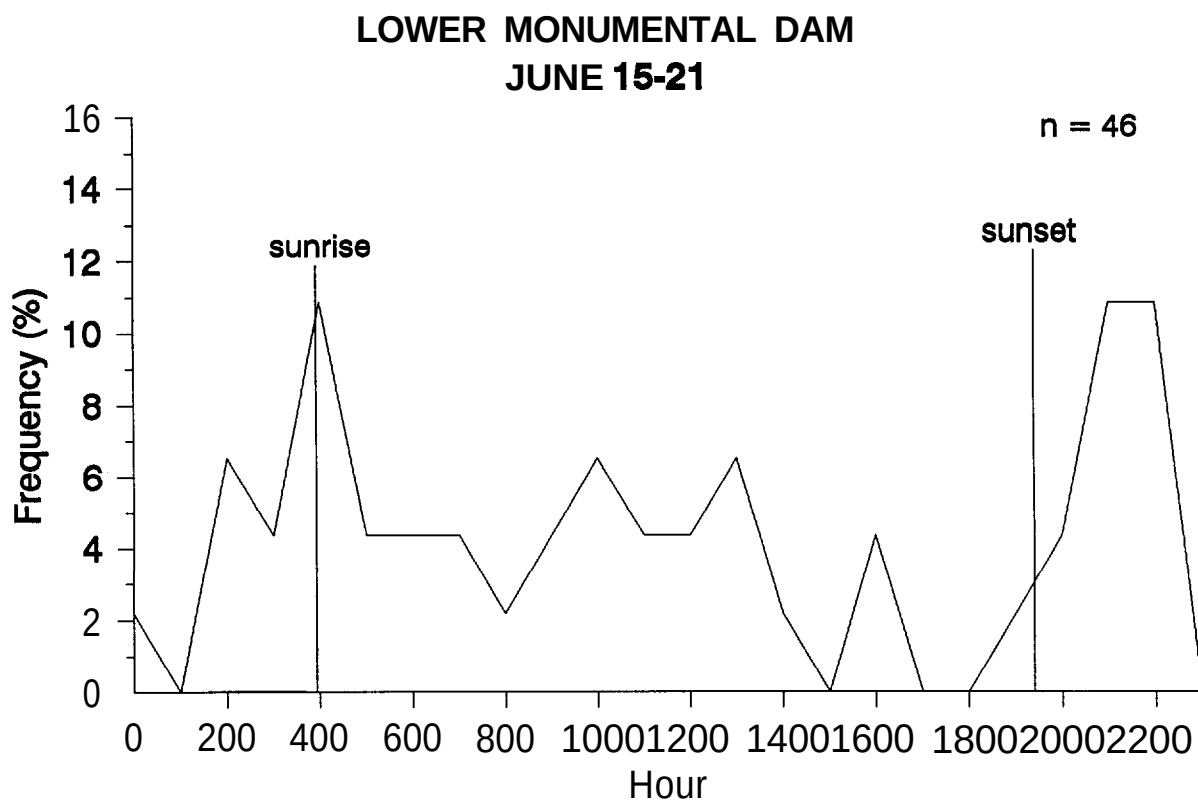


Figure G.32. Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at Lower Monumental Dam during the weeks of June 15-21 (upper) and June 22-28, 1997 (lower).

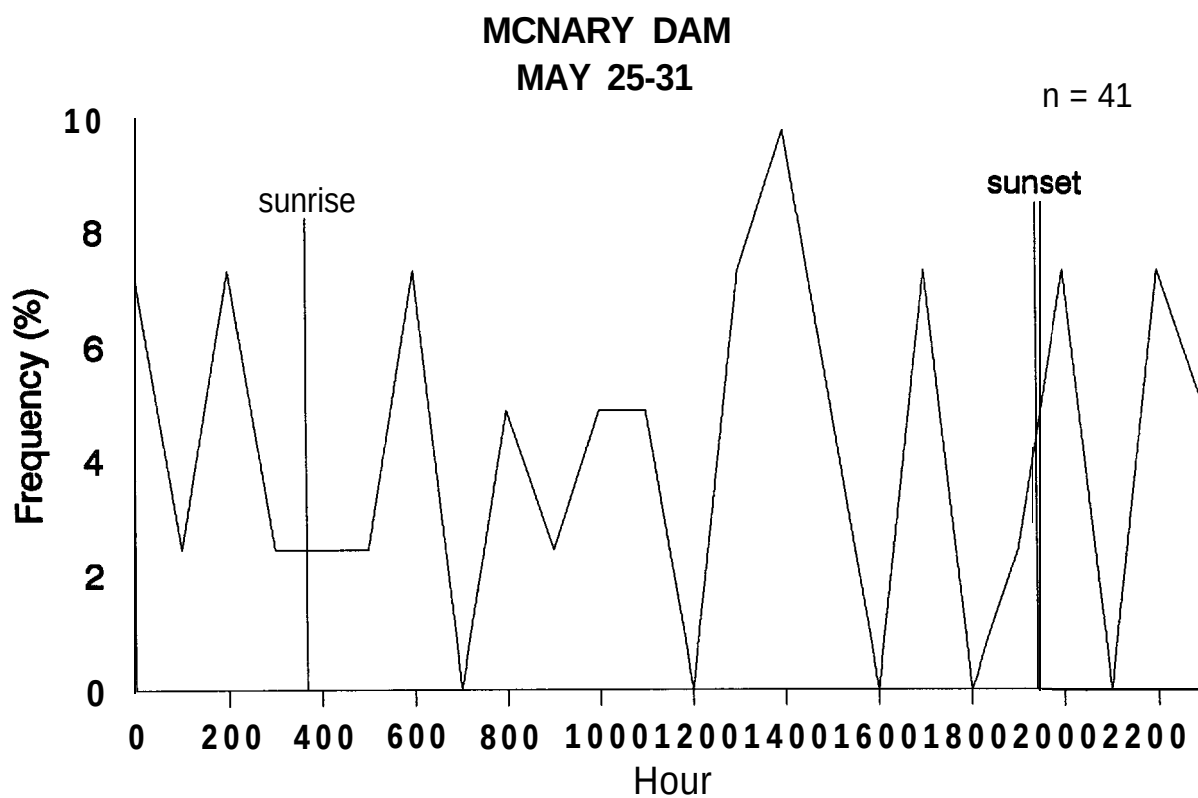
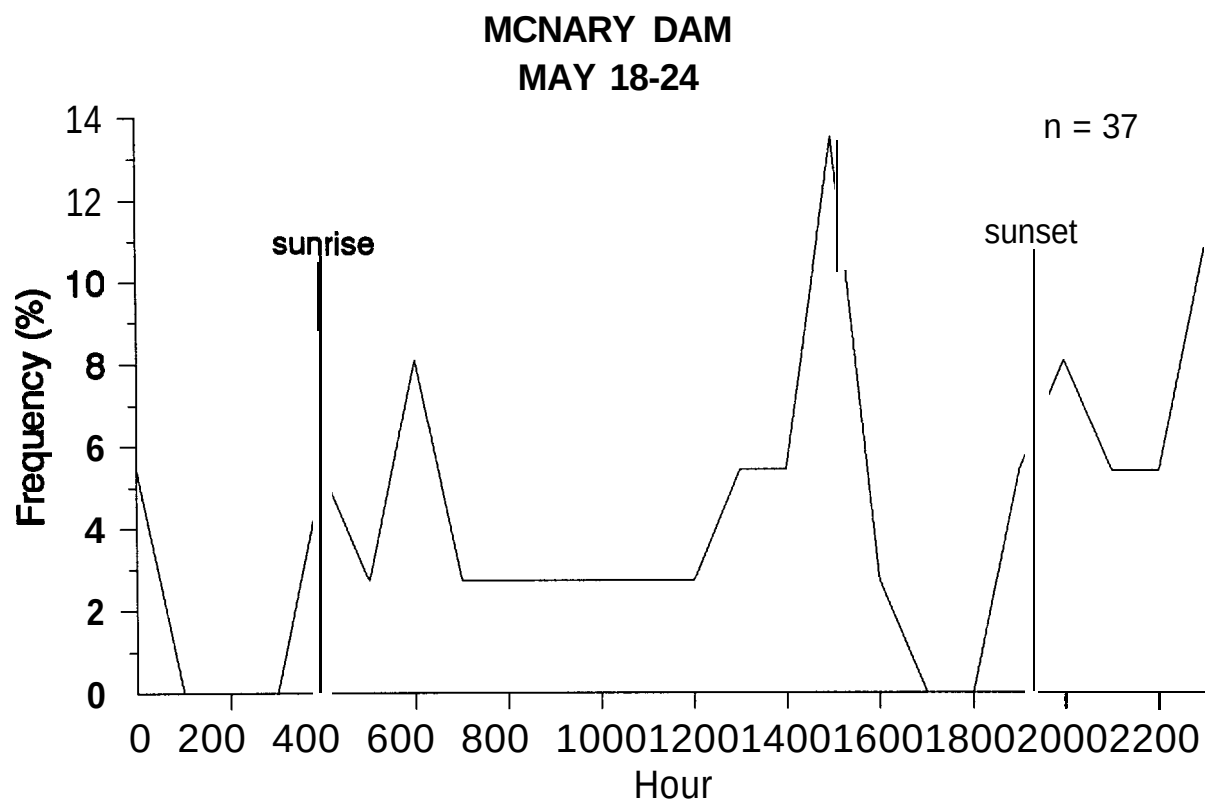


Figure G.33. Average weekly diel passage of PIT tagged Imnaha River hatchery steelhead trout smolts at McNary Dam during the weeks of May 18-24 (upper) and May 25-31, 1997 (lower).

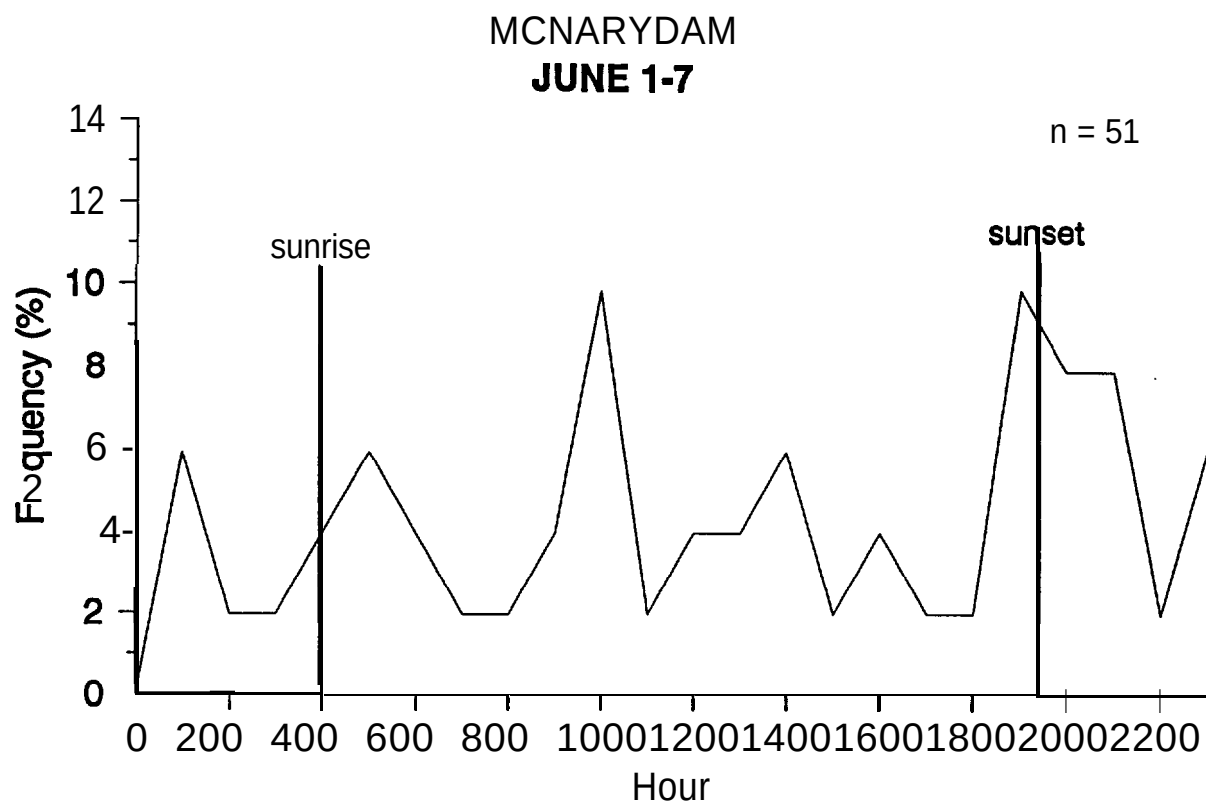


Figure G.34. Average weekly **diel** passage of PIT tagged Imnaha River hatchery steelhead trout smolts at McNary Dam during the week of June 1-7, 1997.