October 2000

COMPARATIVE SURVIVAL RATE STUDY (CSS) OF HATCHERY PIT TAGGED CHINOOK

Status Report For Migration Years 1996-1998 Mark/Recapture Activities

Annual Report 2000

DOE/BP-00006203-1

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:

Berggren, Thomas J., Larry R. Basham - Fish Passage Center, 2000, Comparative Survival Rate Study (CSS) Of Hatchery Pit Tagged Chinook, Status Report for Migration Years 1996-1998 Mark/Recapture Activities, 2000 Annual Report, Report to Bonneville Power Administration, Contract No. 00006203, Project No. 199602000, 61 electronic pages (BPA Report DOE/BP-00006203-1)

This report and other BPA Fish and Wildlife Publications are available on the Internet at:

http://www.efw.bpa.gov/cgi-bin/efw/FW/publications.cgi

For other information on electronic documents or other printed media, contact or write to:

Bonneville Power Administration
Environment, Fish and Wildlife Division
P.O. Box 3621
905 N.E. 11th Avenue
Portland, OR 97208-3621

Please include title, author, and DOE/BP number in the request.

COMPARATIVE SURVIVAL RATE STUDY (CSS) of Hatchery PIT Tagged Chinook

Status Report for Migration Years 1996 – 1998 Mark/Recapture Activities

Project No. 1996-020-00 Contract No. 00006203

Prepared by

Thomas J. Berggren
and
Larry R. Basham
Fish Passage Center
2501 SW First Ave, Suite 230
Portland, OR 97201

representing the

Columbia Basin Fish & Wildlife Agencies
and
Columbia Basin Tribes

Project Leader:
Michele DeHart, Fish Passage Center

Project Steering Committee:
Howard Schaller, Oregon Department of Fish and Wildlife
Charlie Petrosky, Idaho Department of Fish and Game
Olaf Langness, Washington Department of Fish and Wildlife
Earl Weber, Columbia River Inter-Tribal Fish Commission
Paul Wilson, Columbia Basin Fish and Wildlife Authority

October, 2000

Table of Contents

Acknowledgments

Through the course of the Comparative Survival Rate Study, it has taken the cooperation of multiple agencies and individuals to ensure that the major tasks of marking, handling, releasing and recovery of fish in three States and at hatcheries and dams were successful. The scope of this study relies on accurate reporting and recovery of PIT tag information.

The PIT tag systems that are maintained by PSMFC personnel enable PIT tag data to be collected on a real-time basis. We commend Carter Stein and staff for their diligence in repair of PIT tag equipment, both in the juvenile and adult fish passage systems and for the smooth transfer of PIT tag data to the PIT Tag Operations Center located in Portland, OR. In addition, we thank Dr. Sandra Downing of NMFS for her installation of all CSS tag files on the multimon computer systems at Lower Granite, Little Goose, and Lower Monumental dams.

Yearling hatchery chinook were supplied by Idaho Department of Fish and Game (IDFG), Washington Department of Fish and Wildlife (WDFW), U.S. Fish and Wildlife Service (USFWS), and Oregon Department of Fish and Wildlife (ODFW). Individual hatcheries supplying fish were: McCall, Rapid River, Clearwater, Pahsimeroi, and Sawtooth from IDFG; Kooskia, Dworshak, and Carson from USFWS; Cowlitz from WDFW; and Lookingglass, Imnaha, and Round Butte from ODFW. We appreciate and extend thanks to the Fish and Wildlife agencies and all hatchery managers and staff personnel for their assistance in the planning, raising of, and recovery of study fish at the hatcheries.

From 1996 through 1998 about 550,000 hatchery spring/summer chinook were PIT tagged by State and Federal personnel for the CSS Program. This required a lot of time and effort from individual marking crews to complete tagging of these fish. The USFWS Dworshak Fisheries Resource Office (FRO) personnel PIT tagged fish at Dworshak and Kooskia hatcheries while the Vancouver, Washington, FRO personnel marked fish at Carson, Cowlitz, and Round Butte hatcheries. PIT tagging at IDFG hatcheries was completed with supervision provided by the IDFG office in Lewiston, Idaho. The PIT tagging of chinook at the Lookingglass complex was completed by ODFW personnel from the Northeast District fisheries office in LaGrande, Oregon. We thank the field supervisors and crews for an excellent job in completing the PIT tagging operations at the study hatcheries in the first three years of the CSS.

NMFS personnel and two assigned workers from PSMFC under the supervision of Mr. Jerrel Harmon of the NMFS completed the recovery task for PIT tagged CSS adult fish at the Lower Granite trapping facility. We appreciate the professional handling of the adult fish at this site, and efforts taken to assure that accurate data was gathered from these fish.

All photographs in this report were taken by Larry Basham of the Fish Passage Center. We appreciate the diligence and efforts of FPC's computer database specialist Sergei Rasskazov in assembling the CSS PIT tag data into database tables for use in the analyses of this report.

This project was funded by Bonneville Power Administration (BPA Project Number 87127-02) under the Northwest Power Planning Council Fish and Wildlife Program.

Abstract

The Comparative Survival Rate Study (CSS) is a multi-year program of the fishery agencies and tribes to measure the smolt-to-adult survival rates of hatchery spring and summer chinook at major production hatcheries in the Snake River basin and at selected hatcheries in the lower Columbia River. The CSS also compares the smolt-to-adult survival rates for Snake River basin chinook that were transported versus those that migrated in-river to below Bonneville Dam. Estimates of smolt-to-adult survival rates will be made both from Lower Granite Dam back to Lower Granite Dam (upriver stocks) and from the hatchery back to the hatchery (upriver and downriver stocks). This status report covers the first three migration years, 1996 to 1998, of the study. Study fish were implanted with a PIT (Passive Integrated Transponder) tag which allows unique identification of individual fish. Beginning in 1997, a predetermined proportion of the PIT tagged study fish in the collection/bypass channel at the transportation sites, such as Lower Granite and Little Goose dams, was purposely routed to the raceways for transportation and the rest was routed back to the river. Two categories of in-river migrating fish are used in this study. The in-river group most representative of the non-tagged fish are fish that migrate past Lower Granite, Little Goose, and Lower Monumental dams undetected in the bypass systems. This is because all non-tagged fish collected at these three dams are currently being transported. The other in-river group contains those fish remaining in-river below Lower Monumental Dam that had previously been detected at one or more dams. The number of fish starting at Lower Granite dam that are destined to one of these two in-river groups must be estimated. The Jolly-Seber capture-recapture methodology was used for that purpose.

Adult (including jacks) study fish returning to the hatcheries in the Snake River basin were sampled at the Lower Granite Dam adult trap. There the PIT tag was recorded along with a measurement of length, a determination of sex, and a scale sample. The returns to the hatchery rack were adjusted for any sport and tribal harvest to provide an estimate of total return to the hatchery. Adult and jack return data from return years 1997 through 1999 are covered in this status report. Only the returns from the 1996 migration year are complete. A very low overall average of 0.136% survival rate from Lower Granite Dam and back to Lower Granite Dam was estimated for the 1996 migrants. The outcome expected for the 1997 migrants is much better. With one year of returns still to come, the overall average Lower Granite Dam to Lower Granite Dam survival rate is 0.666%, with the McCall Hatchery and Imnaha Hatchery fish already producing return rates in excess of 1%. With 635 returning adults (plus jacks) from the 1997 migration year detected at Lower Granite Dam to date, and one additional year of returns to come, there will be a large sample size for statistically testing differences in transportation versus in-river survival rates next year. From the conduct of this study over a series of years, in addition to obtaining estimates of smolt-to-adult survival rates, we should be able to investigate what factors may be causing differences in survival rates among the various hatchery stocks used in this study.

Comparative Survival Rate Study of Hatchery PIT Tagged Chinook

PART A: Goals, procedures, and preliminary results for migration years 1996 to 1998

Introduction

This status report covers the first three migration years of the Comparative Survival Rate Study (CSS) and corresponding preliminary adult return data. This is a multi-year program to develop smolt-to-adult survival indices for spring and summer stream-type chinook originating above Lower Granite Dam. These survival-to-adult indices will be used to evaluate smolt mitigation measures and actions under the NMFS' Biological Opinion (*e.g.*, flow augmentation, spill, and transportation) for the recovery of listed salmon stocks. PIT tagging hatchery fish provides survival-to-adult rates for transported fish of known origin that can be compared to regional SAR goals. This study also allows us to compare survival-to-adult rates based on whether in-river migrating fish utilized the bypasses at Lower Granite, Little Goose, or Lower Monumental dams rather than passed all three sites via a route other than the bypass/collection system. In-river migrants in this latter category are viewed as the "true" in-river controls to the transport treatment, because the management scenario currently in place calls for the collection and transportation of all non-PIT tagged fish from these dams' bypass/collection system. The objective of developing smolt-to-adult survival indices is recommended by the regional state, federal and tribal salmon managers.

Objectives

1. Develop a long-term index of transport survival rate (smolt-to-adult) to in-river survival rate (smolt-to-adult) for Snake River hatchery spring and summer chinook smolts.

    Task 1(a): Compute an annual ratio of transport survival rate to in-river survival rate (measured at Lower Granite Dam) with associated confidence interval.

    Task 1(b): Test if the annual ratio of transport survival rate to in-river survival rate (measured at Lower Granite Dam) is greater than 1.5 with sufficient power to provide a high probability that the ratio is greater than 1.0.

    Task 1(c): In years when the NMFS transport study is in place, evaluate whether in-river controls obtained from fish PIT tagged at the hatcheries have higher smolt-to adult survival rates to Lower Granite Dam than in-river controls obtained from migrating fish that were collected, handled, and PIT tagged at Lower Granite Dam.

2. For Snake River basin hatcheries, develop a long-term index of survival rates from release of smolts at hatcheries to return of adults to hatcheries.

    Task 2(a): Partition survival rates (*i*) from hatchery (smolts) to Lower Granite Dam (smolts), (*ii*) from Lower Granite Dam (smolts) back to Lower Granite Dam (adults), and (*iii*) from Lower Granite Dam (adults) to the hatchery (adults).

    Task 2(b): For the combined Snake River hatcheries, compute the annual survival rate of smolts transported at Lower Granite Dam to adult returns to the hatcheries.

    Task 2(c): For the combined Snake River hatcheries, compute the annual survival rate of smolts migrating in-river to adult returns to the hatcheries.

Task 2(d): Explore the feasibility of increasing mark sizes to improve precision in the annual ratio of transport survival rate to in-river survival rate [Task 1(a)] measured back to the hatchery.

3. Compute and compare overall smolt-to-adult survival rates for selected upriver and down-river spring and summer chinook hatcheries.

Task 3(a): Compute annual hatchery survival rates (adjusted for terminal harvest rates) using both CWT and PIT tags for selected upriver and down-river hatchery stocks. Compare survival rates of CWT and PIT tag estimates. Estimate survival rates (smolt-to-adult) for these hatchery stocks from previous production type CWT releases.

Task 3(b): Compute an annual ratio of down-river hatchery survival rate to upriver hatchery survival rate (all measured at the hatcheries and adjusted for terminal harvest) with associated confidence interval.

Task 3(c): Test if the annual ratio of down-river hatchery survival rate to upriver hatchery survival rate (all measured at the hatcheries) is greater than 2.0 with sufficient power to provide a high probability that the ratio is greater than 1.0.

Task 3(d): Test, aggregately and individually, if the annual ratio of down-river hatchery survival rate to upriver hatchery's transported smolts survival rate (all measured at the hatcheries) is greater than 2.0 with sufficient power to provide a high probability that the ratio is greater than 1.0.

Task 3(e): Explore the feasibility of developing lower river wild index stocks (*e.g.*, Warm Springs, John Day, and Klickitat rivers) to measure smolt-to-adult survival rates. Note: this task is delayed until after 134.2 kHz PIT tag detection capability is available at Bonneville Dam for returning adults.

4. Begin a time series of smolt-to-adult survival rates for use in the PATH hypothesis testing process and in the regional long-term monitoring and evaluation program, which is under development.

5. Evaluate growth patterns of transported and in-river migrating smolts, and of upriver and down-river stocks.

Task 5(a): Collect and catalog scales from PIT tagged adults detected at Lower Granite Dam adult trap or at the upriver hatcheries.

Task 5(b): Coordinate with the down-river hatcheries to collect and catalog scales from CWT groups that are representative of the production lots from which the PIT tagged fish were taken.

Methods

Smolt releases. From five to seven hatcheries in the Snake River drainage and two to three hatcheries in the lower Columbia River have been used during the first three years of the CSS. Hatcheries involved in one or more years have included McCall, Rapid River, Pahsimeroi, Dworshak, Kooskia, Clearwater, Imnaha, Lookingglass, Carson, Round Butte, and Cowlitz. In years included, these hatcheries have been major producers of smolts in their respective drainages. Over these three years, we have modified our marking quotas from a proportional-to-

production allocation in 1996 and 1997 at Snake River hatcheries to a fixed sample size allocation beginning in 1998 in order to allow more similar release numbers across a set of hatcheries of widely differing production levels.

At all hatcheries used in this study, fish were obtained across as wide a set of ponds and raceways as possible to allow effective representation of production. Collected fish are anesthetized and implanted with an 11 mm PIT (passive integrated transponder) tag. PIT tags were applied with individual syringe injectors. The injector needles were disinfected with ethyl alcohol after each use to minimize the possibility of disease transmission between fish. Tag loss and mortality is monitored at each hatchery. The tagging files are then uploaded to the regional PTAGIS database. At each hatchery, dead fish were removed from the respective raceways or ponds, and checked for PIT tags. The original tagging files were then adjusted to account for raceway or pond mortality.

Assigning PIT tagged smolts to transport and in-river groups at Lower Granite Dam. Beginning in 1997 (second year of this study), the separation-by-code approach has been used to divert a portion of the PIT tag study fish entering Lower Granite Dam to transportation and the remaining proportion back to the river. In 1997 and 1998, between 75 and 80% of the PIT tagged study fish exiting the Lower Granite Dam wet separator were routed to transportation. Because high flows and high spills in 1997 substantially reduced the numbers of PIT tagged study fish being detected at Lower Granite Dam and diverted to transportation, we begin diverting additional fish during the early part of the season in 1998 to transportation at Little Goose Dam. To meet objectives 1 and 2, the cumulative number of fish in the test groups are set at a minimum of 43,000 PIT tagged smolts in the transport group and 64,500 PIT tagged smolts in each of the in-river groups. These smolt numbers are geared to providing a minimum of 86 total adults for testing purposes in each returning group if conditions of historic low SAR's occur. The proportion of fish to divert into transport at the various dams was adjusted in-season in 1998 in an attempt to maintain a 40% transport and 60% in-river split in smolts in these groups. The *multimon.exe* software has been successful in diverting the desired proportions of fish at the dams in the last two years of operation. PIT tagged fish not part of this study were returned back to river, so as not to impact those studies. Use of the separation-by-code program does not impact the timed subsample being taken at these dams because it is in effect only during non-subsampling intervals.

Sampling for physiological analyses. The University of Idaho Cooperative Fish and Wildlife Research Unit (UICFWRU), under a contract with the USACE, began conducting research in 1998 on the changes in physiological condition of smolts as they migrate in-river past multiple dams through the lower Snake and Columbia rivers. The goal of this study is to follow known hatchery chinook populations through the hydro system. The researchers chose to use Dworshak, McCall, and Rapid River hatcheries because of the large number of PIT tagged fish already present. We requested that the researchers provide another 9,000 PIT tags so that each hatchery complement of PIT tagged fish would be increased to 48,000 fish. This higher release number of PIT tagged fish allowed subsequent collection and sacrificing of the maximum 540 PIT tagged fish planned at down-river sites without any impacts to the overall CSS. By conducting a cooperative program, the UICFWRU researchers had a much larger pool of candidate fish at each monitoring site from which to draw their samples over the season.

Adult returns. At Lower Granite Dam adult trap, all returning PIT tagged adult chinook from the CSS were diverted into the trap holding area and subsequently processed. The processing included the collection of 6-8 scales from the left side of the CSS fish in a location anterior to the dorsal fin midway above lateral line. Fork length, fish sex, and general fish condition were recorded on the NMFS adult salmon datasheet. Data on PIT tag code and fork length was also uploaded to the PTAGIS database.

Upon return to the hatchery weirs and holding areas, the adult chinook were scanned by a PIT tag detector to check for possible tags. The PIT tag data for these returning adults are being uploaded to the PTAGIS database.

Study groups. There are three study groups defined for the upriver hatchery stocks: the transported fish (Group T), the in-river fish detected at a COE transportation facility in the Snake River (Group C1), and the in-river fish not detected at a COE transportation facility in the Snake River (Group C0).

! Group T consists of PIT tagged smolts diverted to the fish barge (or truck) at mostly Lower Granite Dam with some additional fish transported at Little Goose and Lower Monumental dams.

! Group C1 consists of PIT tagged smolts detected at one or more of the Snake River collector dams (Lower Granite, Little Goose, or Lower Monumental) that continue migrating in-river below Lower Monumental Dam.

! Group C0 consists of PIT tagged smolts not detected at any of the Snake River collector dams (Lower Granite, Little Goose, or Lower Monumental) that continue migrating in-river below Lower Monumental Dam.

Estimating the number of smolts in each group requires estimates of survival between dams from Lower Granite Dam tailrace to Lower Monumental Dam tailrace, and estimates of population size at Lower Granite Dam. These estimates are computed using the Jolly-Seber methodology (Burnham *et al*. 1987). For unbiased estimates, this methodology requires that the subsequent survivability and collectability of PIT tagged fish are the same between re-released and alive-undetected fish through the reach of reservoirs and dams below Lower Granite Dam. The computer program RELEASE has tests for these assumptions.

! The number of fish estimated in Group T is

$$\mathbf{T} = t_1 + t_2/\mathbf{S_2} + t_3/\mathbf{S_2S_3}$$

! The number of fish estimated in Group C1 is

$$\mathbf{C1} = m_{12} + m_{13}/\mathbf{S_2} + m_{14}/\mathbf{S_2S_3} - (\mathbf{T} + U + M)$$

! The number of fish estimated in Group C0 is

$$\mathbf{C0} = m_{12}/\mathbf{p_2} - (m_{12} + m_{13}/\mathbf{S_2} + m_{14}/\mathbf{S_2S_3})$$

Definitions of symbols above:

t_1 = number transported at Lower Granite Dam
t_2 = number transported at Little Goose Dam
t_3 = number transported at Lower Monumental Dam
$\mathbf{p_2}$ = estimated collection efficiency at Lower Granite Dam
$\mathbf{S}_2$ = survival from Lower Granite tailrace to Little Goose Dam tailrace
$\mathbf{S}_3$ = survival from Little Goose tailrace to Lower Monumental Dam tailrace
m_{12} = number of fish first detected at Lower Granite Dam
m_{13} = number of fish first detected at Little Goose Dam
m_{14} = number of fish first detected at Lower Monumental Dam
U = number of fish detected only on separator (unknown if in-river or transport migrant) at Lower Granite, Little Goose, and Lower Monumental dams
M = number of fish recaptured as mortality at dams (*e.g.*, fish sacrificed for research purposes, fish dying during holding or sampling at dams) (Note: at this

time all morts below Lower Granite Dam are being subtracted from Group C1 rather than allocated between Group C1 and Group C0)

Analytical approaches. Returning adults are assigned to Group T and Group C1 based on which route of passage these fish took as smolts at the dams, and whether fish on a given route were actually being transported during a particular period of time. Returning adult fish that had smolts assigned to the unknown disposition category (Group U) are not used. Returning adults not detected at Lower Granite, Little Goose, and Lower Monumental dams, regardless of any subsequent downstream detection, were assigned to Group C0. For Objective 1, in years when NMFS conducts their transportation studies, survival-to-adult rates of Group C1 and Group C0 (aggregate of the upriver hatcheries) will be compared to that of the mixed stock of in-river migrants collected, marked, and re-released as control groups by NMFS at Lower Granite Dam.

The partitioning of survival rates in Objective 2 will require estimating the survival rate for smolts from hatchery to Lower Granite Dam and between monitored dams for each hatchery group using the Jolly-Seber methodology. The survival rate from Lower Granite (smolts) to Lower Granite (adults) will be generated in the tasks of Objective 1 for Group T, Group C1, and Group C0. These survival rates will be computed for each upriver hatchery separately as well as the aggregate of upriver hatcheries within each group. The survival rate for adults from Lower Granite Dam to their respective hatchery will be computed as a ratio of hatchery detections to prior detections at Lower Granite Dam. Adult returns to the hatcheries will be adjusted by estimated terminal harvest rates when present.

For addressing Objective 3 in the future reports, the CWT (coded-wire-tag) adult return data of Rapid River, McCall, Dworshak, and Lookingglass hatcheries will be compared with the CWT adult return data for Carson, Round Butte, and Cowlitz hatcheries. Carson Hatchery PIT tag adult return data will be compared with that of the four upriver hatcheries. Too few PIT tagged adults returned to the other two down-river hatcheries to use in this analysis. The comparison between smolt-to-adult returns of upriver and down-river hatcheries will be made both with and without jacks included, but in all cases, mini-jacks are excluded.

Scale pattern analysis. The scales of returning PIT tagged adult chinook are being collected for use in a scale pattern analysis to index ocean entrance timing, growth during juvenile migration, and growth that occurred during early ocean residence. Scale pattern analysis of returning adults from the transport and in-river groups will investigate if transport has effects on the life history of the populations that need to be evaluated to better understand the impacts on recovery. The analysis of scale patterns will be performed after more years of scale samples are collected.

Results related to smolts

PIT tag releases at hatcheries above Lower Granite Dam. During the first three years of study, the strategy for hatchery selection and marking evolved in order to better address the objectives of this long-term study. In 1996, a total of 98,000 PIT tags were spread across all hatcheries above Lower Granite Dam (Lookingglass, Sawtooth, McCall, Rapid River, Dworshak, Kooskia, and Clearwater hatcheries) in numbers proportional to approximately 5% of production, excluding all production of high BKD fish. In 1997, a total of 201,000 PIT tags were spread across the six hatcheries above Lower Granite Dam (Clearwater Hatchery was excluded due to low production number) which had production above 5,000 fish and again all production of high BKD fish were excluded. In that year, approximately 26.5% of production was PIT tagged, except at Rapid River Hatchery where 48.2% of production was PIT tagged because a goal of at least 40,000 PIT tag fish from that hatchery was desired for the comparison with down-river stocks.

In planning the marking needs for the 1998 migration year, it was apparent that using a proportional-to-production allocation would result in too many PIT tags being applied at the high

capacity production hatcheries. Therefore, it was decided to establish a fixed PIT tag quota allocation at a reduced set of hatcheries within each tributary above Lower Granite Dam. This set of hatcheries would still account for 80% of overall hatchery production. A tagging quota of 45,000 fish each (plus 3,000 extra PIT tags added by UICFWRU) was established for McCall and Rapid River hatcheries in the Salmon River drainage (no more tagging of Sawtooth and Pahsimeroi Hatchery fish). In the Clearwater River, a tagging quota of 45,000 fish (plus 3,000 extra PIT tags added by UICFWRU) was established for Dworshak Hatchery (no more tagging of Kooskia Hatchery fish). At Lookingglass Hatchery, a tagging quota of 45,000 fish was established for fish to be released on-site into the Grande Ronde River and a smaller tagging quota of 20,000 fish for the fish to be released from the Imnaha River acclimation pond. These fixed quotas allowed a greater control in the allocation of PIT tagged fish across the four drainages above Lower Granite Dam. In 1998, these quotas resulted in PIT tag proportions of approximately 4-5% at Rapid River and Dworshak hatcheries, 12% at Lookingglass and McCall hatcheries, and 20% at Imnaha River acclimation pond.

The set of hatcheries shown in Table 1 provided an adequate population of PIT tagged fish for purposes of computing smolt-to-adult rates (SAR's) for different hatchery groups across the three years. Excluded from this set of hatchery releases are Sawtooth Hatchery and Red River and Crooked River acclimation ponds. Because the release numbers from these three sites was low, only three returning adults total were detected over the three return years. Appendix Tables A-1 to A-3 present the final released numbers (after removing PIT tagged fish that died in the hatchery ponds or raceways before release) of PIT tagged fish released above Lower Granite Dam in each of the first three years of the CSS.

Table 1. Number of PIT tagged juvenile chinook released from each hatchery in migration years 1996 to 1998 for computation of smolt-to–adult rates (SAR's) for the CSS.

Hatchery	**1996**	**1997**	**1998**
Lookingglass H	7,160	40,027	43,939
Imnaha AP	4,715	13,378	19,169
McCall H	29,599	52,654	47,340
Rapid River H	19,169	40,459	48,339
Pahsimeroi H	None	33,481	None
Dworshak H	5,069	14,080	47,704
Kooskia H	16,660	4,075	None
Clearwater H: Powell AP	11,416	None	None

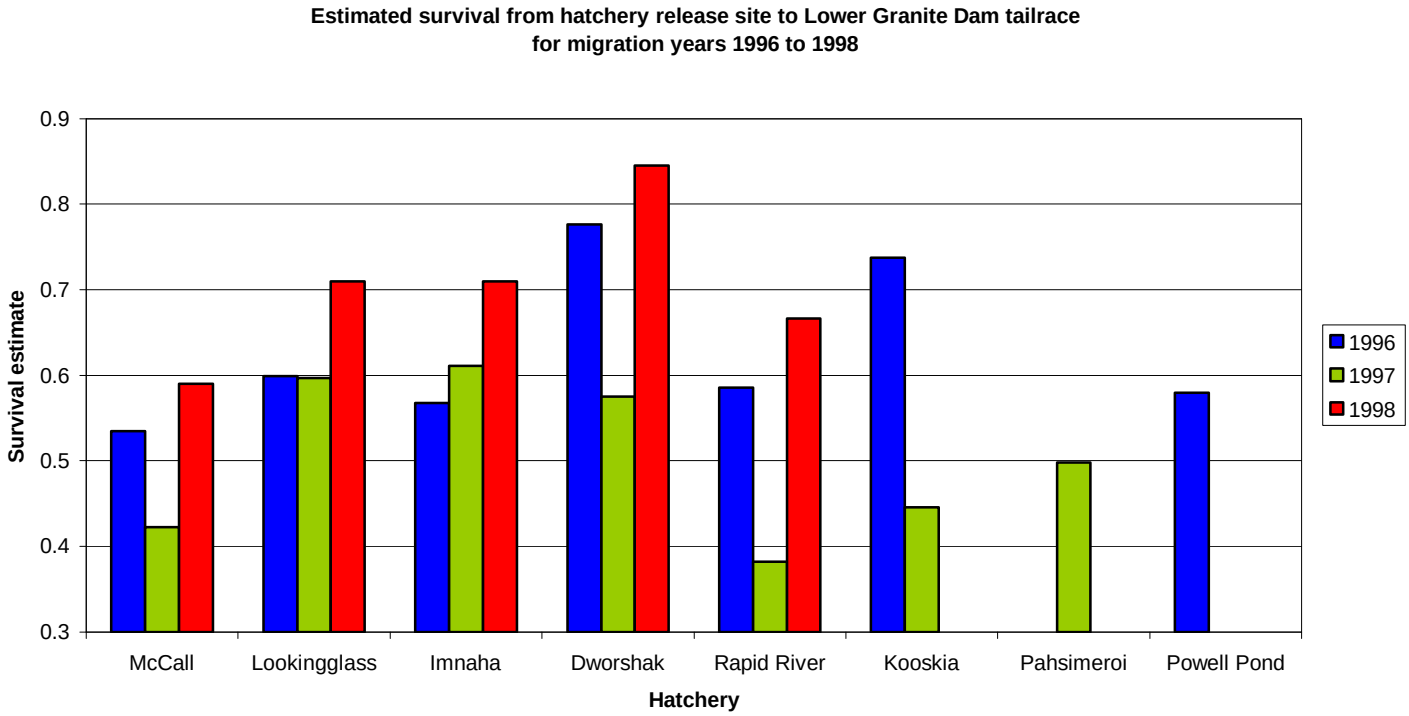

Figure 1. Trends in estimated survival from hatchery site to Lower Granite Dam tailrace for the first three years of the CSS program.

In-river survival estimates. Survival estimates from release to Lower Granite Dam and to additional downriver dams are presented in Appendix B for the CSS hatchery groups shown in Table 1. Estimated survival from hatchery release site to Lower Granite Dam tailrace ranged from a low of 38% to a high of 84% with higher survival estimates among hatcheries in 1998, followed by 1996 and lastly 1997 (Figure 1). For the five hatcheries utilized in all three years (McCall, Lookingglass, Imnaha, Dworshak, and Rapid River hatcheries), the unweighted average survival was 70% in 1998, 61% in 1996, and 52% in 1997 (Appendix Tables B-1). From Lower Granite Dam tailrace to Lower Monumental Dam tailrace, survival was fairly similar among the hatcheries in each year. In 1998, the increased PIT tag detection capability at John Day and Bonneville dams allowed survival estimation for the CSS groups to the tailrace of John Day Dam. The average reach survival from Lower Granite Dam tailrace to John Day Dam tailrace was 61% in 1998 (Appendix Table B-2).

Smolt numbers in transport and control groups. The estimated number of fish from each hatchery in the transport (Group T) and in-river (Group C1 and Group C0) are presented in Tables 2 to 4 for each migration year, respectively. In addition, these tables present all the data that is used in the estimation of fish numbers per group.

Sampling for physiological analyses. The UICFWRU research on the changes in physiological condition of smolts as they migrate in-river past multiple dams through the lower Snake and Columbia rivers began with the 1998 migration year. Table 5 shows the number of fish collected at each dam and sacrificed for this research. Results of this study will be reported separately by University of Idaho researchers.

Table 2. Preliminary transport and control group numbers for 1996 (see footnote for assumptions).

HATCHERY CHINOOK 1996								
	McCall	Lookingglass	Imnaha	Dworshak	Rapid River	Kooskia	Powell Pond	
lgr = S1	0.53482	0.59896	0.56757	0.77664	0.58596	0.73711	0.57961	
se_lgr	0.00710	0.01116	0.01449	0.01772	0.00713	0.00913	0.01368	
lgs = S2	0.92952	0.91128	0.89722	0.94374	0.90878	0.93053	0.85943	
se_lgs	0.02163	0.02671	0.03715	0.03828	0.01782	0.01910	0.03321	
lmn = S3	0.95006	0.93748	0.91219	0.88064	0.92032	0.88629	0.95230	
se_lmn	0.04003	0.04185	0.06190	0.06032	0.02905	0.02789	0.06200	
Release N	29599	7160	4715	5069	19169	16660	11416	
survivals use used to create Lower Granite Dam "equivalents":								
S2	0.92952	0.91128	0.89722	0.94374	0.90878	0.93053	0.85943	
S2*S3	0.88310	0.85430	0.81843	0.83109	0.83637	0.82472	0.81844	
collection efficiency at Lower Granite Dam:								
p2	0.32874	0.39337	0.38713	0.33860	0.38461	0.33770	0.28715	
se_p2	0.00546	0.00974	0.01273	0.01049	0.00612	0.00577	0.00846	
number of first time detections:								
LGR: m12	5204	1687	1036	1333	4320	4147	1900	
LGS: m13	2470	827	499	711	2110	2279	1047	
LMN: m14	2186	529	312	565	1392	1772	845	
MCN: m15	443	214	98	108	441	484	220	
JDA: m16	33	12	9	9	34	50	15	
BON: m17	63	14	9	13	29	72	30	
								TOTAL
S1*N=Popn	15830	4289	2676	3937	11232	12280	6617	56861
Transport Group numbers by dam:								
LGR: t1	379	213	86	98	325	372	156	1629
LGS: t2	143	65	35	41	142	147	68	641
LMN: t3	197	46	54	52	147	181	68	745
Total unknown disposition and known mortality numbers:								
Unknown: U	60	10	5	11	33	26	27	172
Morts: M (mort numbers not available for preliminary analysis)								
In-river Group numbers by category (detected vs nondetected at LGR, LGS or LMN):								
Nondet.: C0	5493	1075	703	1171	2926	3535	2466	17369
Detected: C1	9521	2866	1777	2551	7616	7970	3806	36107
Total transport number expanded to LGR equivalents:								
Trans: T	756	338	191	204	657	749	318	3213

Formula:

C0 = (m12/p2)-m12-(m13/S2)-(m14/(S2*S3))

C1 = m12+(m13/S2)+(m14/(S2*S3))-(T+U+M) Note: since most U and M fish occur at LGR, no expansion to LGR equivalents. The U occur only at LGR, LGS, and LMN while the M occurs at all dams. All morts below LMN are subtracted from C1 rather than split among C0 and C1 groups.

T=t1+(t2/S2)+(t3/S2S3) which expands LBS and LMN transported fish to LGR equivalents, but most study Fish are transported from LGR.

Table 3. Preliminary transport and control group numbers for 1997 (see footnote for assumptions).

HATCHERY CHINOOK 1997								
	McCall	Lookingglass	Imnaha	Dworshak	Rapid River	Kooskia	Pahsimeroi	
lgr = S1	0.42228	0.59652	0.61117	0.57539	0.38196	0.44583	0.49790	
se_lgr	0.00767	0.00953	0.01683	0.01685	0.00760	0.03345	0.00836	
lgs = S2	0.93059	0.93139	0.99283	1.04785	0.96872	1.15710	0.95782	
se_lgs	0.02651	0.02251	0.04218	0.04599	0.03002	0.13548	0.02677	
lmn = S3	0.87969	0.82740	0.76790	0.81800	0.80239	0.57217	0.85525	
se_lmn	0.03432	0.02153	0.04125	0.04751	0.02988	0.07746	0.03189	
Release N	52688	40027	13378	14080	40495	4075	33481	
survivals use used to create Lower Granite Dam "equivalents":								
S2	0.93059	0.93139	0.99283	1.00000	0.96872	1.00000	0.95782	
S2*S3	0.81863	0.77064	0.76239	0.85714	0.77729	0.66205	0.81918	
collection efficiency at Lower Granite Dam:								
p2	0.33305	0.31964	0.31983	0.29044	0.33994	0.26751	0.38152	
se_p2	0.00661	0.00578	0.00997	0.00966	0.00746	0.02211	0.00712	
number of first time detections:								
LGR: m12	7410	7632	2615	2353	5258	486	6360	
LGS: m13	5023	5718	2138	2174	3616	410	3838	
LMN: m14	2225	2979	936	996	1830	214	1656	
MCN: m15	470	733	184	211	347	49	460	
JDA: m16	10	4	1	2	9	0	9	
BON: m17	240	188	66	79	175	19	135	
								TOTAL
S1*N=Popn	22249	23877	8176	8101	15467	1817	16670	96357
Transport Group numbers by dam:								
LGR: t1	5792	5995	2070	1848	4041	365	4887	24998
LGS: t2	115	124	49	58	143	18	154	661
LMN: t3	22	40	14	13	36	3	29	157
Total unknown disposition and known mortality numbers:								
Unknown: U	192	158	52	49	240	17	281	989
Morts: M	23	5	7	7	4	1	6	53
In-river Group numbers by category (detected vs nondetected at LGR, LGS or LMN):								
Nondet.: C0	6724	6240	2180	2412	4122	598	4282	26558
Detected: C1	9369	11294	3799	3712	6866	813	7019	42872
Total transport number expanded to LGR equivalents:								
Trans: T	5942	6180	2138	1921	4235	388	5083	25887

Formula:
C0 = (m12/p2)-m12-(m13/S2)-(m14/(S2*S3))
C1 = m12+(m13/S2)+(m14/(S2*S3))-(T+U+M) Note: since most U and M fish occur at LGR, no expansion to LGR equivalents. The U occur only at LGR, LGS, and LMN while the M occurs at all dams. All morts below LMN are subtracted from C1 rather than split among C0 and C1 groups.
T = t1+(t2/S2)+(t3/S2S3) which expands LGS and LMN transported fish to LGR equivalents, but most study fish are transported from LGR.

Table 4. Preliminary transport and control group numbers for 1998 (see footnote for assumptions).

HATCHERY CHINOOK 1998						
					Rapid River	
lgr = S1	0.58999	0.70959	0.70995	0.84483	0.66671	
se_lgr	0.00396	0.00447	0.00641	0.00615	0.00363	
lgs = S2	0.97203	0.97511	0.96643	1.05825	0.99138	
se_lgs	0.01051	0.01149	0.01387	0.01443	0.00941	
lmn = S3	0.84001	0.82182	0.84502	0.76368	0.84290	
se_lmn	0.01169	0.01375	0.01558	0.01289	0.01132	
Release N	47460	43939	19169	47704	48357	
survivals use used to create Lower Granite Dam "equivalents":						
S2	0.97203	0.97511	0.96643	1.00000	0.99138	
S2*S3	0.81651	0.80137	0.81665	0.80816	0.83564	
collection efficiency at Lower Granite Dam:						
p2	0.46452	0.48771	0.44199	0.37887	0.50577	
se_p2	0.00393	0.00391	0.00547	0.00359	0.00356	
number of first time detections:						
LGR: m12	13007	15206	6015	15269	16306	
LGS: m13	7022	7279	3793	9440	7669	
LMN: m14	3083	2711	1367	3929	3130	
MCN: m15	646	1083	439	3241	952	
JDA: m16	391	311	174	417	315	
BON: m17	191	155	107	384	221	
						TOTAL
S1*N=Popn	28001	31179	13609	40302	32240	145331
Transport Group numbers by dam:						
LGR: t1	9056	10906	4081	11155	11295	46493
LGS: t2	1102	2147	473	4004	1725	9451
LMN: t3	390	357	235	356	516	1854
Total unknown disposition and known mortality numbers:						
Unknown: U	248	233	86	233	218	1018
Morts: M	156	40	17	159	157	529
In-river Group numbers by category (detected vs nondetected at LGR, LGS or LMN):						
Nondet.: C0	3994	5125	1995	10731	4453	26298
Detected: C1	12936	12228	6653	13579	13760	59156
Total transport number expanded to LGR equivalents:						
Trans: T	10667	13553	4858	15600	13652	58330

Formula:
C0 = (m12/p2)-m12-(m13/S2)-(m14/(S2*S3))
C1 = m12+(m13/S2)+(m14/(S2*S3))-(T+U+M) Note: since most U and M fish occur at LGR, no expansion to LGR equivalents. The U occur only at LGR, LGS, and LMN while the M occurs at all dams. All morts below LMN are subtracted from C1 rather than split among C0 and C1 groups.
T = t1+(t2/S2)+(t3/S2S3) which expands LGS and LMN transported fish to LGR equivalents, but most study fish are transported from LGR.

Table 5. Number of PIT tagged fish from Dworshak, McCall, and Rapid River hatcheries that were collected and sacrificed at key monitoring sites for physiological analysis by the University of Idaho Cooperative Fish and Wildlife Research Unit in 1998.

Sample Site	Sample Date	Number of PIT tagged fish sampled per hatchery group		
		Dworshak H	McCall H	Rapid River H
Lower Granite Dam	5/1/98	10	8	9
	5/3/98	9	5	2
	5/5/98	5	8	7
	5/8/98	10	2	0
	5/12/98	1	2	2
	5/14/98	2	14	12
	5/15/98	2	10	6
Little Goose Dam	4/29/98	8	2	7
	5/7/98	8	7	13
	5/13/98	5	9	9
John Day Dam	5/13/98	8	8	12
	5/14/98	12	14	10
	5/16/98	5	6	4
	5/20/98	10	18	15
	5/21/98	11	0	3
Bonneville Dam	5/13/98	2	1	2
	5/15/98	0	0	2
	5/21/98	2	0	1
	5/23/98	1	0	0
	5/26/98	0	3	1
Grand Total		111	117	117

PIT tag releases at hatcheries in lower Columbia River. During the first three years of study from 6,000 to 15,000 fish were PIT tagged at two to three hatcheries in the lower Columbia River (Table 6). During this time, PIT tagging shifted from Cowlitz Hatchery to Carson Hatchery because of logistical problems related to tagging and subsequent recovery of adults and fish health related problems (high incidence of BKD).

Table 6. Number of PIT tagged juvenile chinook released in migration years 1996 to 1998 at lower Columbia River hatcheries used in the CSS for comparison of smolt-to–adult rates (SAR's) with upriver CSS hatcheries.

Hatchery	1996	1997	1998
Round Butte SFH	3,044	4,979	7,493
Carson NFH	None	4,982	7,491
Cowlitz SFH	2,980	4,922	None

Migration timing at Lower Granite and Bonneville dams of CSS hatchery groups in 1996 to 1998. In two out of three years (see Appendix C Figures C-1 to C-3), Lookingglass Hatchery chinook had the earliest passage pattern at Lower Granite Dam (*i.e.*, 1996 and 1997) and McCall Hatchery chinook had the latest passage pattern there (i.e., 1996 and 1998). In 1998, Dworshak Hatchery released their fish earlier than usual, and in that year those fish had the earliest passage pattern at Lower Granite Dam. The passage distributions of PIT tagged fish from Rapid River and Imnaha hatcheries have remained fairly similar to each other across these three years. The migration timing trends established at Lower Granite Dam each year for the various hatchery stocks remains fairly well intact as these fish pass Bonneville Dam (see Appendix C Figures C-4 to C-6). About 75% of the PIT tagged fish released in the lower Columbia River

hatcheries upriver of Bonneville Dam passed that dam before 10% of the in-river migrants from the hatcheries above Lower Granite Dam began to pass. Median passage of Round Butte (Pelton release) and Carson Hatchery fish at Bonneville Dam was one to two weeks earlier than that of the earliest upriver hatchery group during these three years (see Appendix C Figures C-4 to C-6). These lower Columbia River hatchery stocks will be entering the estuary at a time closer to that of upriver transported fish than upriver in-river migrants, as shown for 1998 in Figure 2.

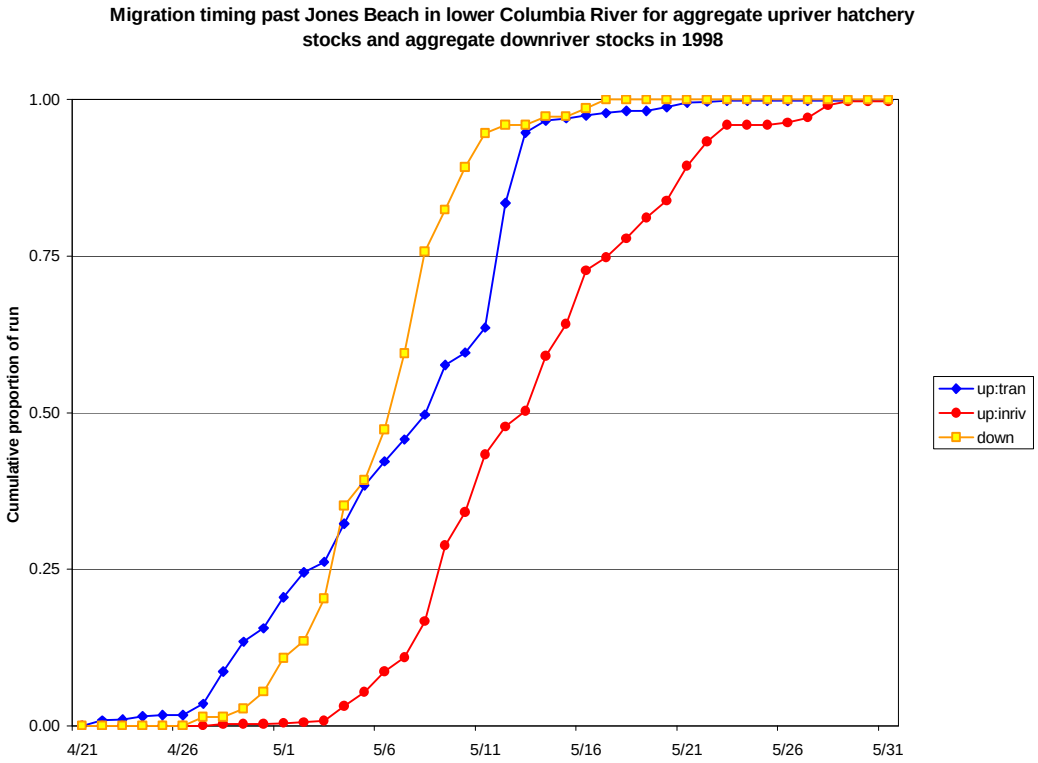

Figure 2. Migration timing of yearling hatchery chinook from upriver and downriver hatcheries comparing transported fish versus in-river migrants for 1998.

Migration timing in the Columbia River estuary of in-river and transport groups released in migration year 1998. In 1998, NMFS operated a trawl fitted with a PIT tag detector extensively during the springtime migration in the lower Columbia River off Jones Beach (74 km upstream from mouth). Since this location is well below Bonneville Dam, both in-river and transported fish are intercepted in the trawl detector. In 1998, PIT tagged fish from the CSS were detected here between April 22 and June 5. As shown in Appendix C, Figures C-7 to C-11, the migration timing distribution of transported PIT tagged fish from Dworshak, Lookingglass, Imnaha, Rapid River, and McCall hatcheries was shifted at least a week earlier than that of their in-river counterparts. The general pattern for lower Columbia migration timing was earlier timing for fish from Dworshak and Lookingglass hatcheries, mid-range timing for fish from Imnaha and Rapid River hatcheries, and later timing for fish from McCall Hatchery. All transported fish had a second peak of passage in the lower Columbia River around May 12. This later peak was due to an unusually high number of PIT tagged fish from Little Goose and Lower Monumental dams being transported between May 8 and 9 due to equipment failures at these two dams. During this time all PIT tagged fish were routed to the raceways because of a crash of the 400 kHz PIT tag controller/computer at Little Goose Dam and a broken yoke on the slide gate used to divert PIT tagged fish to the river at Lower Monumental Dam.

Preliminary findings related to adult returns

Adult (and jacks) returns to Lower Granite Dam adult trap. The number of returning jacks and adults to Lower Granite Dam adult trap from the first three migration years in the CSS are presented in Tables 7 to 9. With the completed returns of jacks, 2-ocean adults and 3-ocean adults, the return data for the 1996 migration year is final since 4-ocean returns are negligibly few. Overall, only 77 jacks and adults (a 0.14% return rate) were detected at Lower Granite Dam adult trap from the 1996 migration year (Table 7). Return rates of less than 0.1% occurred for fish from Imnaha and Lookingglass hatcheries. Return rates of 0.1-0.2% occurred for fish from Kooskia, McCall, Powell Pond, and Rapid River hatcheries. The highest return rate of 0.25% occurred for Dworshak Hatchery fish.

Even with one year of returns to go, the fish from the 1997 migration year have a much higher return rate than their 1996 migration year counterparts. Overall, 635 jacks and adults (0.66% return rate) were detected at Lower Granite Dam adult trap from the 1997 migration year (Table 8). The lowest returns to date of less than 0.3% occurred for fish from Kooskia and Pahsimeroi hatcheries. The next group of fish with return rates between 0.4% and 0.6% occurred for fish from Dworshak, Lookingglass, and Rapid River hatcheries. The highest returns to date, which are above 1.0%, occurred for fish from Imnaha and McCall hatcheries. Both Imnaha and McCall hatcheries had the highest jack return of 1997 migration year fish to the Lower Granite Dam adult trap in 1998. And again in 1999, Imnaha and McCall hatcheries have the highest jack return of 1998 migration year fish (Table 9).

Preliminary SAR's for transported and in-river migrating fish. Tables 7 to 9 also show the SAR's for the groups of transport (Group T) and in-river (Group C1 and Group C0) fish for the 1996 to 1998 migration years, respectively. Although we did not purposely route study fish to transportation in the 1996 migration year, about 6% of the CSS fish were transported that year. For each migration year, the transport fish (Group T) had SAR's that were closer to that of the in-river fish not detected at a COE transportation site in the Snake River (Group C0) than of the in-river fish detected at one or more of the Snake River transportation sites (Group C1). The return data for the 1997 and 1998 migration years will not be completed for another year or two, respectively, so trends seen to date may change with future adult returns. Confidence intervals will be generate later using bootstrapping methods.

Preliminary return data to hatcheries above Lower Granite Dam. Only return data to hatcheries through 1998 is complete and currently available for this report. In return year 1997, only two jacks were detected at Lower Granite Dam, a Lookingglass Hatchery jack that was trucked back to the hatchery and a Rapid River Hatchery jack. No attempt was made to see if this one jack returned to Rapid River Hatchery successfully. In return year 1998, a total of 22 PIT tagged two-ocean adults swam back to the hatchery weirs/traps and were detected out of 50 such fish detected at the adult trap at Lower Granite Dam (Table 10). Likewise, in return year 1998, a total of 23 PIT tagged jacks swam back to the hatchery weirs/traps and were detected out of 50 such fish detected at the adult trap at Lower Granite Dam. Unadjusted for harvest, the percentage of Lower Granite Dam detections subsequently detected at the hatcheries has averaged below 50% for both jacks and two-ocean adults.

In return year 1998, sport and tribal harvest occurred on Dworshak Hatchery adults in the North Fork Clearwater River and on Rapid River Hatchery adults in the Little Salmon River, and

Table 7. Returning CSS jacks and adults detected at GRA from migration year 1996.

CSS adults returning to GRA in 1997 relative to route of smolt passage.

Jacks (1-ocean)	Passage route thru system					Smolts estimated in category			Adult-Smolt ratio in category			
						In-river	In-river	Transport	In-river	In-river	Transport	Total
Hatchery	C1	C0	T	U	Total	C1	C0	T	C1	C0	T	(C1, C0, T)
DWOR						2551	1171	204	0.00%	0.00%	0.00%	0.00%
IMNH						1777	703	191	0.00%	0.00%	0.00%	0.00%
KOOS						7970	3535	749	0.00%	0.00%	0.00%	0.00%
LOOH			1		1	2866	1075	338	0.00%	0.00%	0.30%	0.02%
MCCA						9521	5493	756	0.00%	0.00%	0.00%	0.00%
POWP						3806	2466	318	0.00%	0.00%	0.00%	0.00%
RAPH	1				1	7616	2926	657	0.01%	0.00%	0.00%	0.01%
Grand Total	1		1		2	36107	17369	3213	0.00%	0.00%	0.03%	0.00%

CSS adults returning to GRA in 1998 relative to route of smolt passage.

Adults (2-ocean)	Passage route thru system					Smolts estimated in category			Adult-Smolt ratio in category			
						In-river	In-river	Transport	In-river	In-river	Transport	Total
Hatchery	C1	C0	T	U	Total	C1	C0	T	C1	C0	T	(C1, C0, T)
DWOR	7	2			9	2551	1171	204	0.27%	0.17%	0.00%	0.23%
IMNH					0	1777	703	191	0.00%	0.00%	0.00%	0.00%
KOOS	6	5	1		12	7970	3535	749	0.08%	0.14%	0.13%	0.10%
LOOH	1				1	2866	1075	338	0.03%	0.00%	0.00%	0.02%
MCCA	5	3	1		9	9521	5493	756	0.05%	0.05%	0.13%	0.06%
POWP	2	4			6	3806	2466	318	0.05%	0.16%	0.00%	0.09%
RAPH	9	3	2		14	7616	2926	657	0.12%	0.10%	0.30%	0.13%
Grand Total	30	17	4		51	36107	17369	3213	0.08%	0.10%	0.12%	0.09%

CSS adults returning to GRA in 1999 relative to route of smolt passage.

Adults (3-ocean)	Passage route thru system					Smolts estimated in category			Adult-Smolt ratio in category			
						In-river	In-river	Transport	In-river	In-river	Transport	Total
Hatchery	C1	C0	T	U	Total	C1	C0	T	C1	C0	T	(C1, C0, T)
DWOR	1				1	2551	1171	204	0.04%	0.00%	0.00%	0.03%
IMNH			1		1	1777	703	191	0.00%	0.00%	0.52%	0.04%
KOOS	1	4			5	7970	3535	749	0.01%	0.11%	0.00%	0.04%
LOOH	1				1	2866	1075	338	0.03%	0.00%	0.00%	0.02%
MCCA	3	6			9	9521	5493	756	0.03%	0.11%	0.00%	0.06%
POWP	1				1	3806	2466	318	0.03%	0.00%	0.00%	0.02%
RAPH	4	1	1		6	7616	2926	657	0.05%	0.03%	0.15%	0.05%
Grand Total	11	11	2		24	36107	17369	3213	0.03%	0.06%	0.06%	0.04%

CSS adults returning to GRA in 1997-99 relative to route of smolt passage.

All 3 years of returns:	Passage route thru system					Smolts estimated in category			Adult-Smolt ratio in category			
						In-river	In-river	Transport	In-river	In-river	Transport	Total
Hatchery	C1	C0	T	U	Total	C1	C0	T	C1	C0	T	(C1, C0, T)
DWOR	8	2			10	2551	1171	204	0.31%	0.17%	0.00%	0.25%
IMNH			1		1	1777	703	191	0.00%	0.00%	0.52%	0.04%
KOOS	7	9	1		17	7970	3535	749	0.09%	0.25%	0.13%	0.14%
LOOH	2		1		3	2866	1075	338	0.07%	0.00%	0.30%	0.07%
MCCA	8	9	1		18	9521	5493	756	0.08%	0.16%	0.13%	0.11%
POWP	3	4			7	3806	2466	318	0.08%	0.16%	0.00%	0.11%
RAPH	14	4	3		21	7616	2926	657	0.18%	0.14%	0.46%	0.19%
Grand Total	42	28	7		77	36107	17369	3213	0.12%	0.16%	0.22%	0.14%

Footnote: 6 of 7 cumulative 1 to 3-ocean adult returns of "transport category" fish were transported from Lower Granite Dam. 24 of 28 cumulative 1 to 3-ocean adult returns of "non-Snake River collector dam detected" fish (C0 Group) were never detected at and of the six dams with PIT tag detection capability on the bypass route. The smolt numbers in each category are in Lower Granite Dam equivalents.

Table 8. Returning CSS jacks and adults detected at GRA from migration year 1997.

CSS adults returning to GRA in 1998 relative to route of smolt passage.

Jacks (1-ocean)	Passage route thru system					Smolts estimated in category			Adult-Smolt ratio in category			
						In-river	In-river	Transport	In-river	In-river	Transport	Total
Hatchery	C1	C0	T	U	Total	C1	C0	T	C1	C0	T	(C1, C0, T)
DWOR		1			1	3712	2412	1919	0.00%	0.04%	0.00%	0.01%
IMNH	8	3	13		24	3799	2180	2133	0.21%	0.14%	0.61%	0.30%
KOOS					0	813	598	386	0.00%	0.00%	0.00%	0.00%
LOOH	4		2		6	11294	6240	6159	0.04%	0.00%	0.03%	0.03%
MCCA	9	6	7		22	9369	6724	5929	0.10%	0.09%	0.12%	0.10%
PAHP		1			1	7019	4282	5070	0.00%	0.02%	0.00%	0.01%
RAPH	2				2	6866	4122	4220	0.03%	0.00%	0.00%	0.01%
Grand Total	23	11	22		56	42872	26558	25816	0.05%	0.04%	0.09%	0.06%

CSS adults returning to GRA in 1999 relative to route of smolt passage.

Adults (2-ocean)	Passage route thru system					Smolts estimated in category			Adult-Smolt ratio in category			
						In-river	In-river	Transport	In-river	In-river	Transport	Total
Hatchery	C1	C0	T	U	Total	C1	C0	T	C1	C0	T	(C1, C0, T)
DWOR	12	9	15		36	3712	2412	1919	0.32%	0.37%	0.78%	0.45%
IMNH	24	16	22		62	3799	2180	2133	0.63%	0.73%	1.03%	0.76%
KOOS	1	1	3		5	813	598	386	0.12%	0.17%	0.78%	0.28%
LOOH	37	35	22	1	95	11294	6240	6159	0.33%	0.56%	0.36%	0.40%
MCCA	95	71	86	7	259	9369	6724	5929	1.01%	1.06%	1.45%	1.14%
PAHP	8	7	19	2	36	7019	4282	5070	0.11%	0.16%	0.37%	0.21%
RAPH	34	17	31	4	86	6866	4122	4220	0.50%	0.41%	0.73%	0.54%
Grand Total	211	156	198	14	579	42872	26558	25816	0.49%	0.59%	0.77%	0.59%

CSS adults returning to GRA in 2000 relative to route of smolt passage.

Adults (3-ocean)	Passage route thru system					Smolts estimated in category			Adult-Smolt ratio in category			
						In-river	In-river	Transport	In-river	In-river	Transport	Total
Hatchery	C1	C0	T	U	Total	C1	C0	T	C1	C0	T	(C1, C0, T)
DWOR						3712	2412	1919				
IMNH						3799	2180	2133				
KOOS						813	598	386				
LOOH						11294	6240	6159				
MCCA						9369	6724	5929				
PAHP						7019	4282	5070				
RAPH						6866	4122	4220				
Grand Total						42872	26558	25816				

CSS adults returning to GRA in 1998-2000 relative to route of smolt passage.

All 3 years of returns:	Passage route thru system					Smolts estimated in category			Adult-Smolt ratio in category			
						In-river	In-river	Transport	In-river	In-river	Transport	Total
Hatchery	C1	C0	T	U	Total	C1	C0	T	C1	C0	T	(C1, C0, T)
DWOR						3712	2412	1919				
IMNH						3799	2180	2133				
KOOS						813	598	386				
LOOH						11294	6240	6159				
MCCA						9369	6724	5929				
PAHP						7019	4282	5070				
RAPH						6866	4122	4220				
Grand Total						42872	26558	25816				

Footnote: 213 of 220 cumulative 1 to 2-ocean adult returns of "transport category" fish were transported from Lower Granite Dam. 132 of 167 cumulative 1 to 2-ocean adult returns of "non-Snake River collector dam detected" fish (C0 Group) were never detected at any of the six dams with PIT tag detection capability on the bypass route. The smolt numbers in each category are in Lower Granite Dam equivalents.

Table 9. Returning CSS jacks and adults detected at GRA from migration year 1998.

CSS adults returning to GRA in 1999 relative to route of smolt passage.

Jacks (1-ocean)	Passage route thru system					Smolts estimated in category			Adult-Smolt ratio in category			
						In-river	In-river	Transport	In-river	In-river	Transport	Total
Hatchery	C1	C0	T	U	Total	C1	C0	T	C1	C0	T	(C1, C0, T)
DWOR	9	22	19	1	51	13579	10731	15600	0.07%	0.21%	0.12%	0.13%
IMNH	11	8	34	1	54	6653	1995	4858	0.17%	0.40%	0.70%	0.39%
LOOH	1		2		3	12228	5125	13553	0.01%	0.00%	0.01%	0.01%
MCCA	27	18	61		106	12936	3994	10667	0.21%	0.45%	0.57%	0.38%
RAPH	11	8	13		32	13760	4453	13652	0.08%	0.18%	0.10%	0.10%
Grand Total	59	56	129	2	246	59156	26298	58330	0.10%	0.21%	0.22%	0.17%

CSS adults returning to GRA in 2000 relative to route of smolt passage.

Adults (2-ocean)	Passage route thru system					Smolts estimated in category			Adult-Smolt ratio in category			
						In-river	In-river	Transport	In-river	In-river	Transport	Total
Hatchery	C1	C0	T	U	Total	C1	C0	T	C1	C0	T	(C1, C0, T)
DWOR						13579	10731	15600				
IMNH						6653	1995	4858				
LOOH						12228	5125	13553				
MCCA						12936	3994	10667				
RAPH						13760	4453	13652				
Grand Total						59156	26298	58330				

CSS adults returning to GRA in 2001 relative to route of smolt passage.

Adults (3-ocean)	Passage route thru system					Smolts estimated in category			Adult-Smolt ratio in category			
						In-river	In-river	Transport	In-river	In-river	Transport	Total
Hatchery	C1	C0	T	U	Total	C1	C0	T	C1	C0	T	(C1, C0, T)
DWOR						13579	10731	15600				
IMNH						6653	1995	4858				
LOOH						12228	5125	13553				
MCCA						12936	3994	10667				
RAPH						13760	4453	13652				
Grand Total						59156	26298	58330				

CSS adults returning to GRA in 1999-2001 relative to route of smolt passage.

All 3 years of returns:	Passage route thru system					Smolts estimated in category			Adult-Smolt ratio in category			
						In-river	In-river	Transport	In-river	In-river	Transport	Total
Hatchery	C1	C0	T	U	Total	C1	C0	T	C1	C0	T	(C1, C0, T)
DWOR						13579	10731	15600				
IMNH						6653	1995	4858				
LOOH						12228	5125	13553				
MCCA						12936	3994	10667				
RAPH						13760	4453	13652				
Grand Total						59156	26298	58330				

Footnote: 112 of 129 cumulative 1-ocean jack returns of "transport category" fish were transported from Lower Granite Dam. 44 of 56 cumulative 1-ocean jack returns of "non-Snake River collector dam detected " fish (C0 Group) were never detected at any of the six dams with PIT tag detection capability on the bypass route. The smolt numbers in each category are in Lower Granite Dam equivalents.

Table 10. Jack and 2-ocean returns in 1998 to Lower Granite Dam and individual hatcheries for key CSS hatchery groups.

Migration Year	Hatchery	Detected at Lower Granite Dam		Detected at Hatchery Rack	
		Transported	In-River	Transported	In-River
1996	Dworshak H	0	9	0	1
	Kooskia H	1	11	1	5 @ Kooskia 3 @ Dworshak
	Rapid River H	2	12	0	7
	McCall H	1	8	1	2
	Powell Pond	0	6	0	2
	Imnaha H	0	0	0	0
	Lookingglass H	0	1	n.a.*	n.a.*
1997	Dworshak	0	1	0	1 @ Kooskia
	Rapid River H	0	2	0	1
	McCall H	7	15	3	4
	Pahsimeroi H	0	1	0	0
	Imnaha H	13	11	8	6
	Lookingglass	2	4	n.a.*	n.a.*

*Trucked directly from Lower Granite Dam to Lookingglass Hatchery (only 4 of the 6 jacks detected at Lower Granite Dam adult trap were reported at Lookingglass Hatchery)

tribal harvest alone on McCall Hatchery chinook in the South Fork Salmon River (Table 11). Tribal harvest of Rapid River and McCall Hatchery fish is not separated between 4 and 5 year-old adults (2-ocean and 3-ocean returns); therefore, we assume a similar split in age as reported in the Clearwater River drainage. Tribal harvest of Dworshak Hatchery fish in 1998 was 2 jacks, 35 "2-ocean" adults, and 145 "3-ocean" adults in 1998. Sport harvest of Dworshak Hatchery fish in 1998 was one jack, 19 "2-ocean" adults, and 79 "3-ocean" adults. Sport harvest of Rapid River Hatchery fish in 1998 was 42 "2-ocean" adults and 130 "3-ocean" adults. In all cases, jacks and

Table 11. Proportion of total return of Dworshak, Rapid River, and McCall Hatchery fish taken in sport and tribal harvest in 1998.

Hatchery	Migration year 1997 – Returning jacks		Migration year 1996 – Returning 2-ocean adults	
	Number	Proportion	Number	Proportion
Dworshak Total	14		230	
Hatchery Rack	11	0.786	176	0.765
Tribal Harvest	2	0.143	35	0.152
Sport Harvest	1	0.071	19	0.083
Rapid River Total	7		455 *	
Hatchery Rack	7	1	262	0.576
Tribal Harvest	None	0	(603 total adults) Approx. = 151 **	0.332
Sport Harvest	0	0	42	0.092
McCall Total	64		316 *	
Hatchery Rack	64	1	298	0.943
Tribal Harvest	None	0	(71 total adults) Approx. = 18 **	0.057

* Estimated total return number.
** Assume maximum of 25% of total adult harvest consists of 2-ocean returns.

and 2-ocean fish together accounted for less than 25% of total harvest, due to the strength of the 3-ocean run. It will be assumed that the proportion of PIT tags from the CSS in this harvest will

equal the proportion of the total return being harvested when computing the final return rates to the hatcheries. In Table 11, we estimate the percent of the total return from the 1996 migration year counted at the hatchery racks in return year 1998 (2-ocean returns) was: 76.5% for Dworshak H fish (as well as Kooskia H fish detected at Dworshak H); 57.6% for Rapid River H fish; and 94.3% for McCall H fish. Applying these expansion percentages to the PIT tags detected at the hatchery racks in 1998, we estimate a total (rack plus harvest) 2-ocean return of one PIT tagged Dworshak H fish and three PIT tagged McCall H fish. The total 2-ocean Kooskia H return (both to Kooskia and Dworshak hatcheries adjusted for harvest) is estimated at 10 PIT tagged fish and the total 2-ocean Rapid River H return (adjusted for harvest) is estimated at 12 PIT tagged fish. Compared to the number of PIT tags detected at Lower Granite Dam adult trap in 1998, the total 2-ocean return to the hatchery was 33% or lower for Dworshak H, McCall H, and Powell Pond fish, and 83% or higher for Kooskia H and Rapid River H fish.

Preliminary return data to hatcheries in the lower Columbia River. As shown in Table 12, smolts PIT tagged at Cowlitz and Round Butte hatcheries for migration year 1996 had no PIT tagged fish return to either hatchery as jacks in 1997 or as 2-ocean adults in 1998, or as 3-ocean adults in 1999. From the smolts PIT tagged at Cowlitz and Round Butte hatcheries for migration year 1997, one PIT tagged jack returned to each hatchery in 1998. Both Cowlitz and Round Butte hatcheries have had BKD problems in recent years that have apparently contributed to the lower than historic return levels. No PIT tagged Carson Hatchery jacks returned in 1998, but given the traditionally low jack returns to Carson Hatchery, we did not expect any. Through early August of 1999, Round Butte Hatchery has had returns of six 2-ocean adults and one jack that were PIT tagged for migration years 1997 and 1998, respectively. In addition, a stray Lookingglass Hatchery 2-ocean adult (a CSS fish) was detected at the Pelton Ladder of Round Butte Hatchery in 1999. Through early August of 1999, Carson Hatchery has had returns of nine 2-ocean adults that were PIT tagged for migration year 1997. Since the use of PIT tagged groups at Cowlitz Hatchery was being dropped, there was no effort expended in 1999 to look for any 2-ocean PIT tagged fish at that hatchery.

Table 12. PIT tagged jack and 2-ocean returns in 1996 to 1999 to individual hatcheries in the lower Columbia River for the CSS.

Migration Year	Hatchery	Return Year		
		1997	1998	1999
1996	Round Butte H	No jacks	No 2-ocean	No 3-ocean
	Cowlitz H	No jacks	No 2-ocean	No 3-ocean
1997	Round Butte H	XXX	One jack	Six 2-ocean*
	Cowlitz H	XXX	One jack	Recovery effort dropped
	Carson H	XXX	No jacks	Nine 2-ocean
1998	Round Butte H	XXX	XXX	One jack
	Carson H	XXX	XXX	No jacks

*Plus a CSS PIT tagged stray from Lookingglass Hatchery.

Scale pattern analyses. Scales taken on adults during return years 1998 and 1999 at Lower Granite Dam adult trap from upriver hatchery stocks and at the hatcheries from downriver stocks are being provided to the ODFW laboratory at Clackamas, Oregon. With two years of returns, sufficient scale samples are now available for ODFW researchers to begin preparing and reading the scales. This activity is in its early stage, and results are not available at this time.

Discussion

This study was designed by tribal and state fishery agency representatives to provide information required to make recommendations of the best approaches to mitigate for the hydro

system and produce salmon recovery. The key information needed is estimates of smolt-to-adult survival rates and any ancillary data that may help explain these survival rates. Therefore, this study must be conducted over an extended number of years, since each group of PIT tagged fish released in a particular migration year requires at least three subsequent years to get a complete return record of jacks, 2-ocean adults, and 3-ocean adults. In future years, the study objectives as now written may change (following the philosophy of the Northwest Power Planning Councils "adaptive management") as new information is generated. It is in this long-term context that we will discuss the progress of this study relative to the list of study objectives.

For most objectives and tasks within objectives, it is simply too early to perform the stated tests and comparisons, since not enough completed three-year sets of adult returns are available. This is true for most tasks of Objectives 1 and 2. Because the completed three years of adult returns for the 1996 out-migrants produced so few fish, no comparisons were made between CSS in-river migrant SAR's and NMFS in-river migrant SAR's (Objective 1 Task 1.e). Generation of Transport/Inriver ratios have been deferred to next year when the completed three-years of adult returns for the 1997 out-migration will be available. Poorer than expected recent year returns to the lower Columbia River hatcheries has made it difficult to address many of the tasks of Objective 3 as they are now written. Current survival-to-adult rates to the lower Columbia River hatcheries chosen for use in the CSS appear to be no better and may be worse than the survival-to-adult rates of the upriver hatcheries for smolts that migrated in 1996 to 1998. Scale samples are being collected at the Lower Granite Dam adult trap and at lower river hatcheries. These scale samples are being cataloged for future analysis to address Objective 5.

Most CSS progress has been made in beginning to build the long-term time series of smolt-to-adult survival rates for Objective 4. Cumulative adult returns through August 2, 1999 have been compiled for CSS PIT tag release groups that migrated in 1996, 1997, and 1998. Although the fish from migration years 1997 and 1998 still have one to two additional years of return, some trends related to smolt-to-adult survival rates are beginning to emerge. The return rate from the hatchery chinook that migrated in 1996 was extremely low, well below the minimum 0.2% used in planning. Hatchery chinook that migrated in 1997 and 1998 should have SAR's that approach 1% based on what has been seen so far with only one to two years of returns completed. Adult return percentages widely differ between 1996 migrants and 1997/1998 migrants, yet smolts in each year migrated under conditions of above average flow with the Biological Opinion spill program in place. Climatic conditions (*El Nino*) increased ocean temperatures in 1996 and the ripple effect of this change may be seen in the poor adult returns of the 1996 migrants. The creation of a long time series of SAR data will be useful to fishery managers regardless of the type of regional long-term monitoring and evaluation program developed for salmon recovery.

Summary and Conclusions

- PIT tag release targets at hatcheries above Lower Granite Dam in 1997 and 1998 have provided cumulative returns of 635 jacks and 246 2-ocean adults at the Lower Granite Dam adult trap over the available return years through August 2, 1999. With one to two additional years of returning adults from the 1997 and 1998 migration years, we will have excellent final sample sizes of adult returns for future comparison of smolt-to-adult survival rates of in-river versus transported hatchery yearling chinook.

- Use of the "multimon" computer program to divert specific percentages of PIT tagged fish at a given dam to raceway (transport) routes versus return-to-river routes has worked flawlessly during the 1997 and 1998 migration season. This program was not used in 1996 because PIT tagged fish were not purposely being routed to raceways in that year.

- Use of more than one dam is required to route enough PIT tagged fish to the raceways in order to meet the target of 43,000 PIT tagged fish desired in the transportation group. Starting in 1998, PIT tagged CSS fish were routed to transportation at both Lower Granite and Little Goose dams.

- Estimated smolt survival from hatchery release site to Lower Granite Dam tailrace were highest in 1998 (average 70%), followed by 1996 (average 61%) and lastly 1997 (average 52%).

- For the hatcheries utilized in the Comparative Survival Study, estimated survival from Lower Granite Dam tailrace to John Day Dam tailrace in 1998 was 61%.

- Composite CSS hatchery chinook smolt-to-adult return rates (based on cumulative returns to Lower Granite Dam through August 2, 1999) are over four-fold higher for 1997 out-migrants (jacks and 2-ocean returns) than for 1996 out-migrants (jacks, 2- and 3-ocean returns).

- To date, the 1997 out-migrants smolt-to-adult return rates (2-ocean returns only) have ranged between 0.2% and 1.1%, with the highest rate going to McCall Hatchery summer chinook.

- For each migration year, the transport fish (Group T) had SAR's that were closer to that of the in-river fish not detected at a COE transportation site in the Snake River (Group C0) than of the in-river fish detected at one or more of the Snake River transportation sites (Group C1).

- Returns of PIT tagged CSS fish to the lower Columbia River hatcheries have been lower than were expected during the planning phase of this study. In 1998, we stopped PIT tagging chinook at Cowlitz Hatchery and in 1999 we terminated PIT tag recovery effort at that site.

References

Burnham, K.P., D.R. Anderson, G.C. White, C. Brownie, and K.H. Pollock. 1987. Design and analysis methods for fish survival experiments based on release-recapture. American Fisheries Society Monograph 5. ISSN 0362-1715. Bethesda, Maryland. 437 p.

Comparative Survival Rate Study of Hatchery PIT Tagged Chinook

PART B: Detailed description of PIT tagging activities at hatcheries and of returning adults recovery activities at the Lower Granite Dam adult trap and at the hatcheries

INTRODUCTION

One major objective of the Comparative Survival Study was to "compute and compare overall smolt-to-adult survival rates for selected upriver and downriver spring and summer chinook hatchery stocks. To achieve this objective and the associated tasks, we were required to select hatchery programs that would allow the opportunity to mark sufficient numbers of smolts to give enough returning adult fish so that statistically rigorous smolt-to-adult survival rates could be computed to meet test requirements. The FPC and Oversight Team for the CSS looked at hatchery programs that would meet expected marking needs for the near-term and future. It had been determined that the PIT tag would provide the best information to achieve survival estimates from the hatchery through the hydroelectric projects. An adult PIT tag detection system was already in place at Lower Granite Dam to achieve adult return data for the Snake River basin stocks. At both upriver and downriver sites, available Coded Wire Tag programs might also provide information to help in determining the rate of survival from juvenile fish to the returning adult fish at the hatcheries. Marking activities for the Comparative Survival Study are listed by hatchery with general descriptions of the facilities and marking programs in 1996, 1997 and 1998.

PIT TAGGING ACTIVITIES LISTED BY HATCHERY

Upstream hatcheries

In 1996, 100,000 yearling chinook were PIT tagged at several hatcheries in the Snake River basin to initiate the Comparative Survival Study (see Appendix A Table A-1). About 5% of each hatchery's spring or summer chinook production were PIT tagged by State and Federal fish agencies. From that starting point, the numbers of spring/summer chinook to be PIT tagged and released were reassessed, and as a result, the overall number of fish to be marked for the CSS program was doubled. This increase in number marked would allow more precise juvenile survival estimates to be made through the Snake and Columbia river as well as provide enough adult fish to the sampling site at Lower Granite Dam and upstream hatcheries to determine survival rates to adulthood.

In 1997 and 1998, approximately 200,000 yearling chinook per year were PIT tagged at designated hatcheries by IDFG, ODFW, and USFWS marking crews under separate BPA marking contracts (see Appendix A Tables A-2 and A-3). An additional 9,000 chinook (3,000 each from Rapid River, Dworshak, and McCall hatcheries) were marked in 1998 as part of University of Idaho Fisheries Cooperative Unit fish passage studies aimed at measuring stress and other indices at the mainstem dams. In 1998, hatcheries chosen to best represent the Snake River basin were Rapid River, [IDFG], McCall, [IDFG], Lookingglass, [ODFW], Imnaha, [ODFW], and Dworshak [USFWS].

· **IDFG Marking Procedures at Rapid River, McCall, and Pahsimeroi Hatcheries**

At IDFG hatcheries, fish for the CSS program were marked in a marking trailer that incorporates four tagging stations and necessary equipment to safely and efficiently PIT tag fish. The PIT tagging was normally completed with daily 8-hour shifts in less than one week (1997 and 1998). The daily tally of fish PIT tagged ranged between 4,000 to 6,000 per station or 16,000 to 18,000 per day. Tagging files were kept to 1,000 or less records to aid in computer manipulation. Although the PIT tagged fish numbers varied by year, protocol for marking yearling spring and summer chinook was similar between hatcheries. Fish were marked using

protocol established by the PIT tag steering committee. All PIT tags were placed in the fish using hand-held syringes and standard 12-gage veterinary needles. Syringes were disinfected between each use with 200 proof Ethyl alcohol for at least 10 minutes. Between marking and release periods, dead PIT tagged fish were dotted out of the tagging file. Prior to release, tagging files were submitted to Pacific States Marine Fisheries (PSMFC) PIT tag database with release information.

Rapid River Hatchery

Rapid River Hatchery is located about 3 miles upstream from the confluence of Rapid River with the Little Salmon River, and approximately 7 miles from the nearest town of Riggins, Idaho. Idaho Power Company funds Idaho Department of Fish and Game to operate and rear yearling spring chinook salmon to mitigate for the Idaho Power Hydroelectric Dams, Brownlee, Oxbow, and Hells Canyon. In a normal year, approximately 3.0 million yearling chinook salmon are released from this facility, and this total comprises about one-third of the yearling chinook salmon released in the state of Idaho. Because of its importance as a mitigation hatchery, Rapid River Hatchery was selected for use in CSS. The hatchery uses water from Rapid River as its source of water to incubate and raise spring chinook salmon from eggs to yearling sized smolts in approximately 1.5 years.

Fish to be marked for the CSS program were captured from the ponds with an umbrella net. The captured fish were then transferred to 5-gallon containers and transported to the marking trailer for PIT tagging by the experienced marking crews from IDFG. Generally, this routine required that the fish be handled (netted) at least twice in the marking process. The anesthetic bath used a re-circulating system to keep the anesthetic (MS-222) at a consistent rate to the marking areas and the water temperature near the same throughout the marking. After the individual fish was "lethargic", the fish was PIT tagged, scanned with a PIT tag detector and decoded, a length taken (in mm), along with other parameters as necessary. These details are automatically entered into the computer as an individual PIT tag record. After the marking process, fish were passed back to the pond or held for a time in a holding tank and then put directly back into the pond with the production fish. The PIT tagged fish would intermix with the production fish. All fish are released volitionally from the ponds. This begins mid-March when hatchery personnel pull the stop logs located at the end of the ponds, and ends when all fish are evacuated by mid-April.

1996 Marking Program. Initially, about 2,000 fish were PIT tagged at Rapid River Hatchery at the end of February for the annual Smolt Monitoring Program. These fish were held separately from production in four lots of 500 fish each so that they could be released over four days around the date when the hatchery manager projected that half the fish had volitionally left the ponds. When the CSS was initiated during the spring of 1996, over 17,000 additional fish from production were PIT tagged during mid-March to bring the total percentage of production being marked to approximately 5%.

1997 Marking Program. Approximately 40,500 yearling spring chinook were marked for the CSS in fall 1996 for the 1997 migration season. Because of reduced numbers of production fish from the 1995 brood year and the fact that nearly 50% of production was to be marked, the fish were marked in fall 1996 to reduce handling stresses that might occur during the spring when the fish were beginning to smolt. These fish were marked and held in one large holding pond (Pond 2A) along with the production fish until release the following spring of 1997. The total 1997 production was only 3 percent of full production and was a record low release for the hatchery. The quality of the yearling chinook at time of volitional release was deemed excellent by the State Pathologist.

1998 Marking Program. Approximately 48,000 fish from a production total of 900,000 were randomly selected from one of four large holding ponds at the southern edge of the hatchery and PIT tagged. Marking was conducted in the spring of 1998 between between February 9 and February 11. The marked fish were returned to the holding ponds until Rapid River began volitionally releasing fish between mid-March and mid-April. Approximately 5.3% of total production was PIT tagged. Fish loss from shed tags and delayed mortality in all groups was low

according to the IDFG marking supervisor. In 1998, tag loss between tagging and release from all documented sources was 0.2%. The pathologists examining the fish at time of release rated the fishes' health as being in good condition.

McCall Hatchery

McCall Hatchery is located in McCall, Idaho and operated by IDFG with funding from the US Army Corps of Engineers as part of the Lower Snake Compensation Program for mitigation for construction of the four lower Snake River Dams. The hatchery's water source is the Payette Lake. Annually, hatchery personnel capture adult fish at the South Fork Salmon River, spawn them at that site, and then transport the green eggs to the hatchery. The resulting fish are reared for about 1.5 years at the hatchery and trucked back back to the South Fork of the Salmon River for release near Knox Bridge. The capacity of the two holding ponds is about 1,000,000 yearling summer chinook salmon. McCall Hatchery was selected for the CSS because of the importance of these fish to the total summer chinook production in the Salmon River basin.

At McCall Hatchery, fish to be marked for the CSS program were captured from the large holding ponds by crowding them into a smaller area and then netting them into holding pens. Fish were then transferred to the marking trailer and PIT tagged by the experienced marking crews from IDFG. Generally, this routine required that the fish be handled (netted) at least twice in the marking process. The anesthetic bath used a re-circulating system to keep the anesthetic (MS-222) at a consistent rate to the marking areas and the water temperature near the same throughout the marking. After the individual fish was "lethargic", it was PIT tagged, scanned with a PIT tag detector and decoded, a length taken (in mm), along with other parameters as necessary. These details are entered into the computer as an individual PIT tag record. After the marking process, fish were passed back to the pond or held for a time in a holding tank and put directly back into the pond with the production fish.

1996 Marking Program. Initially, about 2,000 fish were scheduled for PIT tagging at McCall Hatchery around mid-March for the annual Smolt Monitoring Program. Since the CSS was initiated prior to mid-March of 1996, it was possible for IDFG crews to PIT tag 5% of production (over 29,600) during one visit to the hatchery, March 18 to 19.

1997 Marking Program. Yearling summer chinook were marked in March of 1997 for the CSS program. The approximate number of summer chinook PIT tagged for release into the South Fork Salmon River was 53,500. These fish were part of the 238,000 summer chinook released during the 1997 migration season. About 22.5% of the summer chinook received a PIT tag. Fish from McCall Hatchery were trucked off-site to the South Fork Salmon River (Knox Bridge) and released between March 17 and 19. This release was earlier than normal due to the high snow pack and the accessibility of trucks to the release site at that time. This decision was made due to the fear that the roads could be closed later because of slides when the snow began melting.

1998 Marking Program. About 47,500 yearling summer chinook were PIT tagged February 17-19, 1998, for the CSS program. The total production release from the hatchery was approximately 419,000 fish including a 25,000 fish supplemental release into Stolle Meadow Pond in July 1997. The PIT tagged group was about 11.3% of the total hatchery release for the 1998 migration season. All fish were released at Knox Bridge, South Fork Salmon River between March 31 and April 9. Delayed mortality in all McCall Hatchery groups was minimal. In addition, tag loss was also considered minimal. At McCall Hatchery, the good appearance (health) of the fish prior to their release likely led to the reduced mortality rate as well as reduced tag loss. The PIT tagged fish appeared representative of the hatchery production as a whole.

Clearwater Hatchery

In 1996, IDFG marked yearling spring chinook at Clearwater River Hatchery for release from Powell Pond, Red River Pond, and Crooked River Pond. For the CSS Program, approximately 5% of the hatchery release total were PIT tagged at each facility. The PIT tag release groups were Powell Pond – 11,416; Crooked River Pond – 2,099; and Red River Pond –

1,212. The marking program was completed from March 4 through March 12 for the acclimation sites with the fish released about one month later between April 10 and 11.

These three groups were part of the approximate 100,000 yearling chinook that were PIT tagged in 1996 for the initial CSS program. In 1997 and later years, marking from Clearwater Hatchery complex for the CSS Program was dropped.

Pahsimeroi Hatchery

Pahsimeroi Hatchery is located about one mile upstream from the confluence of the Pahsimeroi River with the main Salmon River and near Ellis, Idaho. The Idaho Department of Fish and Game operates the hatchery with funding from Idaho Power Company. For the 1997 migration of juvenile salmon, IDFG was contracted to PIT tag summer chinook salmon at Sawtooth Hatchery in fall 1996 for eventual release from Pahsimeroi Hatchery in spring of 1997. Marking procedures were similar to those listed for McCall and Rapid River hatcheries and followed standard protocol established by the PIT tagging steering committee. About 33,500 juvenile summer chinook from Pahsimeroi Hatchery were marked with PIT tags, representing about 29% of the production total. The production fish were fairly large in size with the overall average being 7 fish per pound. The production fish were released over approximately a one-month period with the estimated release for the PIT tag group of April 7. Based on the marking report submitted by IDFG, mortality on the PIT tagged fish was minimal and the marked fish should have been fairly representative of the hatchery production as a whole.

The summer chinook from Pahsimeroi Hatchery were used for the CSS program only during the 1997 juvenile migration season. This stock of chinook was not chosen for the longer term study as its track record of releases and subsequent adult returns would be hit and miss. Generally, these summer chinook are a South Fork Salmon derivative. This particular year, Pahsimeroi Hatchery had sufficient summer chinook to allow marking of 33,500 juvenile fish for the CSS Program. Because hatchery numbers elsewhere were so reduced in 1997, Pahsimeroi Hatchery's contribution of fish to the CSS was a positive factor for allowing the study to achieve the goal of 200,000 chinook to be PIT tagged for the upriver hatchery groups in 1997.

· **ODFW PIT Tagging Procedures at Lookingglass and Imnaha Hatcheries**

Oregon Department of Fish and Wildlife marked yearling chinook for the CSS in 1996 to 1998. During these years, Imnaha stock and Rapid River stock yearling chinook were marked at Lookingglass Hatchery during the winter/spring period of late January to mid-March. The Imnaha stock chinook were transported to the Imnaha Acclimation Facility about one month prior to release, while the Rapid River stock chinook were released on site into Lookingglass Creek.

Lookingglass Hatchery

Lookingglass Hatchery is located in Northeastern Oregon, about 1.5 miles upstream from the confluence of Lookingglass Creek with the Grande Ronde River. The hatchery is operated by ODFW with hatchery funding provided by the US Army Corps of Engineers as part of the Lower Snake Compensation Program for mitigation of fish losses due to construction of the four lower Snake River dams. Approximately 500,000 yearling spring chinook are slated for release from this hatchery on an annual basis. In addition to the on-site releases, the hatchery rears fish that are released from the Imnaha Acclimation Pond, as well as some captive brood programs initiated due to listing of some chinook stocks under the Endangered Species Act. Lookingglass Hatchery was chosen as a CSS group to represent spring chinook from the Grande Ronde River, a historical stream that always produced large numbers of adult chinook salmon back to the Grande Ronde River. All releases of yearling chinook from Lookingglass Hatchery have been marked with Coded Wire Tags to assure that they will be separated from the unmarked population at Lower Granite adult sampling site and either hauled back to the hatchery or to an alternate hatchery.

Standard protocols for PIT tagging fish were followed during each season. In general, fish were randomly selected from the raceways and held in a net pen that was suspended from the raceway. When fish were required for marking, approximately 500 fish were removed from the

net pens and taken via a bucket to the stations set up in the hatchery building (1996-97) or in a marking trailer (1998). All fish to be marked were anesthetized in a mixture of water and MS-222. When the fish was immobile, a member of the ODFW marking crew implanted a PIT tag in the yearling chinook. Standard 12-gage hypodermic needles were used to implant the tags. After tagging, the needles were soaked in 70% isopropyl alcohol for 10 minutes prior to being used again. Fish lengths were taken to the nearest 1-mm for each individual fish. To the extent possible, known sick fish were not marked, e.g., fish displaying signs of Bacterial Kidney Disease (fish with extended bellies or bulging eyes), during the PIT tagging process. After marking, fish were returned to the raceways via a water-filled pipe [from the marking trailer] or in 19L buckets [from the hatchery building]. Mortality from the marking were collected by hatchery personnel and PIT codes removed from the computer generated files prior to submittal of the final Tagging/Release files to the PTAGIS database, administered by PSMFC.

1996 Marking Program. Initially, about 2,000 fish were PIT tagged at Lookingglass Hatchery early in March for the annual Smolt Monitoring Program. When the CSS was initiated during the spring of 1996, over 5,000 additional fish from production were PIT tagged after mid-March to bring the total percentage of production being marked to approximately 5%.

1997 Marking Program. Approximately 42,000 juvenile spring chinook were PIT tagged from February 3-13, 1997, by ODFW personnel. PIT tag release files were submitted to PTAGIS database excluding all mortality, shed tags as well as duplicate tags. The final PIT tagged release total submitted to PTAGIS was 40,027. The overall rate of mortality of PIT tagged fish was 4.7%. Most mortality occurred within a few days of tagging. Fish pathology personnel reported that the 1995 brood was in good health, with no cases of clinical BKD, IHN, or EIBS diagnosed during the rearing cycle. All Lookingglass production (including PIT tagged fish) were 100% adipose fin and right ventral fin clipped and carried a CWT. The fish were released from Lookingglass Hatchery on April 7th. The PIT tagged chinook were released along with the production chinook. The initial marking quota was 26.5% of total hatchery production of approximately 153,500 yearling spring chinook.

1998 Marking Program. Approximately 45,000 yearling chinook were PIT tagged with an initial release total of 44,234 submitted to the PTAGIS database by ODFW. These fish were 15.2 % of the hatchery production release of 290,000 yearling spring chinook. PIT tagging for the CSS was accomplished from February 23 to March 6. The mean length of the PIT tagged fish was 121.2 mm at time of tagging. ODFW reported a 0.83% PIT mortality from tagging through release. A total of 795 PIT tags or 1.8% were recovered from the raceways from shed tags or other reasons. Since that time, duplicate tags and other changes have reduced the actual PIT tag release total to 43,939 Lookingglass Hatchery fish residing on the PTAGIS database. The fish were released from Lookingglass Hatchery on April 4 into Lookingglass Creek, which flows into the Grande Ronde River. These fish had encountered a high incidence of disease due to clinical levels of BKD prior to tagging and release from the hatchery in 1998 according to personnel from the NE Region Fish Pathology Section who monitored diseases at the hatchery.

Imnaha Hatchery

ODFW operates the Imnaha Hatchery site to mitigate for construction of the Lower Snake River dams. Funding for the Imnaha facility is through the Lower Snake River Compensation Plan. The facility is part of the larger Lookingglass complex with yearling spring/summer chinook reared at Lookingglass Hatchery and released into the Imnaha River from the Imnaha ponds. The Imnaha Hatchery ponds are located about 34 miles upstream from the mouth of the Imnaha River with the Snake River. The yearling chinook are annually trucked from Lookingglass Hatchery in February (normally) to the Imnaha facility where the fish are acclimated for approximately one month before their release. All adult returning salmon are captured at the Imnaha weir when it operates and designated adult fish hauled by truck to Lookingglass Hatchery for spawning. The rearing portion of the fish's life cycle occurs at Lookingglass Hatchery. Most adult salmon returning to the Imnaha weir pass Lower Granite Dam at a time when they would be counted as summer chinook stocks.

The Imnaha River was historically a very productive stream with thousands of salmon returning to the Imnaha River basin to spawn. For this reason, the Imnaha Hatchery spring/summer chinook salmon were chosen for the CSS to represent the Imnaha River basin.

General procedures for marking the Imnaha stock yearling chinook have been covered in the Lookingglass Hatchery section above since ODFW crews supervise and complete the PIT tagging for both the on-site Lookingglass and off-site Imnaha groups from that hatchery.

1996 Marking Program. In mid-February, nearly 3,100 fish were PIT tagged for ODFW studies related to the Imnaha stock, and by mid-March more than 1,600 additional fish were PIT tagged to bring the total percentage of production being marked to approximately 5%.

1997 Marking Program. For the 1997 CSS program, ODFW marked approximately 13,525 yearling summer chinook from January 28-31 1997. These fish were randomly selected and PIT tagged from the Lookingglass Hatchery raceways containing Imnaha stock chinook. The tagging process was completed in the marking trailer operated by ODFW personnel. Fish to be PIT tagged were marked using normal protocol and shunted back to the raceway until trucked to Imnaha acclimation facility for release. A final number of 13,378 PIT tagged fish were entered into the PTAGIS database. The PIT tagged group comprised approximately 26% of the total production release of approximately 50,900. The fish were trucked to the Imnaha pond from Lookingglass Hatchery and acclimated for about one month prior to release from the pond on April 7. All production fish were marked with a Coded Wire Tag and an adipose clip.

1998 Marking Program. For the 1998 CSS program, ODFW marked about 20,200 yearling spring/summer chinook between February 17 and February 23. The fish were captured randomly from the holding raceways containing the Imnaha stock chinook and transferred to the marking trailer via water filled buckets to a larger 90-gallon holding tank with circulating fresh water. The fish were then dipnetted from the circulating tank into a mixture of anesthetic (MS-222 at 40-50 ppm) and water until the fish became lethargic. At that point the fish were PIT tagged and shunted back to the holding raceway. PIT tag mortality for the Imnaha stock was 102 or 0.51% of the tagged total. Other shed tags found in the raceway and subtracted from the tag files total 267 or 369 for the grand total of mortality and shed tags. This equated to 1.8% of the marked total. The marked PIT tagged fish had a mean length of 125.5 mm. One comment made in the ODFW report said that "although there was some clinical level of BKD detected in Imnaha stock mortality, Imnaha stock did not develop increased mortality from BKD." The PIT tagged fish were transferred to the Imnaha acclimation facility in March and held there until released on April 4. The PIT tagged release group comprised about 21% of the production release of 92,500 fish. Initially, tagging/release files containing 19,829 tagged fish were submitted to the PTAGIS database. Since that time, the numbers were revised to exclude duplicate tags, etc., giving 19,169 PIT tag releases now residing on the PTAGIS database.

- **<u>USFWS marking procedures at Dworshak Complex Hatcheries</u>**

USFWS personnel from the Dworshak Fisheries Resource Office took the lead role in marking yearling chinook for the CSS at Dworshak Complex that includes both Dworshak and Kooskia hatcheries. Standard protocols for PIT tagging fish were followed during each season at Kooskia and Dworshak hatcheries. Yearling spring chinook were randomly selected (dip netted) from the raceways after being crowded to one end of the raceway. These fish were transported to the tagging station in 30 gallon tubs. At each hatchery, the chinook were tagged in the hatchery building. The tubs were continuously irrigated with raw water from the same source as supplies the raceways. Fish were anesthetized in four-gallon tubs containing a mixture of MS-222 solution that was buffered with Sodium Bicarbonate. The anesthetic solution was changed frequently to maintain temperature within one degree C of the water in the holding and recovery tanks. Standard 12-gage hypodermic needles were used to implant the tags. After tagging, the needles were soaked in 70% isopropyl alcohol for 10 minutes and then rinsed with fresh water prior to being used again. Fish lengths were taken to the nearest 1-mm and these data accompanied the individual PIT tag code that were placed into the Tagging/Release files submitted to the PIT tag database. To the extent possible, known sick fish were not PIT tagged,

such as fish displaying signs of Bacterial Kidney Disease like extended bellies or bulging eyes. After marking, fish were returned to the raceways via the 30-gallon tubs after being held for about 20 minutes to recover from the effects of anesthetic. The raceways containing PIT tagged fish were flagged and mortality were collected each day and scanned. Tag codes were dotted out and, when possible, the tags re-used.

Dworshak National Fish Hatchery

Dworshak NFH is located within the small town of Ahsahka, Idaho, about 32 river miles upstream of the confluence of the Clearwater River with the Snake River. Dworshak NFH is operated by the USFWS, and annually produces juvenile spring chinook and summer steelhead salmon for release into the Clearwater River basin. Up to 1 million yearling spring chinook are released from the hatchery to compensate for operation of the lower Snake River dams.

1996 Marking Program. For the initial study that began in 1996, a total of 5,069 spring chinook were PIT tagged at Dworshak NFH and released April 11, 1996. The release number was approximately 5% of production that year.

1997 Marking Program. As part of the 1997 CSS marking, Dworshak NFH PIT tagged about 14,170 yearling chinook during the late winter, February 5 to 13. USFWS reported a 0.48% tag loss. About 14,100 yearling chinook with PIT tags were released on April 7, and Tagging/Release files were submitted to the PTAGIS database. The marking and holding of these fish was satisfactory in 1997. No reports of poor fish quality were received from the FRO that indicated that the PIT tagged groups were compromised by the tagging.

1998 Marking Program. Prior to the marking of fish in 1998, it had been decided by the Oversight Committee that Dworshak be one of the main groups of fish to be used in the CSS Program. About 45,000 fish were to be PIT tagged at Dworshak to represent yearling spring chinook from the Clearwater River basin. In addition, a University of Idaho Cooperative Fisheries Unit's study to assess stress-related problems at the dams required the tagging of another 3,000 fish to supplement any taking of fish from our study. The Dworshak Fisheries Resource Office marked fish from February 9 to March 9, 1998. About 47,500 PIT tagged fish were released on March 25 and 26, 1998. As in 1997, there were no reports from the Dworshak FRO to indicate that these fish were compromised by the tagging program. All PIT tag records were submitted to PTAGIS database prior to these fish arriving at Lower Granite Dam.

Kooskia National Fish Hatchery

Kooskia NFH is located at River Kilometer 1 on Clear Creek, which joins with the South Fork of the Clearwater River near the town of Kooskia, Idaho. The facility is operated by the USFWS, and produces about 500,000 yearling chinook for release from the hatchery on an annual basis.

1996 Marking Program. For the initial study that began in 1996, a total of 16,660 spring chinook were PIT tagged at Kooskia NFH. This represented approximately 5% of production that year.

1997 Marking Program. Fish for the 1997 CSS groups were apportioned among the hatcheries with Kooskia having only 4,096 PIT tagged spring chinook. PIT marking was completed at Kooskia on January 29, 1997. The mortality and tag loss was about 0.49%, and 4,075 PIT tagged fish were released on April 8, 1997. The Dworshak FRO provided experienced marking personnel to complete the work. Fish quality was satisfactory and should not have compromised the well being of the tagged fish. All PIT tag records were submitted to PTAGIS database prior to the fish's arriving at Lower Granite Dam.

Kooskia NFH was not used as a key hatchery for the CSS Program after the 1997 fish migration as it was determined that one group of spring chinook could represent the Clearwater River drainage. Because of logistics and other reasons, Dworshak NFH was chosen to provide the spring chinook for the CSS program in 1998 and future years that are representative of the Clearwater River basin.

Downstream Hatcheries

The downstream portion of the CSS program has been conducted at two to three major spring chinook hatcheries in the Lower Columbia River during the first three years of study. These include Cowlitz Hatchery (operated by WDFW), Round Butte Hatchery (operated by ODFW), and Carson Hatchery (operated by USFWS). In 1996, a group of 3,000 yearling spring chinook was PIT tagged at Cowlitz Hatchery and another 3,000 fish at Round Butte Hatchery. By 1997, the plan was to increase numbers marked in the lower river to 15,000 yearling spring chinook split equally among Round Butte Hatchery (Pelton Ladder site) located on the Deschutes River, Carson NFH located on the Wind River, and Cowlitz Hatchery located on the Cowlitz River. But by 1998, it was apparent that factors such as fish health problems and logistical difficulties in fish handling during the marking required the program to be modified with regard to the design of the downstream portion of the CSS. This section details the issues regarding PIT tag marking at the lower river hatcheries.

Cowlitz Hatchery

Cowlitz Salmon Hatchery is located below any mainstem Columbia River dam and about 80 kilometers upstream from the confluence of the Cowlitz River with the mainstem Columbia River. Tacoma Power and Light Company funds WDFW to operate Cowlitz Hatchery as part of mitigation for construction of Cowlitz Falls Dam. Cowlitz Hatchery normally releases about 1,200,000 yearling spring chinook per season with early March and early April release dates. Adult return rate was normally greater than 1.0% during the years prior to 1993. From that point on, it appeared that the SAR decreased for unknown reasons.

1996 Marking Program. During 1996, WDFW was contracted to PIT tag 3,000 yearling spring chinook salmon prior to their release from the hatchery. The procedure of marking these fish during the late winter or early spring was later than normal at this hatchery, so numerous logistics were required to smooth the marking process and not cause undue stress to the animals. USFWS from the Vancouver FRO assisted hatchery personnel and WDFW with the PIT tagging in 1996.

All tagging was completed using the 125 kHz PIT tag as opposed to the 400 kHz PIT tag used at all other hatcheries in the CSS program. The yearling chinook at this hatchery were quite large (between 4-10 fish per pound) when compared to other groups marked in the Columbia River basin. The marking process was somewhat cumbersome with the fish netted from the raceways, placed in a 30-gallon container and driven a short distance to the marking site in the hatchery building. The fish were then netted from the container and transferred to small holding troughs into an anesthetic bath. As fish were sedated, the marker would insert the PIT tag in the fish. All PIT tag marking procedures were similar to protocol set forth by the PIT tag steering committee. The tagging files were modified to account for mortality or tag loss that occurred.

1997 Marking Program. In 1997, the USFWS (Fisheries Resource Office, Vancouver, WA) contracted with BPA to mark 5,000 yearling spring chinook at Cowlitz Hatchery. All marking was again completed inside the hatchery building in the lower level basement. The tagging was completed in late March due to scheduling problems that prevented earlier marking at the hatchery. Cowlitz Hatchery personnel were responsible for gathering fish from the 3 ponds (Numbered P-18, P-20, and P-24). Fish were dip netted from the ponds, placed in a small transport container and hauled to the marking area at least one day prior to the marking whenever possible. The process of taking marked fish back to the raceway was completed after holding the fish for one day (overnight) to check for tag loss and mortality on the marked fish.

The FRO personnel set up a series of 16 ft x 2 ft x 1 ft troughs to hold fish prior to and after tagging the fish. The fish to be marked were large (about 3-8 fish per pound) on the average and well smolted. In general, it was believed that the fish were in good condition. However, it appeared that the netting and handling process were causing stress in the fish. Standard PIT tagging protocol was followed by the USFWS marking crews. As normal, the PIT tags were submersed in 90 proof alcohol for 15 minutes prior to using them and 10 minutes for the needles in 70 proof alcohol after use. MS-222 was the anesthetic bath used at the hatchery, and the

solution was changed as required to assure that water temperatures were near equal in the anesthetic bath and the holding troughs. When a fish was sedated and could be handled, one person would PIT tag the fish and another would assure that the fish was decoded (passed by a detector) and a length added to the record on the computer. After that process was completed, the fish was shunted to a holding tank until taken back to the raceway. Mortality on the marked fish was greater than 3% and was likely due to the handling stresses that occurred at each point in the marking process.

The PIT tag records indicated that 5,098 fish were initially PIT tagged in March 1997 with the release number submitted to PTAGIS of 4,923. The PIT tagged fish were released from the hatchery along with production fish in early April.

Overall adult chinook returns to Cowlitz Hatchery from the 1996 and 1997 releases were very low and few PIT tagged chinook from the marking have ever been recovered. For this and other reasons, it was decided to shift the emphasis to Round Butte and Carson hatcheries. Yearling chinook were not PIT tagged at Cowlitz Hatchery after 1997 and the site has been dropped from the CSS program.

Round Butte Hatchery

Round Butte Hatchery is operated by ODFW with funding from Portland PGE for mitigation of hydroelectric dams built on the Deschutes River. The hatchery is located at the base of Round Butte Dam on the Deschutes River. The hatchery also uses the old Pelton Ladder to rear yearling spring chinook (Figure 1). The Pelton Ladder is located about 161 Km upstream from the mouth of the Deschutes River with the main Columbia River. The nearest town to Round Butte Hatchery and Pelton Ladder is Madras, OR. Annually, juvenile spring chinook are transferred to Pelton Ladder in the fall for final rearing until release in April. The hatchery produces approximately 320,000 yearling spring chinook and 162,000 steelhead for their anadromous program.

Figure 1. Cells in Pelton Ladder where Round Butte Hatchery spring chinook are reared.

1996 Marking Program. In 1996, the initial group of 3,000 yearling chinook from Round Butte Hatchery was marked by ODFW for the CSS Program. The crews seined and dip netted fish from sections (Cells 2 and 3) of the Pelton Ladder. The crews were able to achieve their marking goals, but logistically, it was difficult to access the large ladder sections and obtain a random selection of fish from the holding ponds. The marking station was set up next to the ladder and fish were held in net pens until needed for PIT tagging. The PIT tagging procedures followed normal protocol established by the PIT tag oversight committee. The PIT tagged chinook were placed back into the holding ponds with production fish until released from the ponds. The yearling chinook were marked between April 3 and April 4, and released from the Pelton Ladder on April 23.

1997 Marking Program. Following the 1996 season, it was decided to change the marking procedures at the hatchery based mainly on logistics and safety concerns when attempting to access and randomly grab fish from the large ladder sections (rearing cells) prior to the fish migrating from the ponds. The USFWS contracted to PIT tag 5,000 yearling chinook in spring of 1997 for the CSS Program. To randomly select fish emigrating from the rearing cells, fish were captured at a trapping station (located in a cell below those used for fish rearing) that was already being used by hatchery personnel to randomly subsample fish for fish condition and size measurements. Additional fish were sampled for PIT tagging purposes at this trap after the fish were released from the rearing cells.

The USFWS set up a series of circular and linear troughs under a covered work area to hold fish before and after tagging. Water was pumped and gravity fed to the troughs from the ladder. Fish to be marked were captured at the sampling area during the release and carried to the holding tank in 5-gallon buckets. The PIT tagged fish were held overnight to check for shed tags and mortality before release into the ladder that led to the Deschutes River below the Pelton Re-Regulating Dam. Standard PIT tagging protocol was used during the marking of the yearling chinook. The anesthetic use of MS-222 followed normal concentrations. Fish were marked between April 15 and 21, and released one day after marking was completed. The fish had been treated for BKD with medicated feed up to one week before release. Fish were well smolted, but some were considered to be in marginal condition.

From the 1997 operations it was observed that holding the fish overnight between trapping and tagging periods was beneficial to the fish. Most fish were tagged on the same day they were collected (2,775) while some fish were held overnight and tagged the following day (2,302). There were 44 mortalities from the group tagged the same day and only one mortality from the group held overnight. It was concluded by the USFWS that stress of tagging the fish on the same day they were collected contributed to immediate and overnight mortality. In addition, it was noted that the fish had been treated for BKD with medicated feed up to one week before release.

1998 Marking Program. The USFWS (Vancouver FRO) again contracted to complete the marking of 7,500 yearling chinook at the Pelton Ladder. The set up of equipment and procedures were nearly the same as the 1997 season, with the exception that all fish to be marked would be held overnight after collection. This worked very well as only two mortalities from the 7,500 tagged fish were recovered from the holding tanks. A few PIT tags were non-functioning, so a total of 7,493 PIT tagged chinook were released in 1998. Marked fish were released back into the fish ladder. Emigration of fish through the lower sections of the ladder to the mainstem Deschutes River was fairly rapid. During 1997 and 1998, PIT tag files were validated by the USFWS and sent into PTAGIS database.

In all years of PIT tagging at Round Butte, 100% of the fish were adipose clipped and Coded Wire Tagged. The fish were PIT tagged months after the initial tagging for the CWT Program. The Deschutes stock spring chinook was originally chosen as part of the downstream hatchery program based on the historic excellent performance of this stock of fish. These fish are still required to navigate through two lower river dams, The Dalles and Bonneville, before reaching the free flowing section of Columbia River to the ocean.

Carson National Fish Hatchery

The USFWS operates Carson NFH with funding provided by the NMFS through Mitchell Act appropriations. Carson Hatchery is located about 28 Km up from the mouth of the Wind River. The nearest town is Carson, WA. The hatchery raises spring chinook salmon to yearling age that are released directly into the Wind River and adult fish return to a small fish ladder that leads into the hatchery. The normal production release from the hatchery is about 1.42 million yearling chinook, with additional fish reared for off-site releases. These fish have only to traverse the Wind River and a small section of Bonneville pool before being in the free flowing Columbia River below Bonneville Dam. This stock of fish was added to the downstream portion of the CSS program in 1997 because of its large production and more similar genetic background to the upriver stocks used in the CSS.

At Carson NFH, the marking of yearling chinook can easily be accomplished using the USFWS marking trailer that was set up near the holding raceways. The marking station is set up to accommodate a single marking crew consisting of 5 personnel; 2 people loading the PIT tag syringes; 2 people PIT tagging the fish; and 1 person decoding the marked fish and taking lengths on the fish (Figures 2 to 5). A continuous flow of water from the raceways was pumped into the marking trailer troughs for the holding of all fish. Fish to be marked were dip netted from the designated raceway and carried by 5-gallon buckets into the trailer where the tagging process was ongoing. All marked fish were held in the trailer's holding tank overnight and returned to the raceways after checking for fish mortality and tag loss. PIT tagging protocol was followed using standard procedures for disinfecting the PIT tags and needles in 90 proof and 70 proof alcohol for a minimum of 10 minutes. USFWS submitted all PIT tag release files to PTAGIS.

1997 Marking Program. The USFWS crew PIT marked a total of 5,000 fish on February 4 and 5, 1997. The PIT tagged fish were held with production. On April 17, a total of 4,997 PIT tagged fish were released along with production fish. Three tags were nonfunctioning

Figure 2. PIT tagging fish in USFWS marking trailer.

Figure 3. PIT tag syringes in disinfectant bath.

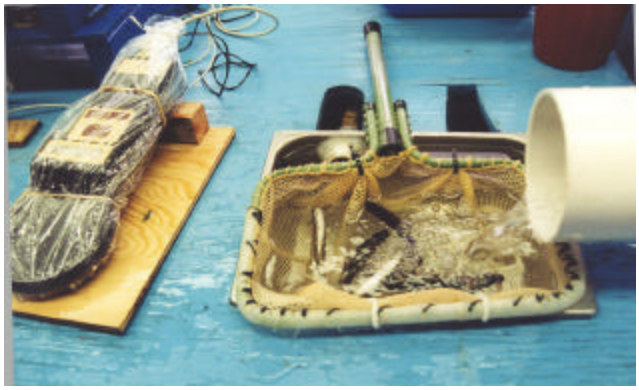

Figure 4. Following PIT tagging, fish are routed to station where their PIT tag code is recorded with paddle-type PIT tag detector before fish is placed on digit-pad.

Figure 5. Length and condition comments taken using digit-pad reader.

at time of release. The quality of fish appeared excellent as they had one mortality reported from the 5,000 fish PIT tagged.

1998 Marking Program. USFWS personnel PIT tagged just above 7,500 yearling chinook from January 6 to January 8, 1998. As noted above, the marking trailer was set up at Carson NFH for the PIT tagging with a five-person crew completing the marking. The fish again appeared to be in excellent condition at the time of marking and release. The PIT tagged fish were held with production until time of release. On April 20, a total of 7,491 PIT tagged fish were released along with production fish. There had been 16 mortalities from time of marking to time of release.

RECOVERY ACTIVIES AT LOWER GRANITE DAM ADULT TRAP

Lower Granite Dam is a primary upriver evaluation site for many objectives of the CSS program. The Lower Granite Dam adult trapping facility will be used to assess smolt-to-adult survival rates for returning adult chinook salmon that were either transported or remained in-river during their downstream migration as juvenile fish. Currently, it is the only dam where virtually all returning adult fish can be routed through PIT tag detectors. As an aside, in 1998 a small percentage of PIT tagged adult fish may get detected and sampled in the Washington shore fish

ladder at Bonneville Dam. A trap is operated on the Washington shore ladder during intermittent periods of the adult chinook and steelhead migrations by fishery agency or tribal agency personnel for research purposes, such as the adult fish radio telemetry studies or adult fish age analysis, or other purposes. But the only intensive sampling for returning adult fish occurs at the adult trapping facility located at Lower Granite Dam.

The adult fish passage facilities at Lower Granite Dam incorporate an adult fish trapping site located just off the main fish ladder (Figure 6). The fish counting facility is located 11 weirs downstream from the trapping site. When trapping occurs, adult fish are diverted from the main fish ladder into a pool area where two false weirs, a metal flume, coded wire detectors, and Passive Integrated Transponder detectors are in line leading to the adult holding trap (Figure 7). Unmarked fish or fish not required to be diverted will drop back into the fish ladder, and continue up to the main fish ladder where they can exit to the forebay of the dam. Adult chinook that were PIT tagged in Idaho and Northwest Oregon hatcheries as part of the CSS and other designated PIT tagged adult fish will be shunted to the holding trap, similar to what happens to all CWT fish. All CSS chinook Tag/Release files were installed in the Multimon program that allowed the PIT tag detector to selectively trip a gate that led to the trap. NMFS or PSMFC employees operating the facility, sample all fish that were diverted into the trap. As the floor of the trap is raised (Figure 8), marked fish voluntarily exit the trap and slide into a holding tank containing a mixture

Figure 6. View down adult fish ladder which adult salmon climb at Lower Granite Dam.

Figure 7. View of false weir at Lower Granite Dam with two exits that lead down two chutes, through PIT tag detectors and CWT detectors that activate swing gates to route selected fish to the adult trap.

Figure 8. Raised adult trap forcing collected adult salmon through exit to sample trough.

of water and an anesthetizing chemical (MS-222). This anesthetic brings the fish to an immobile condition and allows the handlers to examine the fish (Figures 9 and 10). The concentration of the solution falls within the standards for anesthetizing juvenile and adult fish. NMFS and PSMFC employees checked by hand scanning all fish in the sample tank for presence of a PIT tag (Figure 11). When a PIT tagged fish was detected, a laptop computer installed with the Multimon Program will automatically display the disposition of the sampled PIT tagged fish; i.e., whether it was a CSS chinook or a chinook from the NMFS transportation survival studies group or another study. A CSS chinook has its length taken (see Figure 9), determination of sex made, fish condition taken (examination for injury), and a scale sample taken (see Figure 10). [As a side note, in 1998, the PIT tagged CSS fish were marked with a yellow VI Tag having a 3-character alpha-numeric code. The tags were placed above the right eye unless that area was damaged. This practice was discontinued after the 1998 season.] Once the fish data were recorded, each fish was shunted back to the off-ladder trap, where it could recover from the effects of the anesthetic. The fish could then continue up the off-ladder fishway to the main fish ladder and on upstream to the exit of the fish ladder.

The Fish Passage Center assured that adequate personnel (hired by PSMFC) were staffed at Lower Granite to facilitate sampling at the facility. During the past two years, 1998 and 1999, two PSMFC personnel were hired to assist NMFS with the adult fish handling at the trap. This allowed data acquisition to proceed in a timely manner with all the increased PIT tagged fish that returned to Lower Granite Dam as a result of the CSS program. All sampled fish are entered on the PTAGIS database as recaptures at the Lower Granite Dam adult trapping facility.

RECOVERY ACTIVITIES AT INDIVIDUAL HATCHERIES

Upriver hatcheries

The following sections provide a brief description of the adult sampling facilities and methods of handling the PIT tagged fish that return to hatcheries used in the CSS program.
The fish sampled at Lower Granite trap or missed at that trap are free to continue migrating upstream to their hatchery release sites. The normal operation of a hatchery is to either sample fish as they arrive at the hatchery site [daily basis] or when a given number of fish enter the holding pond. During these sampling periods, fish will be interrogated for presence of PIT tags

Figure 9. Length measured on adult chinook that has been anesthesized in sample tank.

Figure 10. Scale sample take from adult chinook for CSS program.

Figure 11. Hand scanning fish for final PIT tag confirmation and associated multimon action code for fish, which may indicate desired final disposition of fish.

and pertinent data will be collected on these marked fish. Finally, the PIT tagged adult fish will be spawned at the hatchery and a new brood cycle will begin.

South Fork Salmon Weir

IDFG operates the trapping facility on the South Fork Salmon River for collection of adult summer chinook broodstock for McCall Hatchery. Returning adult salmon migrate 522 kilometers up the Columbia River, then 303 kilometers up the Snake River and 215 kilometers up the Salmon River before turning off into the South Fork Salmon River. The adults continue to migrate 111 kilometers upstream to a weir that diverts them to a holding area. Total distance traveled is 1,151 kilometers (about 715 miles) from the ocean. Ponded adult salmon are held at the South Fork site until spawned. Eggs are then transferred to McCall Hatchery for incubation and rearing until release as yearling chinook at the Knox Bridge site, located about one mile above the weir.

Adult summer chinook PIT tagged for the CSS program should initially be captured at the Lower Granite adult trap prior to the fish arriving at the South Fork Salmon River weir. The weir can be installed in the river only when flows recede to the point that IDFG can place the leads and pickets without them being washed out. The dates given by the hatchery when the weir was installed for the years 1997, 1998, and 1999 were respectively, July 3, July 6, and July 8. The weir itself was set up in the main South Fork Salmon River (Figure 12) and diverted all fish into a small fish ladder that led to a holding area. From that point, IDFG personnel would begin sampling the adult fish from the holding area. The holding tank had a floor that raised on a slant to where the fish can be netted and the sampling process initiated. An individual fish was held in the net until exhausted and then sampled without use of any anesthetic bath (Figure 13). Normally, sampled fish have a length taken along with other pertinent data. All fish were scanned with a hand-held PIT tag detector to check for tags. While summer chinook that were placed back into the river above the weir received only the hand scanning for presence of PIT tags, the fish selected for broodstock received an additional check for PIT tags. These fish passed through a flume which had PIT tag detection coils installed on their way to the holding ponds located adjacent to the trapping site (Figure 14). All PIT tag data was downloaded or recorded by IDFG personnel at the trapping site.

Figure 12. Weir on South Fork Salmon River which diverts adult fish to holding area.

Figure 13. Transferring adult fish to workup trough where fish are hand-scanned for PIT tags, and length and other data are taken.

Figure 14. PIT tag detection equipment connected to flume that routes handled fish back to raceway for holding until spawning time.

Imnaha River Weir

ODFW operates an adult trapping facility and juvenile acclimation facility on the Imnaha River. Returning adult salmon migrate 522 kilometers up the Columbia River, then 308 kilometers up the Snake River and 74 kilometers up the Imnaha River to a weir that diverts adults to a holding area. Total distance traveled is 904 kilometers (about 562 miles) from the ocean. Adult spring/summer chinook are trapped at this facility for collection of Imnaha River chinook broodstock for Lookingglass Hatchery. Ponded adult salmon were transferred by truck to Lookingglass Hatchery where they are later spawned. The eggs are incubated and the fry reared until yearling age at Lookingglass hatchery. Then these chinook are transported back to the Imnaha River site and released after an acclimation time of about one month.

Returning Imnaha stock adult fish that were PIT tagged as part of the CSS program should have initially been intercepted at Lower Granite Dam. Normally, most Imnaha stock chinook pass Lower Granite Dam in June. The dates that hatchery personnel installed the Imnaha River weir were July 3 in 1997, July 6 in 1998, and July 21 in 1999. The weir is normally placed in the Imnaha River after flows have receded to the point that the anchors and weir sections can be installed without washing out. The weir itself is set up in the main Imnaha River. All fish were diverted into a small fish ladder that leads to a holding area. ODFW personnel would begin sampling the adult fish based on numbers of fish in the holding area. When sampling occurs, fish in the holding area are crowded to an enclosed area (elevator) where they were lifted and shunted

into an anesthetic tank containing a mixture of water and the chemical MS-222 . As a rule, only 3 or 4 fish are placed into the anesthetic box at a time. When the individual fish are fully under the effect of the anesthesia, i.e., lethargic and can be handled by ODFW hatchery personnel, pertinent data such as length, sex of the animal, and mark information are recorded (Figure 15). The fish are then placed headfirst into an adult PIT tag detector to check for presence of a PIT tag. The sampler holds the adult fish by the caudal peduncle and withdraws the fish from the detector after it had passed over the detection coils. The PIT tag code would be recorded along with the other data gathered for that fish. All information was eventually reported to the PTAGIS database for storage.

Figure 15. Taking length and making determination of sex prior to placing adult fish in tunnel-style PIT tag detector to check for presence of PIT tag.

A predetermined percentage of the sampled fish are placed in the hatchery truck and hauled to Lookingglass Hatchery. Another percentage of the chinook are trucked to a site in the Imnaha basin and outplanted. The remaining percentage is shunted directly back to the river above the weir to spawn naturally in the Imnaha River.

Lookingglass Hatchery

Adult spring chinook returning to Lookingglass Hatchery were intercepted at the Lower Granite Dam adult trap in spring/summer of 1997 to 1999. Returning adult salmon migrate 522 kilometers up the Columbia River, then 173 kilometers up the Snake River to this collection site. Total distance traveled is 695 kilometers (about 432 miles) from the ocean. From here the adults and jacks have been trucked to either Lookingglass or Walla Walla hatcheries. The stock of fish used at Lookingglass Hatchery has been Rapid River stock, but use of this stock by ODFW is being shifted from the Grande Ronde River drainage to Walla Walla River drainage at this time. In upcoming years the fish used for the CSS program will be an endemic stock from the Grande Ronde River itself. All PIT tagged spring chinook that were captured at Lower Granite Dam were entered into the PTAGIS database as recaptures. Individual PIT tagged fish will have a sex determination, a length in cm, and other pertinent information stored with the PIT code.

Dworshak National Fish Hatchery

Dworshak NFH annually produces juvenile spring chinook salmon (and summer steelhead) for release into the Clearwater River basin. Returning adult salmon migrate 522 kilometers up the Columbia River, then 224 kilometers up the Snake River and 65 kilometers up the Clearwater River before turning off into the North Fork Clearwater River and entering the hatchery ladder. Total distance traveled is 841 kilometers (about 523 miles) from the ocean. Normally, adult spring chinook pass Lower Granite Dam from late April to early June and enter the hatchery in June and July.

Adult spring chinook that had been PIT tagged as juvenile fish at Dworshak for the CSS program should have been initially intercepted at the Lower Granite adult trapping facility. The actual collection of the adult spring chinook at the hatchery is from a fish ladder on the North Fork of the Clearwater River that leads into the hatchery. The fish ladder was opened on May 19, 1997; May 21, 1998; and June 3, 1999 and stayed open through the adult spring chinook migration season. Adult spring chinook salmon are held in the hatchery holding ponds until spawning occurs. To sample the adult spring chinook, hatchery personnel crowd fish in the holding pond to one end of the pond where they can enter an elevator system that will lift them to the sampling platform. Prior to being lifted to the sampling area, all fish are anesthetized using MS-222 as the chemical agent to allow handling of the fish. Approximately 10 fish at a time would be lifted to the sampling table where the data collection and inoculation of the fish occurs (Figure 16). Prior to spawning, all fish are checked by hatchery personnel to assure the sex of the returning adults, verify that inoculations occurred, and that pertinent data such as length of the fish and marks, including PIT tag information, has been recorded. From the sampling table, individual fish were shunted through an tunnel-style adult PIT tag detector containing two PIT tag coils. If the chinook had a PIT tag, that PIT record would be stored with the other data for that fish. Individual records of PIT tagged fish were reported to the PTAGIS database for storage. The sampled fish were then placed into a pipe with flowing water that directed the fish to a separate holding pond for fish that had been sampled. All mortality from the holding ponds were checked for presence of PIT tags.

Figure 16. Fish being inoculated prior to having data such as length and sex determination taken.

Kooskia NFH

Kooskia NFH produces yearling aged spring chinook (Kooskia stock) that are released directly from the hatchery into Clear Creek located less than 1 mile from the South Fork of the Clearwater River. Returning adult salmon migrate 522 kilometers up the Columbia River, then 224 kilometers up the Snake River and 120 kilometers up the Clearwater River before turning off into the South Fork Clearwater River for a 4 kilometer journey to Clear Creek. Total distance traveled is 871 kilometers (about 541 miles) from the ocean. The Dworshak FRO personnel are responsible for sampling returning adult fish for presence of marks at Kooskia Hatchery. Because of warm water temperatures that occur at Kooskia, all chinook salmon are initially sampled at the hatchery and then transported to Dworshak NFH for holding and later spawning. The fish are anesthetized and sampled to check for CWTs and PIT tags. Lengths and other data will accompany the PIT code if one is found. After these fish are transported to Dworshak, any mortality would be scanned for presence of PIT tags.

Rapid River Hatchery

Rapid River Hatchery annually produces spring chinook salmon that are released directly from the hatchery ponds into Rapid River. Returning adult salmon migrate 522 kilometers up the Columbia River, then 303 kilometers up the Snake River and 140 kilometers up the Salmon River before turning off into the Little Salmon River for a 7 kilometer journey to the confluence with Rapid River. The hatchery's adult trapping site is located an additional 5 km up Rapid River. Total distance traveled is 977 kilometers (about 607 miles) from the ocean. The adult chinook pass Lower Granite Dam in late April through early June with the salmon entering the hatchery in June and July.

Adult spring chinook returning to Rapid River Hatchery pass the adult trapping facility at Lower Granite Dam and are intercepted and sampled there if they had been PIT tagged as part of the CSS program. Adult fish returning to the hatchery are intercepted about 1-mile below the hatchery. Fish are diverted from Rapid River by a velocity barrier and swim into a holding and resting area. At that point, hatchery personnel will assess numbers of fish in the lower section and raise the hinged floor that forces these fish into the upper section. If numbers of fish are less than 50, the hatchery personnel may elect to net them and process them inside the building. An anesthetic bath of MS-222 would be set up and all pertinent information taken on the fish. The normal way of sampling the adult chinook was to operate the Alaskan Steeppass (Denil-type fishway) that has its entrance in the upper section of the holding pool where the chinook should be located. Fish will voluntarily swim up the Steeppass and slide down a chute into a tank(s) that contains the chemical MS-222 mixed in river water. At that point, an individual fish is anesthetized or "knocked out" and can be handled by the hatchery crew. All fish will have the following information taken: a length taken, sex determined, marks determined, e.g., PIT tags or CWT, and whether the fish is "wild" or "natural", and other information as required. All fish that are part of the hatchery group are transported by truck to the hatchery and held until they are spawned during August or September. The "wild" fish are taken to the river upstream from the velocity barrier after it has awakened from the effects of the anesthetic and are released to spawn naturally. To the extent possible, the hatchery checks all mortality from the holding pond as well as from spawning females.

All PIT tag information would be gathered and eventually sent to the PTAGIS database that houses PIT tag data from the Columbia River basin.

Downstream Hatcheries

Carson National Fish Hatchery

From 1997 to present, a small portion of the yearling spring chinook from Carson NFH were marked with PIT tags and released as part of the CSS Program. Returning adults migrate 251 kilometers up the Columbia River, and another 28 kilometers up the Wind River to reach the hatchery. Total distance traveled is 279 kilometers (about 173 miles) from the ocean. The PIT tagged adult fish returning in 1998 and 1999 had a small possibility of being decoded at the Washington shore trapping facility at Bonneville Dam. Primary detection of PIT tagged fish was accomplished at Carson Hatchery.

Generally, adult fish begin migrating from the Columbia River into the Wind River in late May and June with the fish reaching the hatchery in the same months. However, some adult fish arrive at the hatchery through August. The adult chinook (including jacks) that return to the hatchery are normally sampled throughout the migration season. Normally, hatchery personnel sample the returning adults in mid-June and as necessary after that time frame. Fish that are kept for hatchery spawning are given an erythromycin injection, a determination of sex is made, length is taken, and the fish are checked for marks, including a PIT tag. A fish that is detected with a PIT tag would have a scale sample taken in addition to its length and sex determination. This information would accompany the PIT tag code. Recapture files are created for these PIT tagged fish and sent to PTAGIS.

USFWS uses the "tube-tunnel" style PIT tag detector (400 kHz) to check for presence of PIT tags in returning adults and jacks.. The detector has 2 coils and should efficiently detect any

PIT tagged fish passed through it. When fish are initially sampled from a pond, they are marked with a punch (round hole) in the operculum. This allows the hatchery crew to ascertain during later sampling periods if the fish had been previously sampled.

When numbers of fish arriving at the hatchery exceed the hatchery spawning needs, the excess fish were given to the Tribes for their use. These fish were passed through the adult PIT tag detector prior to the fish being sent to the ice totes. Each fish with a PIT tag had its length and a scale sample taken, as well as a sex determination made. PIT tags are not removed from any of the PIT tagged fish that are given to the Tribes.

Adult fish returning to the hatchery pass through a sport fishery in years when adequate numbers are projected back to the Hatchery. Presently, adult fish are not sampled in this fishery, but it appears feasible to have the WDFW personnel check each sampled fish with the hand wands in future years when the 134 kHz PIT tag is used.

Round Butte Hatchery

From 1996 through 1999, a small number of Round Butte Hatchery yearling spring chinook have been PIT tagged as part of the CSS Program. Returning adult fish migrate 328 kilometers up the Columbia River, and another 161 kilometers up the Deschutes River to the Pelton Ladder where an adult trapping station is located (Figure 17). Total distance traveled is 489 kilometers (about 304 miles) from the ocean. This site is in the lower section of the Pelton

Figure 17. Adult trap near exit of Pelton Ladder to collect adults returning to Round Butte Hatchery

Ladder, well below the ladder sections where the juvenile chinook were released. The fish ladder entrance is located a short distance below Pelton Re-regulating Dam. Fish that find the attraction flow swim over several weir sections until the trap site is reached. Fish that enter the trap are held there until sampled by hatchery personnel. Normally the adult fish are sampled at least once a week and more often as numbers of fish increase. The trap itself has a floor that raises from the bottom of the trap and shunts fish to an anesthetic tank located near the trap where the adult fish can be handled and sorted. When the fish are lethargic, fish length, sex determination, and other parameters can be taken on each fish. The preferred method of checking the adult fish for presence of PIT tags at this site was with a “radar-gun” style hand detector. The hatchery personnel found the hand detector much less cumbersome to work with compared to the “tube-tunnel” style adult detector that was on station for one season. Hatchery personnel believed that they were not missing fish checked with the hand-held detector. All fish were sampled whether they were sent to the Warm Springs Tribe (excess fish) or sent to Round Butte Hatchery for spawning.

Cowlitz Salmon Hatchery

A small number of yearling spring chinook were PIT tagged as part of the CSS Program for the 1996 and 1997 migration from Cowlitz Salmon Hatchery. Returning adult salmon migrate 111 kilometers up the Columbia River, and then another 80 kilometers up the Cowlitz River to reach the salmon hatchery. Total distance traveled is 191 kilometers (about 119 miles) from the ocean. The adults return to the base of the barrier dam, located about 200 meters below the hatchery. A small fish ladder is located on the right bank of the river. From that point, fish swim up a channel to a holding area and can exit from that point only when personnel are sampling and sorting fish. Smaller jack salmon and steelhead, for example, may be shunted to temporary holding areas for sampling. Fish were anesthetized with CO2 and handled when fish became lethargic. At that point, a PIT tag detector was used to scan fish for the presence of tags. In addition, fish that went directly to the adult holding ponds (chinook for example) would later be scanned for PIT tags with a larger tube detector. The PIT tag code and pertinent data would be gathered on an annual basis.

Because of logistics and other factors involved (such as continued poor adult returns), the Cowlitz Salmon Hatchery marking was dropped in 1998. Beginning with return year 1999, adult fish are not being scanned for CSS PIT tags at this site anymore.

Appendix A

Table A-1. Number of hatchery chinook smolts from the 1996 migration year PIT tagged and released from Snake River Basin hatcheries for the Comparative Survival Study.

1996 PIT Tag Releases

Tagging Site (*code*)	Tagging Dates	Coord ID	Release Site (*code*)	Release Dates	Release Number
Dworshak NFH (DWOR)	2/14/96	HLB LRB	NF Clearwater R (CLWRNF)	4/11/96	1,203
	3/13/96	HLB			3,866
Kooskia NFH (KOOS)	2/21-2/22/96	HLB LRB RBR	Clear Ck (CLEARC)	4/12/96	2,109
	3/14-3/18/96	HLB			14,551
Clearwater SFH (CLWH)	3/5-3/12/96	DAC	Powell Pond (POWP)	4/11/96	11,416
	3/4-3/7/96		Crooked R Pond (CROOKP)	4/10/96	2,099
	3/4-3/11/96		Red R Pond (REDP)	4/10/96	1,212
McCall SFH (MCCA)	3/18-3/19/96	DAC LRB	SF Salmon R (KNOXB)	4/11 and 4/13/96	29,599
Rapid River SFH (RAPH)	2/29-3/1/96	LRB	Rapid River H (RAPH)	4/2, 4/3, 4/4, and 4/5/96	2,003
	3/14-3/15/96	DAC		Volitional release start date 3/19/96	17,166
Lookingglass SFH (LOOH)	2/15-2/16/96	PMS TRW	Imnaha R Weir (IMNAHW)	4/2/96	3,094
	3/11/96				1,621
	3/5-3/6/96	PMS	Lookingglass H (LOOH)	4/4/96	2,045
	3/20-3/21/96				5,115

Rapid River Hatchery release date is first day of volitional release for DAC coordinator (estimated median date is 15 days later) and actual date of release over 4-day period during median emigration for LRB coordinator.

Table A-2. Number of hatchery chinook smolts from the 1997 migration year PIT tagged and released from Snake River Basin hatcheries for the Comparative Survival Study.

1997 PIT Tag Releases

Tagging Site (*code*)	Tagging Dates	Coord ID	Release Site (*code*)	Release Dates	Release Number
Dworshak NFH (DWOR)	2/5-2/13/97	HLB	Dworshak Hatchery (DWOR)	4/7/97	14,080
Kooskia NFH (KOOS)	1/29/97		Kooskia Hatchery (KOOS)	4/8/97	4,075
Sawtooth SFH (SAWT)	9/30-10/2/96	LRB	Pahsimeroi Hatchery (PAHP)	4/7/97	33,481
McCall SFH (MCCA)	3/4-3/8/97		SF Salmon R (Knox Br) (KNOXB)	3/20/97	52,654
Rapid River SFH (RAPH)	9/25-9/28/96		Rapid River Hatchery (RAPH)	Volitional release median 4/1/97	40,459
Lookingglass SFH (LOOH)	1/28-1/31/97	PMS	Imnaha R Weir (IMNAHW)	4/7/97	13,378
	2/3-2/13/97		Lookingglass Hatchery (LOOH)	4/7/97	40,027

Release date for Rapid River Hatchery for 1997 is estimated median date of volitional release.

Table A-3. Number of hatchery chinook smolts from the 1998 migration year PIT tagged and released from Snake River Basin hatcheries for the Comparative Survival Study.

1998 PIT Tag Releases

Tagging Site (*code*)	Tagging Dates	Coord ID	Release Site (*code*)	Release Dates	Release Number
Dworshak NFH (DWOR)	2/9-3/9/98	HLB	NF Clearwater R (CLWRNF)	3/25 and 3/26/98	47,704
McCall SFH (MCCA)	2/17-2/19/98	LRB	SF Salmon R (Knox Br) (KNOXB)	3/30/98	47,340
Rapid River SFH (RAPH)	2/9-2/11/98		Rapid River Hatchery (RAPH)	Volitional release median 4/13/98	48,339
Lookingglass SFH (LOOH)	2/17-2/23/98	PMS	Imnaha R Weir (IMNAHW)	4/6/98	19,169
	2/23-3/6/98		Lookingglass Hatchery (LOOH)	4/6/98	43,939

Release date for Rapid River Hatchery for 1998 is estimated median date of volitional release.

Table A-4. Number of hatchery chinook smolts PIT tagged and released from lower Columbia River Basin hatcheries for the Comparative Survival Study from the 1996, 1997 and 1998 migration years.

1996 PIT Tag Releases

Tagging Site	Tagging Dates	Coord ID	Release Site	Release Dates	Release Number
Round Butte SFH (ROBU)	4/3-4/4/96	PMS	Pelton Ladder, Deschutes R (DESCHR)	4/23/96	3,044
Cowlitz SFH (COWS)	3/28-4/3/96	CFM	Cowlitz H, Cowlitz R (COWS)	4/4/96	2,980

1997 PIT Tag Releases

Tagging Site	Tagging Dates	Coord ID	Release Site	Release Dates	Release Number
Round Butte SFH (PELTON)	4/16-4/22/97	LRB	Pelton Ladder, Deschutes R (PELTON)	4/16-4/23/97	4,979
Cowlitz SFH (COWS)	3/18-3/24/97	LRB	Cowlitz H, Cowlitz R (COWS)	4/1/97	4,922
Carson NFH (CARS)	2/3-2/5/97	LRB	Carson H, Wind R (CARS)	4/17/98	4,982

1998 PIT Tag Releases

Tagging Site	Tagging Dates	Coord ID	Release Site	Release Dates	Release Number
Round Butte SFH (PELTON)	4/21-4/24/98	LRB	Pelton Ladder, Deschutes R (PELTON)	4/22-4/25/98	7,493
Carson NFH (CARS)	1/6-1/8/98 and 3/6/98	LRB	Carson H, Wind R (CARS)	4/20/98	7,491

Appendix B

In-river survival estimation from release to Lower Granite Dam tailrace and to additional downriver dams for migration years 1996 to 1998

Description of reach survival tables:

Table B-1 presents estimates of survival for yearling chinook in 1996, 1997, and 1998 from CSS hatcheries in the Snake River basin through a complex of three reservoirs and dams to the tailrace of Lower Monumental Dam. In 1998, estimating reach survival to the tailrace of John Day Dam were possible; hatchery chinook survival estimates for this extended reach are reported in Table B-2. The Seber (1965) and Jolly (1965) methodology was used to obtain point estimates of survival (with corresponding standard errors) from release site to Lower Granite Dam tailrace (first reach), Lower Granite Dam tailrace to Little Goose Dam tailrace (second reach), and Little Goose Dam tailrace to Lower Monumental Dam tailrace (third reach). In estimating survival to John Day Dam tailrace, two additional reaches were included: Lower Monumental Dam tailrace to McNary Dam tailrace (fourth reach) and McNary Dam tailrace to John Day Dam tailrace (fifth reach).

The Burnham *et al.* (1987) computer program RELEASE produced the survival estimates for these three reaches (or five reaches), along with corresponding standard errors of the estimates and the correlation between estimates from adjacent reaches. These point estimates, standard errors, and correlations went into computing the overall reach survival estimates and associated confidence intervals. In the tables, the notation **lgr**, **lgs**, **lmn**, **mcn**, and **jda** denotes the point estimates of the first, second, third, fourth, and fifth reaches, respectively. The notation **se_lgr**, **se_lgs**, **se_lmn**, **se_mcn**, and **se_jda** denotes the corresponding standard errors, and the notation **corr_lgrlgs**, **corr_lgslmn**, **corr_lmnmcn**, and **corr_mcnjda** denotes the respective correlations. The product of the first three point estimates results in the overall reach survival estimate from the hatchery release site to Lower Monumental Dam tailrace, and is denoted **surv_reach**. The product of the five point estimates results in the overall reach survival estimate from the hatchery release site to John Day Dam tailrace (also denoted as **surv_reach**). The associated variance for the overall reach estimate, denoted **var_reach**, was computed using Meyer's (1975) formulas for propagation of error (*i.e.*, variance of the product of three random variables whose error may be correlated). Normally distributed 95% confidence intervals were computed for the overall reach survival point estimates, and are denoted **ul_reach** for the upper limit and **ll_reach** for the lower limit.

Sources:

Burnham, K.P., D.R. Anderson, G.C. White, C. Bronwnie, and K.H. Pollock, 1987, *Design and analysis methods for fish survival experiments based on release-recapture*, American Fisheries Society Monograph 5, 437 pp.

Jolly, G.M., 1965, Explicit estimates from capture-recapture data with both death and immigration – stochastic model, *Biometrika*, 52: 225-247.

Meyer, S.L., 1975, *Data analysis for scientists and engineers*, John Wiley and sons, NY, 513 pp.

Seber, G.A.F., 1965, A note on the multiple-recapture census, *Biometrika*, 52: 249-259.

Table B-1. Reach survival estimates of PIT tagged hatchery chinook released from Snake River basin hatcheries between release and tailrace of Lower Monumental Dam, 1996-1998.

HATCHERY CHINOOK 1998					
	McCall	Lookingglass	Imnaha	Dworshak	Rapid River
lgr	0.589992	0.709590	0.709948	0.844827	0.666712
se_lgr	0.003963	0.004474	0.006408	0.006150	0.003630
lgs	0.972028	0.975114	0.966426	1.058247	0.991377
se_lgs	0.010508	0.011485	0.013869	0.014429	0.009408
lmn	0.840008	0.821823	0.845020	0.763682	0.842904
se_lmn	0.011690	0.013747	0.015583	0.012886	0.011315
corr_lgrlgs	-0.624793	-0.634229	-0.666910	-0.687618	-0.577735
corr_lgslmn	-0.340026	-0.370811	-0.323527	-0.467882	-0.374763
N	47460	43939	19169	47704	48357
ul_reach	0.493775	0.585100	0.598911	0.700301	0.570265
ll_reach	0.469695	0.552190	0.560646	0.665217	0.543992
avg_reach	0.481735	0.568645	0.579779	0.682759	0.557128
var_reach	0.000038	0.000070	0.000095	0.000080	0.000045

HATCHERY CHINOOK 1997							
	McCall	Lookingglass	Imnaha	Dworshak	Rapid River	Kooskia	Pahsimeroi
lgr	0.422282	0.596517	0.611166	0.575389	0.381957	0.445833	0.497900
se_lgr	0.007669	0.009529	0.016832	0.016849	0.007597	0.033452	0.008355
lgs	0.930593	0.931392	0.992825	1.047850	0.968719	1.157097	0.957823
se_lgs	0.026505	0.022508	0.042177	0.045992	0.030024	0.135475	0.026765
lmn	0.879690	0.827403	0.767899	0.818003	0.802394	0.572166	0.855253
se_lmn	0.034321	0.021529	0.041252	0.047514	0.029876	0.077459	0.031892
corr_lgrlgs	-0.805775	-0.832582	-0.823102	-0.819349	-0.799772	-0.769661	-0.778725
corr_lgslmn	-0.213973	-0.237963	-0.221479	-0.221222	-0.241784	-0.334012	-0.241507
N	52688	40027	13378	14080	40495	4075	33481
ul_reach	0.370627	0.481287	0.511720	0.545460	0.317038	0.362517	0.435785
ll_reach	0.320761	0.438109	0.420173	0.440923	0.276748	0.227812	0.379955
avg_reach	0.345694	0.459698	0.465946	0.493191	0.296893	0.295164	0.407870
var_reach	0.000162	0.000121	0.000545	0.000711	0.000106	0.001181	0.000203

HATCHERY CHINOOK 1996							
	McCall	Lookingglass	Imnaha	Dworshak	Rapid River	Kooskia	Powell Pond
lgr	0.534820	0.598963	0.567567	0.776640	0.585961	0.737108	0.579610
se_lgr	0.007102	0.011159	0.014490	0.017715	0.007127	0.009130	0.013675
lgs	0.929524	0.911281	0.897217	0.943739	0.908777	0.930530	0.859431
se_lgs	0.021633	0.026712	0.037146	0.038279	0.017823	0.019102	0.033212
lmn	0.950057	0.937476	0.912190	0.880636	0.920320	0.886292	0.952303
se_lmn	0.040029	0.041850	0.061895	0.060323	0.029046	0.027889	0.062000
corr_lgrlgs	-0.494705	-0.496389	-0.484796	-0.523655	-0.485777	-0.544625	-0.562004
corr_lgslmn	-0.389872	-0.425457	-0.410342	-0.415050	-0.418055	-0.424469	-0.377237
N	29599	7160	4715	5069	19169	16660	11416
ul_reach	0.507218	0.551099	0.519442	0.721178	0.516894	0.640314	0.528316
ll_reach	0.437382	0.472294	0.409589	0.569739	0.463262	0.575504	0.420435
surv_reach	0.472300	0.511697	0.464515	0.645458	0.490078	0.607909	0.474375
var_reach	0.000317	0.000404	0.000785	0.001492	0.000187	0.000273	0.000757

Table B-2. Reach survival estimates of PIT tagged hatchery chinook released from Snake River basin hatcheries between release and tailrace of John Day Dam in 1998.

HATCHERY CHINOOK 1998					
	McCall	Lookingglass	Imnaha	Dworshak	Rapid River
lgr	0.589992	0.709590	0.709948	0.844827	0.666712
se_lgr	0.003963	0.004474	0.006408	0.006150	0.003630
lgs	0.972028	0.975114	0.966426	1.058247	0.991377
se_lgs	0.010508	0.011485	0.013869	0.014429	0.009408
lmn	0.840008	0.821823	0.845020	0.763682	0.842904
se_lmn	0.011690	0.013747	0.015583	0.012886	0.011315
mcn	0.937559	0.857007	0.980898	0.919474	0.972895
se_mcn	0.030876	0.029347	0.040678	0.023392	0.029898
jda	0.851010	0.765421	0.774536	0.771758	0.846181
se_jda	0.056330	0.056628	0.063429	0.051560	0.056564
corr_lgrlgs	-0.624793	-0.634229	-0.666910	-0.687618	-0.577735
corr_lgslmn	-0.340026	-0.370811	-0.323527	-0.467882	-0.374763
corr_lmnmcn	-0.287333	-0.331392	-0.304244	-0.352785	-0.295977
corr_mcnjda	-0.436685	-0.388114	-0.442268	-0.293259	-0.402679
N	47460	43939	19169	47704	48357
ul_reach	0.428685	0.422156	0.502979	0.544422	0.513030
ll_reach	0.340041	0.323873	0.377984	0.424565	0.404276
surv_reach	0.384363	0.373015	0.440481	0.484494	0.458653
var_reach	0.000511	0.000629	0.001017	0.000935	0.000770

Appendix C

Migration timing plots of CSS hatchery groups

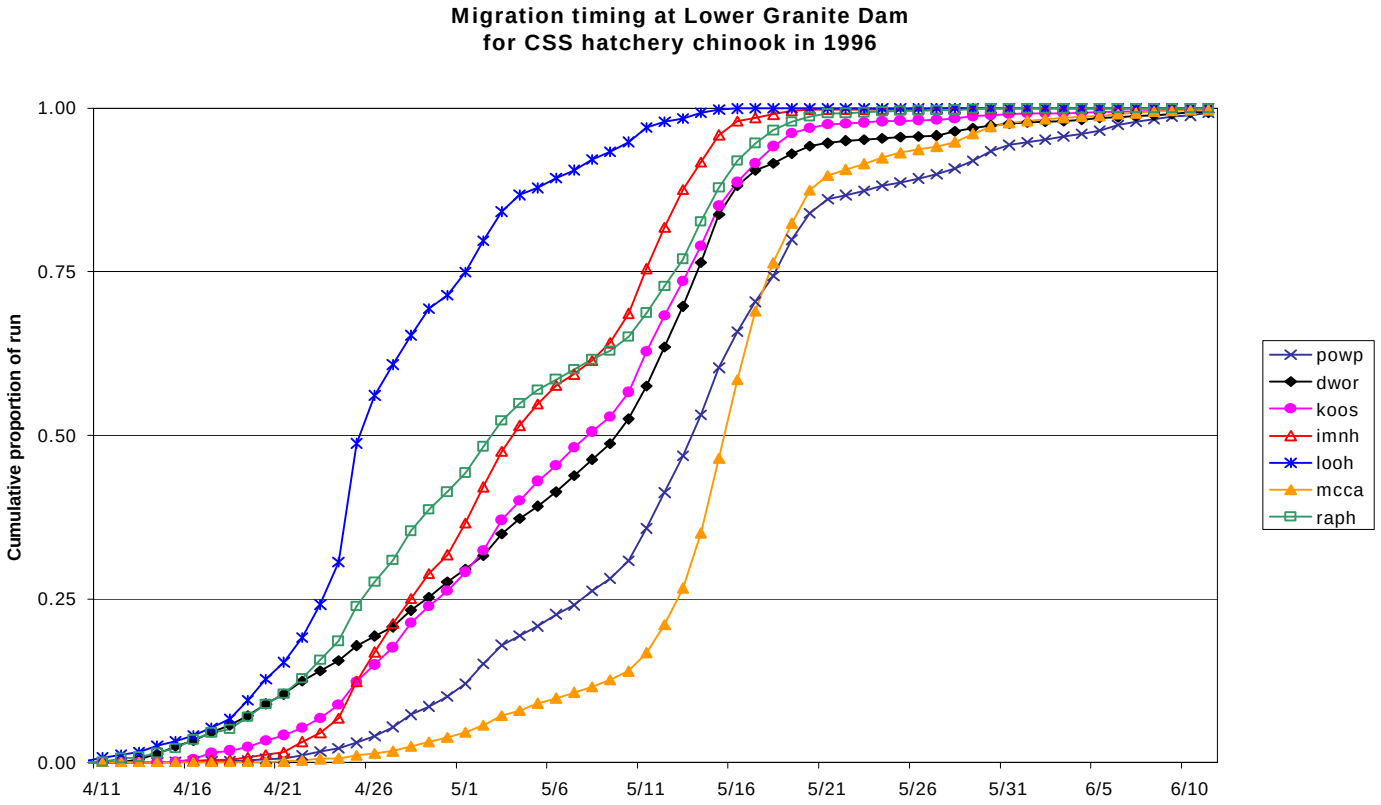

Figure C-1A. Hatchery chinook migration timing at Lower Granite Dam in 1996.

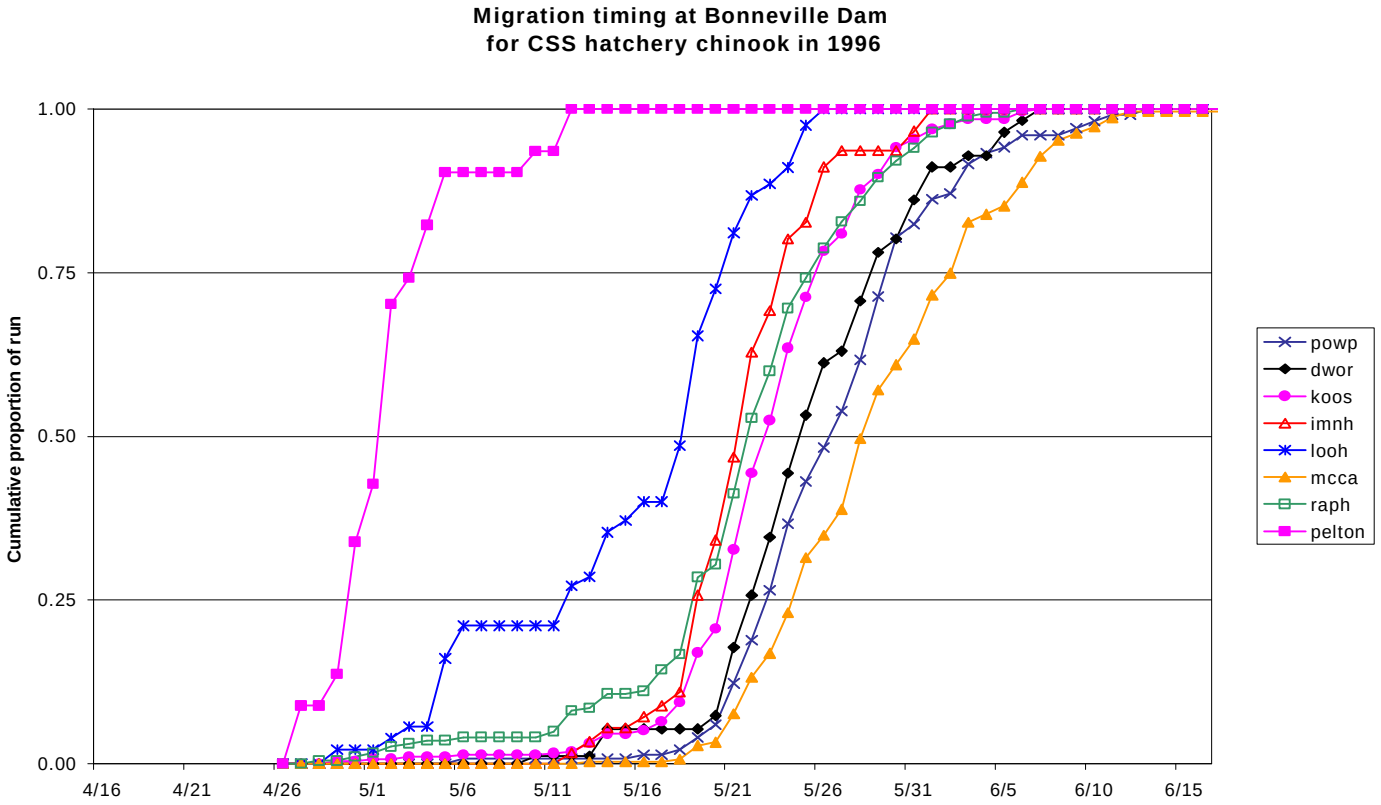

Figure C-1B. Hatchery chinook migration timing at Bonneville Dam in 1996.
Legend: powp=Powell Pond; dwor=Dworshak H; koos=Kooskia H; imnh=Imnaha H; Looh=Lookingglass H; mcca=McCall H; raph=Rapid River H; pelton=Pelton Ladder

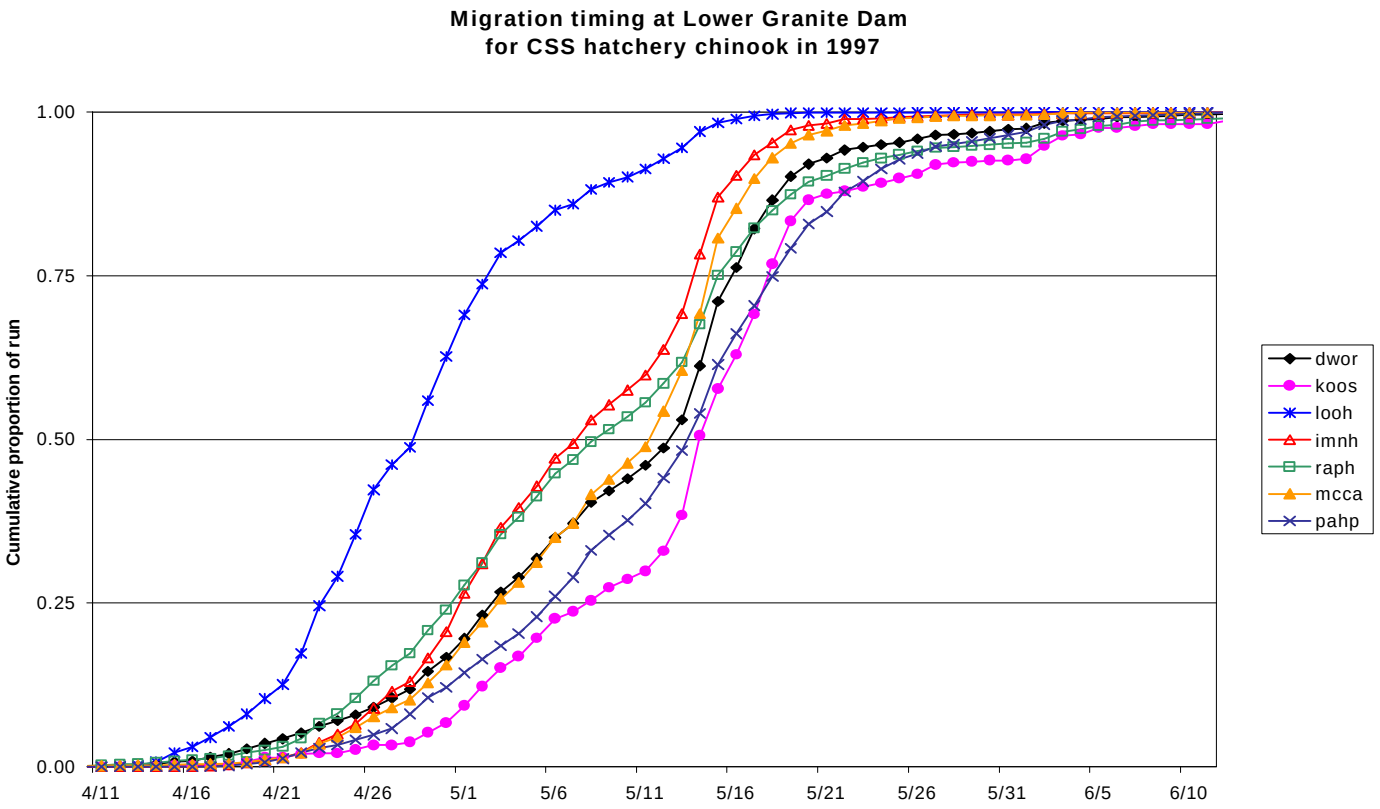

Figure C-2A. Hatchery chinook migration timing at Lower Granite Dam in 1997.

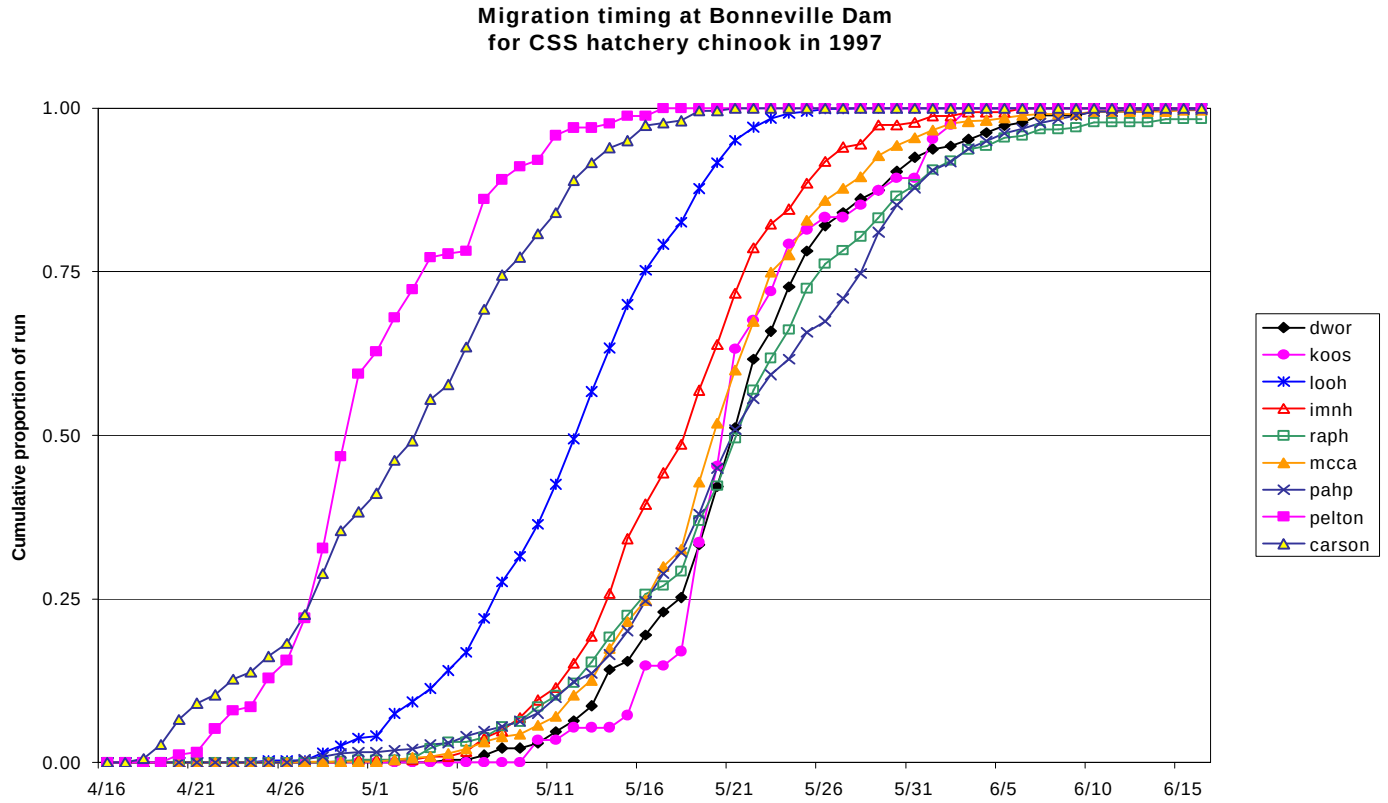

Figure C-2B. Hatchery chinook migration timing at Bonneville Dam in 1997.

Legend: dwor=Dworshak H; koos=Kooskia H; imnh=Imnaha H; looh=Lookingglass H; mcca=McCall H; raph=Rapid River H; pahp=Pahsimeroi H; pelton=Pelton Ladder; carson=Carson H.

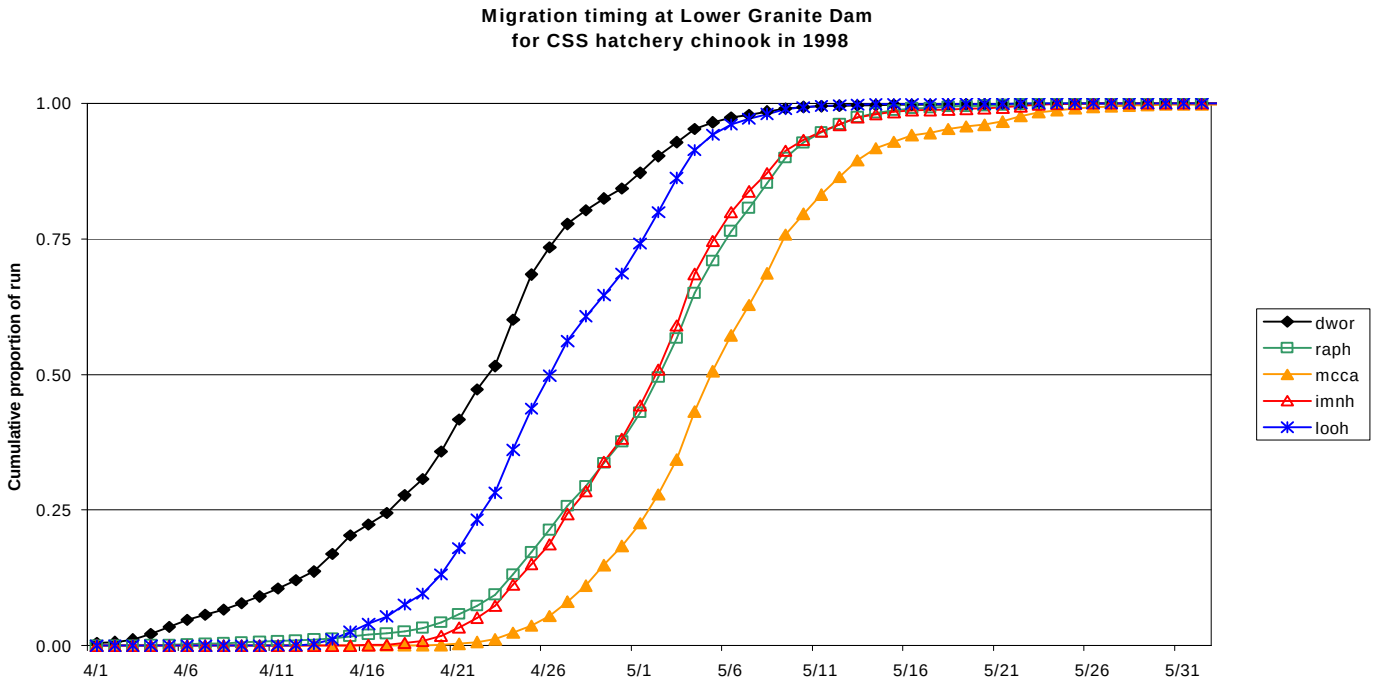

Figure C-3A. Hatchery chinook migration timing at Lower Granite Dam in 1998.

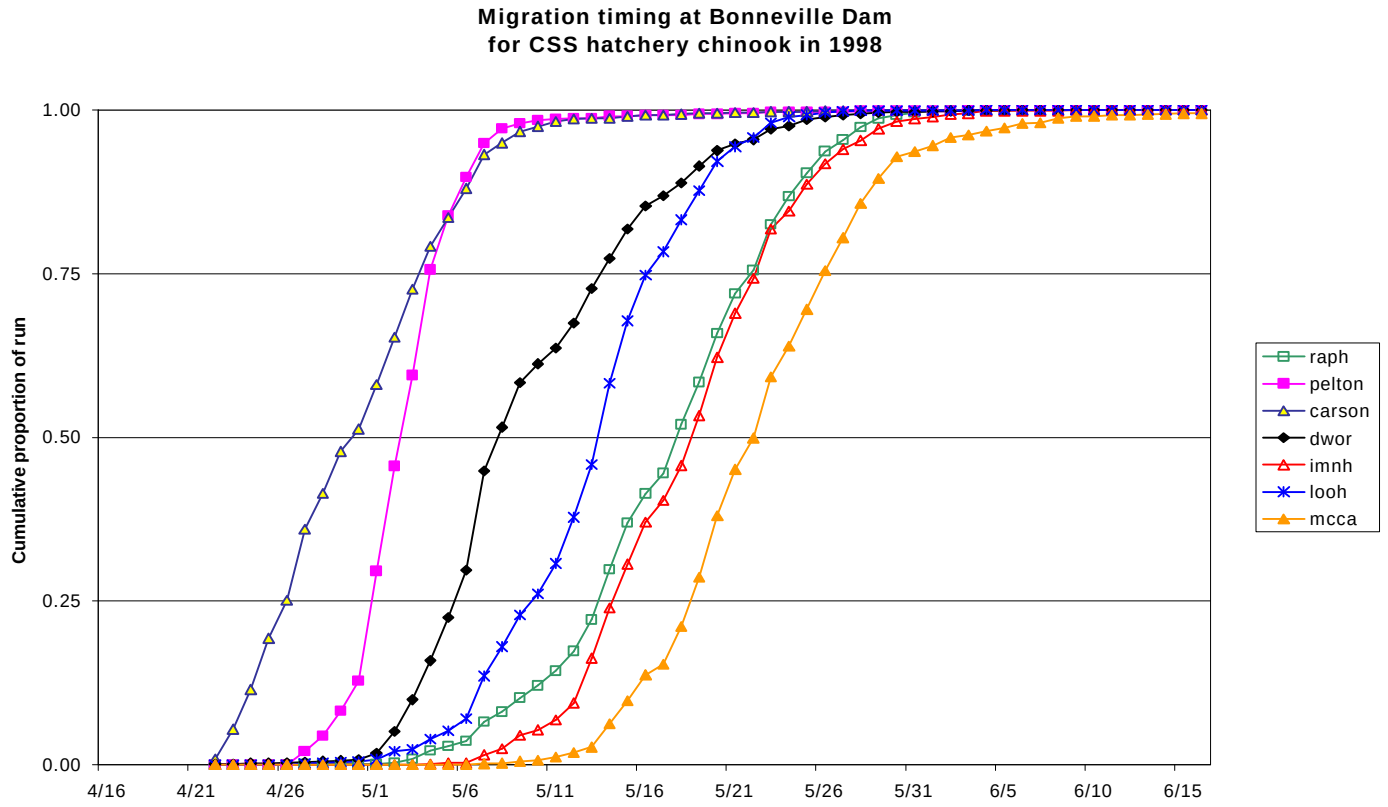

Figure C-3B. Hatchery chinook migration timing at Bonneville Dam in 1998.

Legend: dwor=Dworshak H; imnh=Imnaha H; looh=Lookingglass H; mcca=McCall H; raph=Rapid River H; pelton=Pelton Ladder; carson=Carson H.

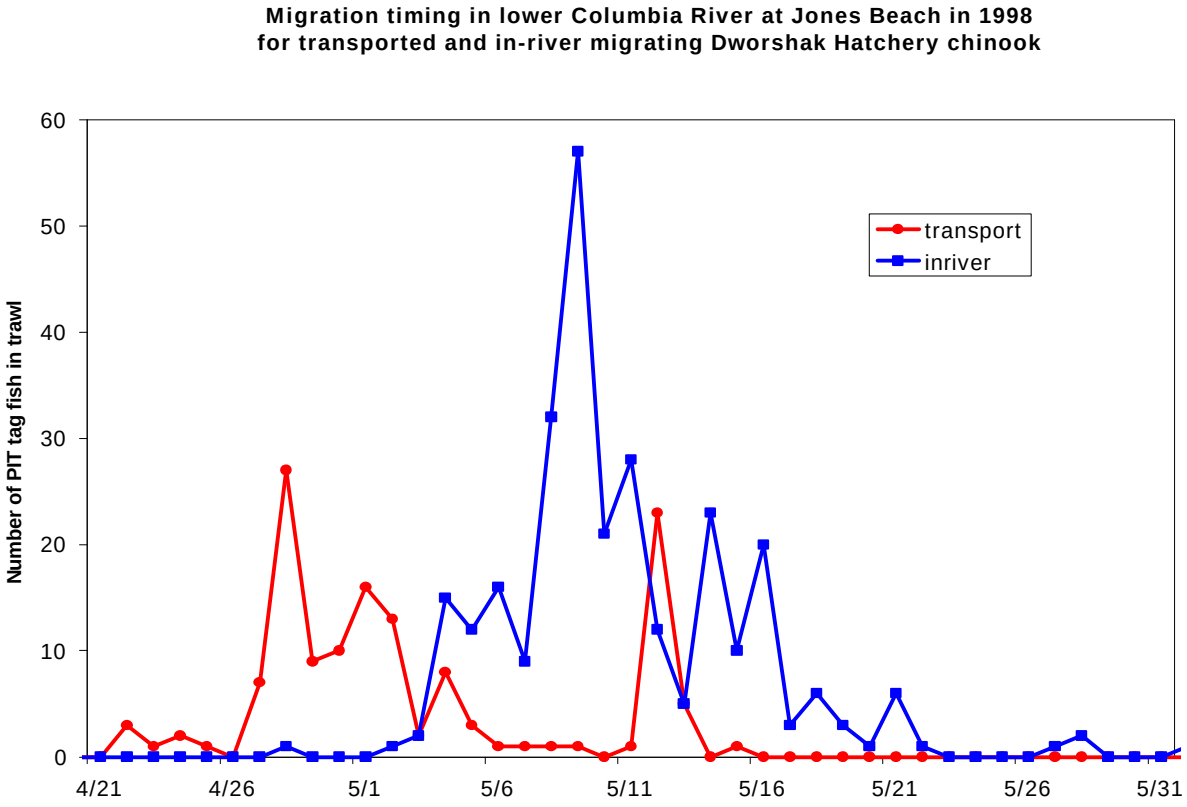

Figure C-4. Migration timing in the lower Columbia River for transported and in-river migrating Dworshak Hatchery chinook in 1998.

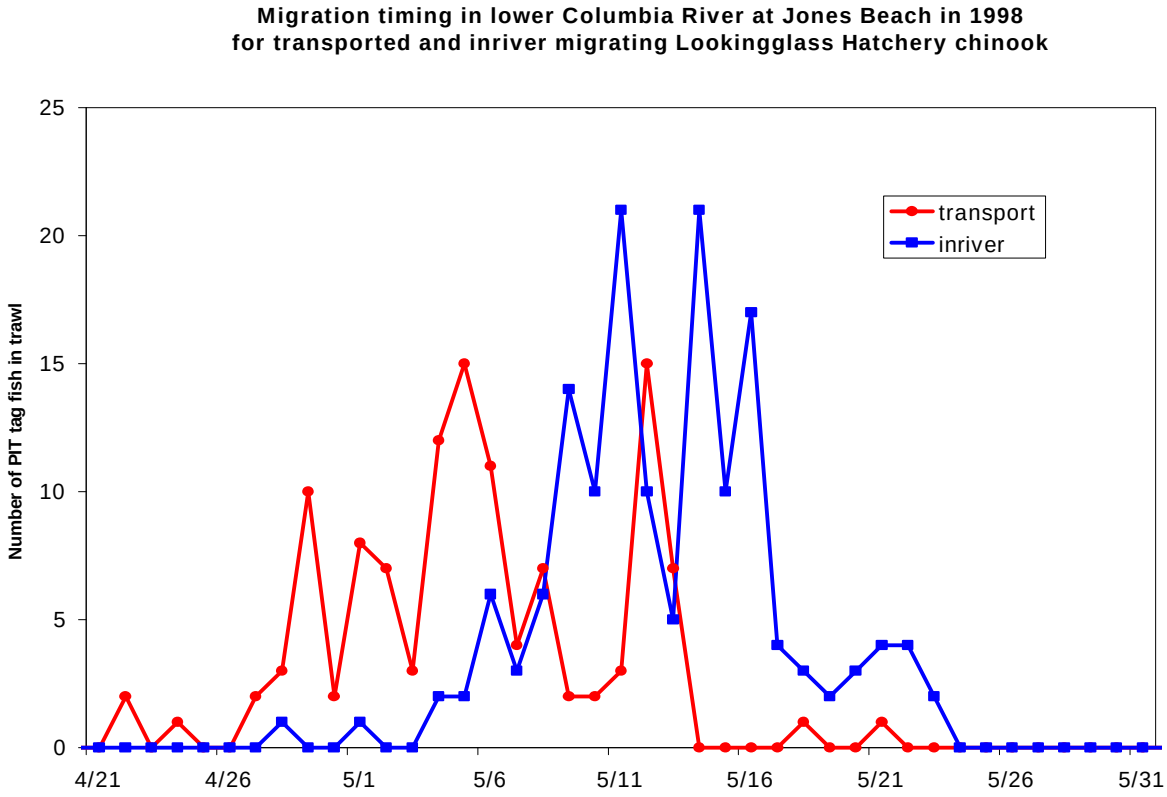

Figure C-5. Migration timing in the lower Columbia River for transported and in-river migrating Lookingglass Hatchery chinook in 1998.

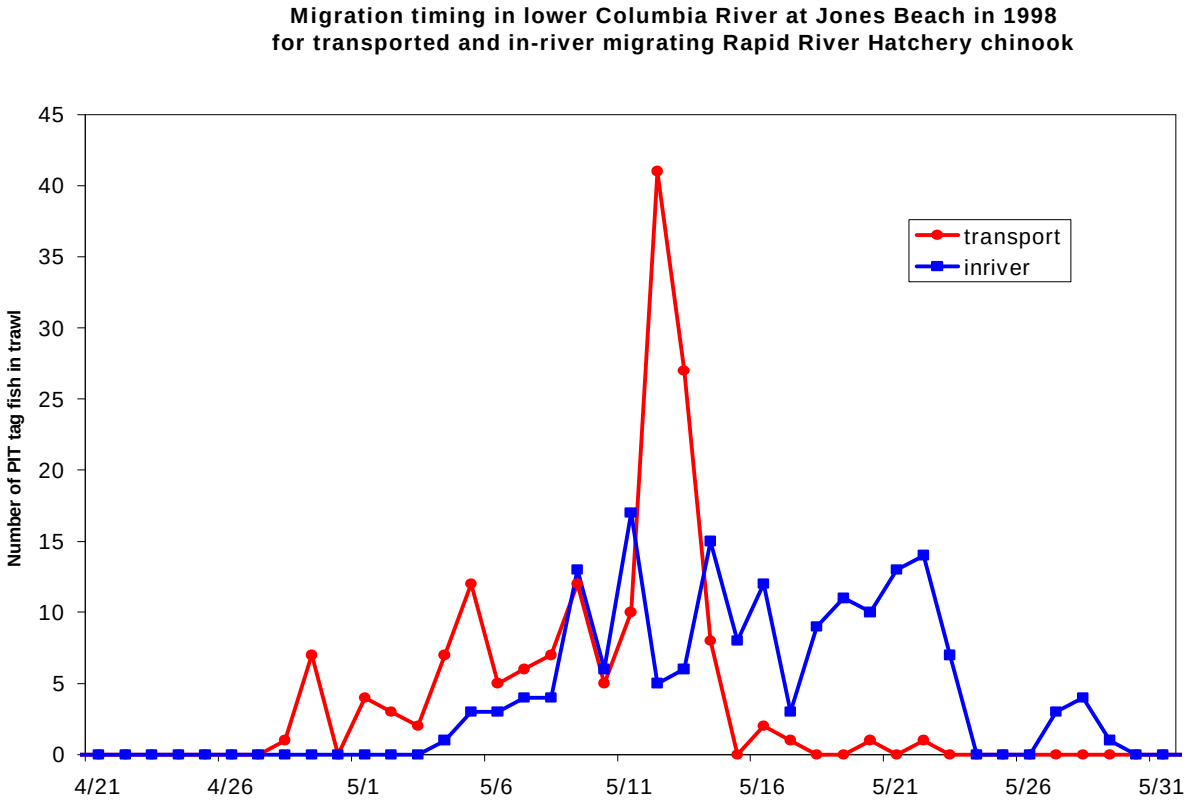

Figure C-6. Migration timing in the lower Columbia River for transported and in-river migrating Rapid River Hatchery chinook in 1998.

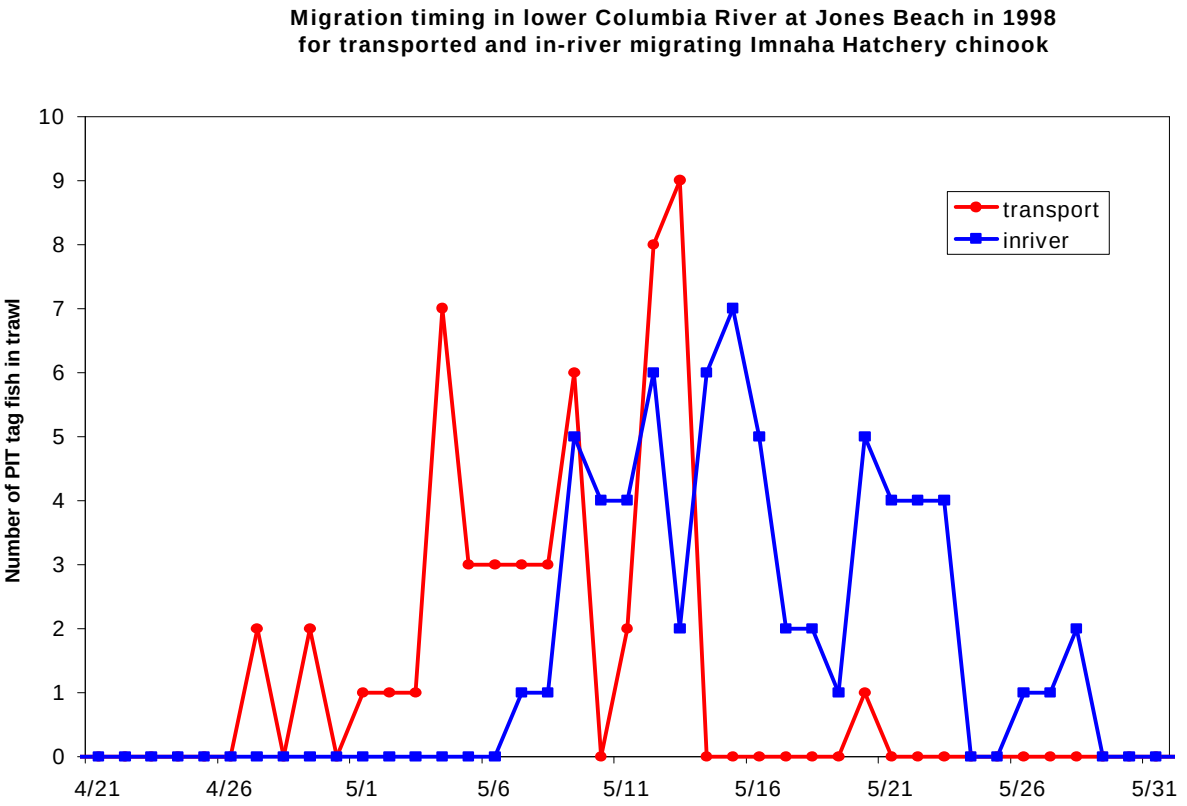

Figure C-7. Migration timing in the lower Columbia River for transported and in-river migrating Imnaha Hatchery chinook in 1998.

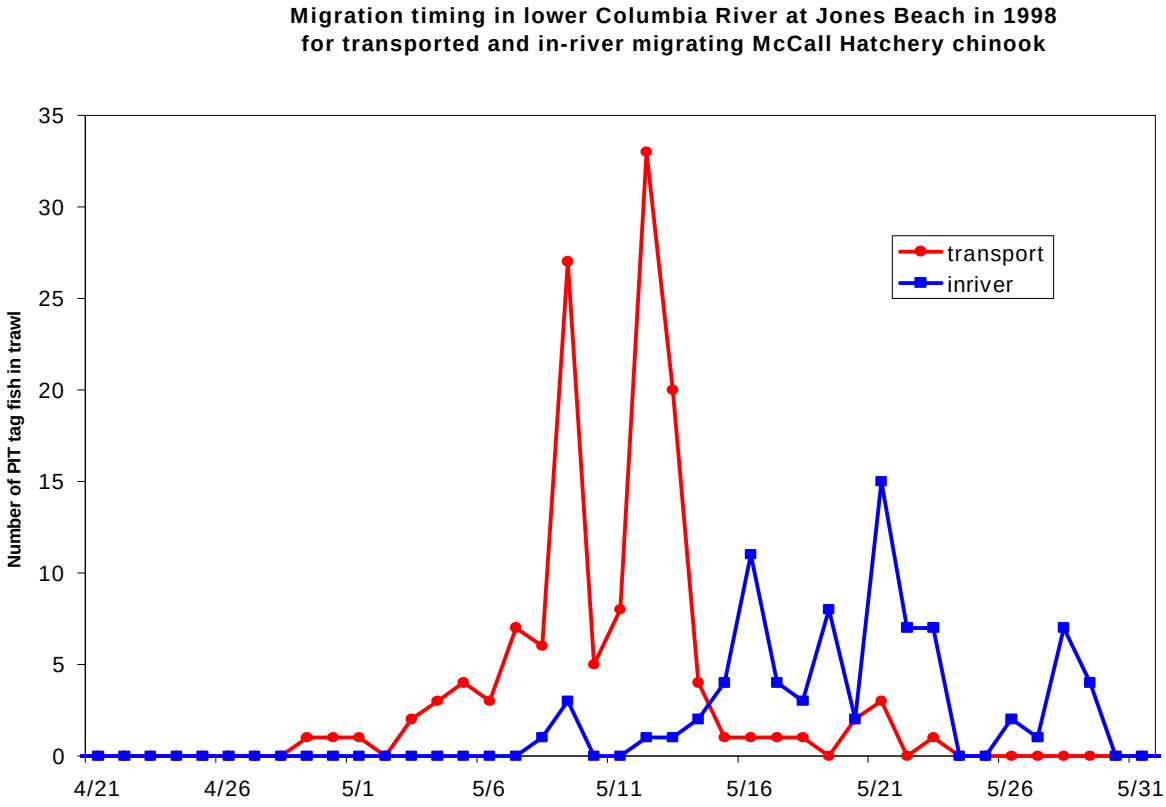

Figure C-8. Migration timing in the lower Columbia River for transported and in-river migrating McCall Hatchery chinook in 1998