MONITORING AND EVALUATION OF SMOLT MIGRATION IN THE COLUMBIA BASIN

VOLUME X

Evaluation of the 2002 Predictions of the Run-Timing of Wild and Hatchery-Reared Salmon and Steelhead Smolt to Lower Granite, Rock Island, McNary, and John Day Dams using Program RealTime

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Volume V: Burgess,C., J.R. Skalski. 2000. Evaluation of the 1999 predictions of the run-timing of wild migrant yearling and subyearling chinook salmon and steelhead trout, and hatchery sockeye salmon in the Snake River Basin using program RealTime. Technical Report to BPA, Project 91-051-00, Contract 96BI-91572.

Volume VI: Burgess,C., J.R. Skalski. 2000. Evaluation of the 2000 predictions of the run-timing of wild migrant chinook salmon and steelhead trout, and hatchery sockeye salmon in the Snake River Basin, and combined wild and hatchery salmonids migrating to Rock Island and McNary Dams using program RealTime. Technical Report to BPA, Project 91-051-00, Contract 96BI-91572.

Volume VII: Skalski, J.R. and R.F. Ngouenet. 2001. Evaluation of the Compliance Testing Framework for RPA Improvement as Stated in the 2000 Federal Columbia River Power System (FCRPS) Biological Opinion. Technical Report to BPA, Project 91-051-00, Contract 96BI-91572.

Volume VIII: Skalski, J.R. and R.F. Ngouenet. 2001. Comparison of the RPA testing rules provided in the 2000 Federal Columbia River Power System (FCRPS) Biological Opinion with new test criteria designed to improve the statistical power of the biological assessments. Technical Report to BPA, Project 91-051-00, Contract 96BI-91572.

Volume IX: Burgess,C., J.R. Skalski. 2001. Evaluation of the 2001 Predictions of the Run-Timing of Wild and Hatchery-Reared Migrant Salmon and Steelhead Trout migrating to Lower Granite, Rock Island, McNary, and John Day Dams using Program RealTime. Technical Report to BPA, Project 91-051-00, Contract 96BI-91572.

Other Publications Related to this Series

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

1997

Townsend, R. L., D. Yasuda, and J. R. Skalski. 1997. Evaluation of the 1996 predictions of run timing of wild migrant spring/summer yearling chinook in the Snake River Basin using program RealTime. Technical Report (DOE/BP-91572-1) to BPA, Project 91-051-00, Contract 91-BI-91572.

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Smith, S. G., J. R. Skalski, and A. E. Giorgi. 1993. Statistical evaluation of travel time estimation based on data from freeze-branded chinook salmon on the Snake River, 1982-1990. Technical Report (DOE/BP-35885-4) to BPA, Project 91-051-00, Contract 87-BI-35885.

Preface

Project 91-051 was initiated in response to the Endangered Species Act (ESA) and the subsequent 1994 Council Fish and Wildlife Program (FWP) call for regional analytical methods for monitoring and evaluation. This project supports the need to have the "best available" scientific information accessible to the BPA, fisheries community, decision-makers, and public by analyzing historical tagging data to investigate smolt outmigration dynamics, salmonid life histories and productivity, and providing real-time analysis to monitor outmigration timing for use in water management and fish operations of the hydrosystem. Primary objectives and management implications of this project include: (1) to address the need for further synthesis of historical tagging and other biological information to improve understanding and identify future research and analysis needs; (2) to assist in the development of improved monitoring capabilities, statistical methodologies and software tools to aid management in optimizing operational and fish passage strategies to maximize the protection and survival of listed threatened and endangered Snake River salmon populations and other listed and nonlisted stocks in the Columbia River Basin; (3) to develop better analysis tools for monitoring evaluation programs; and (4) to provide statistical support to the Bonneville Power Administration and the Northwest fisheries community.

The following report addresses measure 4.3C of the 1994 Northwest Power Planning Council's Fish and Wildlife Program with emphasis on improved monitoring and evaluation of smolt migration in the Columbia River Basin. This report represents the twelfth in a series of technical reports presenting results of applications of statistical program RealTime to present in-season predictions of the status of smolt migrations in the Columbia River Basin. Results and evaluation of program RealTime 2002 predictions of the run-timing of wild and hatchery-reared salmon and steelhead trout to Lower Granite, Rock Island, McNary, and John Day dams are presented. It is hoped that making these real-time predictions and supporting data available on the Internet for use by the Technical Management Team (TMT) and members of the fisheries community will contribute to effective in-season population monitoring and assist in-season management of river and fisheries resources. Having the capability to more accurately predict smolt outmigration status improves the ability to match flow augmentation to the migration timing of ESA listed and other salmonid stocks and also contributes to the regional goal of increasing juvenile passage survival through the Columbia River system.

ABSTRACT

Program RealTime provided monitoring and forecasting of the 2002 inseason outmigrations via the internet for 29 PIT-tagged stocks of wild ESU salmon and steelhead to Lower Granite and/or McNary dams, one PIT-tagged hatchery-reared ESU of sockeye salmon to Lower Granite Dam, and 15 passage-indexed runs-at-large, five each to Rock Island, McNary, and John Day Dams. Of the 19 stocks of wild yearling chinook salmon captured, PIT-tagged, and released at sites above Lower Granite Dam in 2001, in drainages of the Salmon, Grande Ronde and Clearwater Rivers, and subsequently monitored at Lower Granite Dam in 2002, seven were stocks monitored for the first time in 2002 (Big Creek, West Fork Chamberlain Creek, Clear Creek, Grande Ronde River, Lemhi River, Lolo Creek and Lookingglass Creek). The other twelve release sites (each with more than two years' standing in the project) were in Bear Valley Creek, Catherine Creek, Elk Creek, Imnaha River, Johnson Creek, Lake Creek, Lostine River, Marsh Creek, Minam River, South Fork Salmon River, Secesh River, and Valley Creek. In a continuation from last year, seven wild PIT-tagged runs-at-large of Snake or Upper Columbia River ESU salmon and steelhead were monitored at McNary Dam and two were monitored at Lower Granite Dam. The stock of hatchery-reared PIT-tagged sockeye salmon smolts outmigrating to Lower Granite Dam consisted of fish from Alturas Lake Creek, Redfish Lake Creek Trap and Sawtooth Trap. The passage-indexed stocks (stocks monitored by FPC passage indices) included combined wild and hatchery runs-at-large of subyearling and yearling chinook, coho, and sockeye salmon, and steelhead trout forecasted to Rock Island, McNary, and John Day Dams.

Program RealTime performance is evaluated using MADs (*mean absolute differences*, the average, over all days, of the absolute difference between predicted and true passage percentiles), calculated for the first half of the outmigration, for the last half and for the season-wide outmigration. The forecasting of wild PIT-tagged Snake River subyearling fall chinook passage at Lower Granite Dam was comparable to previous years (season-wide MAD = 5.2%). The run of wild PIT-tagged Upper Columbia subyearling fall chinook salmon monitored at McNary Dam was predicted very well in 2002 (season-wide MAD = 3.4%). Unusual run-timing characteristics and higher detection rate than expected for wild Snake River subyearling fall chinook salmon monitored at McNary Dam likely contributed to the large first-half MAD of 15.7% and season-wide MAD of 7.2%. The run ended earlier than expected resulting in passagelater than the observed

passage percentages.

The run-at-large of wild PIT-tagged Snake River yearling chinook salmon smolts monitored at McNary Dam was predicted extremely well in 2002, with a season-wide MAD of 0.8% compared to 3.3% in 2001. Program RealTime predictions for the run-at-large of wild PIT-tagged yearling chinook salmon from the Snake River drainage outmigrating to Lower Granite Dam were comparable to last year (MAD = 5.2%). Stocks from release sites that were monitored individually by Program RealTime in 2002 were predicted better than average on the whole, with RealTime performance better than average for 7 out of 12 stocks for which historical averages were available (stocks with at least three years standing in the project). Two of these stocks, Imnaha River and Elk Creek, were much more poorly predicted in 2002 than average, with season-wide MADs of 30.6% and 13.9%, respectively. The likely reason for these poor predictions was the smaller-than-expected number of detections at Lower Granite Dam. Indeed, this was a pattern observed for many of the individually-monitored stocks from release sites above Lower Granite, seen in sixteen of the 19 stocks, though not as extremely as Imnaha River and Elk Creek. As a consequence the project's traditional overall indicator of passage characteristics for these stocks, the RealTime Select composite (a composite of fish from all sites treated as a single stock) was not predicted as well as usual. The actual passage timing was earlier than predicted.

The run of wild PIT-tagged Snake River sockeye salmon monitored and forecasted at McNary Dam was well-predicted in 2002 (season-wide MAD = 5.6% compared to 6.0% last year) but the arrival of PIT-tagged hatchery sockeye from the Redfish Lake area at Lower Granite Dam was, like the yearling chinook salmon runs, earlier than predicted throughout the season producing a large season-wide MAD (18.3%).

RealTime predictions of the run-timing of wild PIT-tagged Snake River steelhead trout to Lower Granite and McNary Dams were comparable to last year with season-wide MADs within 5% and 7%, respectively, of the end-of-season observed run-timing. Upper Columbia River steelhead trout outmigrated to McNary Dam earlier than predicted this year (season-wide MAD was 10.6% compared to 4.9% in 2001).

The results of program RealTime in forecasting run-timing and passage percentiles of FPC passage-indexed runs-at-large to Rock Island, McNary, and John Day Dams were excellent this year. In particular the last half of the outmigrations were predicted to within 2% of the true distribution for all five species (subyearling and yearling chinook, coho and sockeye salmon, and steelhead trout) at McNary Dam, to within 5% at Rock Island Dam, and to within 6% at John Day Dam. Season-wide MADs were smaller this year than last year without exception.

Executive Summary

2002 Objectives

1. Expand application of program RealTime to include in-season predictions of the run-timing of passage-indexed runs-at-large of combined wild and hatchery-reared yearling chinook, coho, and sockeye salmon and steelhead trout to John Day Dam, and to include seven new stocks of wild PIT-tagged yearling chinook salmon which were tagged and released in 2001 and subsequently monitored at Lower Granite Dam in 2002.
2. Continue to predict and report in real-time the “percent run-to-date” and “date to specified percentiles” of the outmigrations to Lower Granite Dam of wild PIT-tagged runs-at-large of yearling chinook salmon and steelhead, and release-recovery stocks of wild PIT-tagged subyearling and yearling chinook salmon and hatchery-reared PIT-tagged sockeye salmon; of wild PIT-tagged runs-at-large of subyearling and yearling chinook and sockeye salmon. Continue to predict and report on the outmigrations to McNary Dam of wild PIT-tagged runs-at-large of Snake and Upper Columbia River subyearling chinook and steelhead trout and of wild PIT-tagged runs-at large of Snake River yearling chinook and sockeye salmon. And continue to predict and report on the outmigrations to Rock Island and McNary dams of passage-indexed runs-at-large of combined wild and hatchery subyearling and yearling chinook salmon, coho and sockeye salmon and steelhead based on the Fish Passage Center’s (FPC) passage indices; and of the outmigration to John Day Dam of the passage-indexed run-at-large of combined wild and hatchery subyearling chinook salmon based on the Fish Passage Center’s (FPC) passage indices.
3. Post on-line Internet-based predictions on outmigration status and trends in order to improve in-season population monitoring information available for use by the Technical Management Team and the fisheries community to assist river management.

Accomplishments

New runs-at-large of passage-indexed salmon and steelhead outmigrating to John Day Dam were added to the RealTime project in 2002 to increase information about run-timing and passage information on threatened or endangered stocks on the mainstem Columbia River. There were also seven new stocks of wild PIT-tagged yearling chinook salmon PIT-tagged and released at sites above Lower Granite Dam in 2001 and monitored at Lower Granite Dam during migration year 2002. These stocks have never before been included in the RealTime project and they include Big Creek, Chamberlain Creek-West Fork, Clear Creek, Grande Ronde River, Lemhi River, Lolo Creek and Lookingglass Creek. In addition to these new stocks, the RealTime 2002 project continued to monitor and forecast fish passage percentages of twelve other release-recovery stocks of Snake River spring/summer yearling chinook salmon to Lower Granite Dam, making a total of nineteen such stocks, all of which met RealTime's data requirements of three years of historical data, each year having at least 30 detections of PIT-tagged fish. Beyond the new stocks, the nineteen were from Bear Valley Creek, Catherine Creek, Elk Creek, Imnaha River, Johnson Creek, Lake Creek, Lostine River, Marsh Creek, Minam River, South Fork Salmon River, and Secesh River, and Valley Creek.

The protocol of releasing unmarked hatchery salmon of all *Oncorhynchus* species into the Snake River has continued since 1999. To provide run-timing information on wild runs-at-large since then, the RealTime forecasting project has monitored and forecasted wild, PIT-tagged subpopulations of subyearling chinook salmon, and runs-at-large of wild, PIT-tagged yearling chinook salmon and steelhead trout to Lower Granite Dam. In 2001 seven new PIT-tagged runs-at-large of wild salmonids were added to the project and monitored at McNary Dam to provide similar information on Upper Columbia River ESUs during a predicted drought year and these stocks were monitored again in 2002. The objective of providing run-timing forecasts for PIT-tagged hatchery-reared sockeye salmon from the Redfish Lake area in Idaho, begun in 1997, was accomplished in 2001 and in 2002 by including a composite of Alturas Lake Creek, Redfish Lake Creek Trap, and Sawtooth Trap fish. This composite replaced the stock of Redfish Lake summer-run hatchery-reared sockeye salmon which was monitored from 1997-2000. In 2001 and 2002, there were no releases of PIT-tagged hatchery sockeye into Redfish Lake.

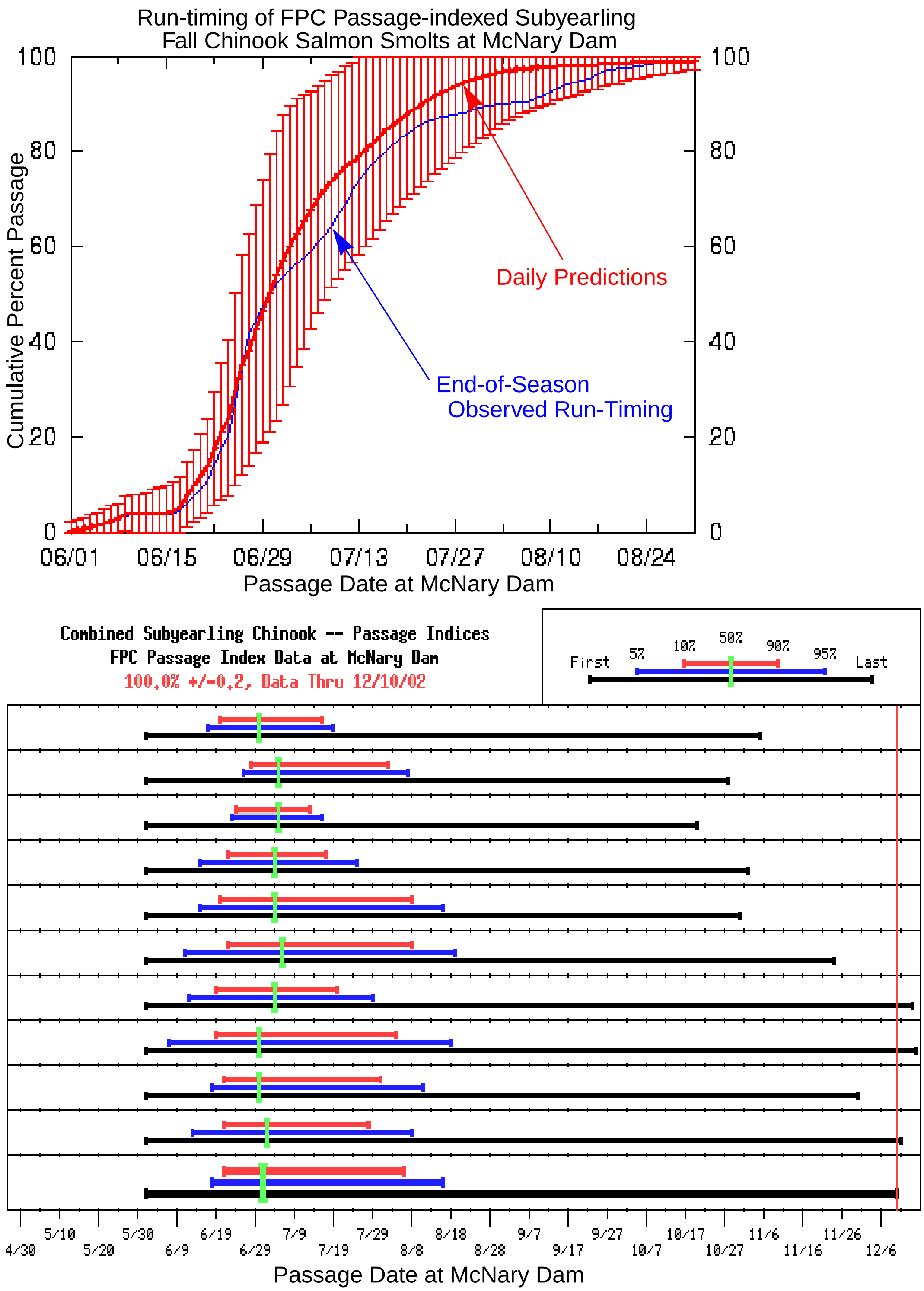
Passage indices provided by the Fish Passage Center at Rock Island, McNary, and John Day-Dams were utilized by the RealTime project in 2002 to forecast run-timing for the combined wild and hatchery-reared runs-at-large of subyearling and yearling chinook, coho, and sockeye salmon, and steelhead trout from the Upper Columbia and mainstem Columbia Rivers.

On-line run-timing predictions were provided via the Internet at *http://www.cbr.washington.edu/crisprt* to the fisheries community throughout each smolt outmigration. Figure 1 illustrates two types of graphical displays available for each stock in the RealTime project. Also

Figure 1: Example of two types of graphical displays available for all stocks in the RealTime project. (a) Program RealTime 2002 predictions of run-timing of subyearling fall chinook salmon smolts at McNary Dam (thick red line, with 95% confidence intervals) compared to end-of-season observed run-timing (thin blue line) based on FPC passage-indices of combined wild and hatchery-reared fish. (b) Historical and current-year run-timing characteristics.

(a)

(b)



available (and included in the appendices to this report) are detailed tabular displays of historical run-timing information and expected rates of detection for each stock (Appendix B).

Findings

Run-timing and passage information provided by Program RealTime about the passage-indexed stocks of combined wild and hatchery salmon and steelhead to Rock Island, McNary, and John Day Dams was more accurate in 2002 than in 2001 for every stock for which comparisons were available. In particular, the last half of the runs, often more crucial for water managers to accurately forecast, were predicted to within 2% of the observed, end-of-season distributions of fish passage at McNary Dam (e.g., Figure 1). And last-half predictions were within 5% and 6% of the true distributions, at Rock Island and John Day Dams, respectively.

Wild PIT-tagged runs-at-large to Lower Granite Dam included yearling chinook salmon and this run was well-predicted in 2002 with a season-wide MAD of 5.2%, a performance comparable to past years. Wild subyearling chinook salmon PIT-tagged and released in the Snake River between river kilometer 224 and 268 and detected at Lower Granite Dam were also predicted comparably to previous years (season-wide MAD = 5.2%). The wild PIT-tagged run-at-large of steelhead trout to Lower Granite Dam was predicted to within 7% of the end-of-season observed distribution, a performance somewhat worse than average. These fish arrived at the dam later than predicted.

Program RealTime performance in predicting passage percentages and run-timing at Lower Granite Dam of stocks of PIT-tagged yearling chinook salmon, tagged and released in 2001 and monitored at the facility in 2002 was, on the whole, somewhat better than previous years. Out of twelve 2002 stocks for which historical MAD data were available (i.e., for stocks with more than two years of inclusion in the RealTime project), seven had season-wide MADs that were smaller than average. However some stocks were very poorly predicted, and the composite runs were accordingly affected. In particular RealTime performance in predicting the 2002 RealTime Select Composite, consisting of the aggregate of all stocks, was the worst on record, season-wide and for the last half of the outmigration because of the extremely poor predictions for the Imnaha River and Elk Creek stocks (season-wide MADs were 30.5% and 13.9% respectively). The reason for the extremely poor predictions this year was that these two stocks had extremely small recapture percentages compared to the historical average. The few detections at the beginning of the season resulted in run-timing to be predicted later than what actually occured. Indeed, fewer than expected numbers of detections were made in 2002 for sixteen of the nineteen release-recovery stocks of yearling chinook.

Program RealTime performance in predicting run-timing for the PIT-tagged runs-at-large of wild Snake and Upper Columbia River salmon and steelhead to McNary Dam was mixed. The run-timing of Snake River yearling chinook salmon smolts was predicted extremely well with a season-wide MAD of 0.8%. The runs of Upper Columbia subyearling fall chinook salmon and of Snake River sockeye salmon were also well-predicted (season-wide MADs were 3.4% and 5.6%, respectively), and the season-wide MAD for Snake River steelhead trout was 4.3%. However Snake River subyearling chinook salmon were not as well predicted at McNary Dam this year as last (the first-half MAD of 15.7% contributed to a fairly large season-wide MAD 7.2%) nor were Upper Columbia River steelhead trout (the first-half MAD of 14.0% contributed to the large season-wide MAD of 10.6%). Unusual run-timing or detection-rate characteristics likely account for these inaccuracies in prediction.

Performance in predicting timing of the PIT-tagged run of hatchery-reared sockeye salmon from the Redfish Lake area to Lower Granite Dam was poor compared to last year. This stock, like several Snake River yearling chinook salmon stocks, had a much smaller-than-expected recapture (detection) rate at Lower Granite Dam, approximately a third of its historical average. The season-wide MAD was 18.3%.

Run-timing characteristics overall were mixed but a disproportionate number of stocks appeared to have extreme run-timing characteristics in 2002, with some unusually long and others unusually short. Flow and spill were comparable to standard flow years, although a period of high flow and spill was observed at Lower Granite Dam in June and July.

Management Implications

The ability to accurately predict the outmigration status of composite or individual salmon and steelhead stocks at different locations in the Federal Columbia River Power System (FCRPS) can provide valuable information to assist water managers. Since the 1994 outmigration, program RealTime has been applied to provide in-season predictions of smolt outmigration timing for individual and aggregates of listed threatened and endangered Snake River salmon stocks. These predictions have been made available to the fisheries community to assist in-season river management.

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Special appreciation is extended to Chris Van Holmes, Susannah Iltis and Peter Westhagen of the School of Fisheries at the University of Washington for providing critical technical, data management and computer programming support.

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1.0 Introduction

Regulating the timing and volume of water released from storage reservoirs (often referred to as flow augmentation) has become a central mitigation strategy for improving downstream migration conditions for juvenile salmonids in the Columbia River Basin. Snake River and Upper Columbia River water managers have used flow augmentation to improve the outmigration survival of stocks listed as threatened or endangered under the Endangered Species Act (ESA). Timing the release of water so that the listed stocks are in place to encounter these augmented flows requires knowledge of the status and trend of the stocks' outmigration timing.

In 1993, work was begun under this project to develop real-time predictions of smolt outmigration dynamics for ESA-listed stocks from the Snake and Columbia Rivers. The fruit of this labor was Program RealTime, a statistical software program which predicts run-timing of individual stocks of salmonids (Skalski et al. 1994). It uses historical data to predict the percentage of the outmigration that will reach an index site, in real-time; and it forecasts the elapsed time until some future percentage is observed at that site. The first in-season predictions were of wild spring/summer chinook salmon smolts from the Snake River drainage above Lower Granite Dam during the 1994 outmigration. These fish originate in streams listed by the National Marine Fisheries Service (NMFS) as evolutionarily/ecologically significant units (ESUs). As parr, a portion of these fish are annually implanted with passive integrated transponder (PIT, Prentice et al., 1990a, b, c) tags, and released back into their natal streams (Achord et al., 1994, 1995, 1996, 1997, 1998, 2000) where they over-winter until their outmigration as yearlings in the spring and summer. During outmigration, PIT-tag detectors at Lower Granite Dam read the tag codes so individual stocks can be monitored.

University of Washington fisheries scientists subsequently incorporated Program RealTime predictions into their CRiSP model to move the forecasted runs of these stocks down the Snake and Columbia Rivers to McNary Dam (e.g., Hayes et al. 1996, Beer et al. 1999, *http://www.cqs.washington.edu/crisprt*).

Since 1994, the RealTime forecasting project has expanded its scope to monitor and forecast other NMFS-listed populations of Columbia River Basin salmonids. In 1997 Program RealTime began forecasting the run-timing of hatchery-reared PIT-tagged summer-run sockeye salmon released into remote lakes and streams in Idaho over 700 kilometers upriver from Lower Granite Dam.

The type of data used for these first stocks was *release-recovery* data, but for the 1997 migration year, Program RealTime was adapted to utilize *index-count* data such as Fish Passage Center (FPC) passage indices (e.g., FPC, 1999). The distinction between these two types of data is mainly important for understanding how RealTime makes initial predictions early in the season. These differences are described in detail in the models section (Section 2.6.1). Release-recovery counts consist only of those detections of fish that are identified to a specific release batch, i.e. fish with PIT-tags identifying their release to a specific time or place (or both). By contrast, index-count stock data consist of all detections at the dam of a particular species, regardless of their release details, i.e. regardless of when or where they were released. In 1997, new runs of index-count stocks using FPC passage indices were included in the RealTime project to provide run-timing forecasts for wild runs-at-large of yearling and subyearling chinook salmon and steelhead trout to Lower Granite Dam. These runs were predicted with considerable accuracy (Townsend et al. 1998, Burgess et al. 1999) but were discontinued in 1999 and 2000 when hatcheries ceased their practice of marking their fish to distinguish them from wild fish (Burgess et al., 1999). To continue to provide run-timing information on these wild Snake River runs-at-large of yearling and subyearling chinook salmon and steelhead trout, the RealTime project began to monitor PIT-tagged wild fish. The first such stock was a release-recovery stock of wild subyearling fall chinook tagged for doctoral research by William Connor (Burgess et al., 1999), a subpopulation whose run-timing characteristics were believed to mimic those of the larger wild population. In 2000, RealTime began monitoring two wild index-count stocks of PIT-tagged salmon and wild steelhead trout at Lower Granite Dam, and in 2001, seven new such stocks were monitored at McNary Dam, including runs from the Upper Columbia River as well as the Snake River, reflecting concern about water management during a predicted drought year (Burgess and Skalski, 2001).

While releasing unmarked hatchery fish into the Snake River spelled the demise of the RealTime project’s capability of monitoring wild runs-at-large to Lower Granite (because hatchery releases swamp the signature passage patterns of wild fish), the same is not true for all Columbia River Basin dams. In 2000, the RealTime project began monitoring and forecasting runs-at-large of combined hatchery and wild salmon and steelhead to Rock Island Dam on the upper Columbia River and to McNary Dam on the mainstem Columbia. For these forecasts, Program RealTime used FPC passage indices. In 2001, out of concern about passage status in a low flow year, the run-at-large of combined wild and hatchery subyearling fall chinook salmon was monitored and forecasted to John Day Dam on the Columbia River, using FPC passage indices (Burgess and Skalski, 2001). In 2002, we expanded RealTime's John Day forecasting to include all species of salmonid.

This report presents a post-season analysis of Program RealTime performance for 2002. Here we compare RealTime predictions with end-of-season observed distributions of passage indices or PIT-tag detections at Lower Granite, Rock Island, McNary, and John Day dams. During the outmigration season, predictions were accessible daily, via the World Wide Web at address *http://www.cqs.washington.edu/crisprt.* The website's end-of-season graphical and tabular displays of Program RealTime results, by stock, are included in Appendices A through D. Appendix A contains the daily record of RealTime predictions compared with the end-of-season observed distributions for all runs monitored by Program RealTime in 2002. Appendix B contains graphical and tabular displays of historical run-timing characteristics, including the dates of the first and last detections of the season, and dates of the 5th, 10th, 50th, 90th and 95th percentiles of passage, the middle 80% passage period (in days), the total numbers of fish counted inseason annually, and for the release-recovery stocks, the expected number of annual detections. Appendix C contains records of daily flow, spill and spill-adjustment parameters (Section 2.3). Appendix D displays the record of RealTime performance since 1995 of all stocks included in the 2002 project for which there are at least two other years of inclusion in the project.

2.0 Methods

2.1 Description of Data

2.1.1 *PIT-tagged Stocks*

PIT-tag data are made available by the Pacific States Marine Fisheries Commission's PIT Tag Information System (PITAGIS) project. In 2002 we monitored and prepared forecasts for 23 PIT-tagged stocks of salmon and steelhead to Lower Granite Dam, and seven stocks of salmon and steelhead to McNary Dam.

Release-recovery Stocks

The RealTime project provided run-timing information on twenty-one release-recovery stocks, all monitored at Lower Granite Dam. These were 1) nineteen stocks of wild spring/summer yearling chinook salmon captured, tagged and released into streams above Lower Granite during the spring, summer and fall of 2001, 2) a population of wild subyearling fall chinook salmon PIT-tagged by William Connor (Burgess et al., 1999) and released into the Snake River near its confluence with the Salmon River, and 3) a hatchery-reared, summer-run sockeye salmon composite of fish outmigrating from Alturas Lake Creek, Redfish Lake Creek Trap and Sawtooth Trap (new in 2001; previously we monitored hatchery sockeye from Redfish Lake but this stock was has not been PIT-tagged since 2000). Table 2.1 displays the U.S. Geological Survey hydrounit numbers for these release sites. Figure 2.1 shows the locations of the 21 sites from which wild smolts were sampled, PIT-tagged and released. (The three sockeye salmon release sites that make up the composite are treated as one site in Figure 2.1).

Release-recovery stocks have special data requirements that index-count stocks do not. The 2002 RealTime project included nineteen release-recovery stocks of spring/summer yearling chinook salmon smolts originating from tag/release sites above Lower Granite Dam (Figure 2.1). Each stock constitutes a unique ESU. Originally, tag/release sites were chosen on the basis of their consistent recovery numbers (PIT-detections at LGR)[1], and by virtue of having at least three years of historical data, each with at least 30 PIT-tag detections. Over the years, stocks with less historical information were also forecasted in order to determine whether a lower data standard

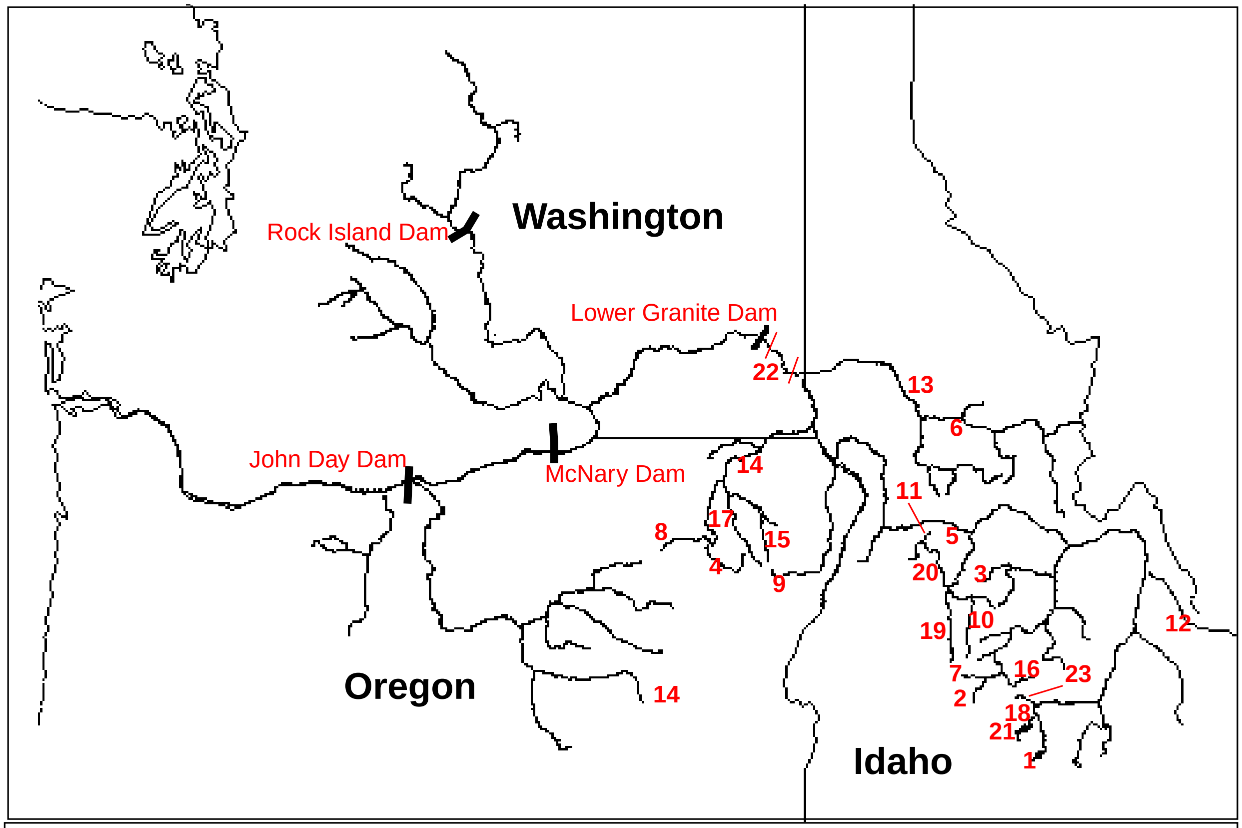
1.Detections of PIT-tagged smolts at Lower Granite Dam are seen as recaptures or recoveries in a tag-release-recapture experiment, so the terms "recapture", "recovery", and "detection" may be used interchangeably.

Table 2.1: The GIS hydrounits of the 18 PIT-tag release sites for spring/summer yearling chinook salmon, the single PIT-tag release site for fall subyearling chinook salmon, and the 3 PIT-tag release sites (constituting one composite stock) for sockeye salmon, the release sites for the 21 release-recovery stocks included in the 2002 Program RealTime forecasting project, monitored at Lower Granite Dam.

Release Site					GIS
Abbreviation	Long Name	Rearing	Run	Species	Hydrounit[a]
ALTULC[b]	Alturas Lake Creek	H	Su	Sockeye	17060201
BEARVC	Bear Valley Creek	W	Sp/Su	Chinook	17060205
BIGC	Big Creek	W	Sp/Su	Chinook	17060206
CATHEC	Catherine Creek	W	Sp/Su	Chinook	17060104
CHAMWF	West Fork Chamberlain Creek	W	Sp/Su	Chinook	17060207
CLEARC	Clear Creek	W	Sp/Su	Chinook	17060304
ELKC	Elk Creek	W	Sp/Su	Chinook	17060205
GRANDR	Grande Ronde River	W	Sp/Su	Chinook	17060106
IMNAHR	Imnaha River	W	Sp/Su	Chinook	17060102
JOHNSC	Johnson Creek	W	Sp/Su	Chinook	17060208
LAKEC	Lake Creek	W	Sp/Su	Chinook	17060208
LEMHIR	Lemhi River	W	Sp/Su	Chinook	17060204
LOLOC	Lolo Creek	W	Sp/Su	Chinook	17060306
LOOKGC	Lookingglass Creek	W	Sp/Su	Chinook	17060104
LOSTIR	Lostine River	W	Sp/Su	Chinook	17060105
MARSHC	Marsh Creek	W	Sp/Su	Chinook	17060205
MINAMR	Minam River	W	Sp/Su	Chinook	17060106
RLCTRP[b]	Redfish Lake Creek Trap	H	Su	Sockeye	17060201
SALRSF	Salmon River, South Fork	W	Sp/Su	Chinook	17060208
SAWTRP[b]	Sawtooth Trap	H	Su	Sockeye	17060201
SECESR	Secesh River	W	Sp/Su	Chinook	17060208
SNAKER	Snake River (RK 224 to 268)	W	Fall	Chinook	17060110
VALEYC	Valley Creek	W	Sp/Su	Chinook	17060201

a. Geographical Information System (GIS) designations established by the U.S. Geological Survey.
b. These three stocks form the hatchery sockeye composite.

Figure 2.1: Map showing release sites for the 21 release-recovery stocks (Table 2.1) monitored by Program RealTime in 2002 to Lower Granite Dam.



Release Sites

1. Alturas Lake Creek
2. Bear Valley Creek
3. Big Creek
4. Catherine Creek
5. Chamberlain Creek, West Fork
6. Clear Creek
7. Elk Creek
8. Grande Ronde River
9. Imnaha River
10. Johnson Creek
11. Lake Creek
12. Lemhi River
13. Lolo Creek
14. Lookingglass Creek
15. Lostine River
16. Marsh Creek
17. Minam River
18. Redfish Lake Creek Trap
19. Salmon River, South Fork
20. Secesh River
21. Sawtooth Trap
22. Snake River, kilometer 224-268
23. Valley Creek

would still provide good predictions. In addition, we forecast "composite runs" which are the combined data from several streams treated as a single stock. The composite runs produce good predictions because they smooth and dampen the randomness of individual stocks. They can be useful for providing general run-timing information for broad geographical regions. Since 1999, the RealTime project has provided run-timing information and forecasts on three composites. The first, the CRiSP/RealTime composite includes only release sites that meet the extreme data requirements of the CRiSP model. These sites included Catherine Creek, Imnaha River, Minam River, and South Fork Salmon River. The second composite, the RealTime Select Composite, consists of sites that meet the less stringent historical data requirements described above for Program RealTime. In addition to the four stocks listed above, this composite included Bear Valley Creek, Big Creek, West Fork Chamberlain Creek, Clear Creek, Elk Creek, Grande Ronde River, Johnson Creek, Lake Creek, Lemhi River, Lolo Creek, Lookingglass Creek, Lostine River, Marsh Creek, Secesh River, and Valley Creek. The third composite, the RealTime All-Stocks composite, include all sites by definition and this year was identical to the Select composite (Figure 2.1, Table 2.1).

Further data criteria for choosing yearling chinook stocks ensure consistent fish passage patterns. The RealTime project uses detections of fish tagged May 31 - November 1 of the previous year because fish marked later may have different migrational timing characteristics (Keefe et al. 1995, 1996). In past years (1998 through 2001), only stocks PIT-tagged by experienced taggers Steve Achord or Paul Sankovitch were included in the project. These taggers did not tag fish in the summer and fall of 2001, so this criteria had to be dropped in the RealTime 2002 project.

Numbers of yearling chinook parr released in 2001 at the sites illustrated in Figure 2.1 are displayed in Table 2.2. Historical releases are given in Tables B1-B19 (Appendix B).

Included in 2002 for the fourth consecutive year, the subpopulation of PIT-tagged wild fall subyearling chinook salmon was monitored to provide run-timing information about the wild run-at-large of Snake River fall subyearling chinook salmon because passage indices for the wild run became unavailable after June 6, 1999 (Burgess et al., 1999). Historical comparisons from 1993 to 1998, of the passage distributions of the run-at-large with the PIT-tagged subpopulation are available at the world-wide website *www.cbr.washington.edu/crisprt/info.html.* Since 1993,

Table 2.2: Numbers of releases of PIT-tagged salmon smolts in 2001 (wild spring/summer yearling chinook salmon) or early in 2002 (hatchery sockeye salmon, wild subyearling salmon) at each site[a]. Each site represents a stock monitored and forecasted to Lower Granite Dam by Program RealTime in 2002.

Tagging Location	Number Parr Pit-tagged and Release in 2001/ 2002
Bear Valley Creek	1495
Big Creek	409
Catherine Creek	970
Chamberlain Creek, West Fork	527
Clear Creek	729
Elk Creek	1519
Grande Ronde River	193
Imnaha River	1001
Johnson Creek	235
Lake Creek	3193
Lemhi River	700
Lolo Creek	1932
Lookingglass Creek	2185
Lostine River	903
Marsh Creek	1056
Minam River	1533
Salmon River, South Fork	1534
Secesh River	4285
Valley Creek	1497
Sockeye for Alturas Lake Creek, Redfish Lake Creek Trap, and Sawtooth Trap	2836
Wild Subyearling Fall Chinook Salmon Tagged and Release between Snake River km 224 and 268	2402

a. Data Sources: PTAGIS and FPC Smolt Index Databases and RealTime program output as of 15 December 2002.

William Connor (USFWS at Dworshak Fisheries Complex) has sampled, PIT-tagged and released subyearling fall chinook in the Snake River between river kilometers 224 and 268 as part of doctoral program and ongoing research. The smolts were tagged and released at regular intervals, from April into July or until water temperatures approached 20^{o}C or catches neared zero. These smolts begin to appear at Lower Granite Dam around June 1 and continue through October. The subpopulation mimics the run-at-large passage percentiles well during the first and middle portions of the run. There were 2402 PIT-tagged smolts released for this migration year into the Snake River (Table 2.2). Historical releases are given in Table B23.

The composite of hatchery-reared summer-run sockeye salmon from the Redfish Lake area was monitored for the first time in 2001 (Burgess and Skalski, 2001) to replace the Redfish Lake stock which had four years standing in the RealTime project (Townsend et al. 1998, Burgess et al. 1999, Burgess and Skalski 2000a, b). Redfish Lake was not stocked with new hatchery releases in 2000, or 2001, so for the second time the composite consisted of PIT-tagged hatchery-reared summer-run sockeye salmon smolts released after May 1 of 2002 into Alturas Lake Creek, Redfish Lake Creek Trap, and Sawtooth Trap (Figure 2.1). There were 2836 PIT-tagged smolts released in May of 2002 (Table 2.2). Historical releases are given in Table B12 (Appendix B).

Index-Count Stocks

Two PIT-tagged runs-at-large of wild fish were monitored by Program RealTime to Lower Granite Dam, and seven such wild runs were monitored and forecasted to McNary Dam. The stocks monitored at Lower Granite were 1) all the wild PIT-tagged yearling chinook salmon from the Snake River and 2) all wild PIT-tagged steelhead from the Snake River. The stocks monitored at McNary were 1) all wild PIT-tagged subyearling chinook salmon from the Snake River, 2) all wild PIT-tagged subyearling chinook salmon from the Upper Columbia River, 3) all wild PIT-tagged yearling chinook salmon from the Snake River, 4) all wild PIT-tagged sockeye salmon from the Snake River, 5) all wild PIT-tagged steelhead from the Snake River, 6) all wild PIT-tagged steelhead from the Upper Columbia River, 7) the aggregate of Snake and Columbia River wild PIT-tagged steelhead above McNary Dam (i.e., 5) and 6) taken together).

2.1.2 Fish Passage Center (FPC) Passage-Indexed Stocks

Passage index data were made available by the Northwest Power Planning Council's (NWPPC) Fish Passage Center (FPC). Passage indices are sample counts in the bypass system at the dam divided by the proportion of water passing through the sampling system. They are collected according to FPC sampling plans (e.g., Fish Passage Center, 1999), and are intended to reflect the size of the run. All FPC passage-indexed stocks are index-count stock. Run-timing characteristics of these runs of mid-Columbia and mainstem Columbia River yearling and subyearling chinook salmon, coho and sockeye salmon and steelhead trout runs were monitored and forecasted to Rock Island and McNary dams for the third consecutive year in 2002. The subyearling chinook salmon run was monitored at John Day Dam for the first time in 2001 and the other four runs were forecasted to John Day Dam for the first time in 2002. The runs can be very accurately predicted, provided large hatchery releases to not overwhelm the normal signature pattern of fish passage run-timing (Burgess and Skalski, 2000).

2.2 Preprocessing of Data

Raw PIT-tag detections data are adjusted for spill fraction (Section 2.3) and smoothed using three 5-day smoothing passes to filter out statistical randomness before input to the RealTime forecaster algorithm. Raw passage index data are smoothed the same as PIT-data.

2.3 Adjustment of Raw Smolt Counts for Spill or Flow.

2.3.1 PIT-tagged Stocks

Spillways at hydroelectric projects are low-mortality routes of passage for fish and managers at projects spill water to encourage that route of passage. Fish that pass through the spillway are not detected by PIT-tag interrogation systems, so formulas are used to upwardly adjust the raw counts of PIT-detections. The daily number of fish detected, "raw counts" are multiplied by an expansion factor, resulting in "adjusted counts" according to the formula

raw counts x expansion factor = adjusted counts.

The expansion factor is

$$\frac{1}{1 - SE}, \qquad (2.1)$$

where *SE* is *spill effectiveness,* the fraction of smolts passing through the spillway (NMFS, 2000). Different formulations for SE are required for different species of salmonids (Skalski and Perez-Comas 1998) and for different dams configurations (NMFS, 2000). The formula for spill effectiveness for chinook and sockeye salmon at Lower Granite Dam is given by Smith et al. (1993) as

$$SE_{chinook,sockeye} = 1.667\left(\frac{S}{F}\right)^3 - 3.25\left(\frac{S}{F}\right)^2 + 2.583\left(\frac{S}{F}\right) \qquad (2.2a)$$

(Figure 2.2, red), and the formula for steelhead is given by Skalski and Perez-Comas (1998) as

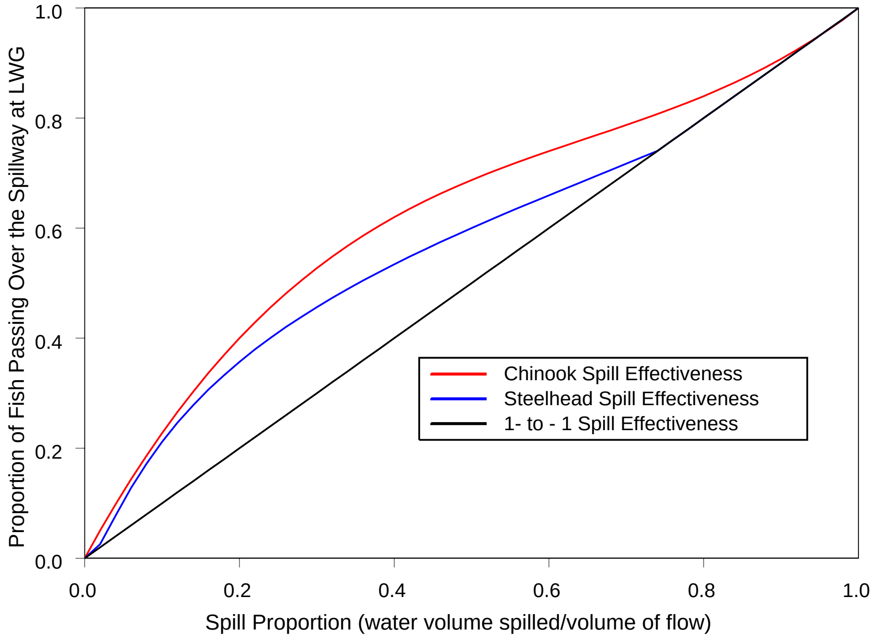
$$SE_{steelhead} = 0.6001^{\exp\left(-0.5063 \cdot \log\left(\frac{S/F}{1 - S/F}\right)\right)} \qquad (2.2b)$$

(Figure 2.2, blue), where S is the daily volume of water spilled and F is daily outflow volume. The 2002 formulation of SE at McNary Dam used by Program RealTime was a one-to-one function (NMFS, 2000) of SE to spill proportion, or volume of water spilled divided by volume of outflow (Figure 2.2, black),

$$SE = \frac{S}{F} = \text{spill volume / flow volume = spill proportion.} \qquad (2.2c)$$

2.3.2 FPC Passage-Indexed Stocks See Section 2.1.2

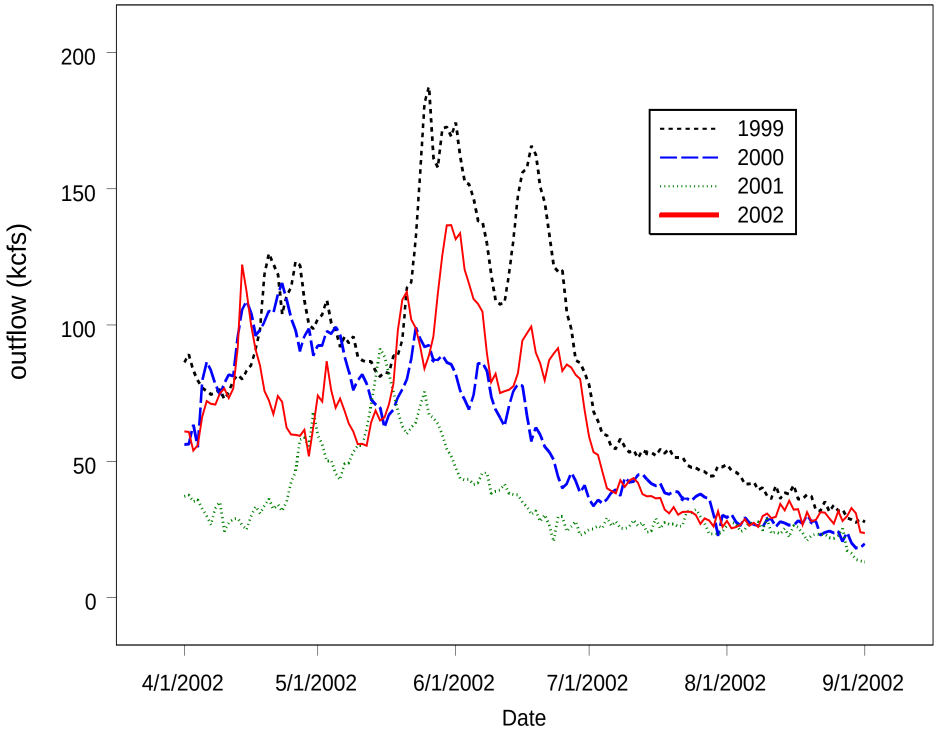
Figure 2.2: Spill effectiveness (SE) functions (equations 2.2a, b, c) used by Program RealTime to upwardly adjust raw PIT-tag detections. Shown are the 2002 RealTime spill effectiveness curves as functions of spill proportion (S/F) at Lower Granite Dam (red, blue) and at McNary Dam (black).



2.4 River Flow

Although it has not been conclusively demonstrated, flow is thought to substantially affect outmigration timing (Connor, et al. 1994b and 1996; Giorgi and Schlechte 1997; Smith et al.1997). Flow is highly correlated with other important river variables, such as turbidity and temperature. Flow surges may influence the numbers of fry that migrate from upriver spawning grounds (Healey, 1991). The 2002 flow year was considered a standard-flow year compared to 2001 (low flow), 1999 (high flow) (Figure 2.3).

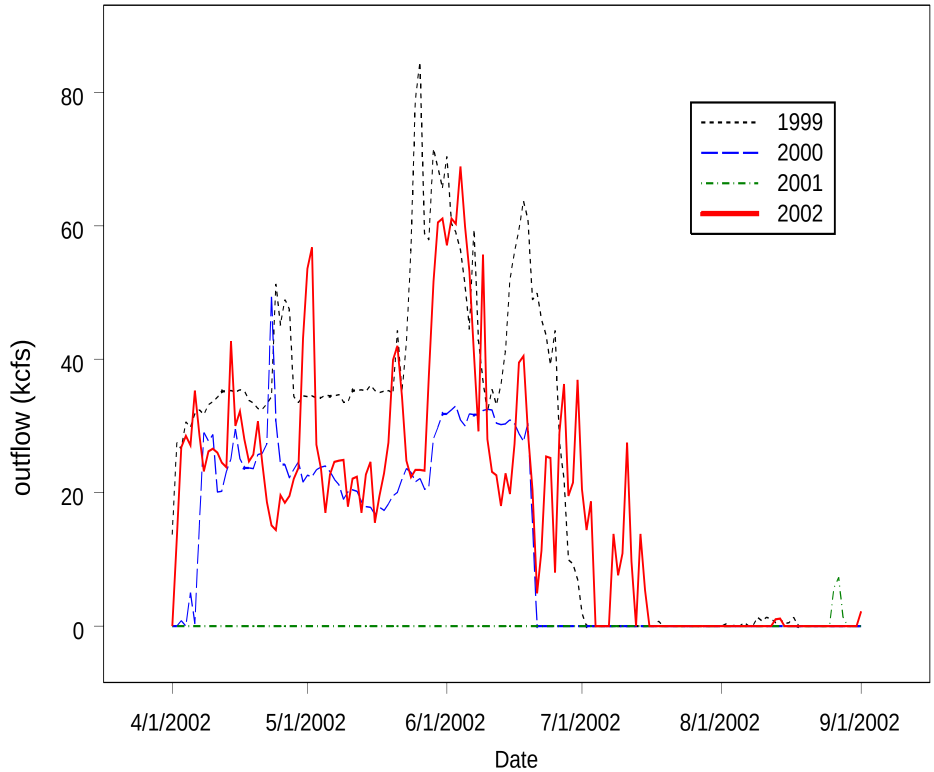
Figure 2.3: Outflow volumes at Lower Granite Dam, April 1-September 1, for 1999, and 2000, 2001, 2002. Inseason classification determined 2000 was a standard flow year, that 1999 was a high flow year, and 2001 was a low-flow year.



2.5 Migration Year 2002

Migration year 2002 was a standard flow year with little to report in the way of unusual events. Spill was normal for a standard to high-flow year (Figure 2.4). Some patterns were observable in the run-timing characteristics but no pattern extended to all stocks. Subyearling fall chinook salmon smolts from the Snake River had a very short migration period, particularly the middle 80% of the run (i.e., passage between the 10th and 90th percentiles). Some stocks had a very early run, including the subyearling fall chinook from the Snake River migrating to Lower Granite Dam, and 5 of the wild PIT-tagged release-recovery stocks of spring/summer yearling chinook salmon detected at Lower Granite Dam. And finally, the rate of detection of fish at the facilities was very different from expected for a large number of stocks. However, there was not ubiquitous pattern observed. Some rates of detections were much smaller (yearling chinook salmon stocks) and others were much larger (e.g., sockeye and steelhead stocks) than expected.

Figure 2.4: Spill in kilo-cubic feet per second (kcfs) at Lower Granite Dam for 1999 (high flow), 2000 (standard flow), and 2001 (low flow), and 2002.



2.6 The RealTime Forecaster

2.6.1 Models and Algorithm

The RealTime forecaster is essentially a pattern-matching algorithm. However, at the beginning of the outmigration there is very little in the way of a pattern to match. To optimize predictions for all phases of the outmigration, the forecaster utilizes three models: a start-up model for initial predictions, the pattern-matching model, and a switching model to govern the timing of the switch between the start-up and pattern-matching models.

The pattern-matching portion is accomplished by a least-squares (LS) model, where the patterns are cumulative percentage curves of outmigrating smolts. Current-year data are compared with historical cumulative percentage curves by comparing their slopes at each percentile, $j = 1, \dots, 100$, using the measure

$$\sum_{j} (s_j - s_{ijp})^2 \quad , \tag{2.3}$$

where s_j is the slope at the j^{th} percentile of current-year data to-date and s_{ijp} is slope at the j^{th} percentile of p percent of historical year i 's outmigration. The value of p that minimizes (2.3), i.e.,

$$\min_{p} \left[\sum_{j=1} (s_j - s_{ijp})^2 \right], \qquad p = 0, \ldots, 100 \tag{2.4}$$

is the best predictor from the point of view of pattern-matching to historical year i.

The start-up model produces run-percentage (RP) estimates

$$\hat{P}_{\text{RP}} = \frac{x_d}{E(\hat{S})}, \tag{2.5}$$

where x_d is the total number of fish observed by day d of the outmigration, and $E(\hat{S})$ estimates the total expected outmigration to the detection facility. The expectation is estimated differently, depending on the type of data. For tagged stocks for which there is reliable annual release/recapture data (i.e., the 21 release-recovery stocks monitored at Lower Granite Dam, Section 2.1.1), $E(\hat{S}) = \bar{r} \cdot N$, where $\bar{r}$ is the average of the annual historical recapture percentages (annual recapture percentage is the number of detections divided by the number released) at the detection facility, and N is total number of fish released from the release site the previous year (for yearling chinook salmon) or earlier in the year (for subyearling chinook and sockeye salmon). Table 2.3 displays N, $\bar{r}$, and $E(\hat{S})$ for each release-recovery stock. For index-count data such as FPC

Table 2.3: Data used by Program RealTime in 2002 to compute initial predictions (formula 2.5), for PIT-tagged release-recovery stocks of wild Snake River spring/summer yearling chinook salmon, hatchery sockeye salmon, and wild PIT-tagged Snake River subyearling fall chinook salmon[a]. Column (1) is the number, N, of PIT-tagged parr released by site. Column (2) shows historical averages of annual recapture percentage for each site. Column (3) contains expected number of detections for the 2002 migration year.

Tagging Location	(1) Parr released, N	(2) Average Historical %, $\bar{r}$	(3) $\hat{E}(S)$
Bear Valley Creek	1495	11.2	168
Big Creek	409	10.1	41
Catherine Creek	970	11.5	111
Chamberlain Creek, West Fork	527	5.8	31
Clear Creek	729	13.4	98
Elk Creek	1519	12.9	196
Grande Ronde River	193	11.6	22
Imnaha River	1001	11.4	114
Johnson Creek	235	11	26
Lake Creek	3193	9.8	313
Lemhi River	700	12.4	86
Lolo Creek	1932	14.3	276
Lookingglass Creek	2185	11.5	251
Lostine River	903	14.2	128
Marsh Creek	1056	8.7	92
Minam River	1533	13.3	204
Salmon River, South Fork	1534	8.2	125
Secesh River	4285	11.2	482
Valley Creek	1497	5.9	89
Sockeye Composite (ALTULC, RLCTRP, SAWTRP)	2836	23.8	675
Wild Subyearling Fall Chinook Salmon Tagged and Release between Snake River km 224 and 268	2402	24.7	593

a.Data Sources: PTAGIS Databases and RealTime program output as of 15 December 2002.

passage indices and PIT-tagged aggregates (Section 2.1.1), $E(\hat{S})$ is the expected number of fish detections. Table 2.4 displays expected observed counts for each index-count stock.
The RP estimates, (2.5), are more accurate than LS (pattern-matching) estimates (2.4) initially, but are quickly outperformed by LS estimates as the season progresses (Townsend et al., 1995, 1996, 1997).

The switching model is an age-of-run (AR) model based on mean fish run age (MFRA). This switching model weights the predictions from the LS and RP models differentially as the outmigration season progresses. Thus each model provides its unique estimate for the true passage percentile for the day, and the algorithm computes the best estimate by minimizing a complex formula including estimates from each model and estimates of the error of each model estimate (see Burgess et. al, 1998 for complete algorithm details). The forecaster effectively combines age-of-run (AR) and run percentage (RP) indicators together with the least-squares (LS) pattern-matching principle into a single, more accurate and robust predictor.

2.6.2 Precision of Estimator: Confidence Intervals for $\hat{P}$

Each day of the run, a jackknife confidence interval is constructed for the daily prediction estimate, $\hat{P}$ (Section 2.6.1). Jackknifing is a computer-intensive method of extracting sampling distribution information about an estimator by recomputing the estimator from different subsets of the historical data. A jackknife subset consists of the complete set of historical years minus one year. If a release site has, say, six years of historical data, there will be 6 subsets of 5 years each. A prediction is estimated from each subset, and these jackknife predictions provide a measure of dispersion on which the daily confidence interval is based.

Table 2.4: Data used by Program RealTime in 2002 to compute initial predictions (formula 2.5) for index-count stocks. Average historical expected observed counts[a] of index-count stocks (runs-at-large) monitored and forecasted by RealTime in 2002 are used to predict current year expected numbers of counts, $\hat{E}(S)$, (Section 2.6.1) for initial predictions using the run percentage (RP) model.

Rearing	Type of Data	Stock	Passage Predictions made at	$\hat{E}(S)$
Wild	PIT-tag	Spring/Summer Yearling Chinook	Lower Granite Dam	10241
		Steelhead		6566
		Snake River Subyearling Chinook Salmon	McNary Dam	171
		Upper Columbia River Subyearling Chinook Salmon		1612
		Snake River Yearling Chinook Salmon		7273
		Snake River Sockeye Salmon		214
		Snake River Steelhead		2132
		Upper Columbia River Steelhead		1366
		Snake and Upper Columbia River Steelhead		3401
Combined Wild and Hatchery	FPC Passage Indices	Subyearling Chinook Salmon	Rock Island Dam	16311
		Yearling Chinook Salmon		27307
		Coho Salmon		35637
		Sockeye Salmon		13706
		Steelhead		19872
		Subyearling Chinook Salmon	McNary Dam	7843083
		Yearling Chinook Salmon		2182610
		Coho Salmon		307765
		Sockeye Salmon		602611
		Steelhead		703016
		Subyearling Chinook Salmon	John Day Dam	1592185
		Yearling Chinook Salmon		907868
		Coho Salmon		349834
		Sockeye Salmon		235136
		Steelhead		833019

a. Data Sources: PTAGIS and FPC Smolt Index Databases and RealTime program output as of 15 December 2001.

2.6.3 Evaluating RealTime Performance

The true outmigration percentile on day d (i.e., P_d) can only be observed after the run is finished (i.e. $P_{last} = 100\%$). When the run is over, we evaluate RealTime's performance using the mean absolute difference (MAD) between observed outmigration percentiles, P_d, and their estimates, $\hat{P}_d$, for all days, d:

$$MAD = \frac{\sum_{d=1}^{n} \left|\hat{P}_d - P_d\right|}{n} \times 100\%$$

where *n* is the total number of days in the outmigration run for the season.

3.0 Results

3.1 Wild ESUs

3.1.1 PIT-tagged Subyearling Chinook Salmon

Release-recovery Stock Monitored at Lower Granite Dam

The stock of subyearling fall chinook salmon smolts captured, PIT-tagged and released during April through July into the Snake River, near its confluence with the Salmon River (Section 2.1.1) has been monitored by the RealTime project since 1999. MADs (Section 2.6.3) are given for the first and last halves of the outmigration, and for the entire outmigration (Table 3.1). The first half the migration was well-predicted (unusually well, in fact), with a MAD of 1.8% (Table 3.1). The last half predictions of passage percentages were later than the true observed percentages. The last-half and season-wide MADs (6.2% and 5.2%,respectively), though slightly larger than last year (5.4% and 4.8, respectively), were still very good. In 2002 the number of days between the 10th percentile of fish passage at Lower Granite Dam and the 90th percentile, referred to as the *middle 80% period*, was the shortest on record of only 27 days compared to the expected 54 days (Figure B23, Table B23). The initial ten percent of the fish arrived as usual (the 10th-percentile passage date was close to the mean) but the timing of the 90th percentile was the earliest on record (Figure B23). The number of fish that were detected at Lower Granite Dam was somewhat larger than expected (789 observed, 664 expected).

Table 3.1: Mean absolute deviations (MADs) for the 2001 and 2002 outmigrations to Lower Granite Dam, of PIT-tagged populations of wild Snake River fall subyearling chinook salmon and wild Upper Columbia River subyearling chinook salmon monitored at Lower Granite Dam and McNary Dam. Columns show MADs for the entire run, the first 50% of the run, and the last 50% of the run.

Stock	2001			2002		
	Entire Run	First 50%	Last 50%	Entire Run	First 50%	Last 50%
Wild PIT-tagged Fall Subyearling Chinook Salmon released between river kilometers 224 and 268 (SNAKER) and recovered at Lower Granite Dam	4.8	3.3	5.4	5.16	1.80	6.17
All Wild PIT-tagged Snake River Subyearling Chinook Salmon Detected at McNary Dam	4.7	3.7	5.3	7.20	15.68	4.68
All Wild PIT-tagged Upper Columbia River Subyearling Chinook Salmon Detected at McNary Dam.	7.9	1.8	10.0	3.42	1.61	3.92

Index-Count Stocks Monitored at McNary Dam

The passage characteristics of the wild PIT-tagged run-at-large of Snake River subyearling fall chinook (of which the SNAKER population is a subset) monitored at McNary Dam were similar to the passage characteristics of fish monitored at Lower Granite Dam. The 10th percentile passage date was close to the historical average, but the 90th percentile passage date was early (Figure B25, Appendix B). The first half of the run was not as well-predicted as last year (MAD = 15.7% in 2002 compared to 3.7% in 2001, Table 3.1) but the last half was predicted better (4.7% compared to 5.3% in 2001). The season-wide MAD of 7.2%, was up from last year (2001 MAD = 4.7%).

The first-half MAD in 2001 for the run-at-large of wild PIT-tagged Columbia River subyearling fall chinook monitored at McNary Dam was very good (1.8%) but this year's was even better (MAD = 1.6%). The last-half and season-wide MADS were also very good this year, 3.9% and 3.4%, respectively, compared to 10.0% and 7.9%, respectively in 2001. The passage timing characteristics were close to the average historical run-timing characteristics (Figure B26, Appendix B).

3.1.2 PIT-tagged Yearling Chinook Salmon

Release-recovery Stocks Monitored at Lower Granite Dam

An overall indicator of Program RealTime forecasting performance for the 19 wild PIT-tagged yearling chinook salmon release-recovery stocks is the RealTime Select composite stock (Section 2.1.1 for definition). This year's RealTime Select composite included all 19 stocks, meaning every stock met the original RealTime historical data criteria of three years with at least 30 detections each (Section 2.1.1). There were far fewer fish observed by season's end for this composite stock (336) than were expected (2854) and the observed percentages were earlier than predicted throughout the season (Figure 3.1). Sixteen of the 19 release-recovery stocks had fewer fish in their outmigrations than were expected, or, equivalently, smaller-than-expected recapture percentages (Table 3.2). Passage percentiles for ten of the 19 stocks were initially predicted to be earlier than the observed percentiles, including Bear Valley Creek (Figure A1, Appendix A),

Figure 3.1: Comparison of RealTime daily predictions of fish passage to Lower Granite Dam with the actual year-end distribution of the RealTime Select Composite run (Section 2.1.1), a composite of all 19 PIT-tagged spring/summer yearling chinook release-recovery stocks.

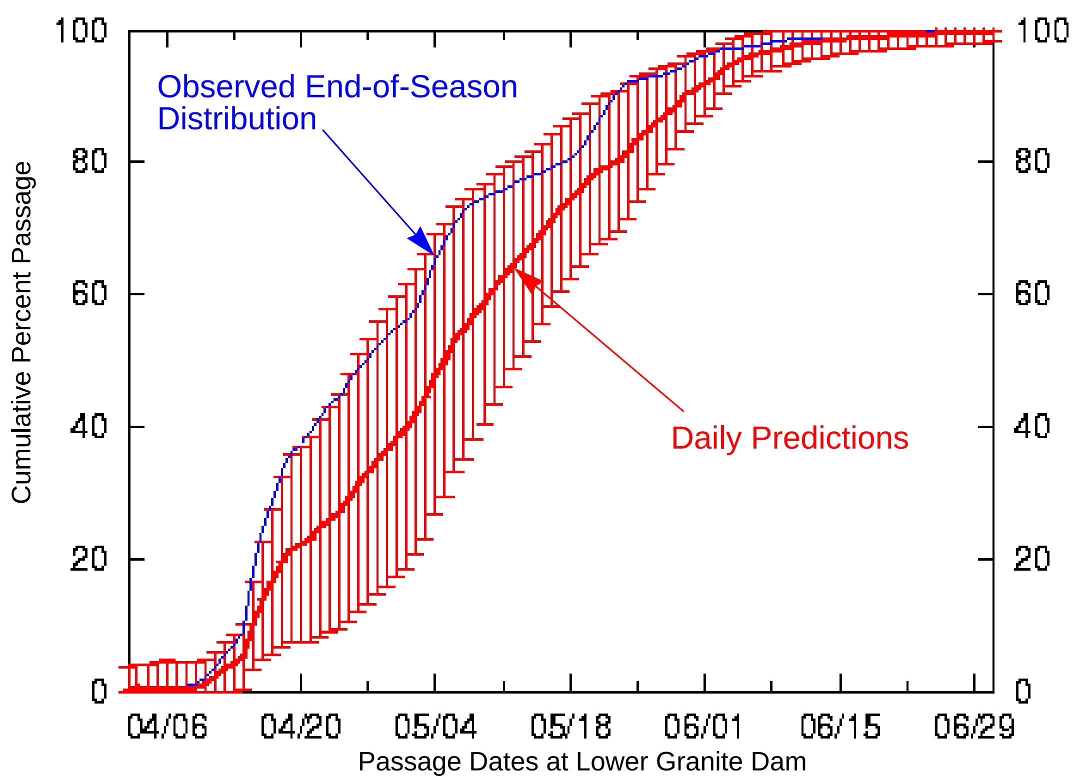


Table 3.2: Comparison of observed versus expected total (spill-adjusted) fish detected (Columns 1 and 2) at Lower Granite Dam for each release-recovery stock of yearling chinook salmon stocks monitored by Program RealTime in 2002, and comparison of observed versus historical average recapture percentages (Columns 3 and 4). Average recapture percentages are fundamental to making initial fish passage predictions (Sections 2.6). Most stocks showed smaller-than-average recapture percentages (fewer than expected fish) in 2002.

Tagging Location	(1) Observed Detections	(2) Expected No. Detections $\hat{E}(S)$	(3) Observed Recapture Percentage	(4) Average Historical %, $\bar{r}$
Bear Valley Creek	128	168	8.6	11.2
Big Creek	75	41	18.3	10.1
Catherine Creek	82	111	8.5	11.5
Chamberlain Creek, West Fork	57	31	10.8	5.8
Clear Creek	82	98	11.3	13.4
Elk Creek	76	196	5.0	12.9
Grande Ronde River	22	22	11.5	11.6
Imnaha River	33	114	3.3	11.4
Johnson Creek	22	26	9.6	11.0
Lake Creek	208	313	6.5	9.8
Lemhi River	61	86	8.7	12.4
Lolo Creek	167	276	8.6	14.3
Lookingglass Creek	158	251	7.2	11.5
Lostine River	112	128	12.4	14.2
Marsh Creek	90	92	8.5	8.7
Minam River	150	204	9.8	13.3
Salmon River, South Fork	70	125	4.6	8.2
Secesh River	350	482	8.2	11.2
Valley Creek	90	89	6.0	5.9

Catherine Creek (Figure A2), Elk Creek (Figure A3), Imnaha River (Figure A4), Johnson and Lake Creeks (Figure A5), Lemhi River and Lolo Creek (Figure A6), Lookingglass Creek (Figure A7), and Salmon River South Fork (Figure A8). Passage timing characteristics were not out-of-the-ordinary for the Select composite or its constituents (Appendix B).

Table 3.3 displays the mean absolute differences (MADs, Section 2.6.3) of RealTime predictions for this composite and its constituents for 2002, and comparisons to 2001 MADS where applicable. The RealTime Select composite run was predicted with less accuracy than last year. The first-half MAD was 5.8% compared to 3.2% last year, last-half MAD was 5.2% compared to 2.7% last year and the full-season MAD was 5.4% compared to 2.8% last year.

Table 3.3 shows that the average MAD for the first half of the 2002 outmigration, averaged over all stocks, was 6.9% compared to 7.6% in 2001, an improvement over last year. The last-half MAD (averaged over all stocks) was less accurate, 8.8% compared to 6.8% in 2001. The season-wide MAD averaged over all stocks was 8.1% compared to 7.0% in 2001. The range of MADs from best to worst was quite large this year due to the exceptionally small run from the Imnaha River, which was responsible for the unprecedentedly large MADs for that site of 19.4% for the first-half, 35.5% for the last-half and 30.5% for the full outmigration (Figure A4, Appendix A).

Although the overall indicators for RealTime performance were down this year from last year, a number of individual stocks were better predicted than last year. Of the nine 2002 release-recovery stocks that were also monitored last year, five had smaller season-wide MADs in 2002 than in 2001 (Bear Valley Creek, Catherine Creek, Johnson Creek, Secesh River and Valley Creek, Table 3.3) and 7 out of 12 stocks for which historical averages are available (i.e., those monitored by RealTime more than twice) had smaller-than-average season-wide MADs (Table D1, Appendix D). Five stocks had earlier and or shorter outmigrations than usual but there was no widely discernible pattern in run-timing characteristics for this set of stocks in the 2002 migration year (Appendix B).

Table 3.3: Mean absolute differences (MADs, section 2.6.3) for the 2001 and 2002 outmigrations to Lower Granite Dam of 19 wild PIT-tagged Snake River spring/summer yearling chinook salmon ESUs and the RealTime Select Composite (section 2.1.1). Columns show MADs for the entire run, the first 50% of the run, and the last 50% of the run. All sites met the RealTime historical data criteria.

Tagging Site/Stock Name	2001			2002		
	Entire Run, %	First 50%, %	Last 50%, %	Entire Run, %	First 50%, %	Last 50%, %
Bear Valley Creek	9.1	7.0	10.1	4.29	5.58	3.80
Big Creek	---	---	---	9.26	6.01	10.37
Catherine Creek	6.5	10.0	5.4	3.91	5.45	3.37
Chamberlain Creek, West Fk	---	---	---	10.31	7.90	11.28
Clear Creek	---	---	---	8.12	3.78	8.55
Elk Creek	---	---	---	13.85	17.97	12.59
Grande Ronde River	---	---	---	3.41	1.17	6.25
Imnaha River	5.6	5.1	5.8	30.46	19.40	35.46
Johnson Creek	8.7	6.7	9.6	6.35	6.65	6.10
Lake Creek	---	---	---	8.44	8.99	8.28
Lemhi River	---	---	---	7.57	11.69	5.83
Lolo Creek	---	---	---	8.95	5.10	9.95
Lookingglass Creek	---	---	---	7.75	4.09	8.89
Lostine River	3.0	3.1	3.0	3.04	1.81	3.50
Marsh Creek	---	---	---	8.38	1.48	12.72
Minam River	1.6	2.1	1.3	4.12	5.10	3.28
Salmon River, South Fork	5.2	4.7	5.4	9.25	9.98	8.94
Secesh River	12.1	19.3	9.6	3.23	6.39	2.78
Valley Creek	10.3	10.1	10.4	3.67	2.13	4.74
mean MAD[a]	7.0	7.6	6.8	8.12	6.88	8.77
median MAD[a]	7.1	6.9	6.7	7.75	5.58	8.28
range[a]	10.6	17.2	9.1	27.42	18.23	32.68
Select Composite Run[b]	4.3	3.2	4.9	5.36	5.80	5.19

a.These statistics are based on all release sites for the given year.

b. Combined data from RealTime Select composite sites, processed by Program RealTime as a single population.

Index-Count Stocks Monitored at Lower Granite and McNary Dams

Unlike the individual release-recovery ESUs of wild Snake River yearling chinook salmon, the wild PIT-tagged run-at-large of these fish to Lower Granite Dam had a somewhat larger rate of detection in 2002 than expected and consequently the observed outmigration distribution was later than predicted (Figure A10, Appendix A). In addition and the middle 80% period was the longest on record (Table B21). The last-half MAD for this stock was somewhat larger than in 2001 but the first-half MAD was smaller. The season-wide MAD was 5.2% compared to 3.6% in 2001 (Table 3.4). The run-at-large of wild PIT-tagged Snake River yearling chinook salmon monitored at McNary was extremely well predicted, particularly in the last half of the season (MAD=0.4%, Table 3.4, Figure A13). The season-wide MAD was 0.8%, down from the 3.3% MAD found for 2001.

Table 3.4: Mean absolute deviations (MADs) for the 2001 and 2002 outmigration to Lower Granite and McNary Dams, of the PIT-tagged population of wild Snake River spring/summer yearling chinook salmon. Columns show MADs for the entire run, the first 50% of the run, and the last 50% of the run.

Stock	2001			2002		
	Entire Run	First 50%	Last 50%	Entire Run	First 50%	Last 50%
All Wild PIT-tagged Yearling Chinook Salmon Detected:						
at Lower Granite Dam	3.6	6.0	3.0	5.20	4.49	5.46
at McNary Dam	3.3	4.6	2.9	0.80	3.79	0.36

3.1.3 PIT-tagged Sockeye Salmon

This index-count stock of Snake River fish was monitored at McNary Dam for only the second time in 2002. Only 38 fish were detected last year but 418 were detected this year (Table B18, Table 3.5), nearly twice the expected number of 239 smolts. Initially the observed distribution was later than predicted, then it was earlier than predicted (Figure A14, Appendix A). The first-half MAD was smaller this year than last (3.9% compared to 8.2% last year) and the last-half MAD was somewhat larger, resulting in a slightly smaller season-wide MAD this year than last year (5.6% compared to 6.0% in 2001, Table 3.6).

Table 3.5: Comparison of expected number of detections or passage indices and the observed numbers for all index-count stocks monitored by Program RealTime in 2002.

Rearing/ Type of Data	Salmon Stock	Detection Facility	Expected 2002 Counts	Observed 2002 Counts
Wild/ PIT-tag	Spring/Summer Yearling Chinook	Lower Granite Dam	10241	11503
	Steelhead		6566	10265
	Snake River Subyearling Chinook	McNary Dam	171	510
	Columbia River Subyearling Chinook		1612	1521
	Snake River Yearling Chinook		7273	18235
	Snake River Sockeye		214	418
	Snake River Steelhead		2132	10426
	Columbia River Steelhead		1366	329
	Snake, Columbia River Steelhead		3401	10753
Combined Wild and Hatchery/ FPC Passage Indices	Subyearling Chinook	Rock Island Dam	16311	25462
	Yearling Chinook		27307	28982
	Coho		35637	86227
	Sockeye		13706	20629
	Steelhead		19872	28714
	Subyearling Chinook	McNary Dam	7843083	8384676
	Yearling Chinook		2182610	3519374
	Coho Salmon		307765	201998
	Sockeye		602611	1410444
	Steelhead		703016	794572
	Subyearling Chinook	John Day Dam	1592185	3448212
	Yearling Chinook		907868	2112370
	Coho Salmon		349834	316507
	Sockeye		235136	936132
	Steelhead		833019	547546

Table 3.6: Mean absolute deviations (MADs) for the 2001 and 2002 outmigrations to McNary Dams, of the PIT-tagged population of wild Snake River sockeye salmon. Columns show MADs for the entire run, the first 50% of the run, and the last 50% of the run.

	2001			2002		
Stock	Entire Run	First 50%	Last 50%	Entire Run	First 50%	Last 50%
All Wild PIT-tagged Sockeye Salmon Detected at McNary Dam	6.0%	8.2%	5.6%	5.63	3.91	7.29

3.1.4 PIT-tagged Steelhead Trout

The number of wild PIT-tagged Snake River steelhead, detected at Lower Granite Dam, was larger than expected in 2002 (10,265 smolts in 2002 compared to the expected number, the historical average of 6566 smolts, Table 3.5). The middle 80% period was also the longest on record (Figure B24, Table B24, Appendix B). Probably because of these unusual outmigration characteristics the passage percentiles were not as well predicted in 2002 as in 2001. The first-half MAD was 9.8% in 2002 compared 2.7% in 2001 and the last-half MAD was 5.7% in 2002 compared to 1.6.% in 2001 (Table 3.7).

The character of RealTime predictions for the stock of Snake River wild PIT-tagged steelhead forecast at McNary was similar to that at Lower Granite Dam (Figure A13, Appendix A). The

observed outmigration distribution was later than predicted throughout the season, probably due to fact that there were many more smolts detected than were expected (Table 3.5), and the middle 80% period was the longest on record (Table B29, Appendix B). The stock was extremely well-predicted last year and not as well this year. The 2002 season-wide MAD was 4.6% compared to 1.4% in 2001 (Table 3.7).

The PIT-tagged run-at-large of Upper Columbia wild steelhead was also not as well-predicted this year as last. The season-wide MAD was 4.3% compared to 2.3% in 2001 (Table 3.7). However, unlike the Snake River run, this stock had many fewer fish detections than were expected (329 compared to 1366 expected, Table 3.5) and consequently the observed passage percentiles were reached earlier than predicted (Figure A14, Appendix A). Run-timing characteristics for this stock were not out-of-the-ordinary (Table and Figure B30).

Table 3.7: Mean absolute deviations (MADs) for the 2001 and 2002 outmigrations to Lower Granite Dam, of the PIT-tagged subpopulations of wild Snake River fall subyearling chinook salmon, spring/summer yearling chinook salmon and steelhead. Columns show MADs for the entire run, the first 50% of the run, and the last 50% of the run.

	2001			2002		
Stock	Entire Run	First 50%	Last 50%	Entire Run	First 50%	Last 50%
All Wild PIT-tagged Snake River Steelhead Detected at Lower Granite Dam	1.8	2.7	1.6	6.79	9.83	5.72
All Wild PIT-tagged Snake River Steelhead Detected at McNary Dam	1.4	1.6	1.4	4.64	8.95	3.82
All Wild PIT-tagged Upper Columbia River Steelhead Detected at McNary Dam	4.9	8.0	3.2	10.55	14.03	9.79
All Wild PIT-tagged Steelhead Detected at McNary Dam	2.3	3.2	2.0	4.33	8.22	3.57

3.2 Hatchery-reared ESUs

The only hatchery-reared PIT-tagged stock monitored by Program RealTime since its inception has been the summer-run sockeye reared and released in the Redfish Lake area. In 2001 and in 2002, the stock was a composite of smolts released into Alturas Lake Creek, Redfish Lake Creek Trap and Sawtooth Trap. First-half predictions were better than last year (MAD = 6.8%, Table 3.8) but last-half predictions were substantially worse (MAD = 22.0% compared to 5.5% in 2001). The recovery percentage at Lower Granite Dam was much smaller than average, at 11.2% this year, compared to 29.8% historically. Many fewer fish than expected were detected at Lower Granite Dam (317 compared to an expected 844). These unusual characteristics, and the fact that the middle 80% period was longer than average resulted in the observed distribution being earlier than predicted (Figure A11, Appendix A). The season-wide MAD was 18.3% this year compared to 6.4% last year.

Table 3.8: Mean absolute deviations (MADs, section 2.6.3) for the 2001 and 2002 outmigrations to Lower Granite Dam of the PIT-tagged hatchery-reared composite stock from Alturas Lake Creek, and Redfish Lake Trap and Sawtooth Trap. Columns show MADs for the entire run, the first 50% of the run, and the last 50% of the run.

	2001			2002		
Stock	Entire Run	First 50%	Last 50%	Entire Run	First 50%	Last 50%
Composite Sockeye Run	6.4	11.3	5.5	18.28	6.76	22.01

3.3 Combined Wild and Hatchery Runs-At-Large

The runs-at-large of combined wild and hatchery-reared stocks for subyearling and yearling chinook salmon, coho and sockeye salmon, and steelhead trout were monitored and forecasted at Rock Island Dam on the Mid-Columbia River and at McNary and John Day Dams on the main-stem Columbia River in 2002.

The run of subyearling chinook salmon monitored at Rock Island Dam was, on the whole, better predicted this year than last year. The season-wide MAD was 5.7% compared to 9.1% in 2001 (Table 3.9), even though the first-half MAD was somewhat larger this year than last. The subyearling chinook salmon outmigration to McNary Dam was as expected more or less, in terms of expected run-timing and numbers counted, and it was very well predicted throughout the run (Figure A15) with season-wide MAD of 1.7% compared to 6.3% last year. RealTime forecasting performance was better in the first half of the season for predicting run-timing of subyearling fall chinook at John Day Dam than it was last year, and very similar to last year for the last-half resulting in an improved season-wide MAD of 6.5% compared to 10.0% last year (Table 3.9).

Program RealTime predictions for yearling chinook salmon at Rock Island Dam were excellent (first-half MAD = 2.0%, last-half MAD = 1.1% and season-wide MAD = 1.3%, a great improvement over last year which had a season-wide MAD of 7.7%, Table 3.9). The character of predictions of the mainstem Columbia River run of yearling chinook salmon to McNary Dam and to John Day Dam, compared to the observed distributions was similar (Figures A16 and A17). At

McNary dam the season-wide MAD was 1.8% compared to 5.7% last year reflecting the superior last-half performance this year (Table 3.9). The season-wide MAD for yearling chinook salmon passage at John Day Dam was 2.8%, an excellent forecast, largely due to the excellent last-half predictions (last-half MAD = 2.0%). This run was not monitored at John Day Dam last year so comparison with last year's performance is not available.

RealTime performance in predicting the run of coho salmon to Rock Island Dam was also excellent this year (Figure A19). The full-season MAD was 2.1%, even better than last year's 3.7%. Predictions of run-timing for these fish at McNary and John Day Dams were also very

Table 3.9: Mean absolute deviances (MADs, section 2.6.3) for the 2001 and 2002 outmigrations to Rock Island, McNary, and John Day dams of FPC passage indices of the combined wild and hatchery runs-at-large of salmon and steelhead. Columns show MADs for the entire run, the first 50% of the run, and the last 50% of the run.

Run-of-Year	2001			2002			Forecast to
	Entire Run	First 50%	Last 50%	Entire Run	First 50%	Last 50%	
Subyearling Chinook Salmon	9.1	6.8	10.8	5.71	8.67	3.70	Rock Island Dam
Yearling Chinook Salmon	7.7	13.5	5.8	1.30	1.96	1.06	
Coho Salmon	3.7	5.6	3.2	2.13	4.77	1.10	
Sockeye Salmon	12.8	3.6	15.9	4.99	6.51	4.55	
Steelhead	4.1	9.7	1.3	2.76	4.12	2.14	
Subyearling Chinook Salmon	6.3	4.9	6.6	1.66	1.14	1.75	McNary Dam
Yearling Chinook Salmon	5.70	1.21	7.12	1.8	5.27	1.1	
Coho Salmon	2.55	2.84	2.43	1.40	1.79	1.15	
Sockeye Salmon	8.52	1.47	10.92	1.31	4.37	0.77	
Steelhead	9.36	15.14	7.69	2.83	9.96	1.25	
Subyearling Chinook Salmon	10.0	16.0	4.4	6.47	8.66	5.79	John Day Dam
Yearling Chinook Salmon	--	--	--	2.80	4.53	1.95	
Coho Salmon	--	--	--	3.34	4.99	2.05	
Sockeye Salmon	--	--	--	3.03	6.09	1.80	
Steelhead	--	--	--	3.67	2.72	4.21	

good, with the season-wide MAD for coho salmon at McNary Dam at 1.4%, even better than the MAD of 2.6% last year, and the season-wide MAD at John Day Dam for this run at 3.3%.

Season-wide RealTime performance in predicting passage percentiles of sockeye salmon at Rock Island Dam was better this year than last (MAD in 2002 was 5.0% compared to 12.8% last year, Table 3.9). MADs for these stocks at McNary and John Day Dams season-wide were 1.3% at McNary Dam compared to 8.5% last year (Table 3.9) and 3.3% at John Day Dam.

Steelhead trout were more numerous than expected at Rock Island Dam and McNary Dam in 2002, but there were fewer than expected at John Day Dam (Table 3.5). Predictions at Rock Island and McNary Dams were within 3% of the observed distribution season-wide (MAD at Rock Island = 2.8% compared to 4.1% last year; MAD at McNary Dam = 2.8% compared to 9.4% last year). Run-timing characteristics at Rock Island and McNary Dams were close to the historical averages (Figures and Tables B45 and B46). Predictions at John Day Dam for steelhead trout were also good (season-wide MAD = 3.7%) even though run-timing characteristics were unusual (the middle 80% period of steelhead trout passage at John Day Dam was the longest on record, Figure and Table B44).

4.0 Discussion

Program RealTime 2002 performance in predicting run-timing of passage-indexed stocks was very consistent and an improvement over last year and over the historical average for every stock forecasted. The Rock Island and McNary Dam runs were, in 2002, in their third year of inclusion in the RealTime project. The last-half of the outmigration season predictions in 2002 were extremely accurate (see Results section), providing valuable information for water managers concerning the appropriate time to stop spilling the water that promotes fish passage through the spillway. Unlike last year, there were no large releases of hatchery fish early in the season, an event which can produce substantial error in predictions.

Runs-at-large consisting of many thousands or hundreds of thousands of smolts are generally easier to predict than runs of stocks with few fish and from highly specific geographical origins.

Therefore, as expected, Program RealTime predictive performance for the PIT-tagged stocks was less consistent than for the passage-indexed stocks in 2002. Many of these stocks are small even though they are “runs-at-large” (e.g., wild PIT-tagged Snake River sockeye salmon, Section 3.1.3). Although some of these PIT-tagged stocks were predicted with extraordinary accuracy, many were not. In general, poor predictions during 2002 can be traced to two things. Firstly, if the number of detections or counts relative to the expected number is very small or very large, the accuracy of the initial predictions (RP model predictions, see section 2.61) will be adversely affected. Secondly if the run-timing of the outmigration is unusually long or short (often best measured by the middle 80% period of passage) the accuracy of the mid-season predictions (LS or pattern-matching model predictions, sections 2.6.1) will be affected.

The run-at-large of wild PIT-tagged yearling chinook salmon to Lower Granite Dam and the run of wild PIT-tagged subyearling chinook to Lower Granite Dam are examples of abridged or protracted migrations and their effects on run-timing predictions. Both showed close-to-expected detection numbers, and had good first-half predictions (the smallest on record, Tables 3.1, 3.5 and D1 and Figure A10). But season-wide MADs were slightly higher than average for both stocks (Table D1). The effect of the length of the middle 80% period on predictions later in the outmigration is clearly illustrated in Figure A10, which shows the daily predictions and the end-of-season observed distributions for these two stocks. The yearling chinook middle 80% period was the longest on record (70 days compared to an average of 49) while the subyearling chinook middle 80% was the shortest (27 days compared to an average of 54). The result of these unusual run-timing characteristics was to throw predictions off during the last half of the season. Predicted percentages at Lower Granite Dam were too late in the last half of the season for the subyearling chinook salmon stock, and were too early for the yearling chinook stock.

The observed and predicted passage percentiles of wild steelhead at Lower Granite Dam provide another example of the effect on predictive accuracy of disparities between observed and expected PIT-detection numbers or run-timing characteristics (Figure A11, top). The counts of steelhead were larger than expected and the outmigration was longer than expected. Each of these events independently would be likely to produce predictions that are too early, and both of them together produced MADs that were the largest on record for this stock (Table D1, Appendix D).

In some cases, however, large MADs are not easy to explain. Displayed in Figure A11 (bottom) are the observed and predicted passage percentages of hatchery sockeye salmon from the Redfish Lake area forecast to Lower Granite Dam. This run had a smaller-than-expected detection rate which would lead to initial run-timing predictions that are later than the true passage percentages. Often, even though initial predictions are poor, if the run-timing for the rest of the season is normal, there is a closing of the gap between predicted and true passage percentages. This stock demonstrated normal run-timing characteristics and yet MADs continue to get larger as the season progressed and it it is not clear why. While large MADs are sometimes difficult to explain, so can better than expected MADs. Figure A13 shows the daily predictions and observed percentages of the run-at-large of wild PIT-tagged yearling chinook salmon at McNary Dam. There were over twice the number of detections observed than expected. Except for a few days of too-early predictions early in the season, the performance of Program RealTime was astonishingly close to the observed for most of the season. Another stock that was very well-predicted was the run of wild PIT-tagged Columbia river subyearling fall chinook salmon (the season-wide MAD was 3.4% compared to 7.9% last year). Observed detection rates for this stock were very close to expected and run-timing characteristics were typical.

While individual stocks of yearling chinook salmon above Lower Granite Dam were, on the whole, observed arriving earlier than predicted, the run-at-large arrived later than predicted. The outmigrations of the individual release-recovery stocks of yearling chinook salmon to Lower Granite Dam were unusual in 2002 (see Results section) insofar as detections for these stocks were down. Flow and spill were normal at the dam, however, and the reason for this is not clear. The method for selecting these stocks in 2002 was different from previous years (Section 2.1.1). In past years, only stocks PIT-tagged by Steve Achord or Paul Sankovitch were considered for inclusion in the RealTime project but this year there were no stocks tagged by these experienced taggers.

There was a disproportionately large number of extreme run-timing characteristics seen in the stocks monitored by the 2002 RealTime project, the year following a stand-out low-flow migration year. Examples of unusual run-timing characteristics include the release-recovery stock of subyearling fall chinook salmon monitored at Lower Granite Dam which had the shortest middle 80% passage period on record and the run-at-large of subyearling fall chinook salmon to McNary

Dam, which also had the shortest middle passage period on record, as well as far more than expected fish. The run-at-large of wild PIT-tagged Snake River yearling chinook salmon monitored at Lower Granite Dam had the longest middle 80% passage period on record and so did the run-at-large of wild PIT-tagged Snake River steelhead trout monitored at Lower Granite and McNary Dams.

5.0 Recommendations

It is recommended that wild PIT-tagged runs-at-large of subyearling fall chinook salmon, yearling chinook salmon, sockeye salmon and steelhead trout continue to be monitored and forecasted at both Lower Granite and McNary Dams, for the purpose of estimating outmigration timing of ESUs. It is also recommended that the individual stocks from the Salmon, Grande Ronde and Clearwater River drainages continue to be monitored and forecasted to Lower Granite Dam. The large combined wild and hatchery-reared runs-at-large of chinook, coho and sockeye salmon and steelhead trout should also be monitored at Rock Island, McNary and John Day Dams. The RealTime project supplied critical information about passage and run-timing for these stocks in 2002.

In order to further increase the accuracy of Program RealTime, spill effectiveness curves should be adapted for each site based on the best available information from radio-tag, acoustic-tag and hydroacoustic assessments. These site-specific and species-specific curves should be incorporated into Program RealTime and updated as new information is generated.

6.0 Conclusions and Summary

Program RealTime performance in predicting fish passage percentiles of FPC passage-indexed runs-at-large of combined wild and hatchery salmon and steelhead to Rock Island, McNary and John Day dams was excellent in forecasting for these stocks. The last half of the outmigration season for all stocks forecasted at McNary Dam were predicted to within 2% of the true timing on average. The analogous statistics for Rock Island and John Day Dams were 5% and 6%, respectively.

Realtime predictive performance for the 29 PIT-tagged ESUs of wild salmon and steelhead trout monitored by Program RealTime in 2002 to Lower Granite and McNary dams was mixed. There were unexpectedly large numbers of wild PIT-tagged Snake River subyearling and yearling chinook, and sockeye salmon, and of steelhead trout, resulting in predictions that were too early. There were also unexpectedly few hatchery-reared sockeye salmon monitored at Lower Granite Dam and Upper Columbia River steelhead trout, resulting in timing predictions that were too late.

The run of wild PIT-tagged Snake River yearling chinook salmon to McNary Dam was predicted extremely well (season-wide MAD = 0.8%). The run of wild PIT-tagged Snake River yearling chinook was also well predicted (season-wide MAD = 5.2%). It is interesting to note that these fish were detected at a higher-than-expected rate at Lower Granite Dam in 2002, while the individual wild yearling chinook release-recovery stocks had smaller-than-expected detection rates (16 of 19 stocks). While most (7 out of 12) of these individual stocks with more than two years standing in the RealTime project were better-predicted than average, the RealTime Select Composite stock was predicted poorly in 2002 (season-wide MAD =5.4% compared to the historical average of 2.8%). The reason for the poor performance of this normally well-predicted composite was that two stocks, the Imnaha River and Elk Creek stocks from the Salmon and Grande Ronde River drainages respectively, were very poorly predicted this year, with season-wide MADs of 30.5% and 13.9% respectively. These two stocks had the smallest observed detection rates relative to the historical average of all the stocks (30% and 40% of expected, respectively) and run-timing was predicted too late throughout the outmigration. The 19 release-recovery stocks of yearling chinook salmon forecasted at Lower Granite Dam in 2002 were Bear Valley Creek, Big Creek (new), Catherine Creek, Chamberlain Creek- West Fork (new), Clear Creek (new), Elk Creek, Grande Ronde River (new), Imnaha River, Johnson Creek, Lake Creek, Lemhi River (new), Lolo Creek (new), Lookingglass Creek (new), Lostine River, Marsh Creek, Minam River, Salmon River-South Fork, Secesh River, and Valley Creek.

Three out of 9 wild PIT-tagged runs-at-large were better predicted this year than last year, and these were the subyearling chinook salmon run from the Upper Columbia River, and the yearling chinook and sockeye salmon runs from the Snake River, all runs monitored at McNary (season-wide MADs were 3.4%, 0.8% and 5.6%, respectively). The run of wild PIT-tagged Snake River subyearling fall chinook salmon to McNary Dam was less well-predicted this year (season-wide MAD was 7.2%) than last season but the release-recovery stock of subyearling fall chinook salmon smolts to forecast to Lower Granite Dam were predicted fairly well (season-wide MAD = 5.2%), a performance comparable to previous years. Partial explanation for poorer performance in predicting Snake River subyearling chinook salmon passage to McNary may lie in the fact that more fish were detected than expected, while at the same time there was a shorter outmigration than usual. None of the wild PIT-tagged steelhead runs were as well-predicted in 2002 as they were in 2001. The Snake River outmigrations to both Lower Granite and McNary Dams were longer than expected and had higher detection rates than expected. Run-timing predictions for both were too early (season-wide MADs were 6.8% and 4.6%, respectively). The Columbia River run of wild PIT-tagged steelhead trout was not predicted well in 2002 (season-wide MAD was 10.6%). There were fewer than expected detections in this run, and the run-timing was unusually short.

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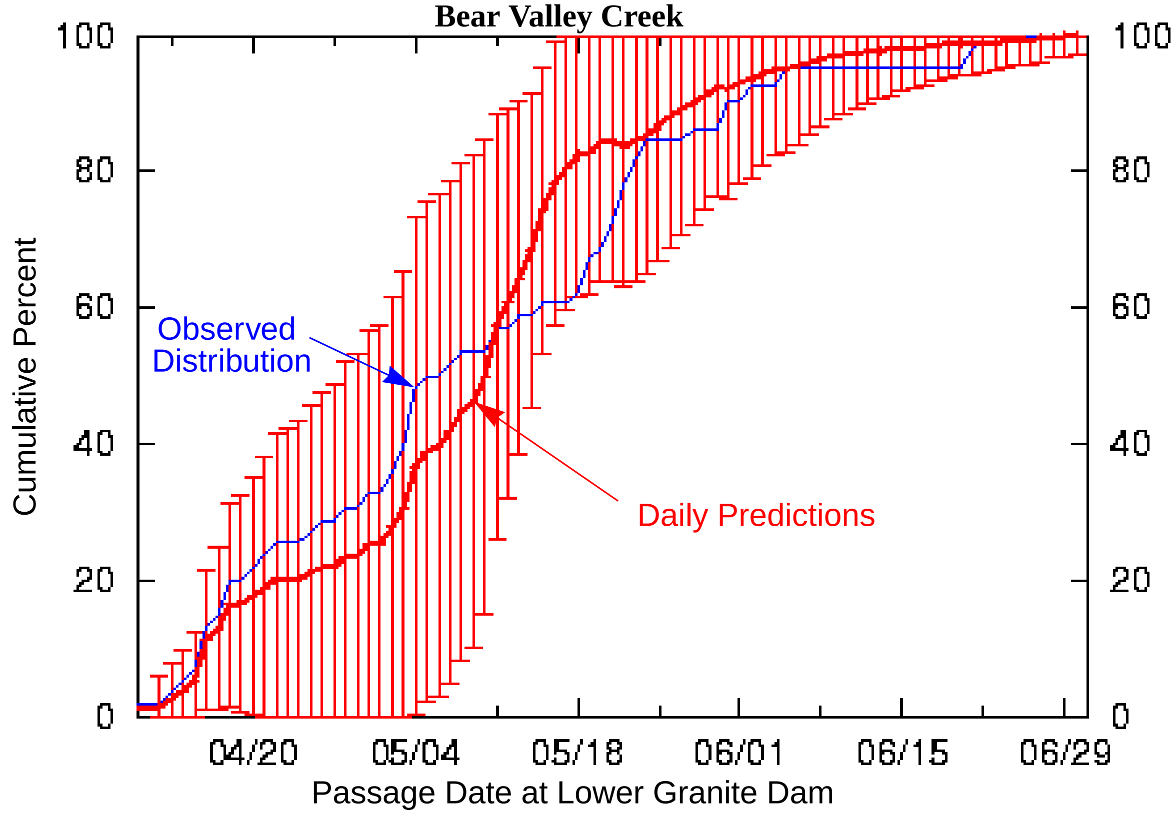
Appendix A

Performance Plots for the 2002 Outmigration Season

Figure A1: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from Bear Valley Creek and Big Creek .



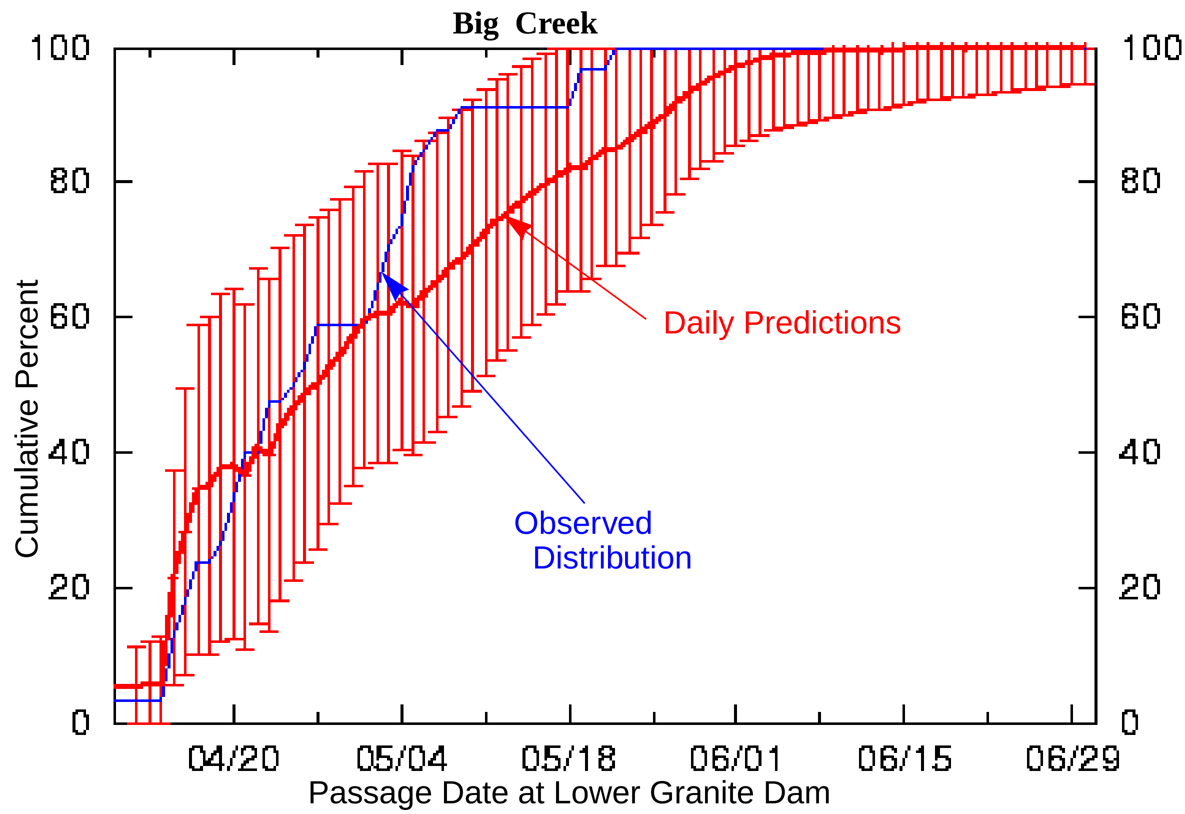
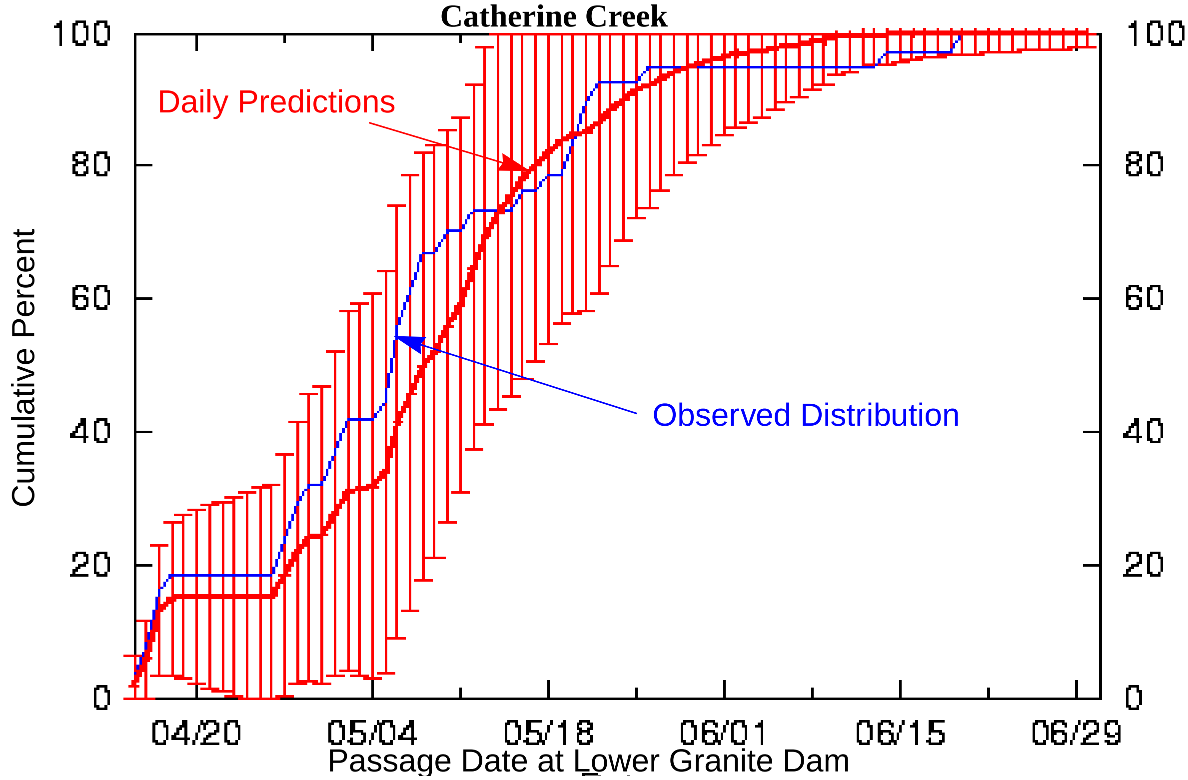


Figure A2: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from Catherine Creek and West Fork Chanberlain Creek.

Catherine Creek



Chamberlain Creek, West Fork

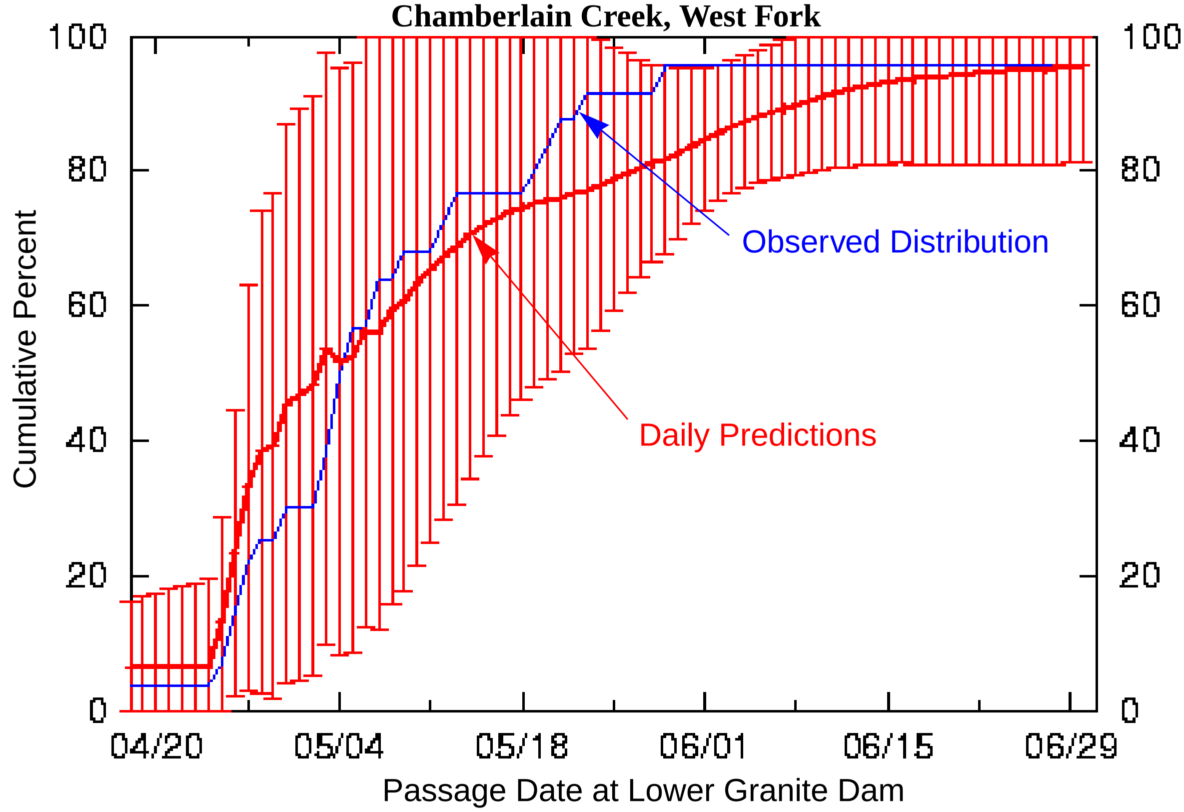


Figure A3: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from Clear Creek and Elk Creek.

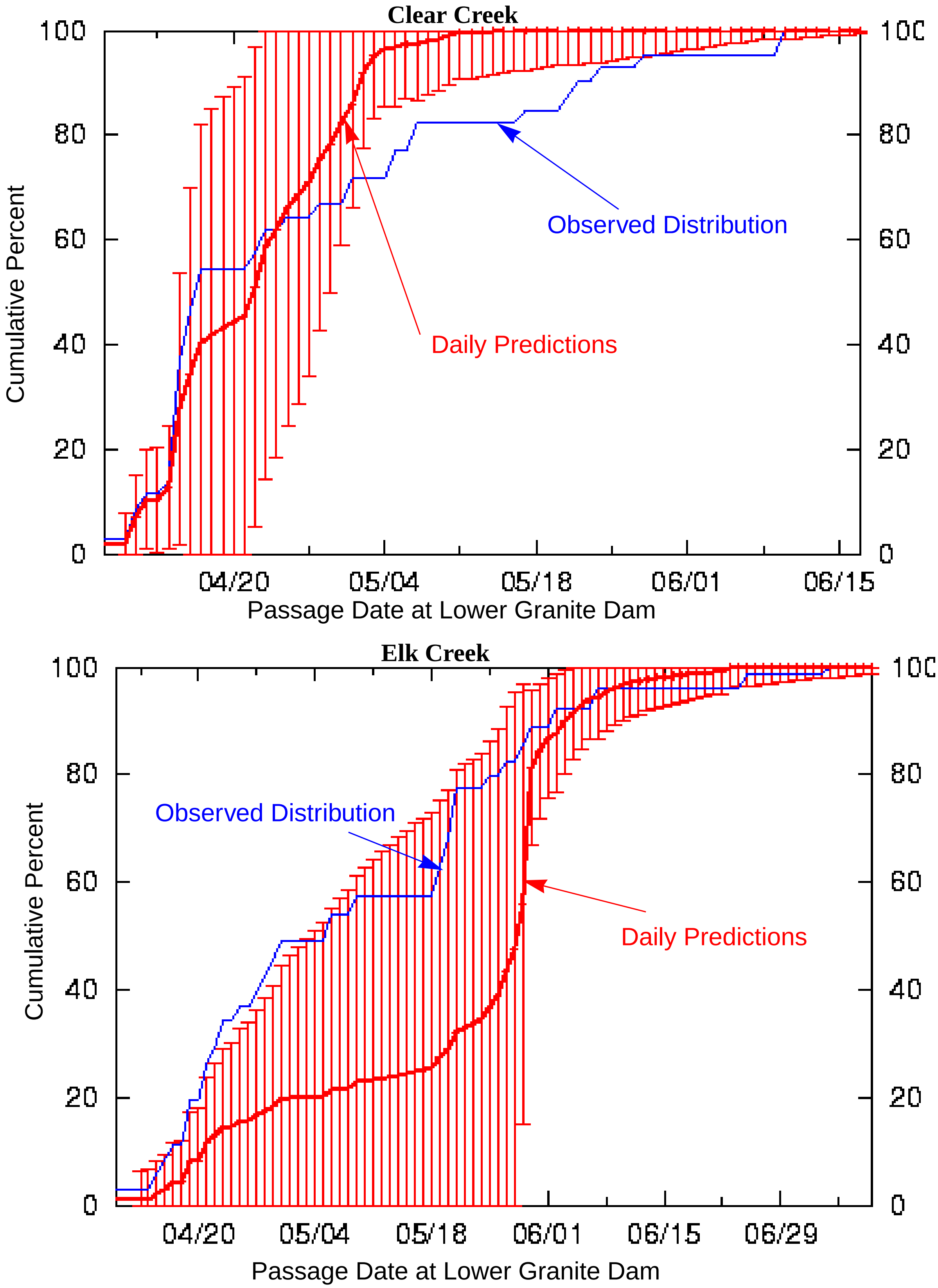
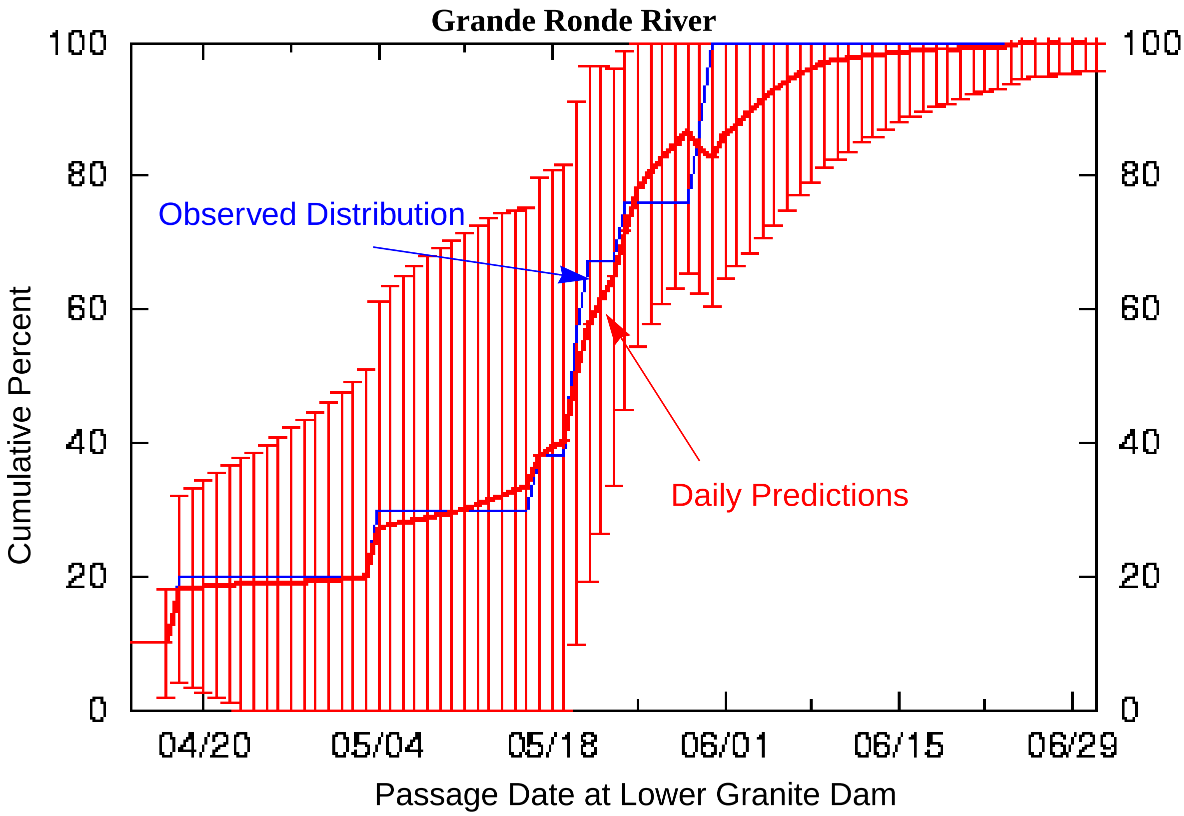


Figure A4: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from Grande Ronde River and Imnaha River.



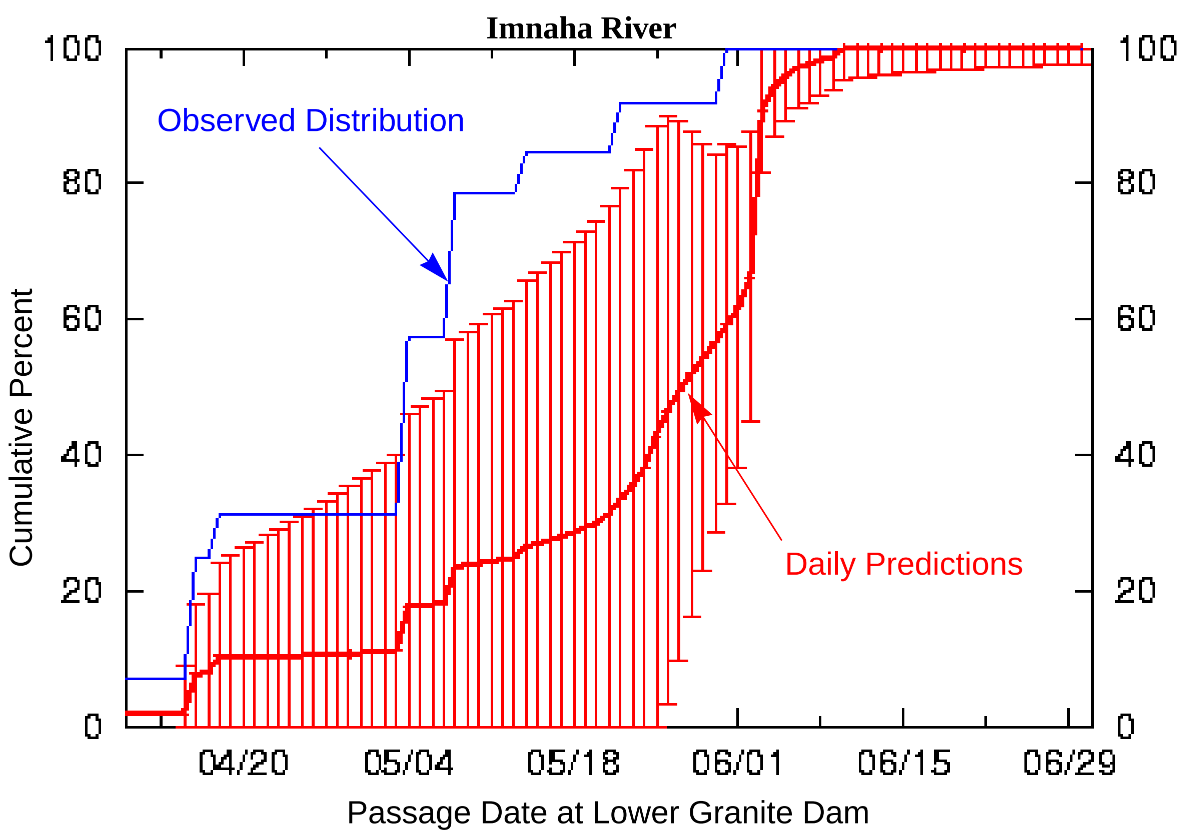
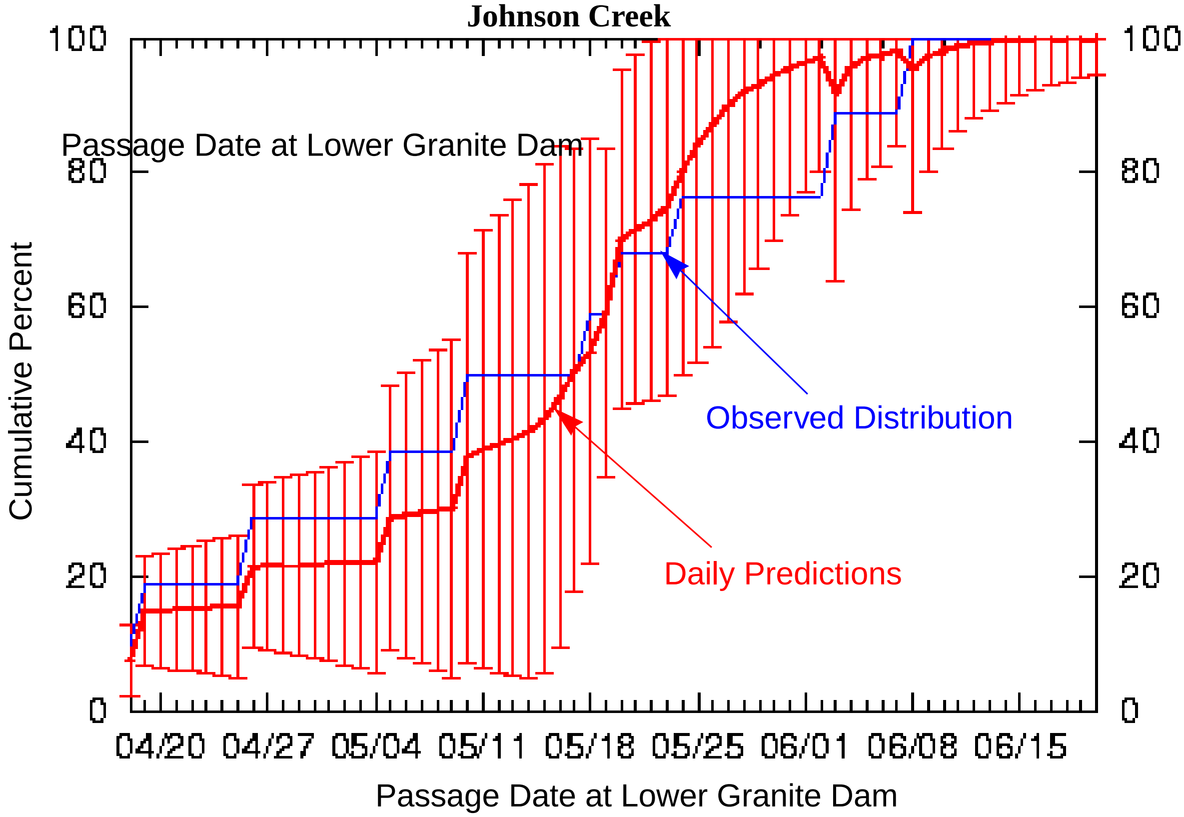


Figure A5: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from Johnson Creek and Lake Creek.



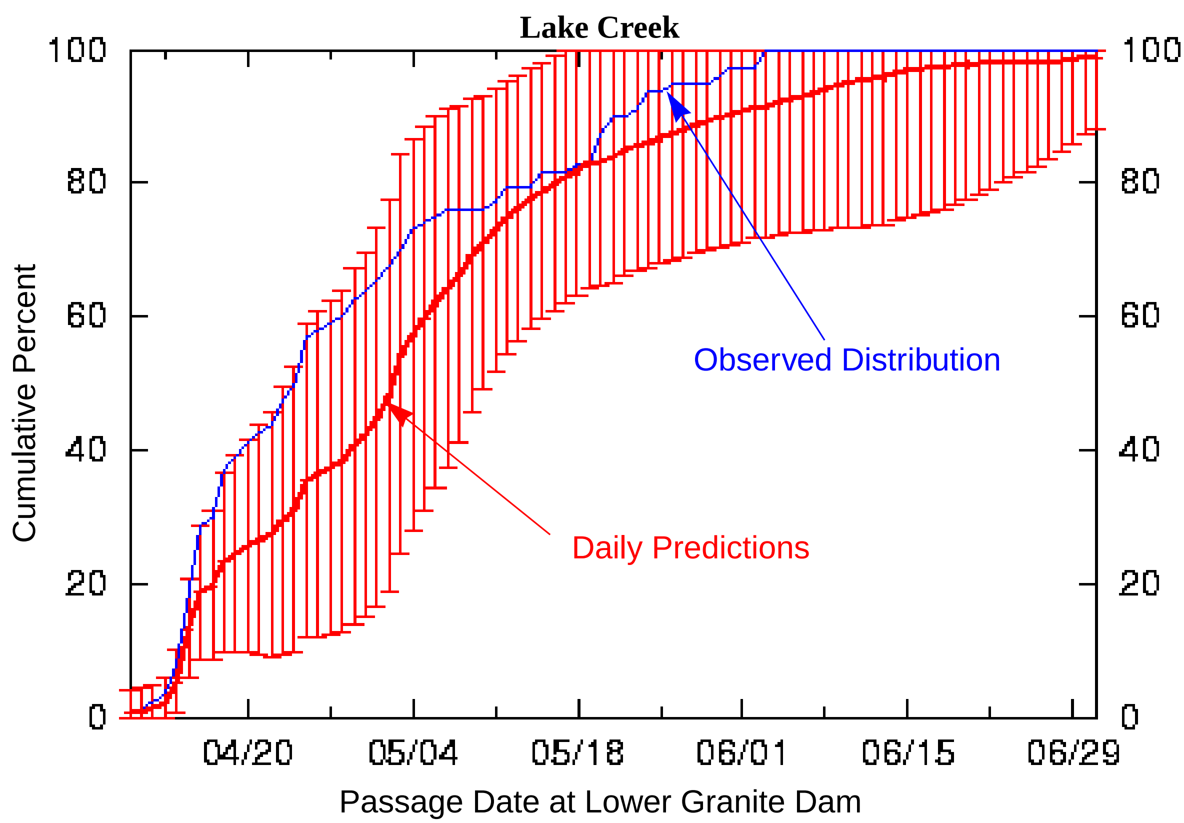
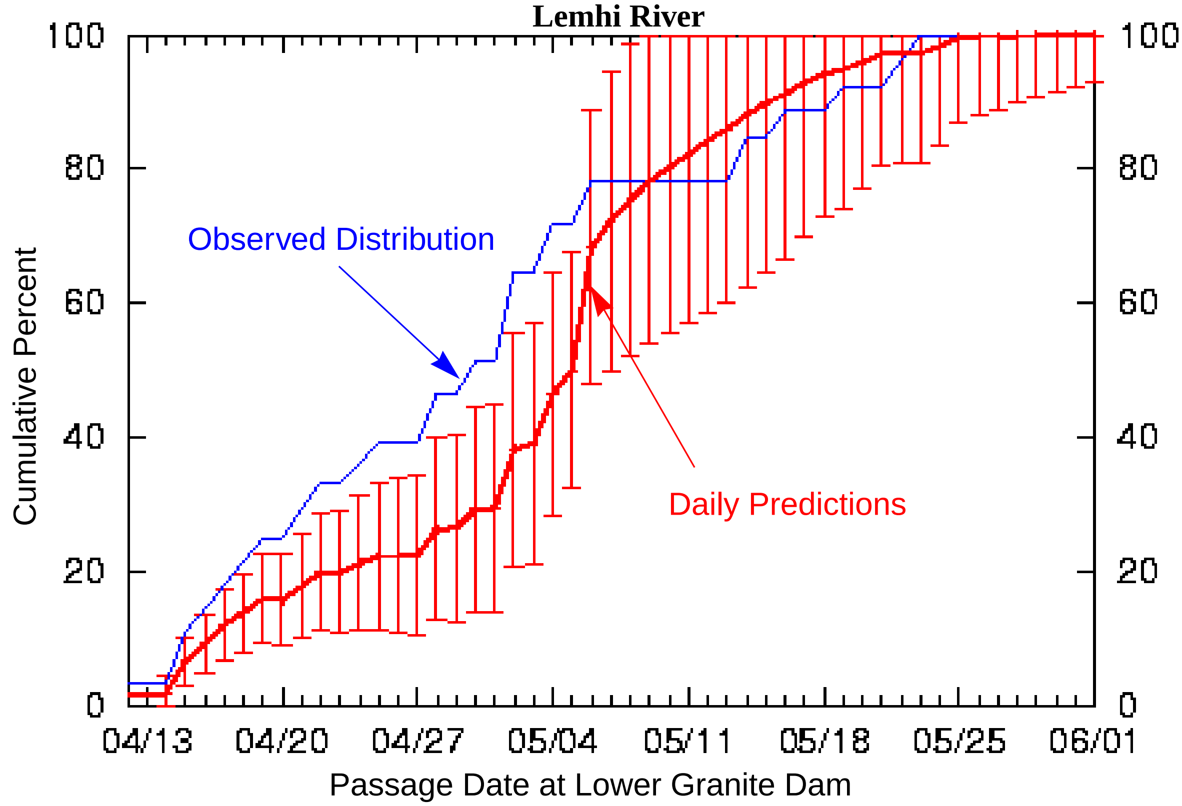


Figure A6: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from Lemhi River and Lolo Creek.



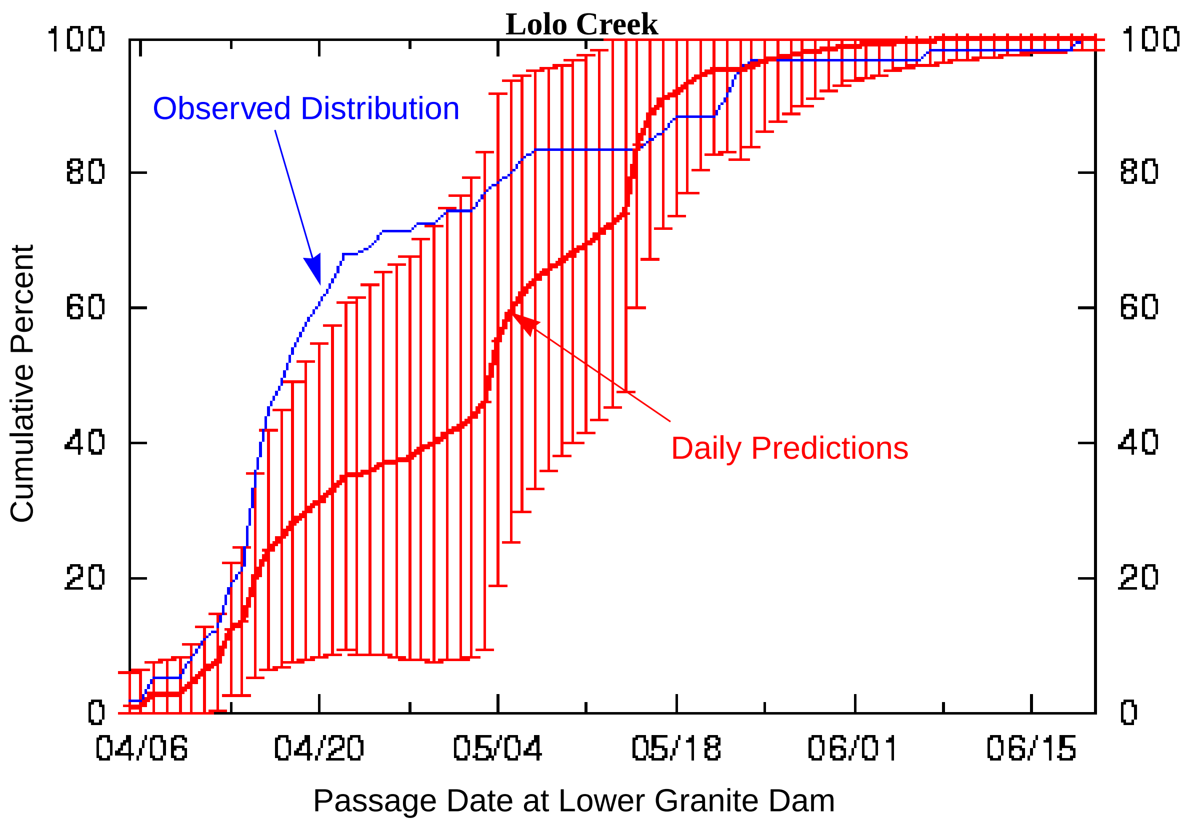


Figure A7: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from Lookingglass Creek and Lostine River.

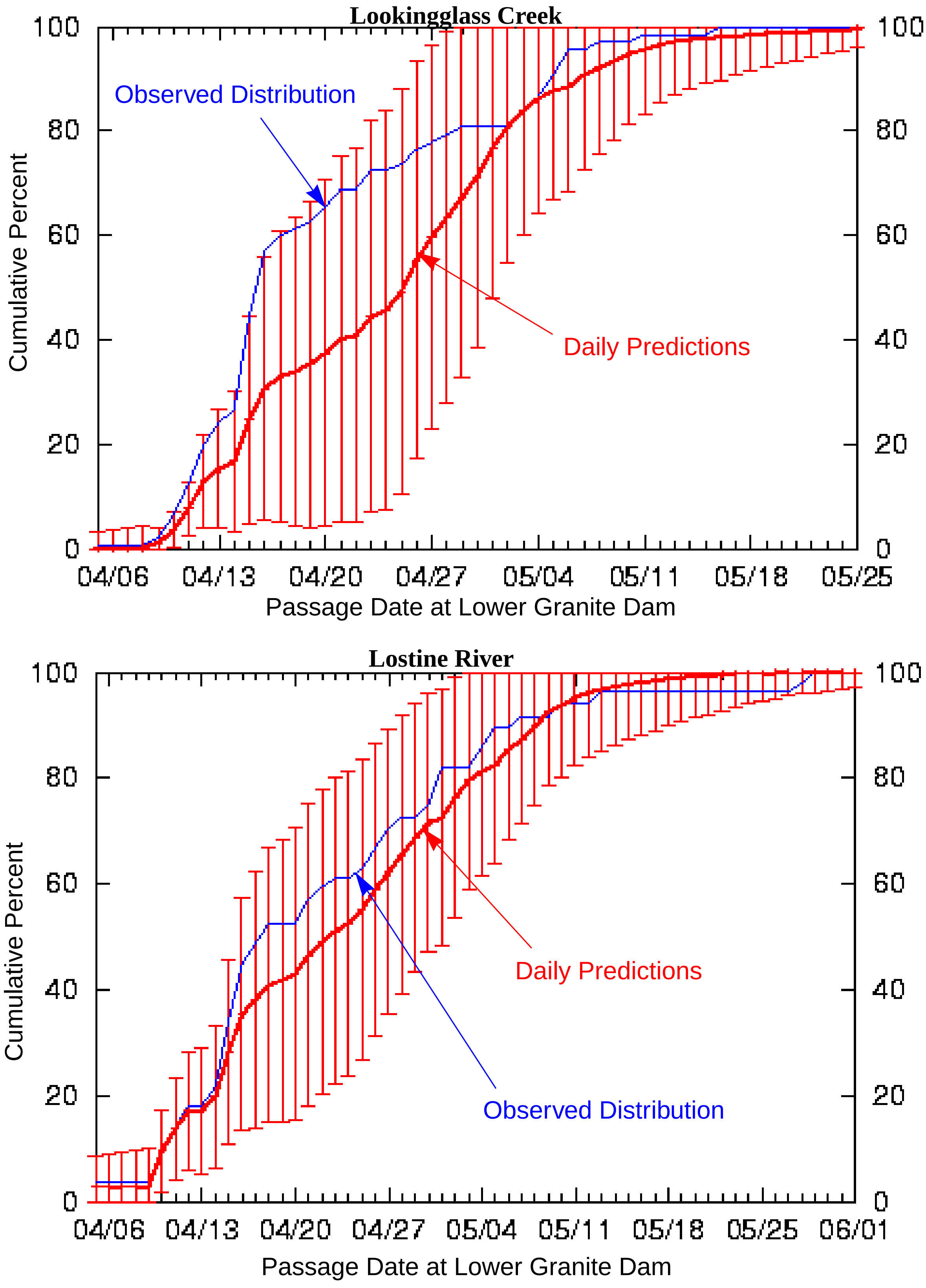
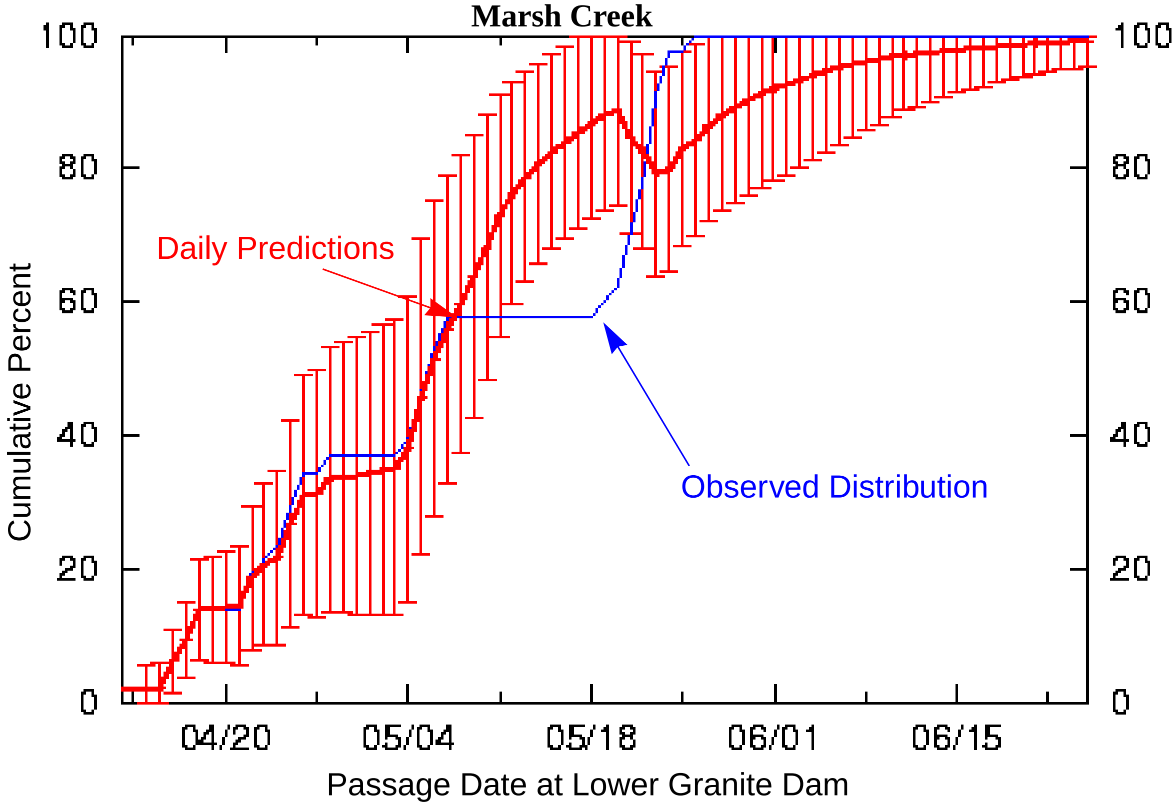


Figure A8: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from Marsh Creek and Minam River.



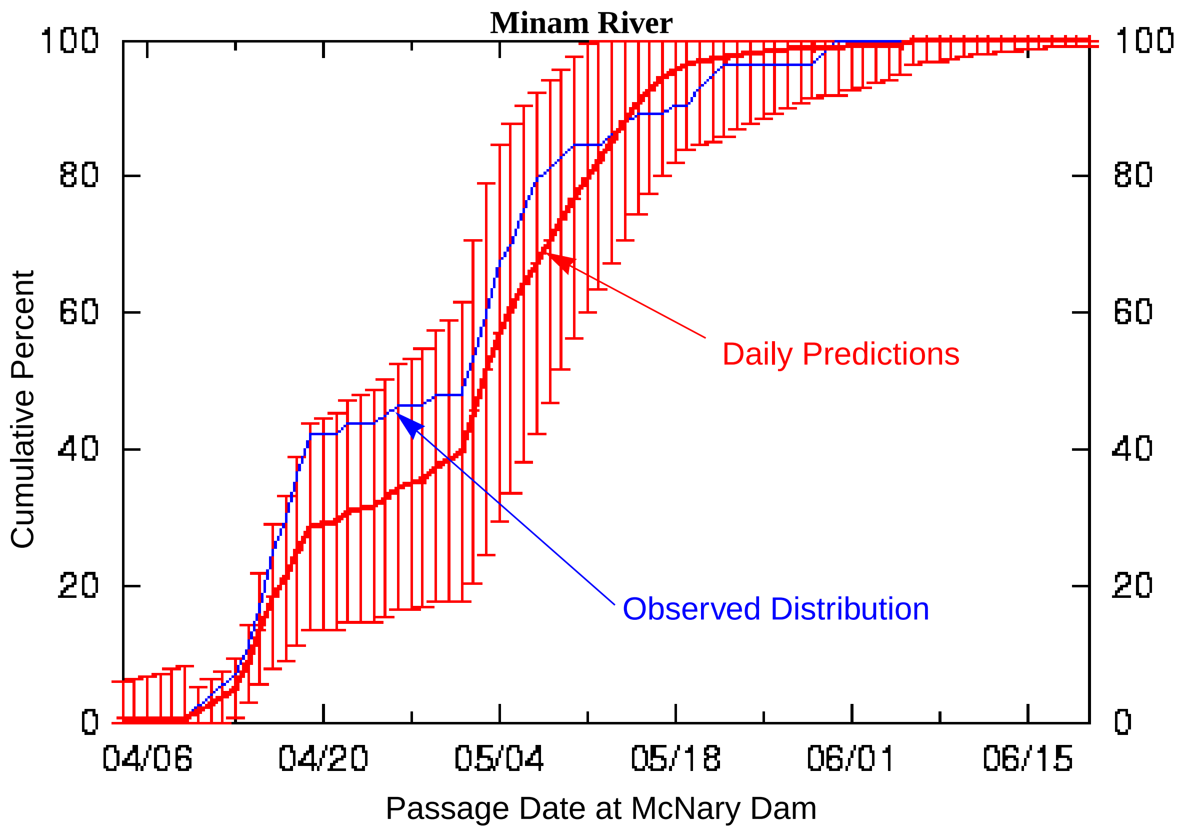
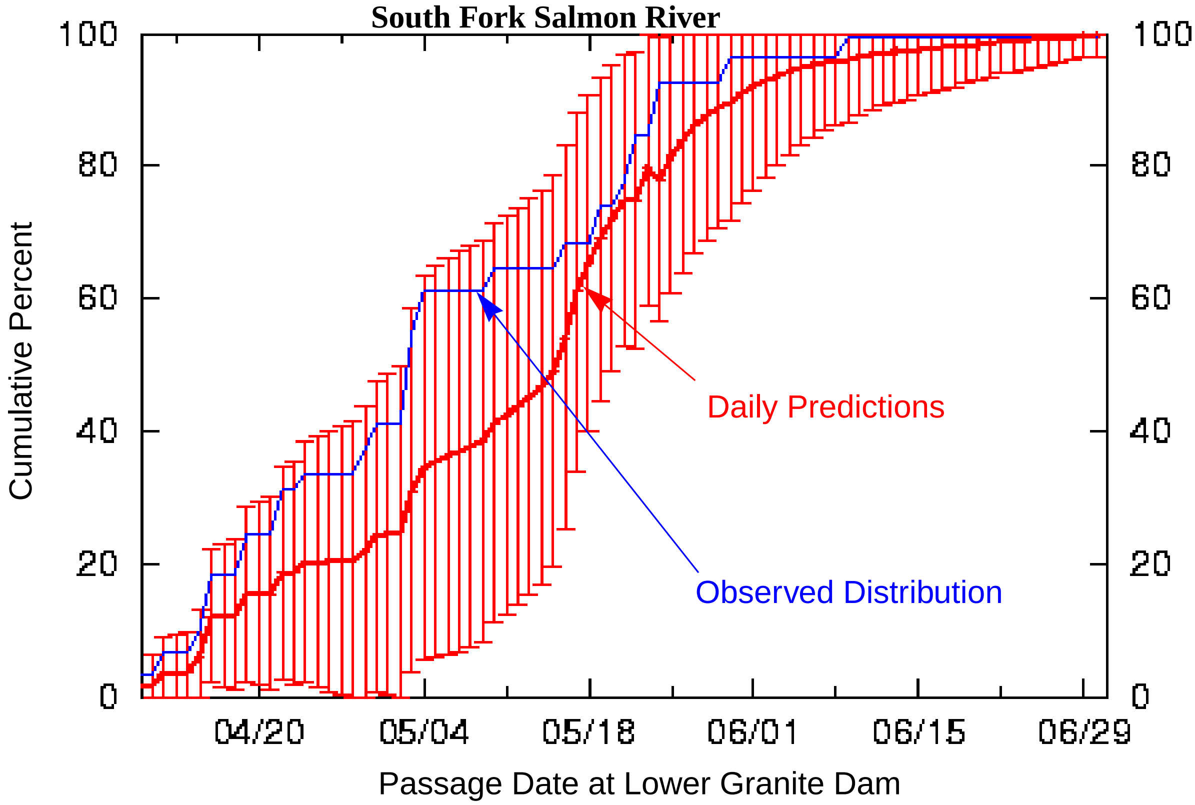


Figure A9: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from South Fork Salmon River and Secesh River.



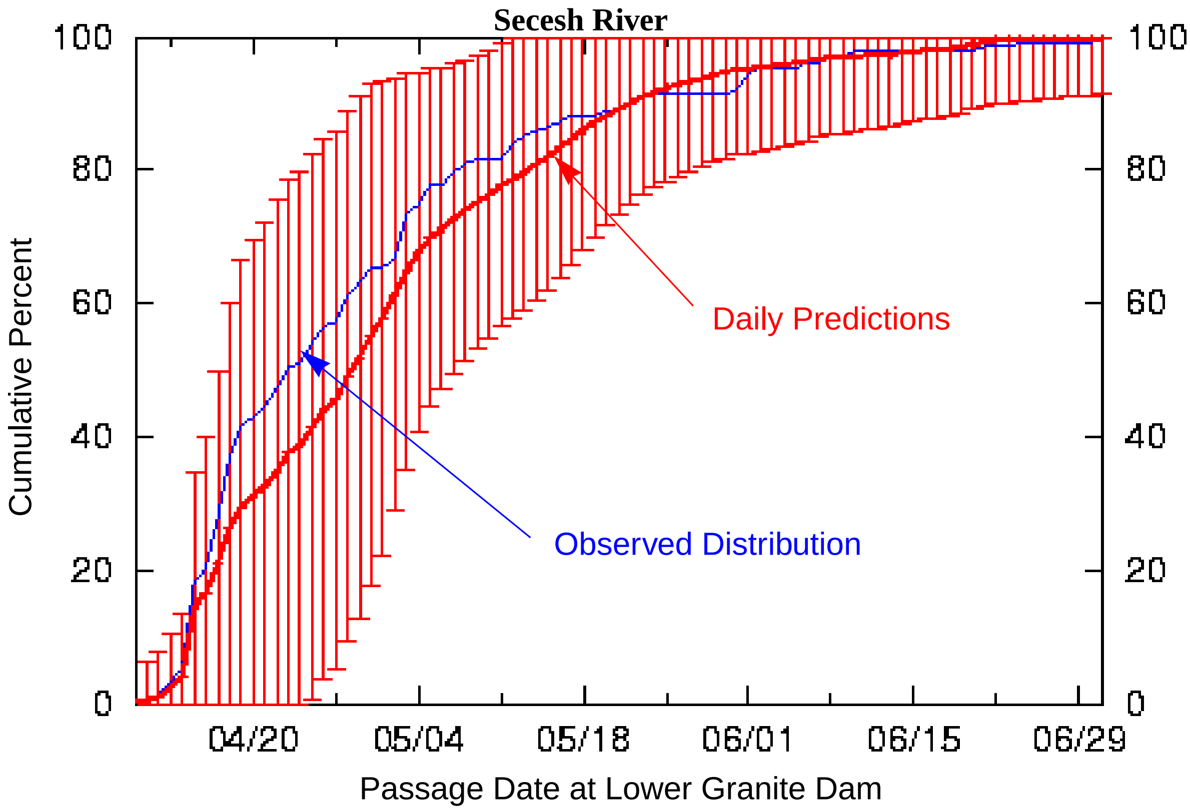
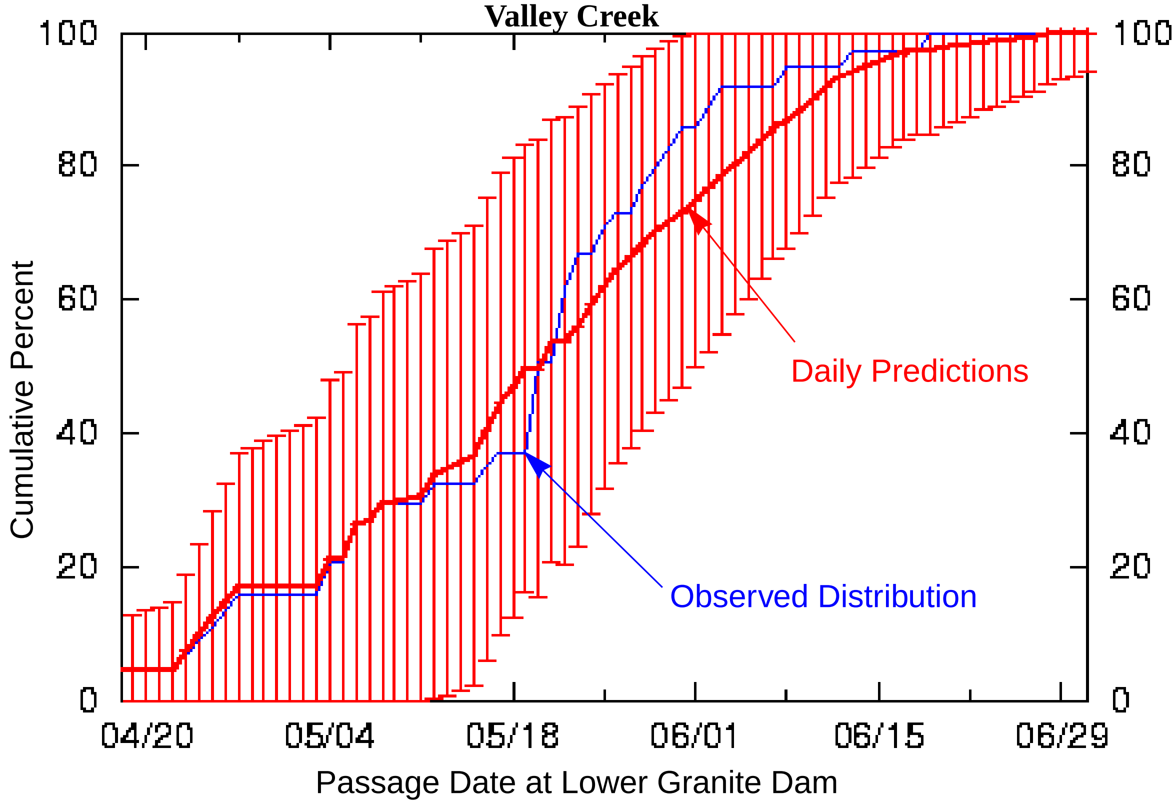


Figure A10. Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from Valley Creek and the CRiSP Composite.



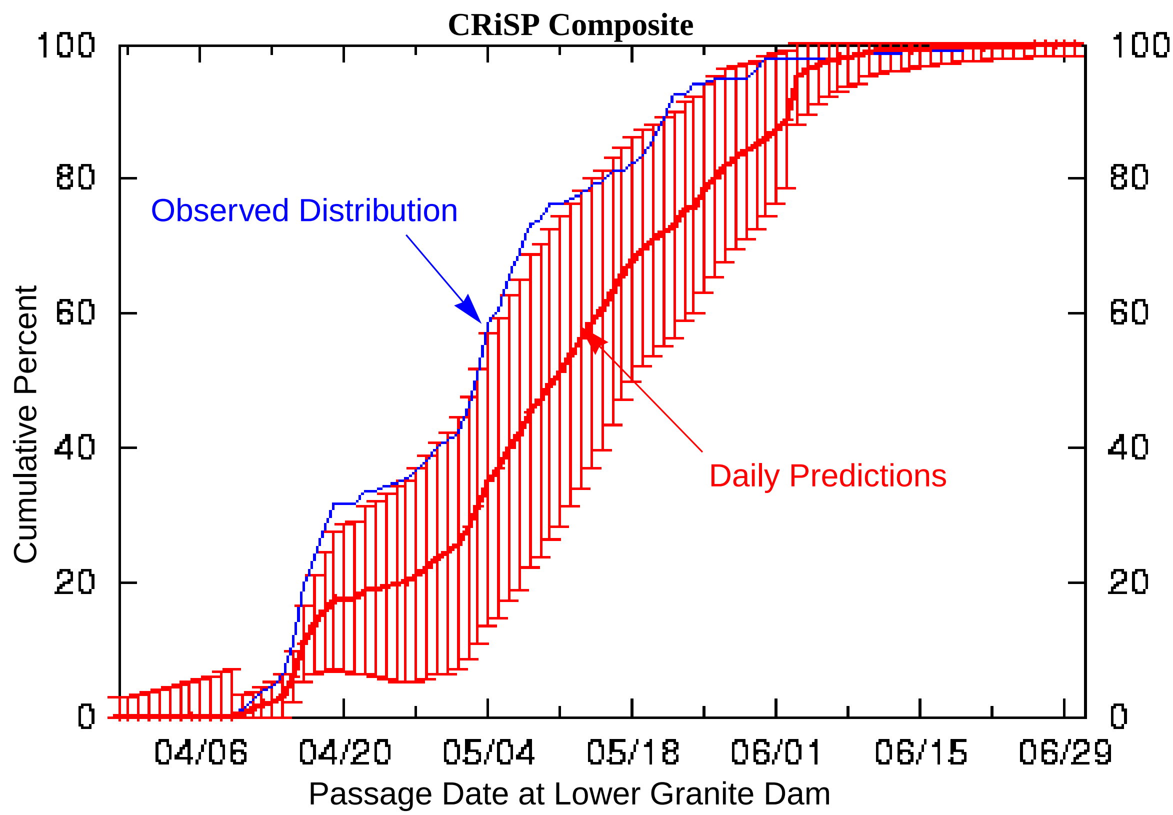
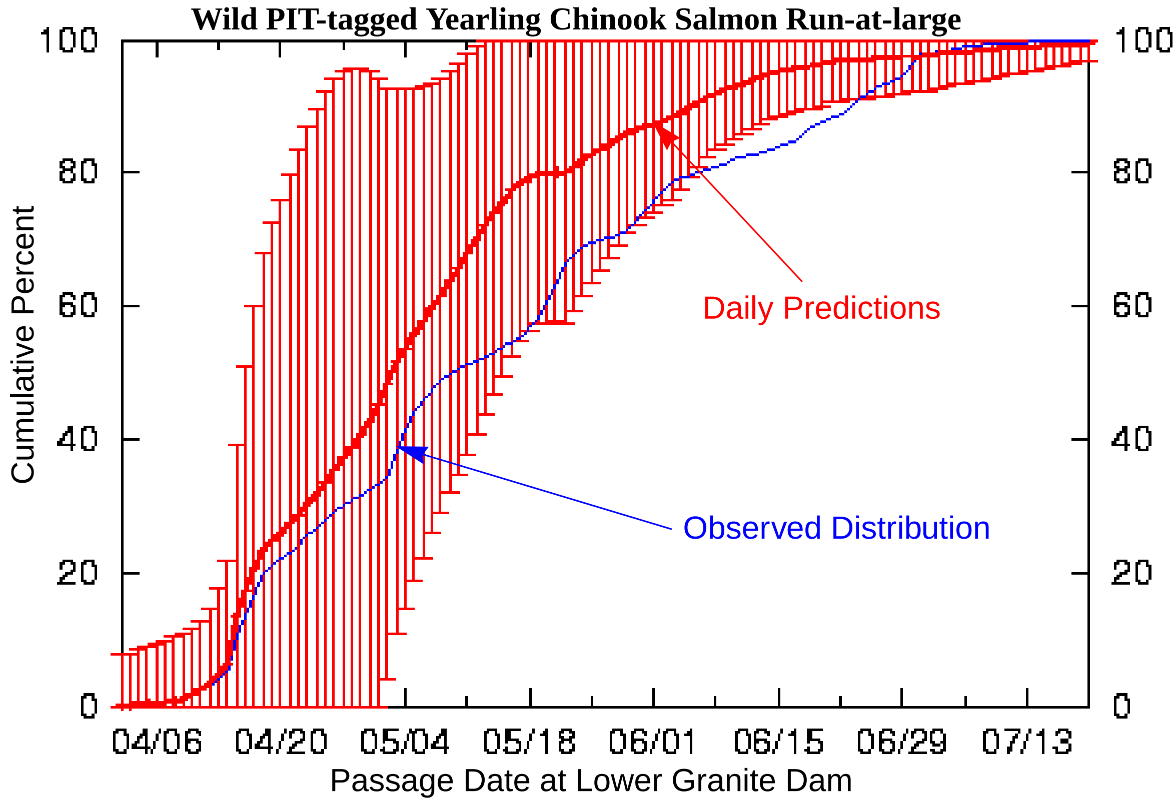


Figure A11. Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from the Snake River drainage and subyearling chinook salmon from the Snake River.



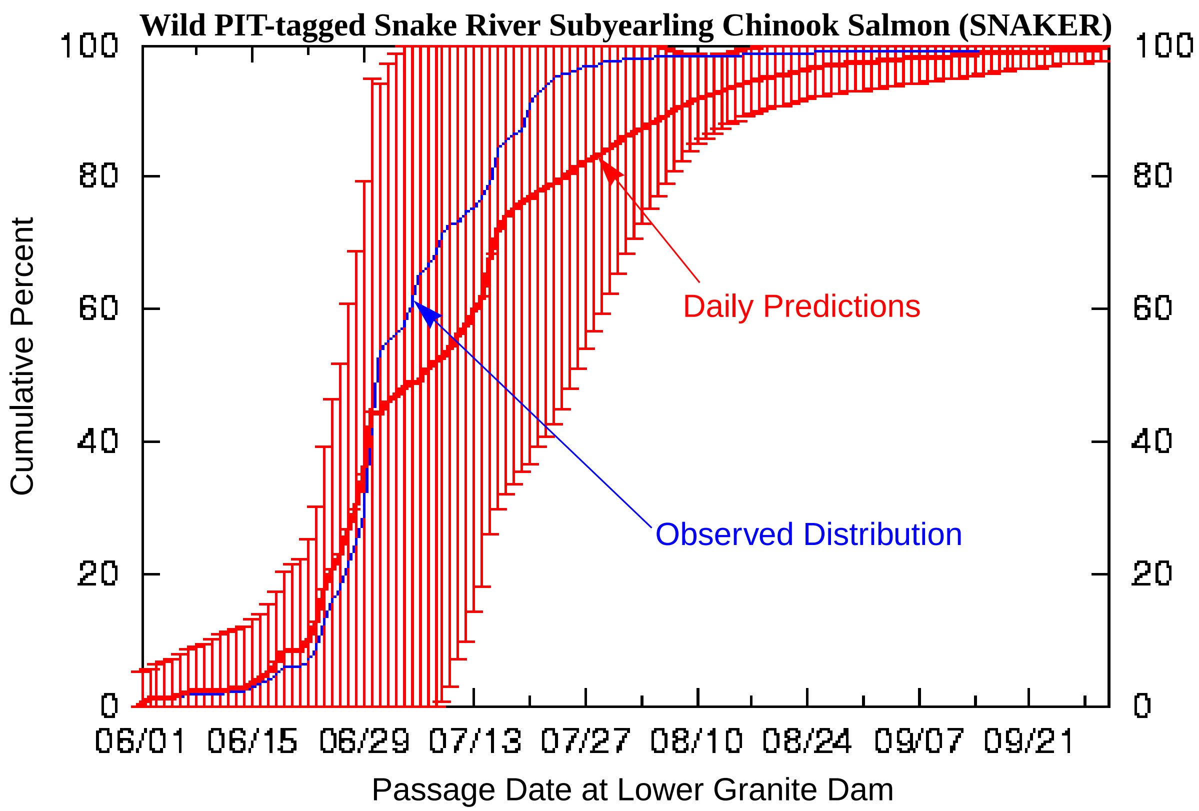
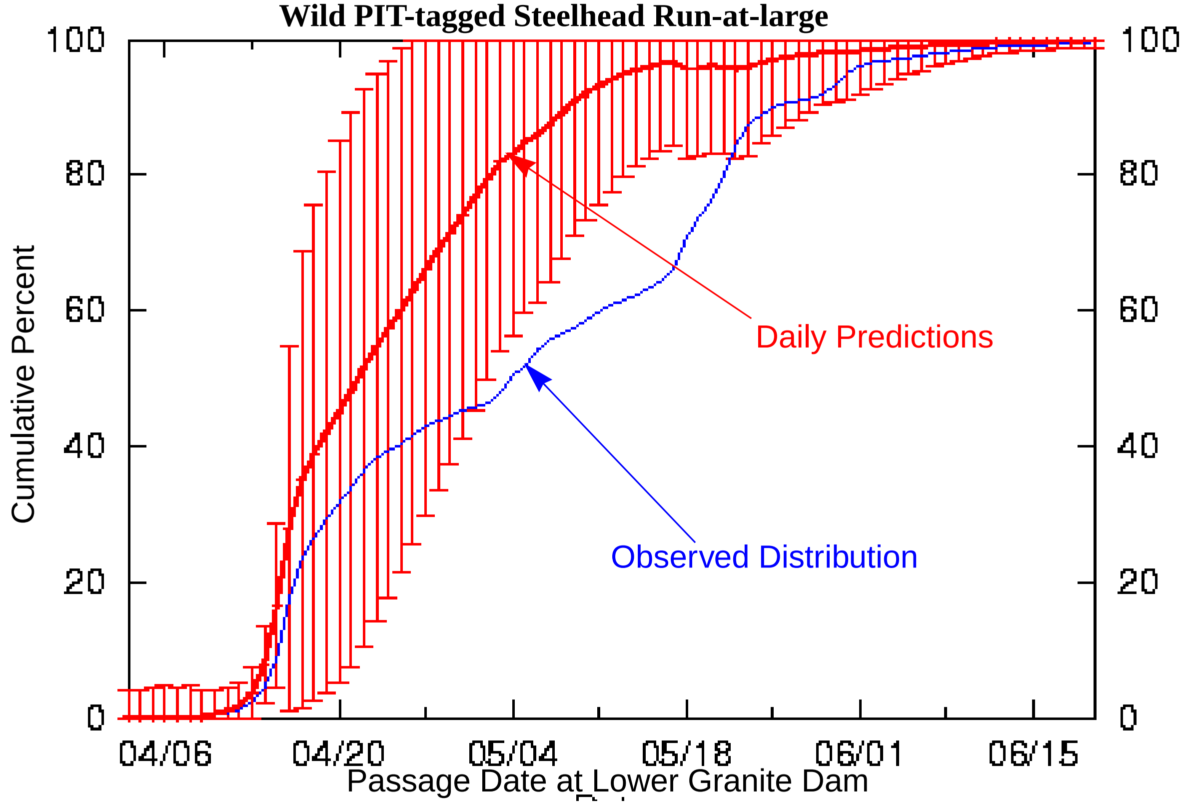


Figure A12. Daily Predictions of run-timing of wild PIT-tagged steelhead from the Snake River drainage and hatchery-reared PIT-tagged sockeye salmon composite.

Wild PIT-tagged Steelhead Run-at-large



PIT-tagged Hatchery Sockeye Salmon from Alturas Lake Creek, Redfish Lake Creek and Sawtooth Trap

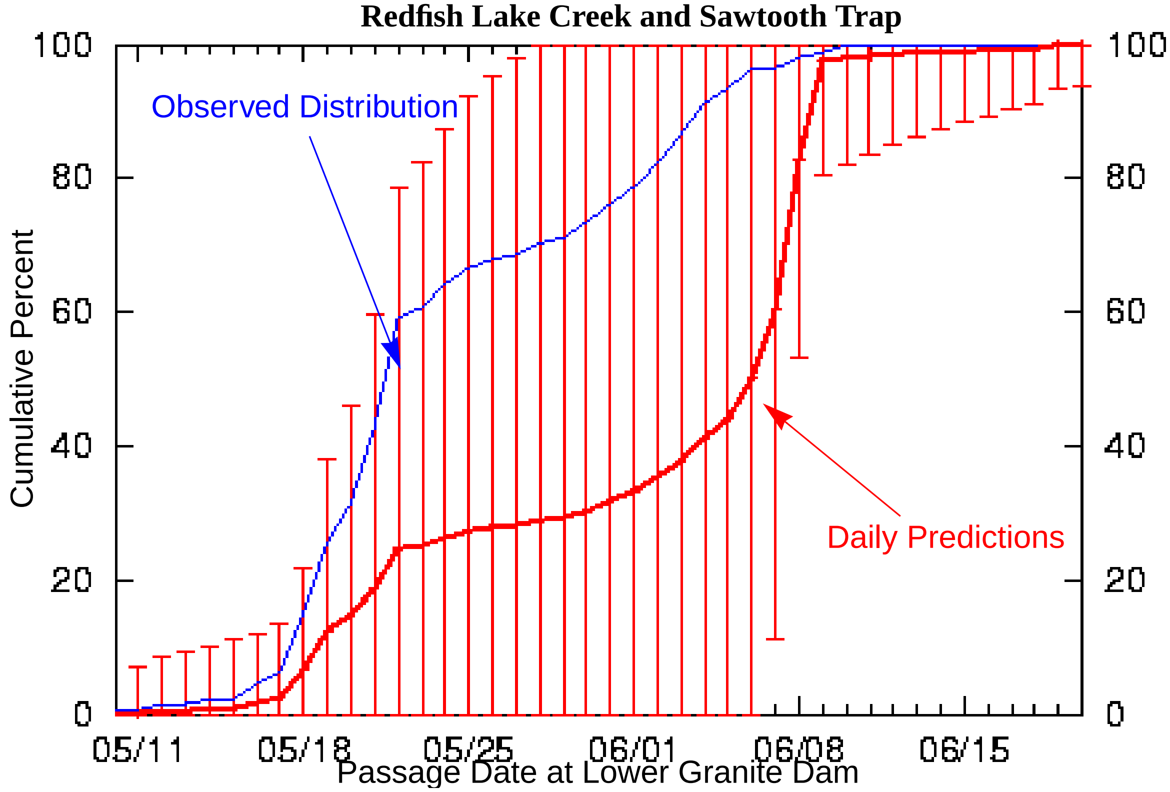
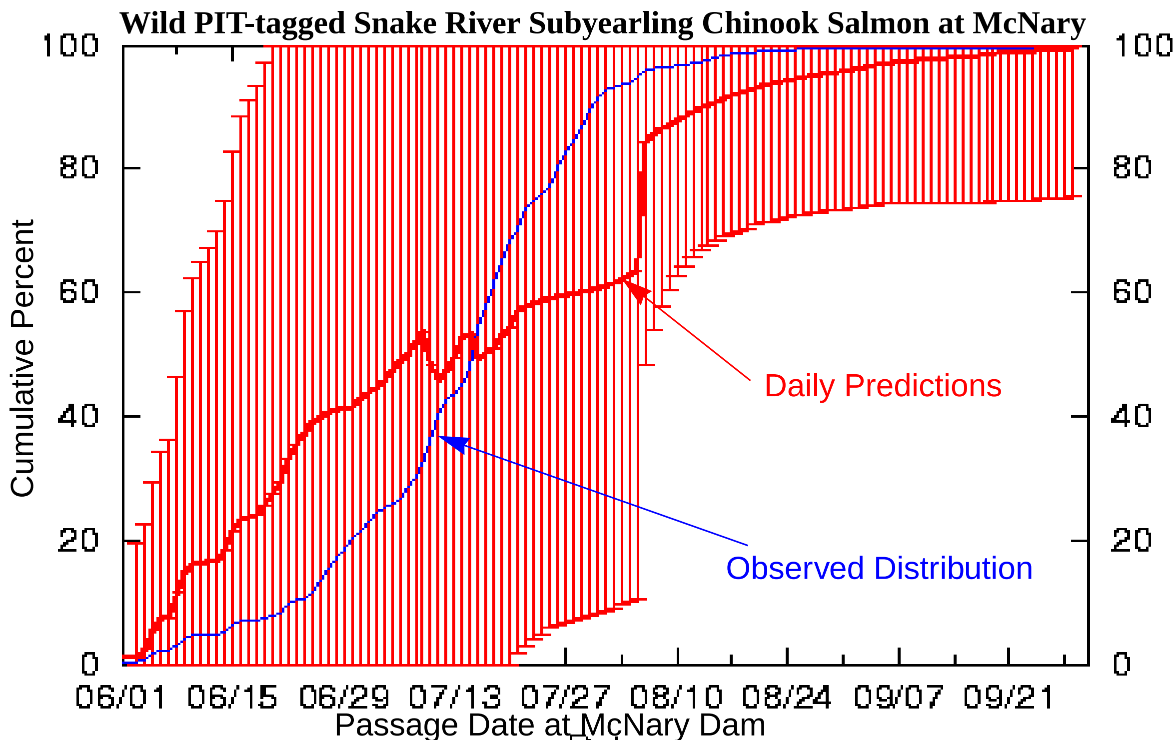


Figure A13: Daily predictions of the run-timing of wild PIT-tagged runs-at-large of Snake River and Upper Columbia subyearling chinook salmon at McNary Dam.



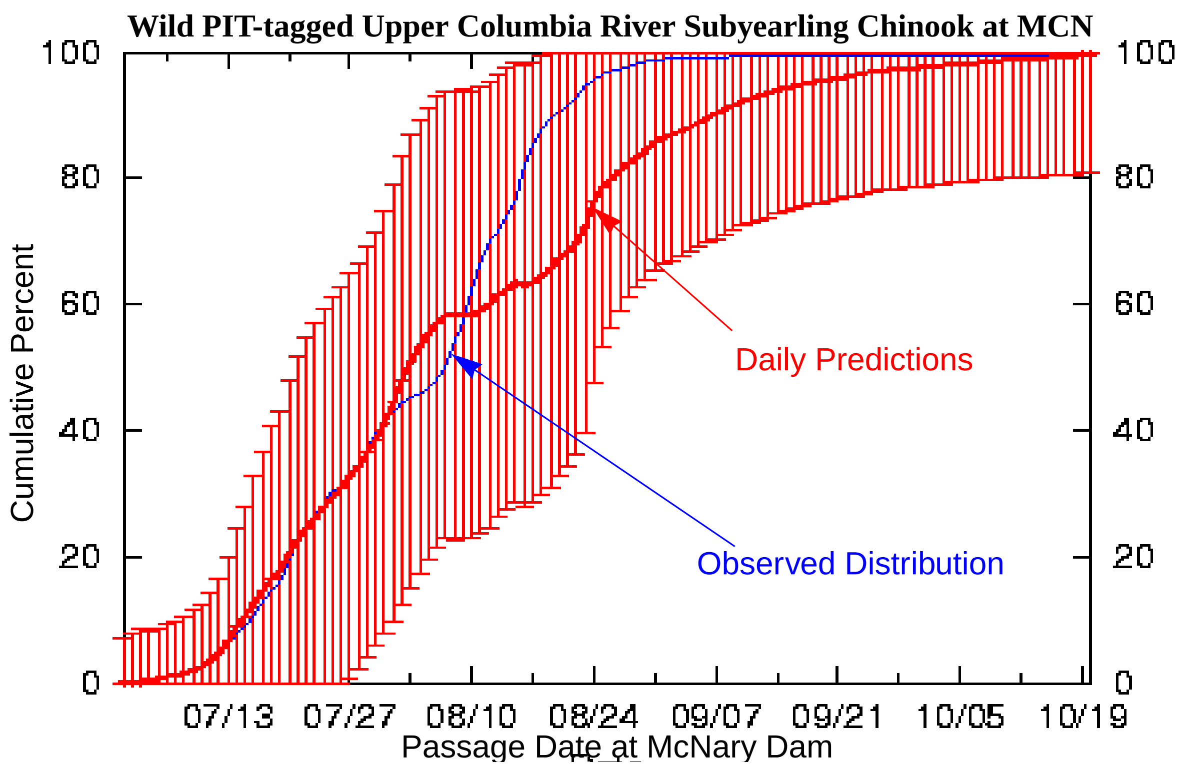
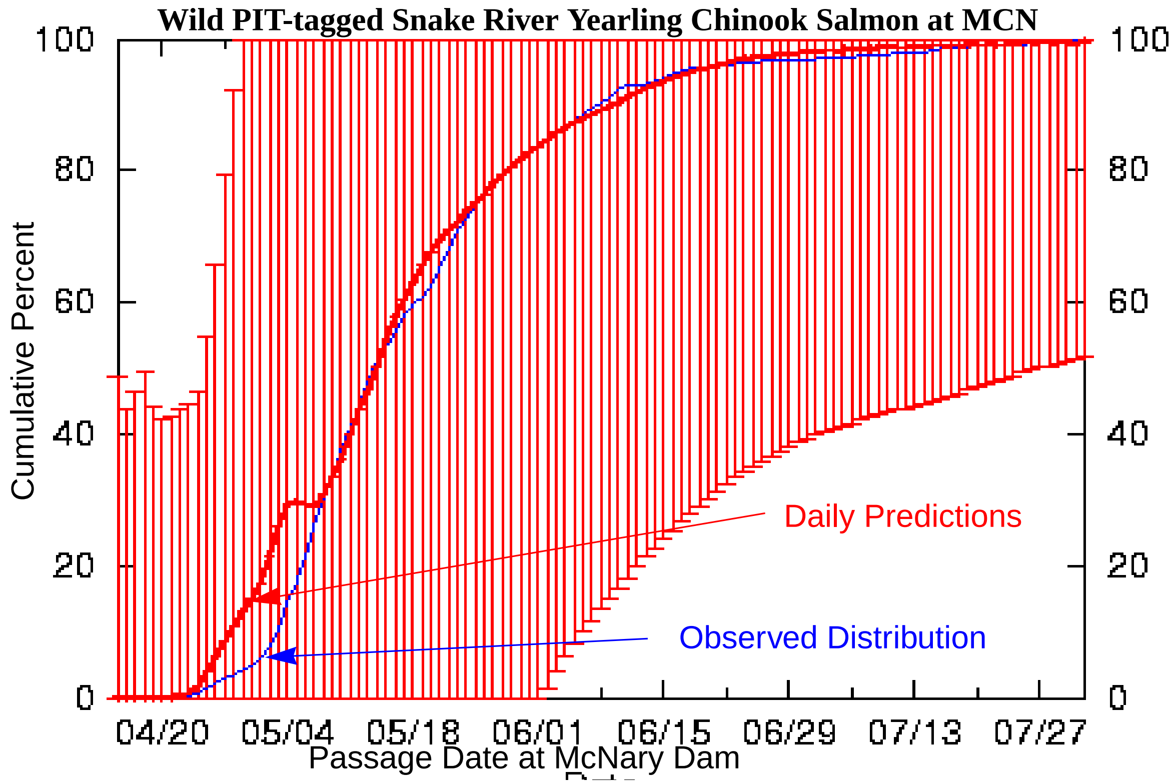


Figure A14: Daily predictions of the run-timing of wild PIT-tagged runs-at-large of Snake River yearling chinook salmon and steelhead trout at McNary Dam.



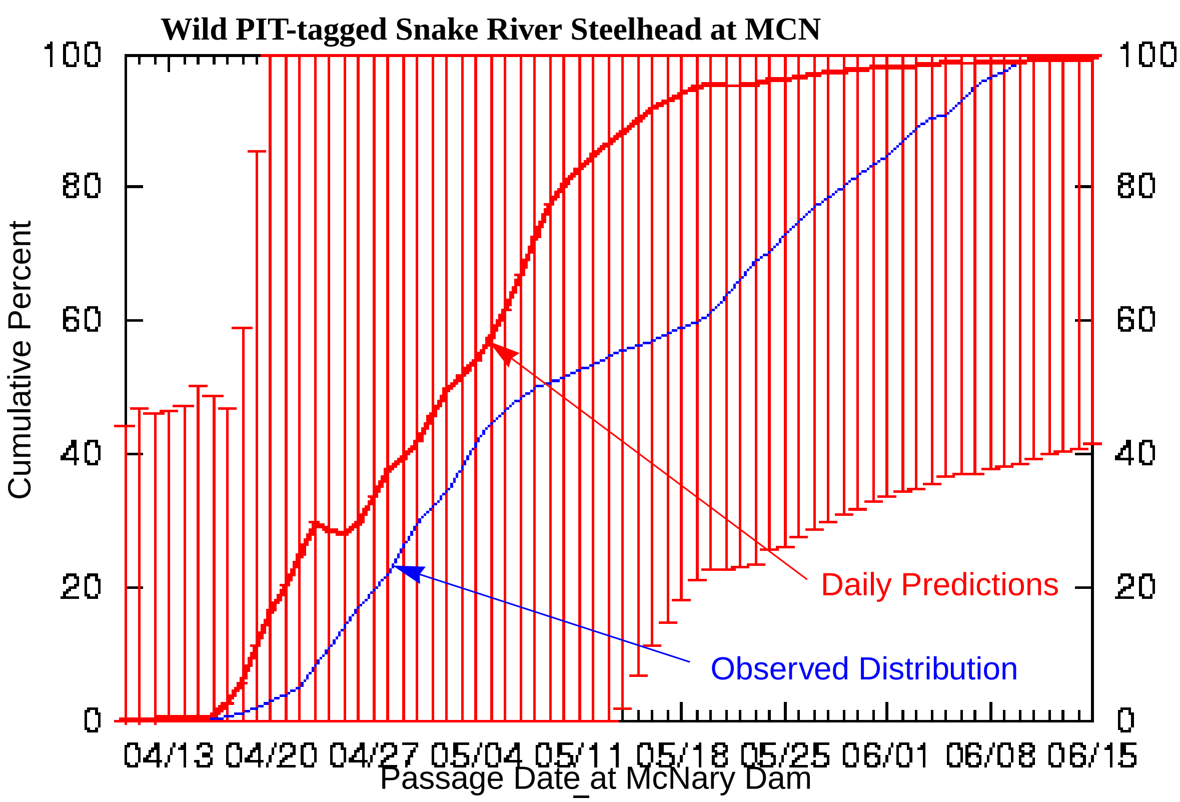
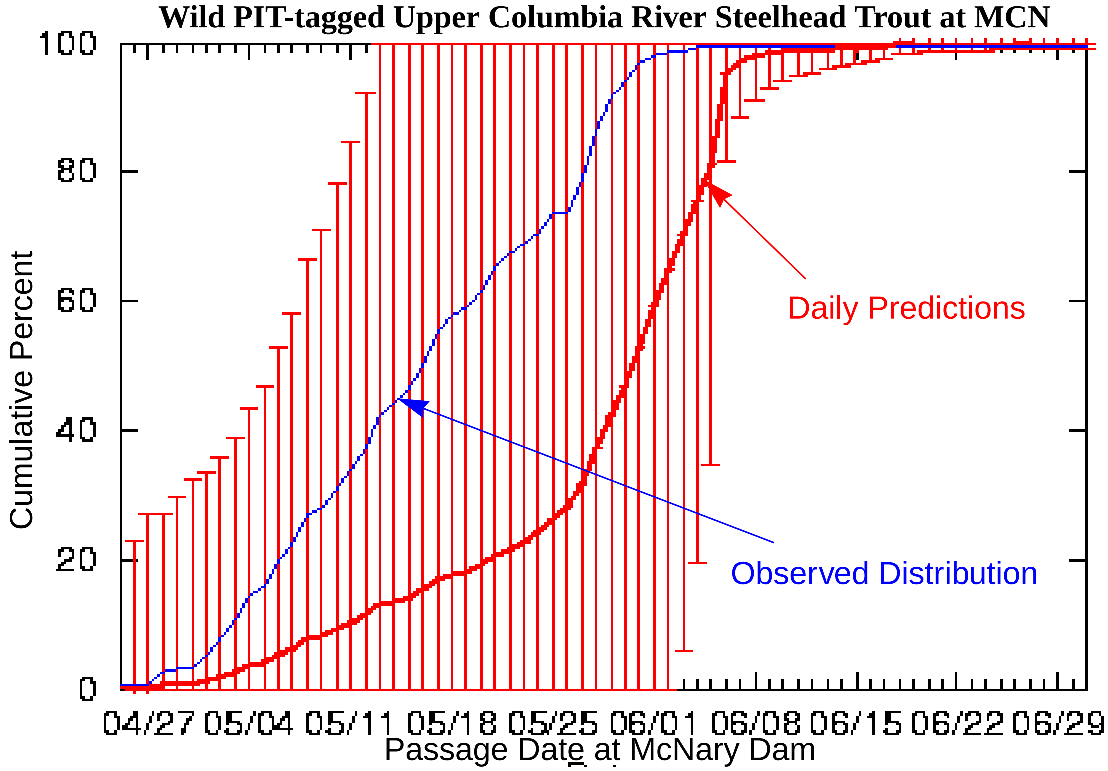


Figure A15: Daily predictions of the run-timing of wild PIT-tagged runs-at-large of Upper Columbia River steelhead trout and Snake River sockeye salmon at McNary Dam.



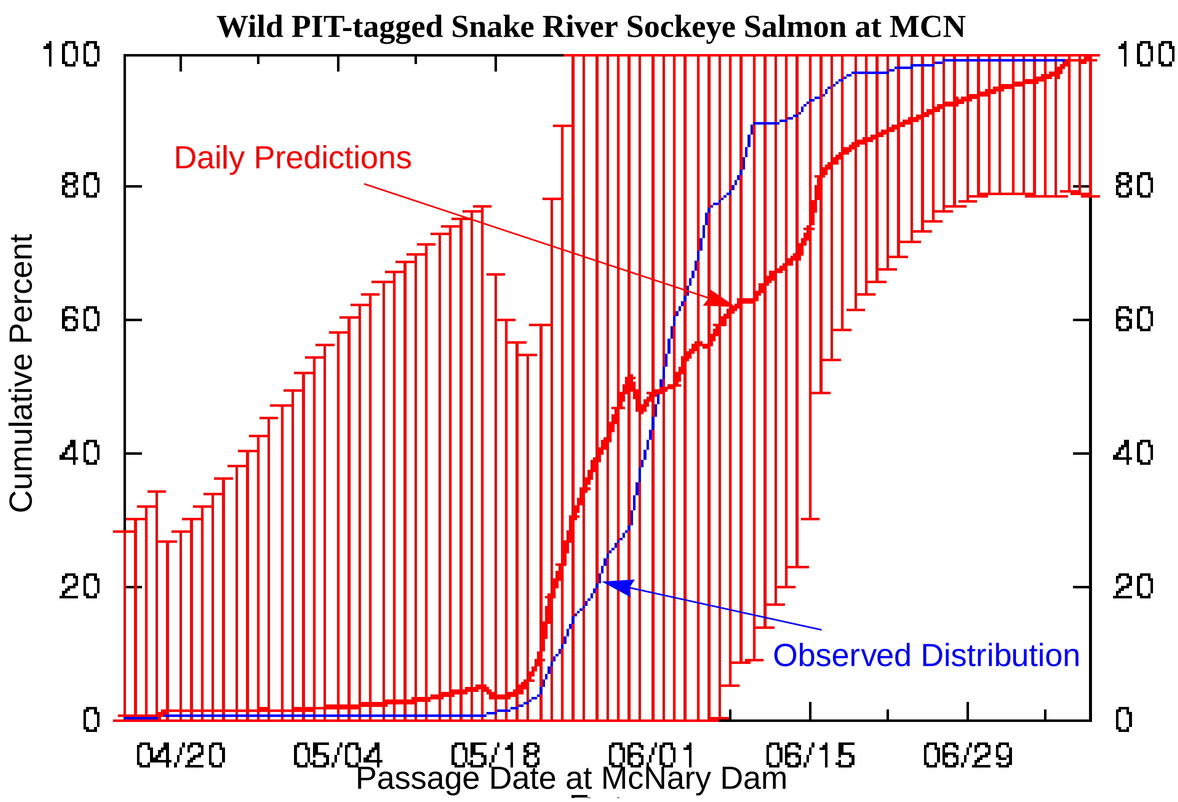
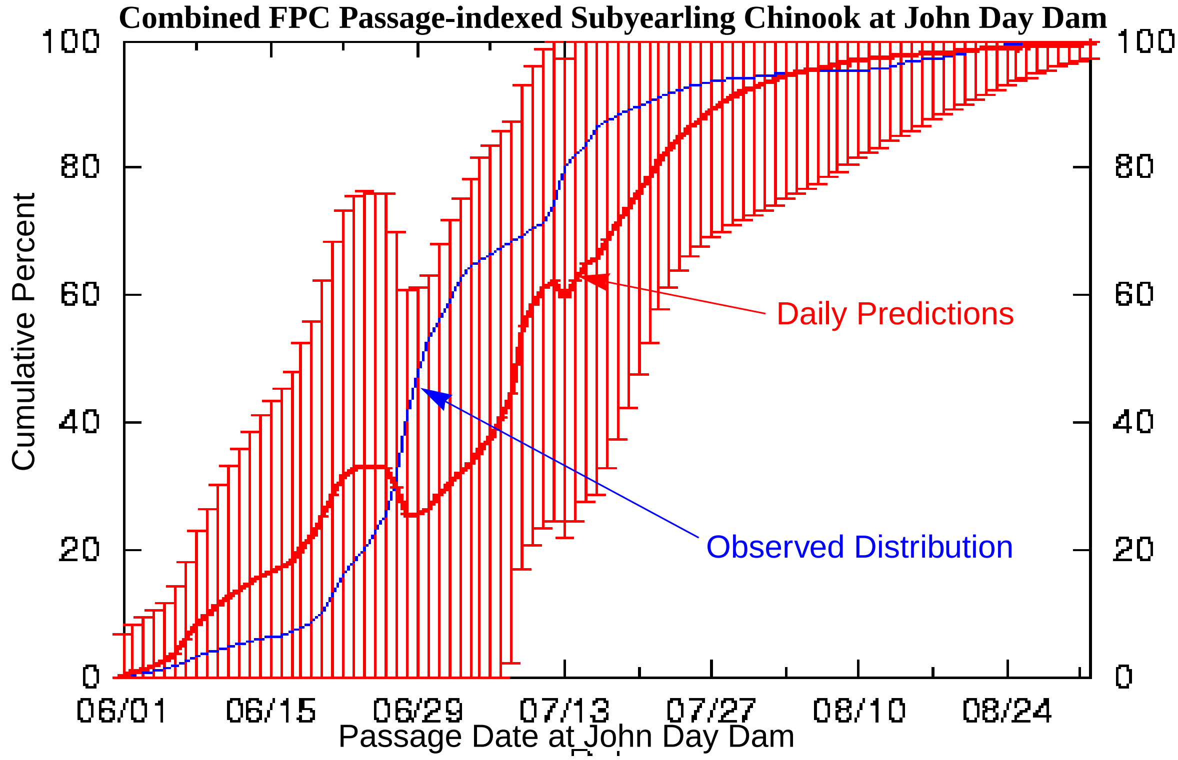


Figure A16: Daily predictions of the run-timing of FPC passage-indexed combined wild and hatchery runs-at-large of subyearling chinook salmon at John Day Dam and McNary Dam.



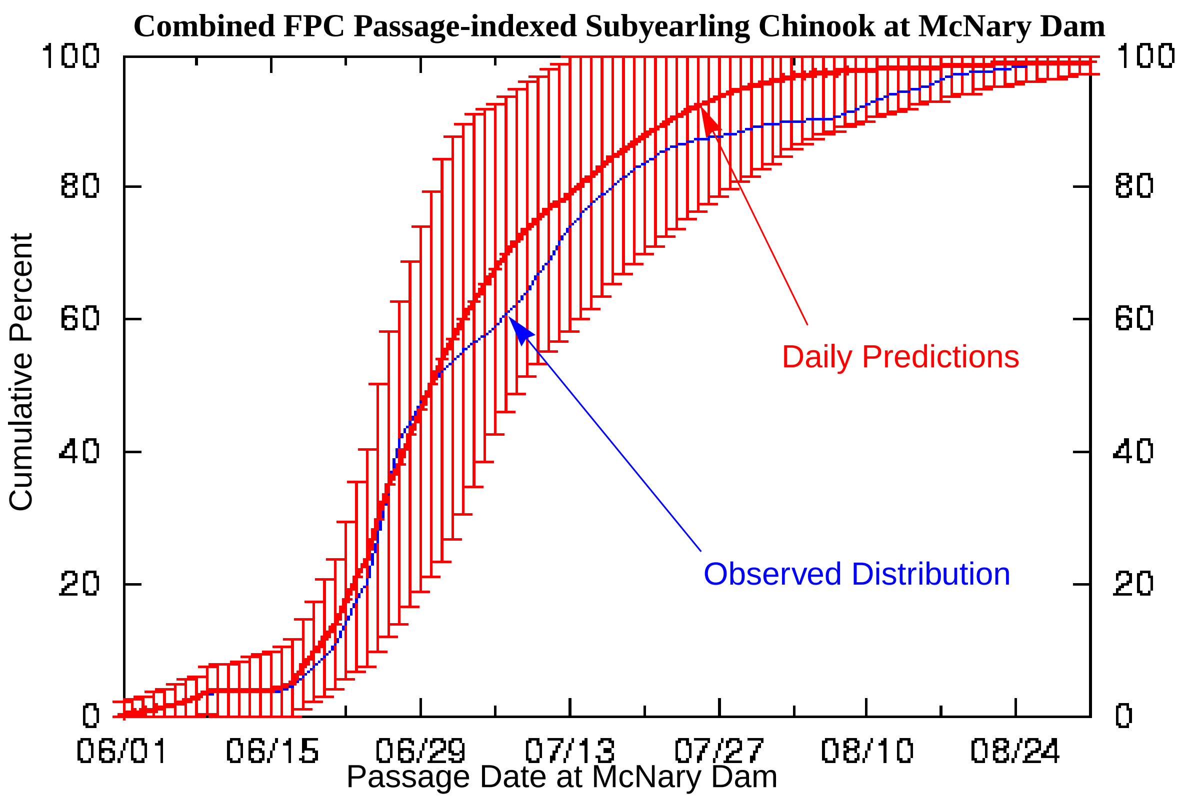
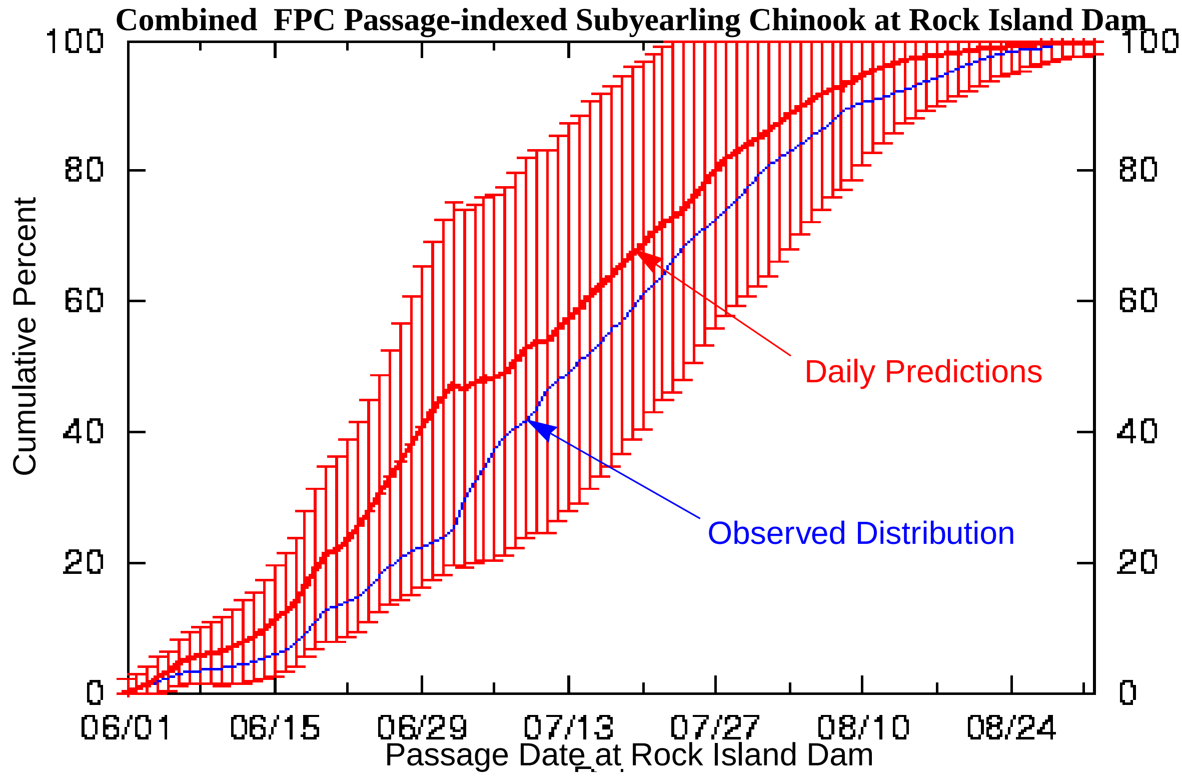


Figure A17: Daily predictions of the run-timing of the FPC passage-indexed combined wild and hatchery run-at-large of subyearling chinook salmon at Rock Island Dam and of yearling chinook salmon at John Day Dam.



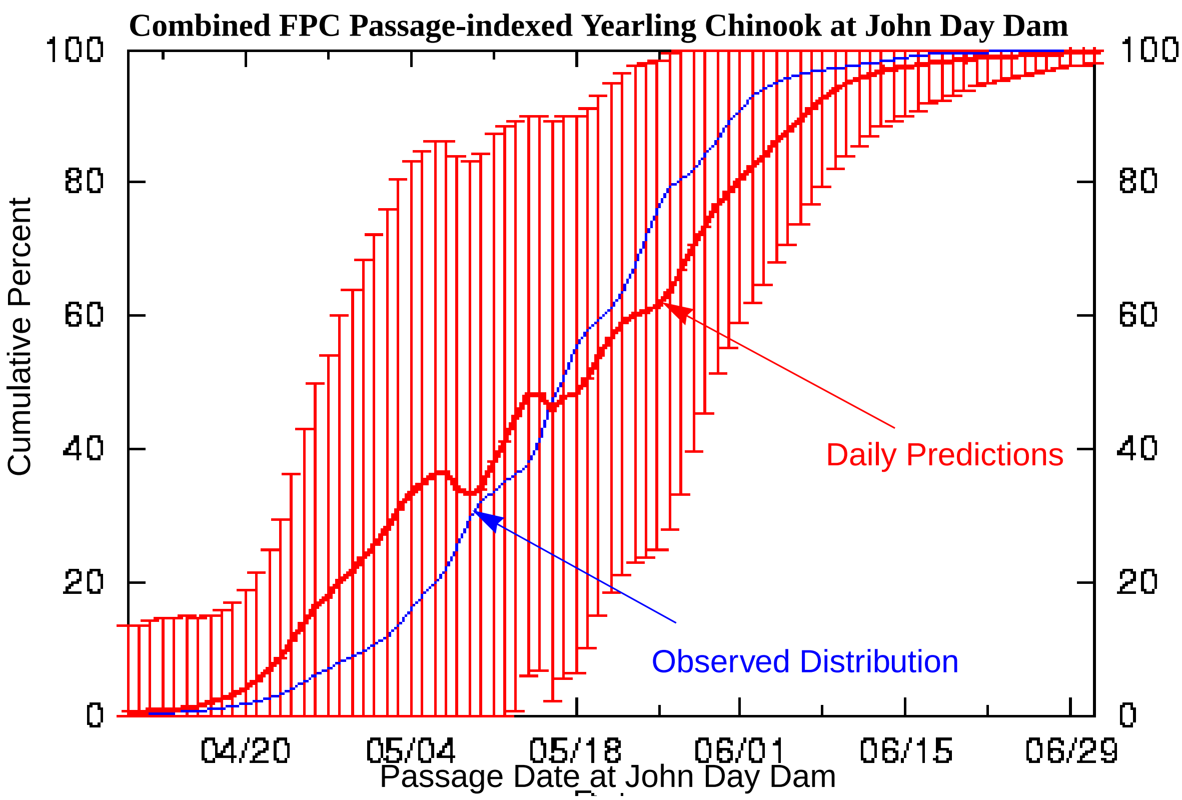
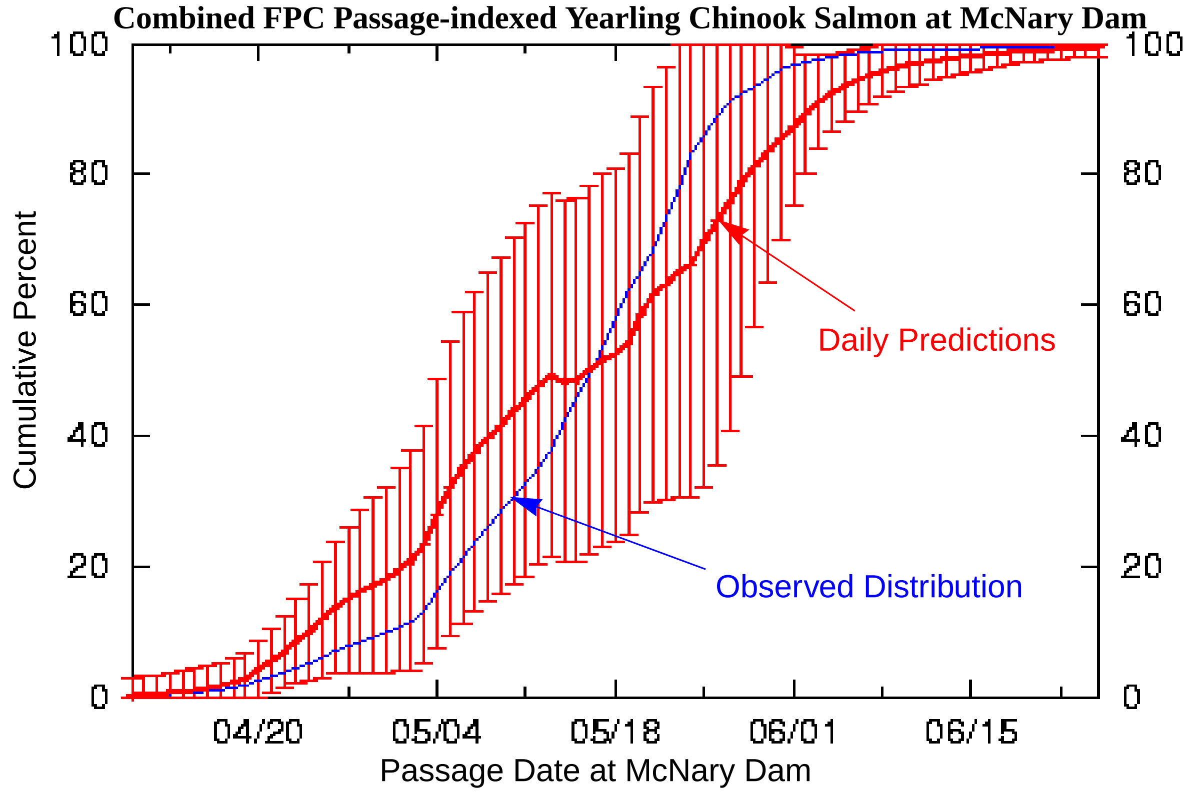


Figure A18: Daily predictions of the run-timing of FPC passage-indexed combined wild and hatchery runs-at-large of yearling chinook salmon at McNary and Rock Island Dams.



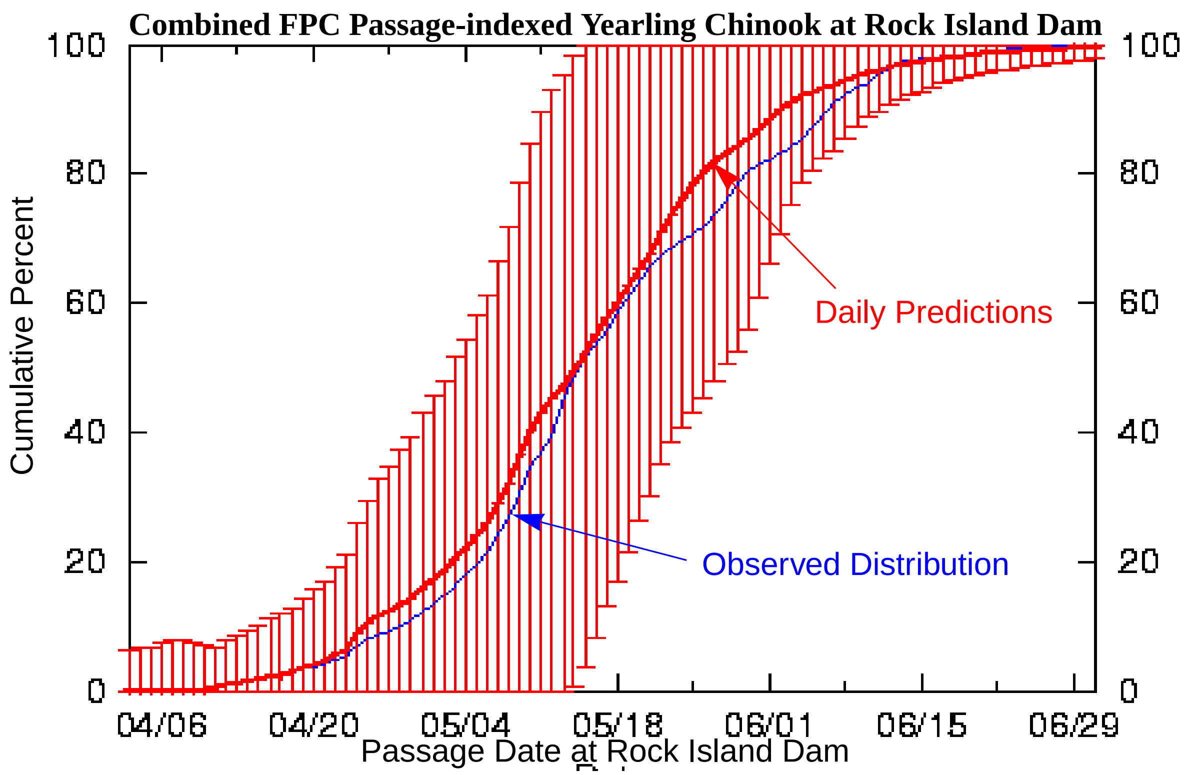
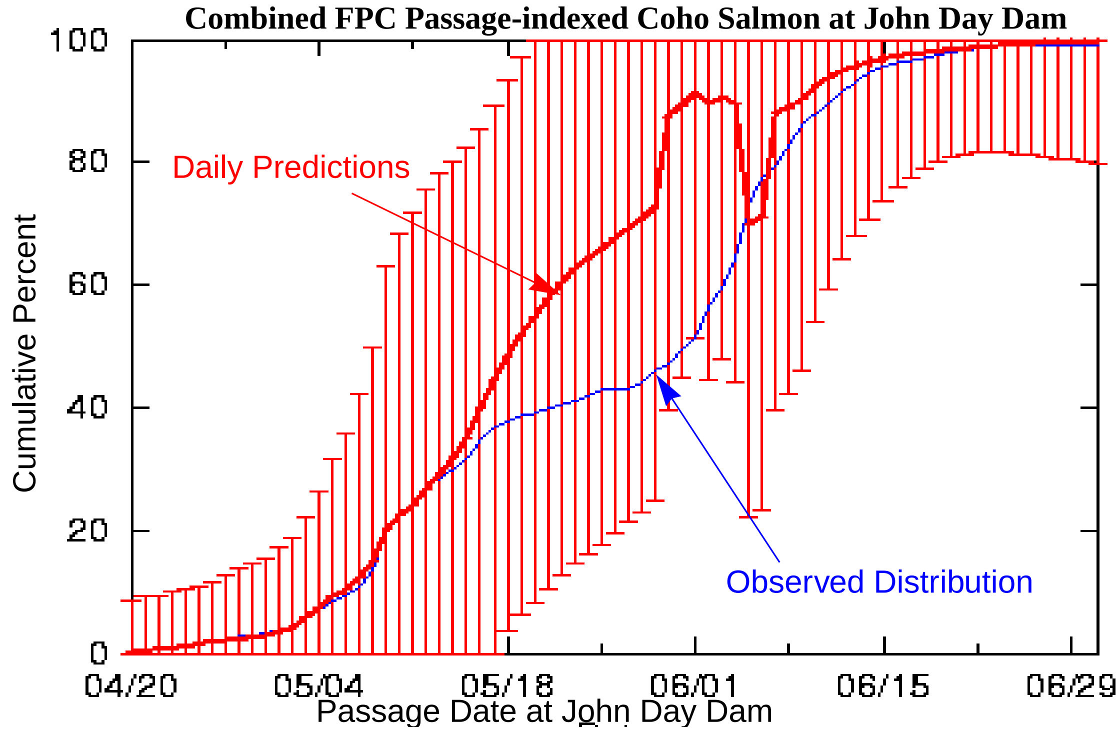


Figure A19: Daily predictions of the run-timing of FPC passage-indexed combined wild and hatchery runs-at-large of coho salmon at John Day and McNary Dams.



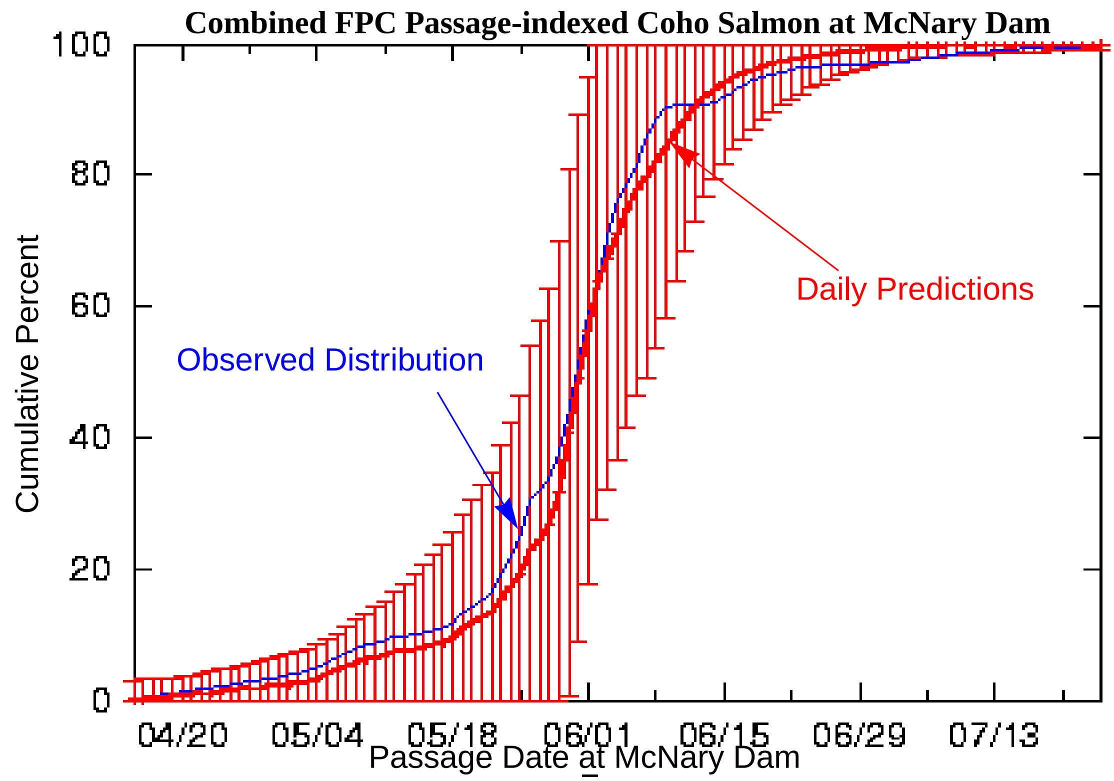
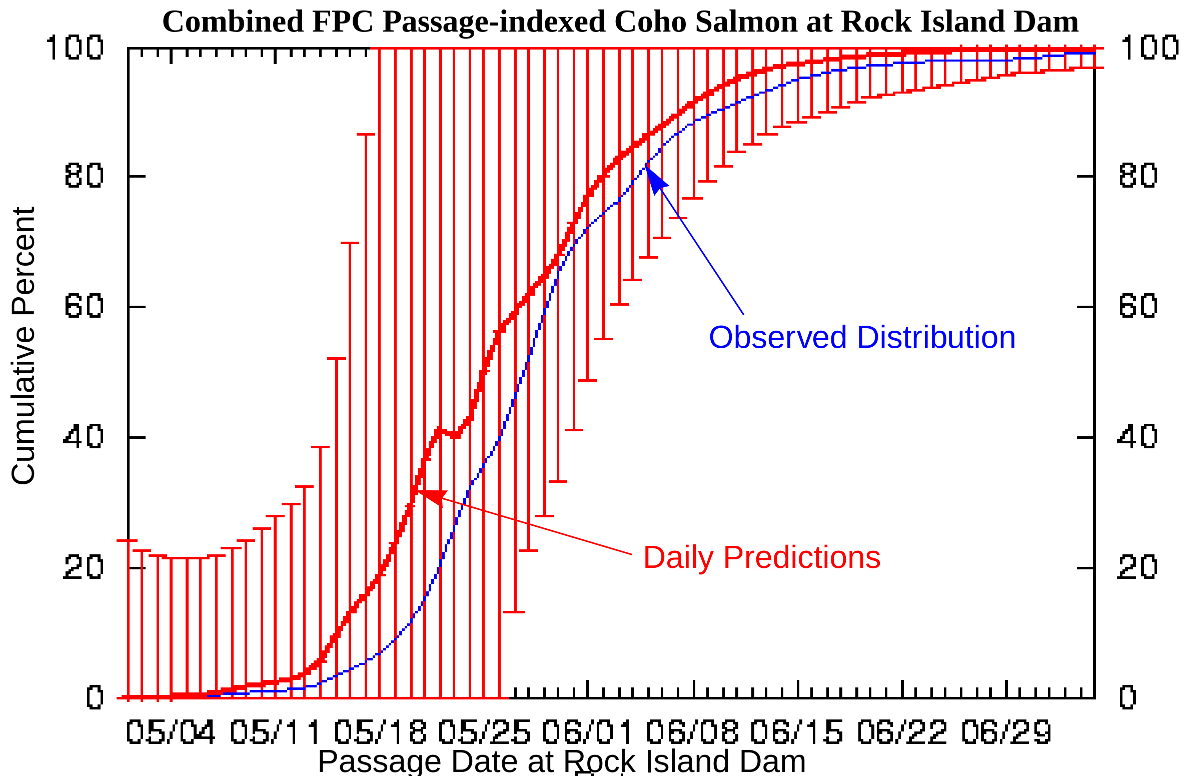


Figure A20: Daily predictions of the FPC passage-indexed combined wild and hatchery run-at-large of coho salmon at Rock Island Dam and of sockeye salmon at John Day Dam.



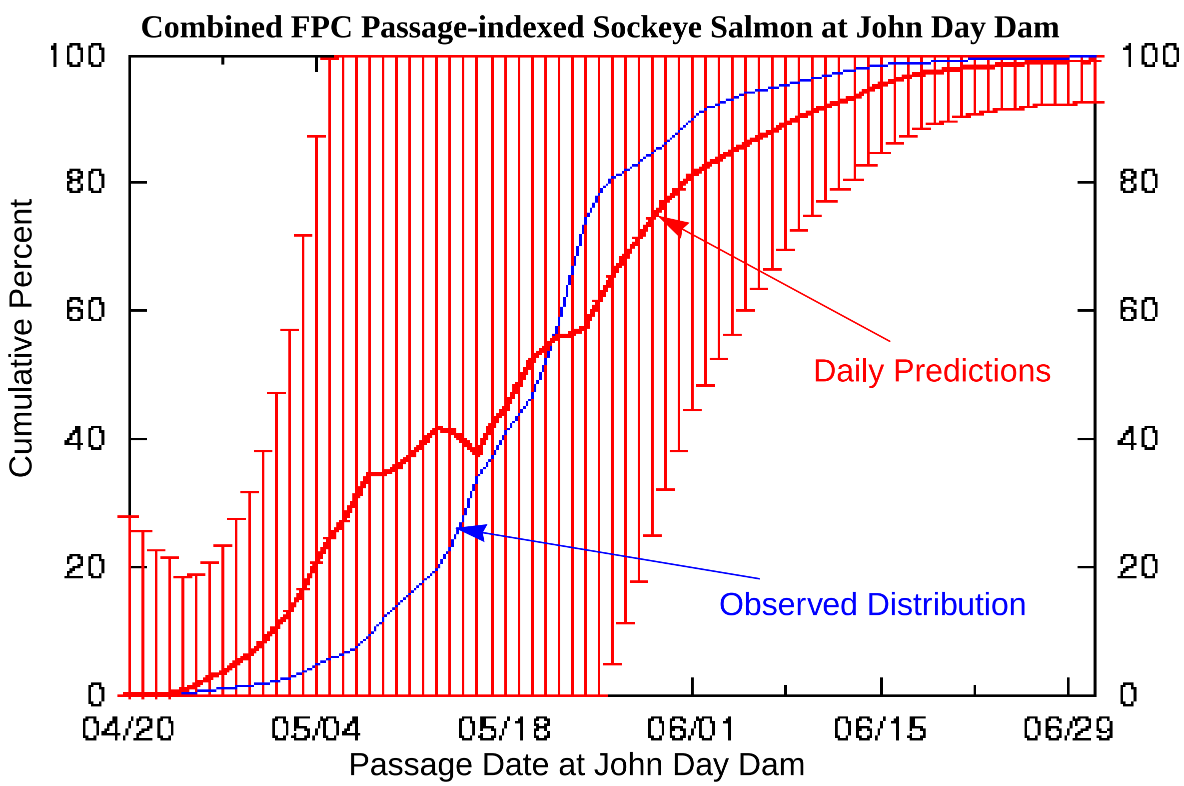
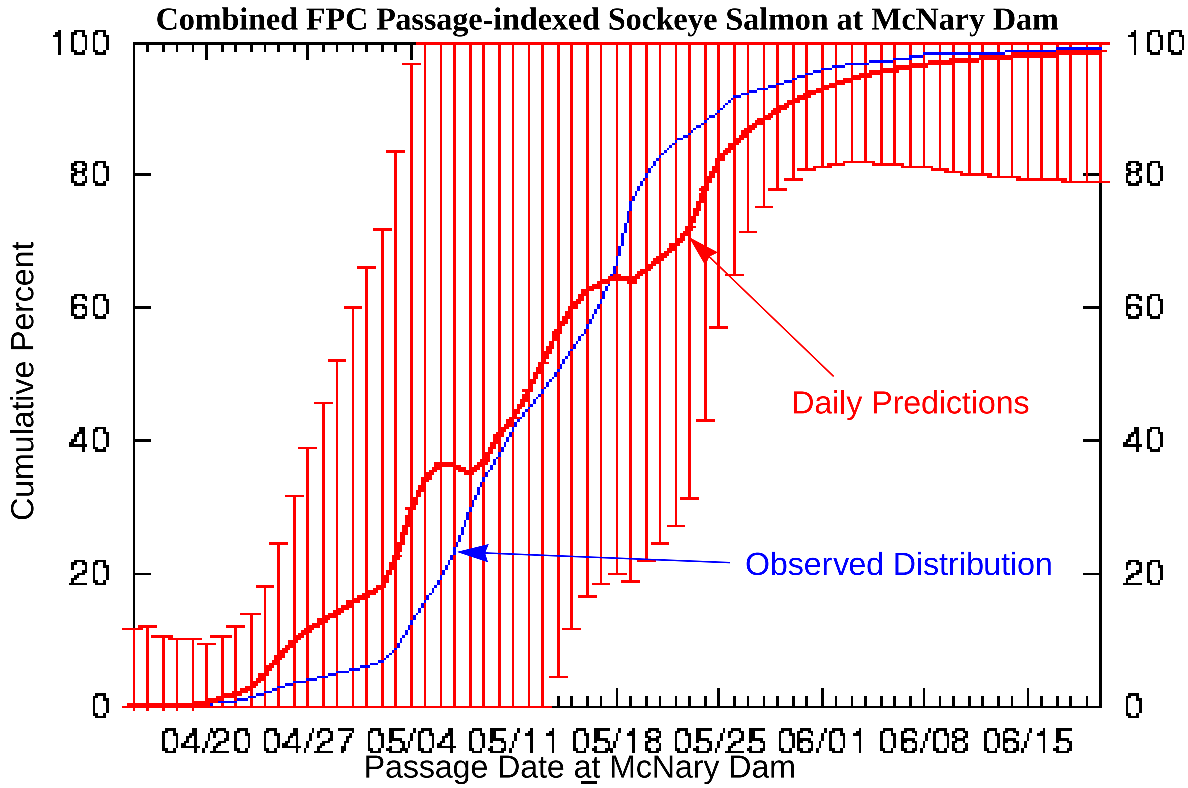


Figure A21: Daily predictions of the FPC passage-indexed combined wild and hatchery runs-at-large of sockeye salmon at McNary and Rock Island Dams.



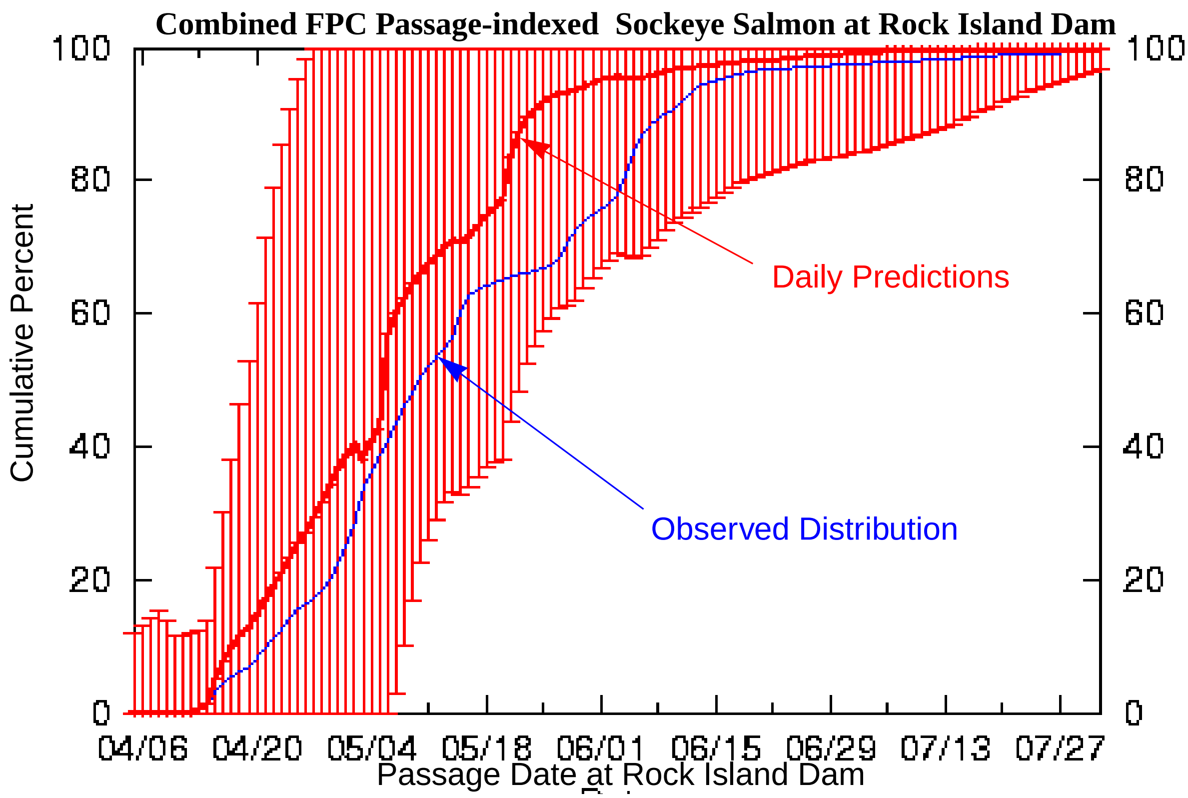


Figure A22: Daily predictions of the FPC passage-indexed combined wild and hatchery runs-at-large of steelhead trout at John Day and McNary Dams.

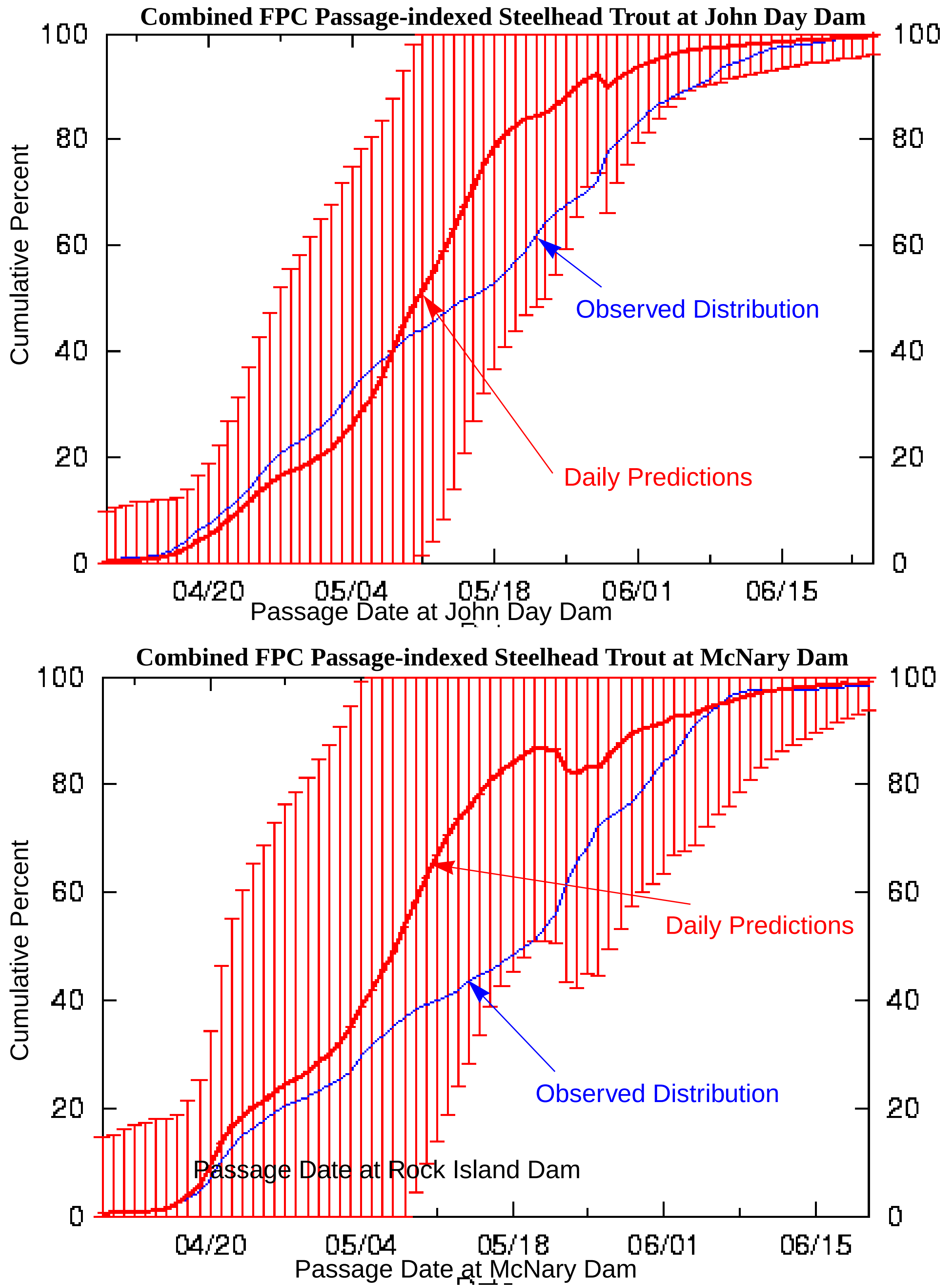
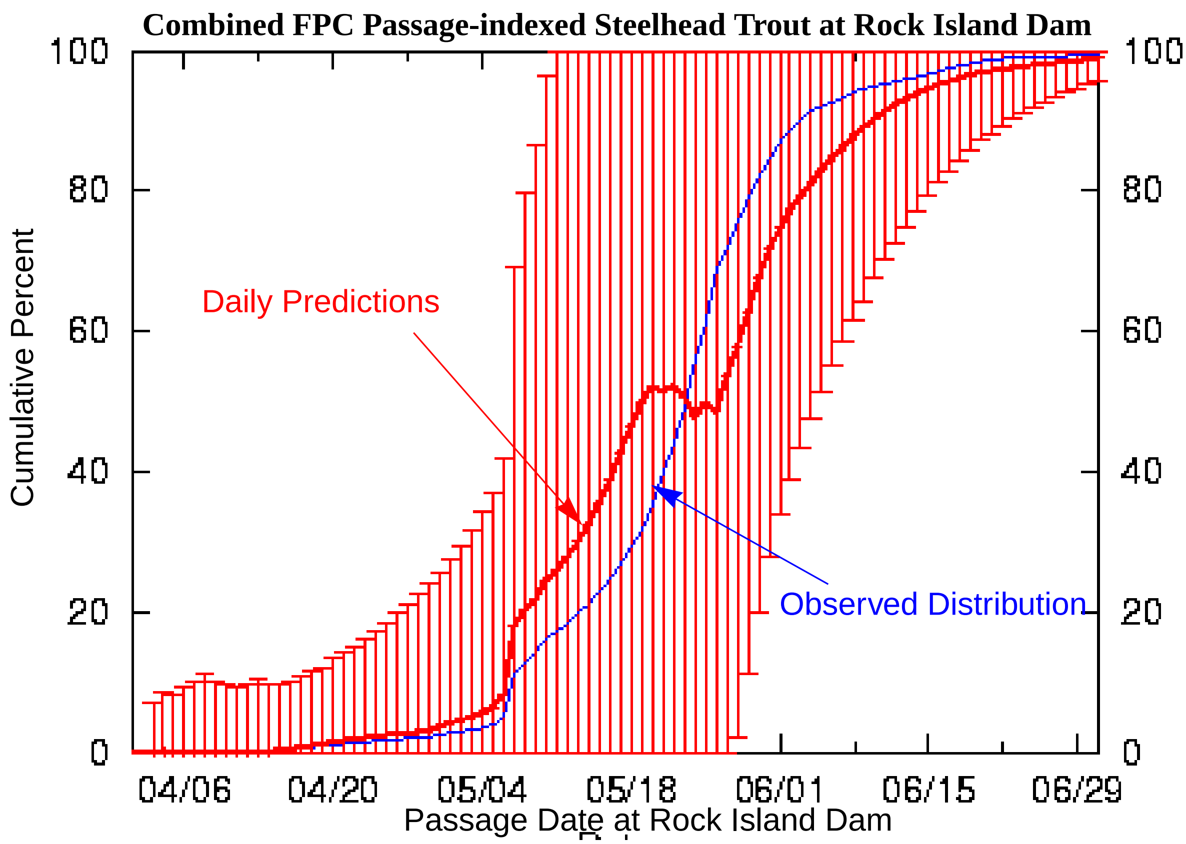


Figure A23: Daily predictions of the FPC passage-indexed combined wild and hatchery run-at-large of steelhead trout at Rock Island Dam.



Appendix B

Historical timing plots and dates of passage at Lower Granite Dam, Rock Island Dam, McNary Dam and John Day Dam for individual stocks tracked and forecasted by Program RealTime during the 2002 outmigration. Stocks tracked at Lower Granite Dam were wild PIT-tagged yearling and subyearling chinook salmon and steelhead trout ESUs, and a hatchery-reared PIT-tagged sockeye salmon ESU. Stocks tracked at McNary were wild PIT-tagged yearling and subyearling chinook salmon, sockeye salmon and steelhead trout ESUs, and FPC passage-indexed runs-at-large of combined wild and hatchery-reared yearling and subyearling chinook salmon, coho and sockeye salmon and steelhead trout. Stocks tracked at Rock Island and John Day Dams were FPC passage-indexed runs-at-large of combined wild and hatchery yearling and subyearling chinook salmon, coho and sockeye salmon and steelhead trout.

Figure B1: Historical Bear Valley Creek outmigration run-timing at Lower Granite Dam.

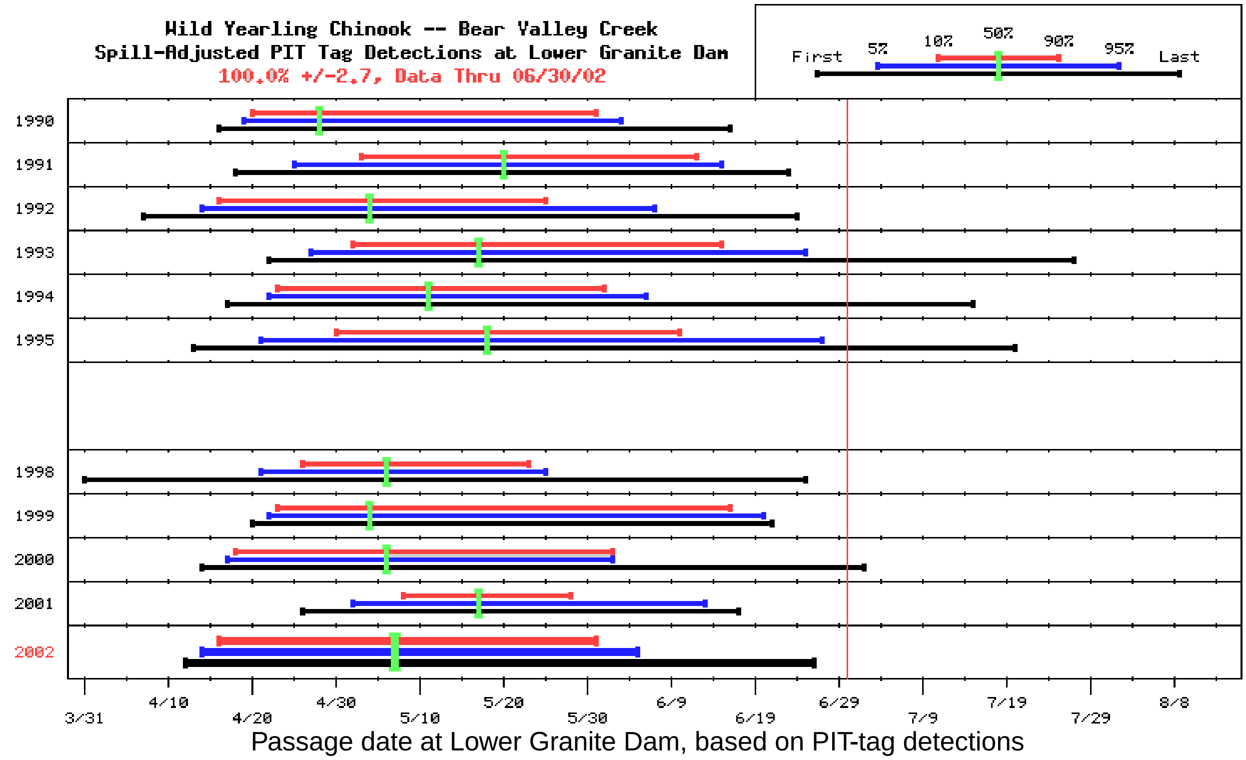


Table B1: Historical Bear Valley Creek outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1990	04/16	04/19	04/20	04/28	05/31	06/03	06/16	42	471	31	31.0	6.6
1991	04/18	04/25	05/03	05/20	06/12	06/15	06/23	41	352	44	44.4	12.6
1992	04/07	04/14	04/16	05/04	05/25	06/07	06/24	40	944	57	57.0	6.0
1993	04/24	04/27	05/02	05/17	06/15	06/25	07/27	45	1015	67	105.1	10.4
1994	04/21	04/22	04/23	05/11	06/01	06/06	07/15	40	856	85	115.4	13.5
1995	04/16	04/21	04/30	05/18	06/10	06/27	07/20	42	1455	74	101.7	7.0
1998	04/14	04/21	04/26	05/06	05/23	05/25	06/25	28	427	59	113.5	26.6
1999	04/20	04/22	04/23	05/04	06/16	06/20	06/21	55	820	39	92.2	11.2
2000	04/14	04/17	04/18	05/06	06/02	06/02	07/02	46	837	44	85.1	10.2
2001	04/27	05/02	05/08	05/17	05/28	06/13	06/17	21	581	112	112.0	19.3
2002	04/12	04/14	04/16	05/07	05/31	06/05	06/26	46	1495	56	128.4	8.6

Figure B2: Historical Big Creek outmigration run-timing at Lower Granite Dam.

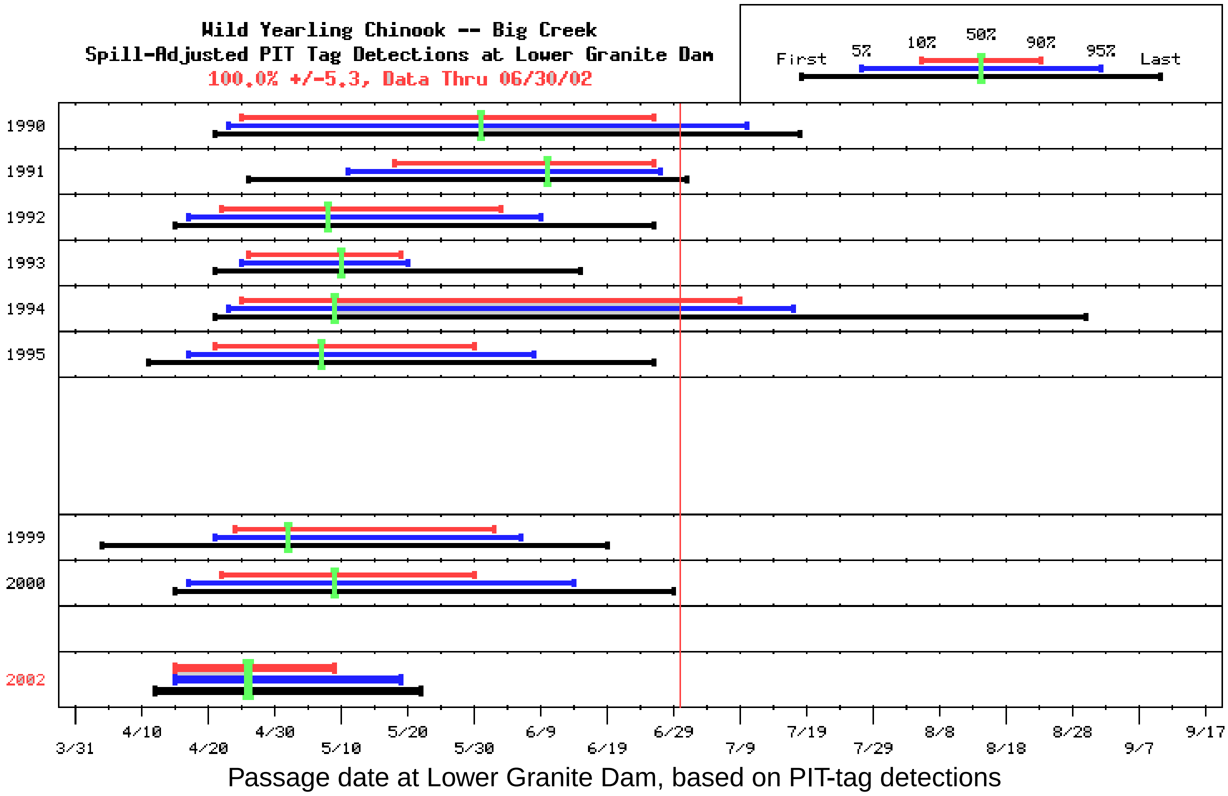


Table B2: Historical Big Creek outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1990	04/21	04/23	04/25	05/31	06/26	07/10	07/18	63	1134	75	75.0	6.6
1991	04/26	05/11	05/18	06/10	06/26	06/27	07/01	40	724	67	67.8	9.4
1992	04/15	04/17	04/22	05/08	06/03	06/09	06/26	43	1002	57	57.0	5.7
1993	04/21	04/25	04/26	05/10	05/19	05/20	06/15	24	733	65	84.7	11.6
1994	04/21	04/23	04/25	05/09	07/09	07/17	08/30	76	721	56	68.7	9.5
1995	04/13	04/17	04/21	05/07	05/30	06/08	06/26	40	1482	164	220.2	14.9
1999	04/10	04/21	04/24	05/02	06/02	06/06	06/19	40	1427	100	242.1	17.0
2000	04/15	04/17	04/22	05/09	05/30	06/14	06/29	39	1090	92	177.2	16.3
2002	04/12	04/15	04/15	04/26	05/09	05/19	05/22	25	409	32	74.9	18.3

Figure B3: Historical Catherine Creek outmigration run-timing at Lower Granite Dam.

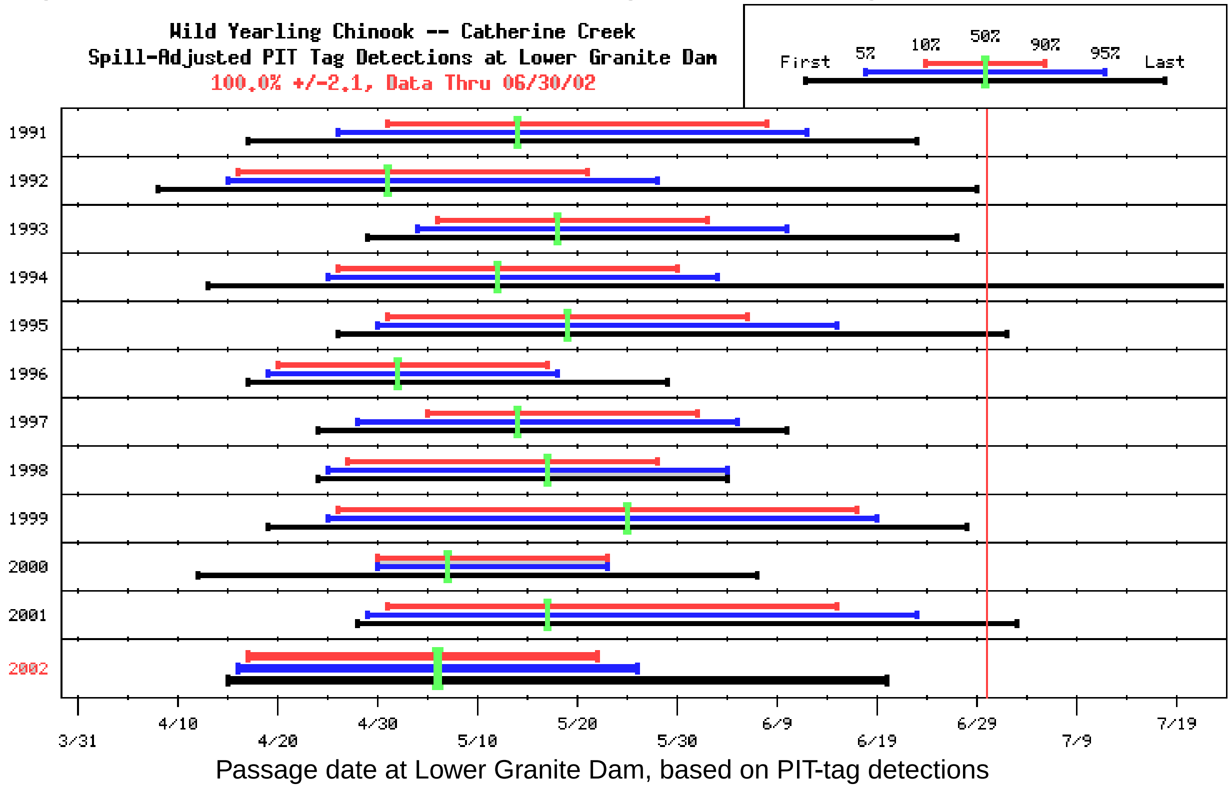


Table B3: Historical Catherine Creek outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1991	04/17	04/26	05/01	05/14	06/08	06/12	06/23	39	1012	77	77.8	7.7
1992	04/08	04/15	04/16	05/01	05/21	05/28	06/29	36	940	67	67.0	7.1
1993	04/29	05/04	05/06	05/18	06/02	06/10	06/27	28	1093	102	158.2	14.5
1994	04/23	04/25	04/26	05/12	05/30	06/03	07/26	35	1000	76	110.5	11.0
1995	04/28	04/30	05/01	05/19	06/06	06/15	07/02	37	1301	115	153.8	11.8
1996	04/17	04/19	04/20	05/02	05/17	05/18	05/29	28	499	40	86.2	17.3
1997	04/24	04/28	05/05	05/14	06/01	06/05	06/10	28	585	51	120.2	20.6
1998	04/24	04/25	04/27	05/17	05/28	06/04	06/04	32	500	43	91.3	18.3
1999	04/19	04/25	04/26	05/25	06/17	06/19	06/28	53	949	44	107.9	11.4
2000	04/12	04/30	04/30	05/07	05/23	05/23	06/07	24	499	30	57.2	11.5
2001	04/28	04/29	05/01	05/17	06/15	06/23	07/03	46	501	33	33.0	6.6
2002	04/15	04/16	04/17	05/06	05/22	05/26	06/20	36	970	36	82.1	8.5

Figure B4: Historical Chamberlain Creek (WF) outmigration run-timing at L.Granite Dam

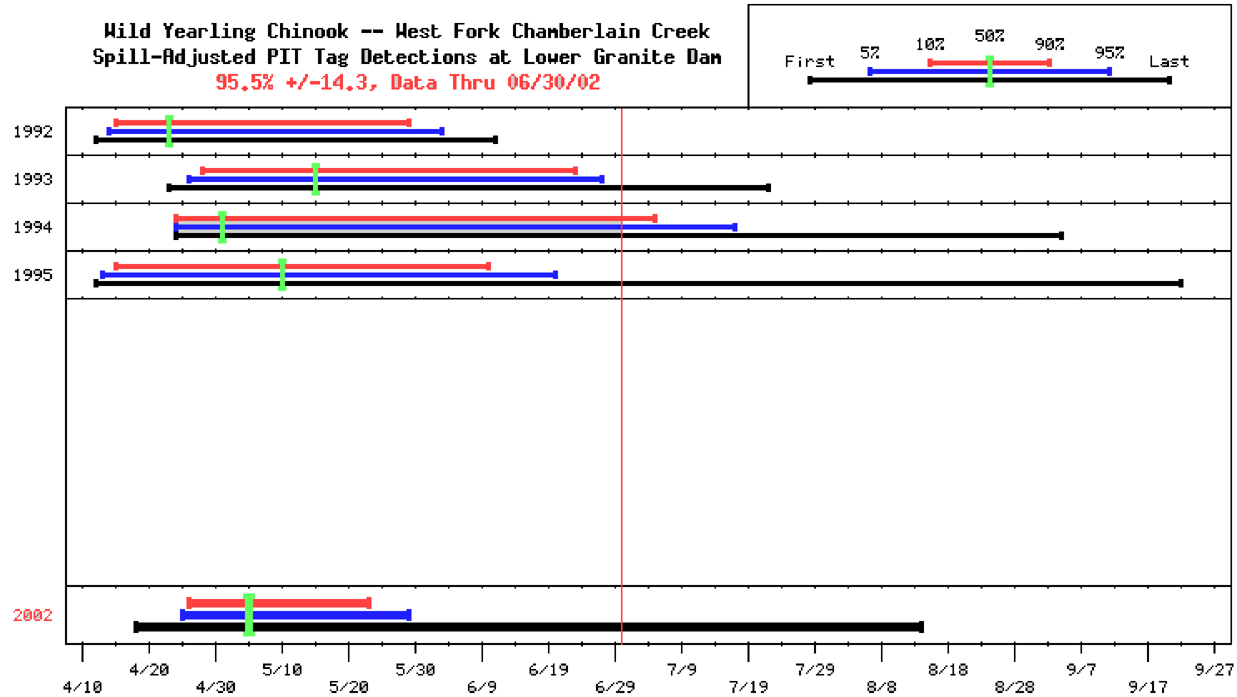


Table B4: Historical Chamberlain Creek (WF) outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1992	04/12	04/14	04/15	04/23	05/29	06/03	06/11	45	1057	47	47.0	4.4
1993	04/23	04/26	04/28	05/15	06/23	06/27	07/22	57	498	49	58.6	11.8
1994	04/24	04/24	04/24	05/01	07/05	07/17	09/04	73	496	31	32.3	6.5
1995	04/12	04/13	04/15	05/10	06/10	06/20	09/22	57	916	43	59.5	6.5
2002	04/18	04/25	04/26	05/05	05/23	05/29	08/14	28	527	24	56.7	10.8

Figure B5: Historical Clear Creek outmigration run-timing at L.Granite Dam.

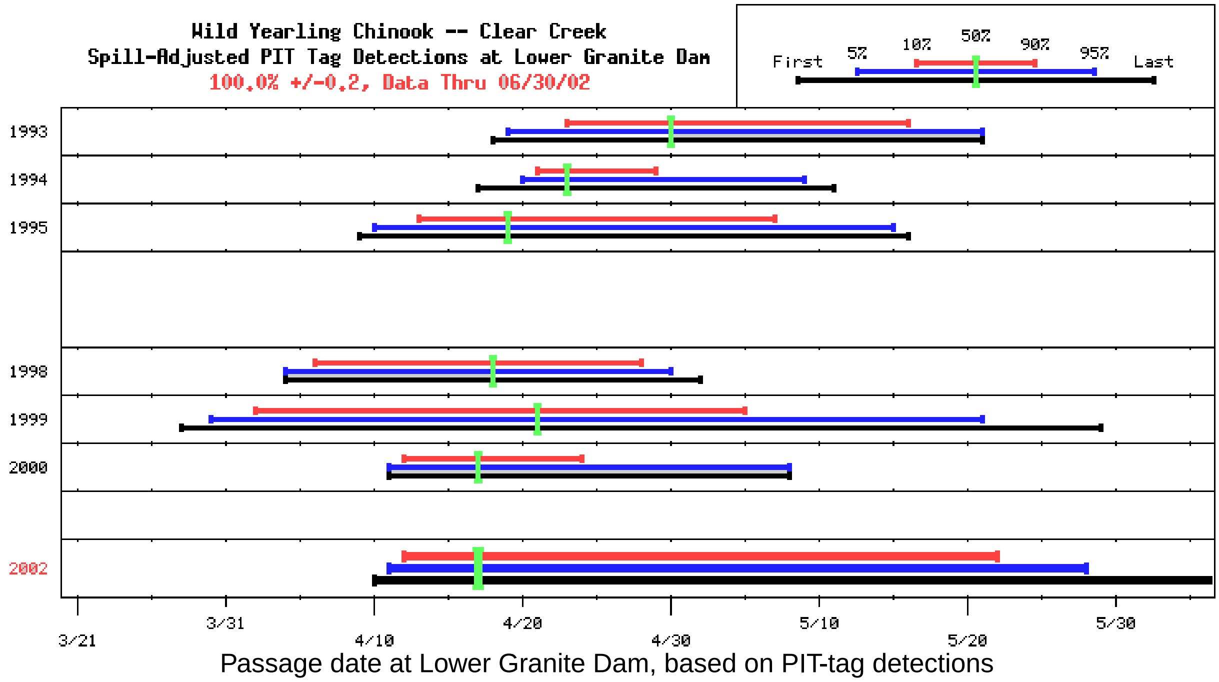


Table B5: Historical Clear Creek outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1993	04/18	04/19	04/23	04/30	05/16	05/21	05/21	24	426	33	37.5	8.8
1994	04/17	04/20	04/21	04/23	04/29	05/09	05/11	9	296	45	45.6	15.4
1995	04/09	04/10	04/13	04/19	05/07	05/15	05/16	25	450	43	47.3	10.5
1998	04/04	04/04	04/06	04/18	04/28	04/30	05/02	23	144	30	45.5	31.6
1999	03/28	03/30	04/02	04/21	05/05	05/21	05/29	34	499	35	74.3	14.9
2000	04/11	04/11	04/12	04/17	04/24	05/08	05/08	13	251	16	31.4	12.5
2002	04/10	04/11	04/12	04/17	05/22	05/28	06/10	41	729	36	82.0	11.3

Figure B6: Historical Elk Creek outmigration run-timing at L.Granite Dam.

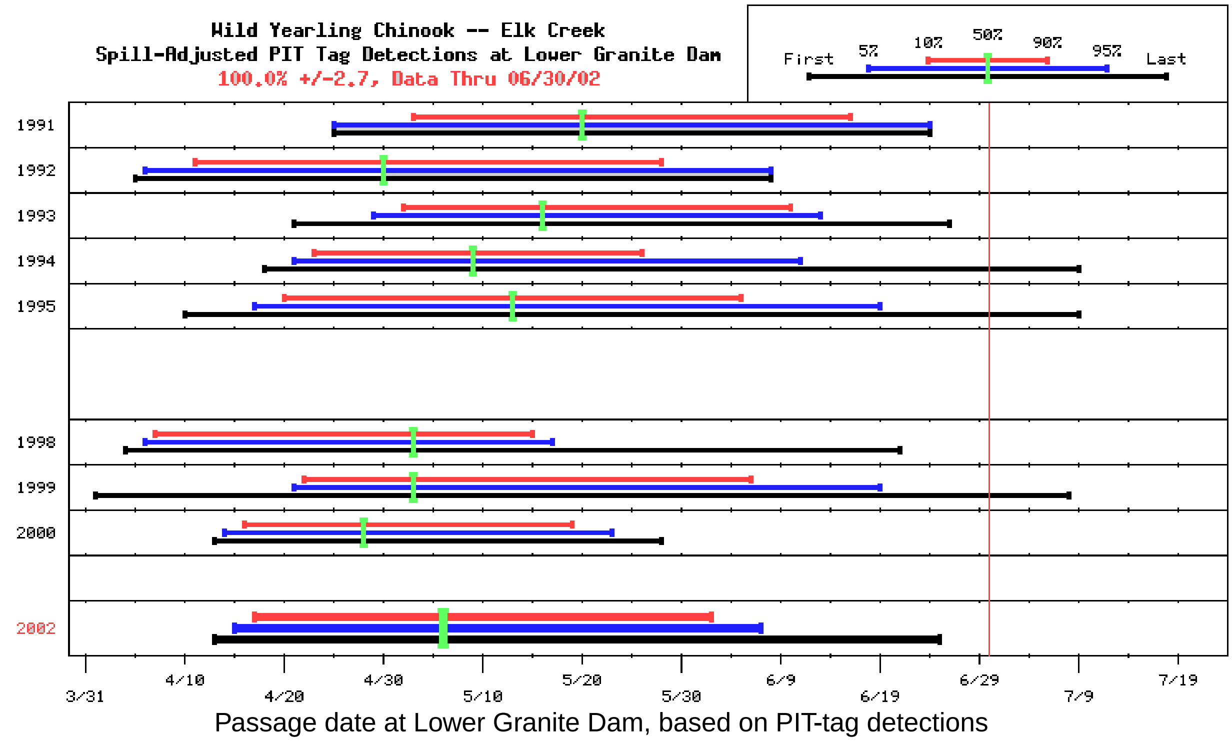


Table B6: Historical Elk Creek outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1991	04/25	04/25	05/03	05/20	06/16	06/24	06/24	45	247	32	32.8	13.3
1992	04/05	04/06	04/11	04/30	05/28	06/08	06/08	48	462	36	36.0	7.8
1993	04/21	04/29	05/02	05/16	06/10	06/13	06/26	40	628	42	63.8	10.2
1994	04/18	04/21	04/23	05/09	05/26	06/11	07/09	34	998	76	96.4	9.7
1995	04/11	04/17	04/20	05/13	06/05	06/19	07/09	47	1512	75	100.4	6.6
1998	04/04	04/06	04/07	05/03	05/15	05/17	06/21	39	246	57	104.0	42.3
1999	04/01	04/21	04/22	05/03	06/06	06/19	07/08	46	700	44	99.1	14.2
2000	04/13	04/14	04/16	04/28	05/19	05/23	05/28	34	660	42	80.3	12.2
2002	04/13	04/15	04/17	05/06	06/02	06/07	06/25	47	1519	34	76.2	5.0

Figure B7: Historical Grande Ronde River outmigration run-timing at L.Granite Dam.

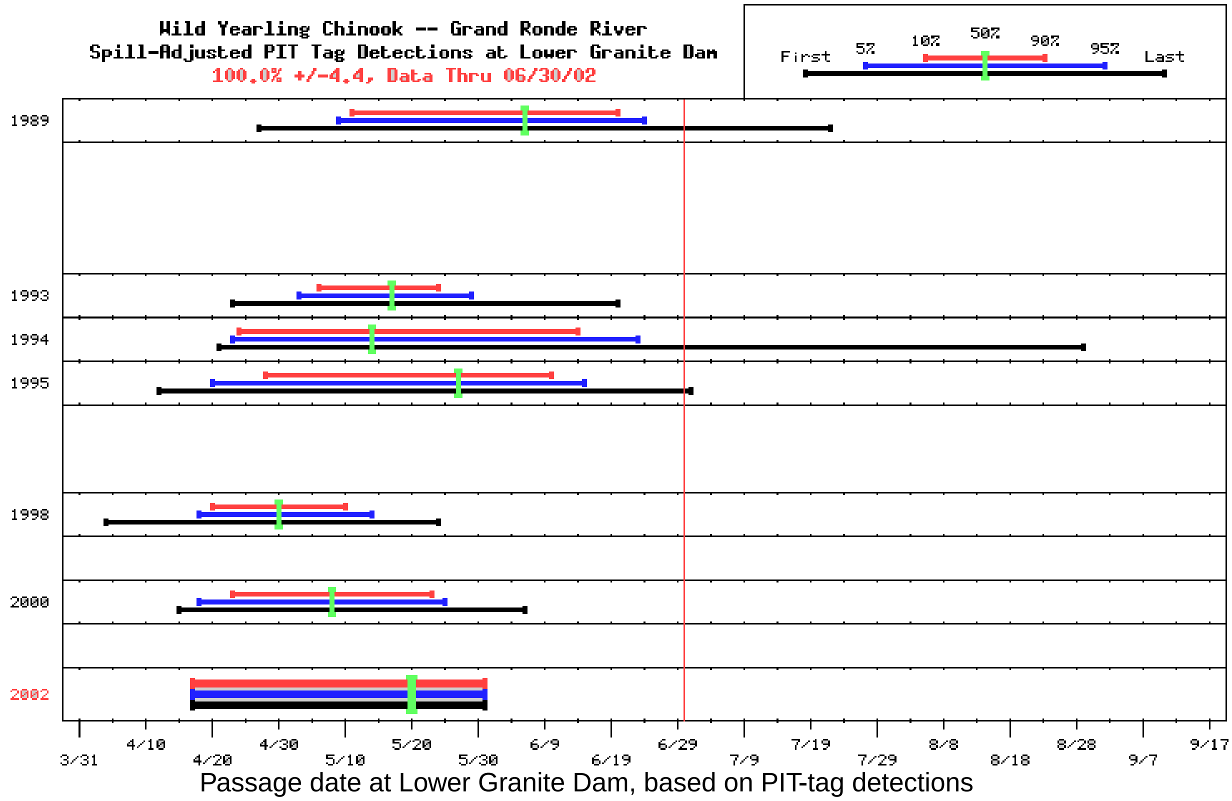


Table B7: Historical Grande Ronde River outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1989	05/05	05/09	05/11	06/06	06/20	06/24	07/22	41	2971	239	239.0	8.0
1993	04/25	05/03	05/06	05/17	05/24	05/29	06/20	19	918	89	162.0	17.6
1994	04/21	04/23	04/24	05/14	06/14	06/23	08/29	52	1355	101	140.2	10.3
1995	04/12	04/20	04/28	05/27	06/10	06/15	07/01	44	1575	88	115.6	7.3
1998	04/04	04/18	04/20	04/30	05/10	05/14	05/24	21	377	48	84.7	22.5
2000	04/15	04/18	04/23	05/08	05/23	05/25	06/06	31	368	30	58.2	15.8
2002	04/17	04/17	04/17	05/20	05/31	05/31	05/31	45	193	10	22.2	11.5

Figure B8: Historical Imnaha River outmigration run-timing at Lower Granite Dam.

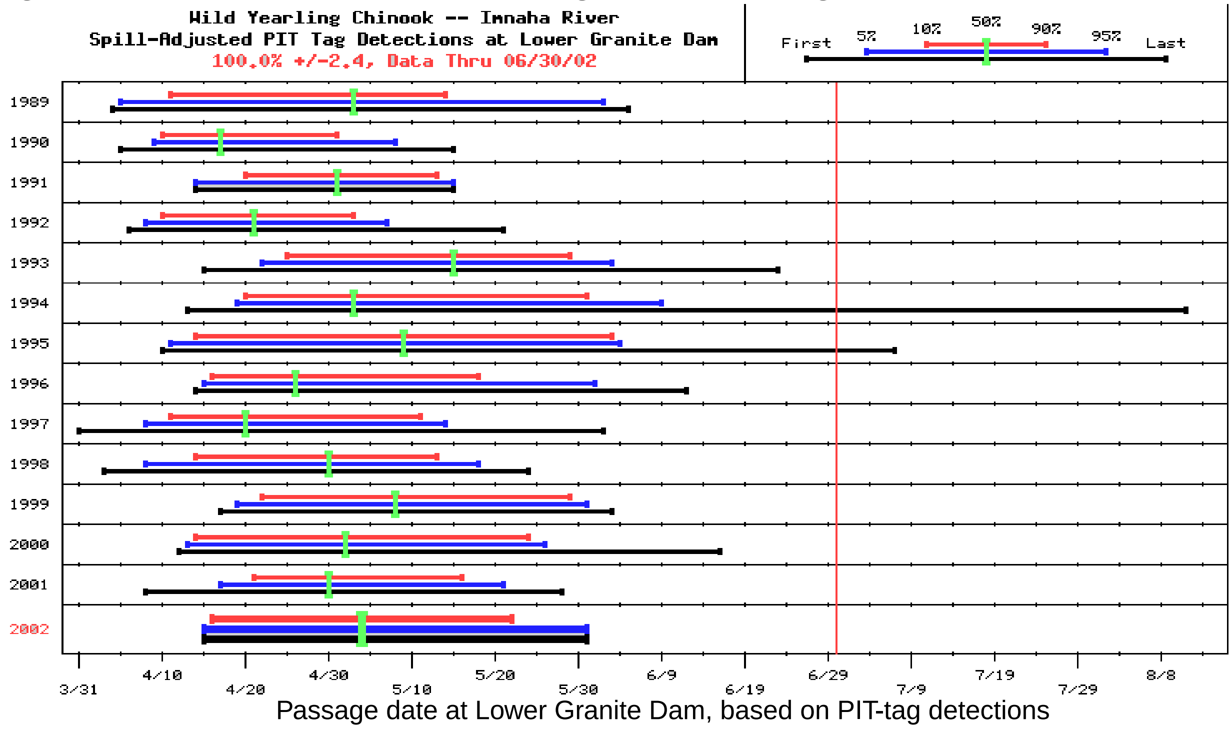


Table B8: Historical Imnaha River outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1989	04/04	04/05	04/11	05/03	05/14	06/02	06/05	34	588	36	36.0	6.1
1990	04/05	04/09	04/10	04/17	05/01	05/08	05/15	22	897	69	69.0	7.7
1991	04/14	04/14	04/20	05/01	05/13	05/15	05/15	24	327	18	18.0	5.5
1992	04/06	04/08	04/10	04/21	05/03	05/07	05/21	24	758	73	73.0	9.6
1993	04/15	04/22	04/25	05/15	05/29	06/03	06/23	35	1003	63	88.3	8.8
1994	04/13	04/19	04/20	05/03	05/31	06/09	08/11	42	1167	91	104.2	8.9
1995	04/10	04/11	04/14	05/09	06/03	06/04	07/07	51	996	40	50.9	5.1
1996	04/14	04/15	04/16	04/26	05/18	06/01	06/12	33	997	97	233.5	23.4
1997	04/03	04/08	04/11	04/20	05/11	05/14	06/02	31	1017	98	191.1	18.8
1998	04/03	04/08	04/14	04/30	05/13	05/18	05/24	30	1010	159	283.5	28.1
1999	04/17	04/19	04/22	05/08	05/29	05/31	06/03	38	1009	41	97.7	9.7
2000	04/12	04/13	04/14	05/02	05/24	05/26	06/16	41	982	63	119.5	12.2
2001	04/10	04/17	04/21	04/30	05/16	05/21	05/28	26	1000	159	159.0	15.9
2002	04/15	04/15	04/16	05/04	05/22	05/31	05/31	37	1001	15	33.5	3.3

Figure B9: Historical Johnson Creek outmigration run-timing at Lower Granite Dam.

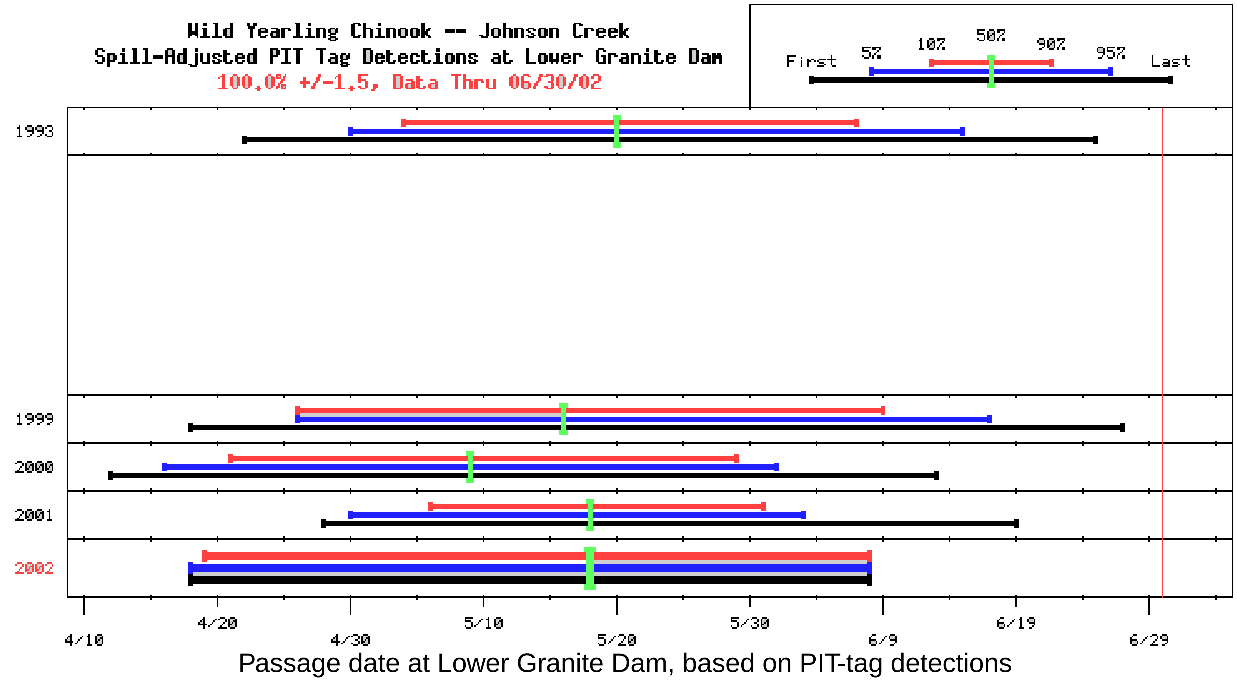


Table B9: Historical Johnson Creek outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1993	04/22	04/30	05/04	05/20	06/07	06/15	06/25	35	634	53	81.0	12.8
1999	04/18	04/26	04/26	05/16	06/09	06/17	06/27	45	1177	58	141.9	12.1
2000	04/12	04/16	04/21	05/09	05/29	06/01	06/13	39	913	49	94.5	10.3
2001	04/28	04/30	05/06	05/18	05/31	06/03	06/19	26	677	134	134.0	19.8
2002	04/18	04/18	04/19	05/18	06/08	06/08	06/08	51	235	10	22.5	9.6

Figure B10: Historical Lake Creek outmigration run-timing at Lower Granite Dam.

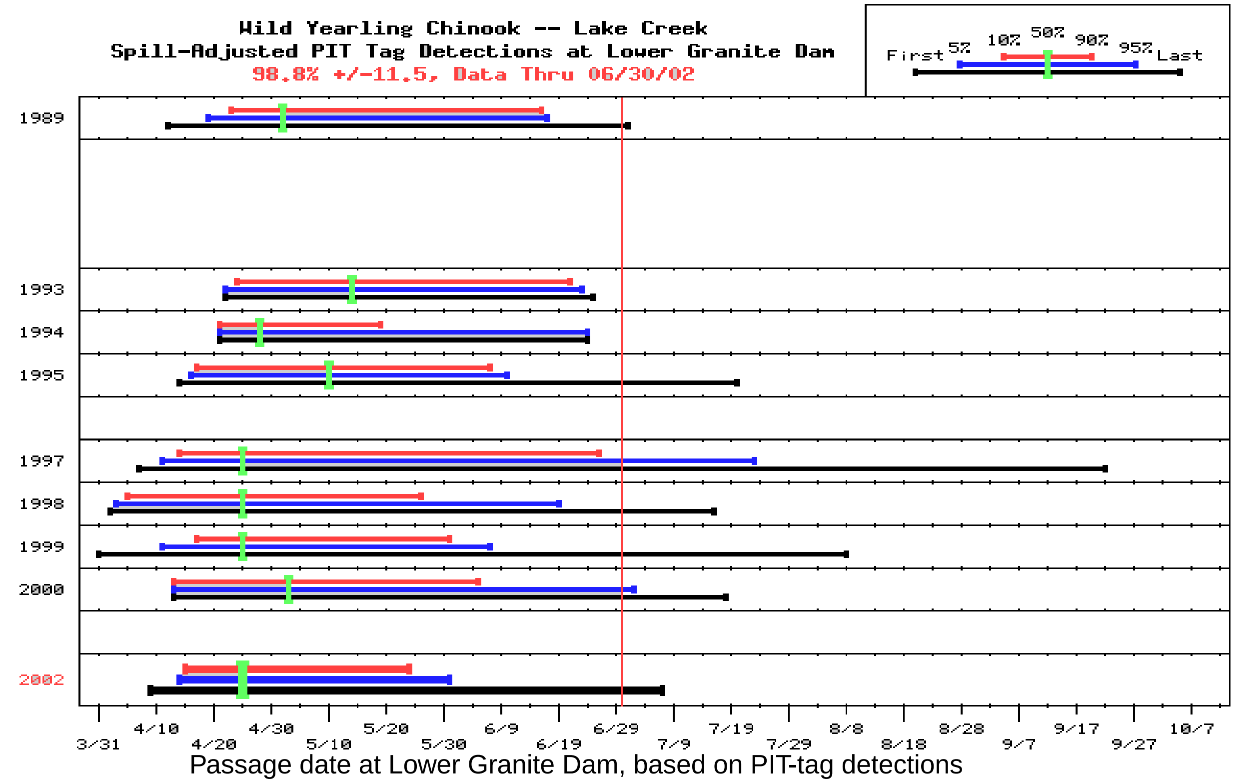


Table B10: Historical Lake Creek outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1989	04/12	04/19	04/23	05/02	06/16	06/17	07/01	55	657	51	51.0	7.8
1993	04/22	04/22	04/24	05/14	06/21	06/23	06/25	59	255	27	31.1	12.2
1994	04/21	04/21	04/21	04/28	05/19	06/24	06/24	29	252	17	19.8	7.9
1995	04/14	04/16	04/17	05/10	06/07	06/10	07/20	52	405	25	33.2	8.2
1997	04/07	04/11	04/14	04/25	06/26	07/23	09/22	74	400	22	41.8	10.4
1998	04/02	04/03	04/05	04/25	05/26	06/19	07/16	52	418	48	80.3	19.2
1999	04/03	04/11	04/17	04/25	05/31	06/07	08/08	45	5267	306	705.0	13.4
2000	04/13	04/13	04/13	05/03	06/05	07/02	07/18	54	603	30	54.5	9.0
2002	04/09	04/14	04/15	04/25	05/24	05/31	07/07	40	3193	94	207.8	6.5

Figure B11: Historical Lemhi River outmigration run-timing at Lower Granite Dam.

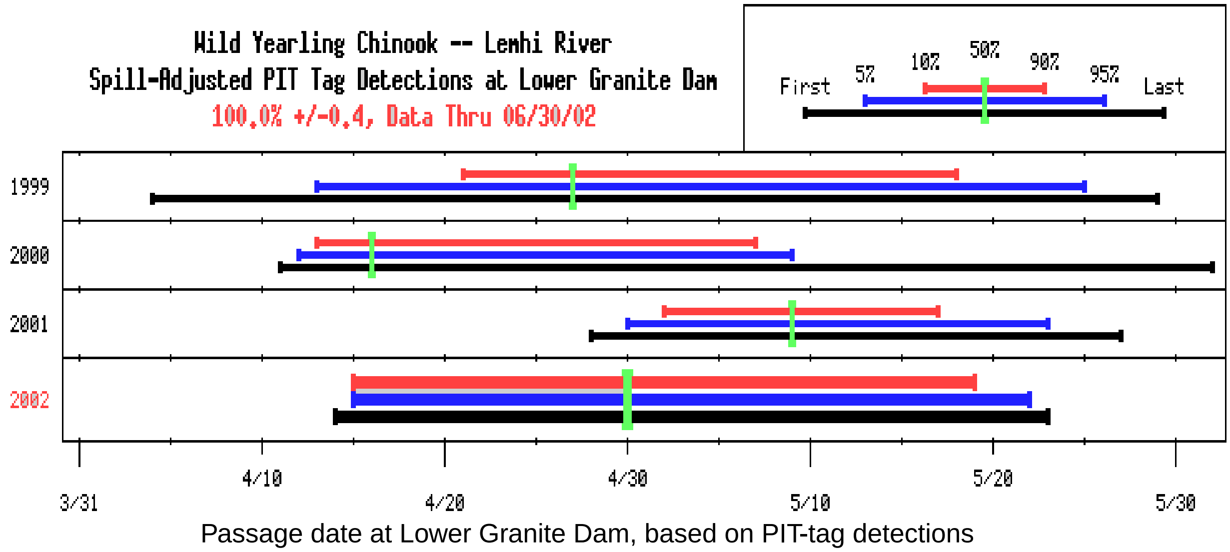


Table B11: Historical Lemhi River outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1999	04/04	04/13	04/21	04/27	05/18	05/25	05/29	28	699	55	129.5	18.5
2000	04/11	04/12	04/13	04/16	05/07	05/09	06/01	25	468	41	78.4	16.8
2001	04/28	04/30	05/02	05/09	05/17	05/23	05/27	16	700	99	99.0	14.1
2002	04/14	04/15	04/15	04/30	05/19	05/22	05/23	35	700	26	60.6	8.7

Figure B12: Historical Lolo Creek outmigration run-timing at Lower Granite Dam.

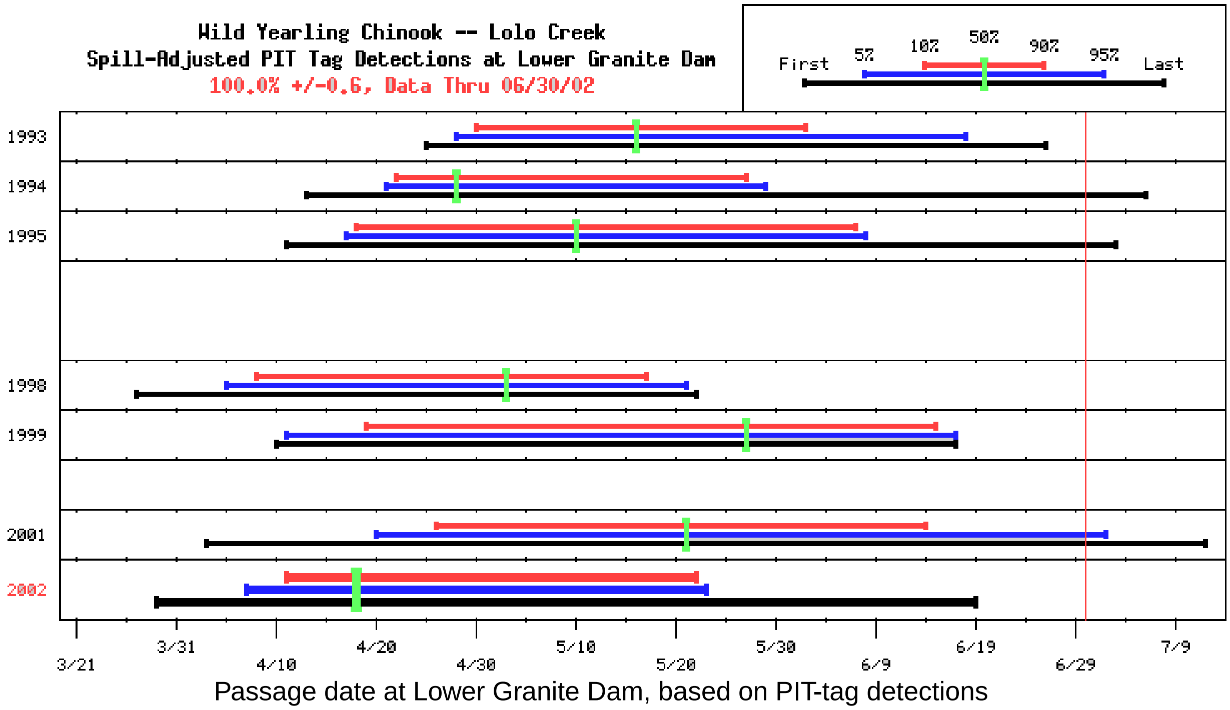


Table B12: Historical Lolo Creek outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1993	04/25	04/28	04/30	05/16	06/02	06/18	06/26	34	364	41	56.5	15.5
1994	04/18	04/21	04/22	04/28	05/27	05/29	07/06	36	1204	138	168.9	14.0
1995	04/11	04/17	04/18	05/10	06/07	06/08	07/03	51	766	61	78.2	10.2
1998	03/27	04/05	04/08	05/03	05/17	05/21	05/22	40	283	53	93.2	32.9
1999	04/10	04/11	04/19	05/27	06/15	06/17	06/17	58	856	38	92.4	10.8
2001	04/09	04/20	04/26	05/21	06/14	07/02	07/12	50	1203	198	198.0	16.5
2002	03/30	04/07	04/11	04/18	05/22	05/23	06/19	42	1932	75	166.8	8.6

Figure B13: Historical Lookingglass Creek outmigration run-timing at Lower Granite Dam.

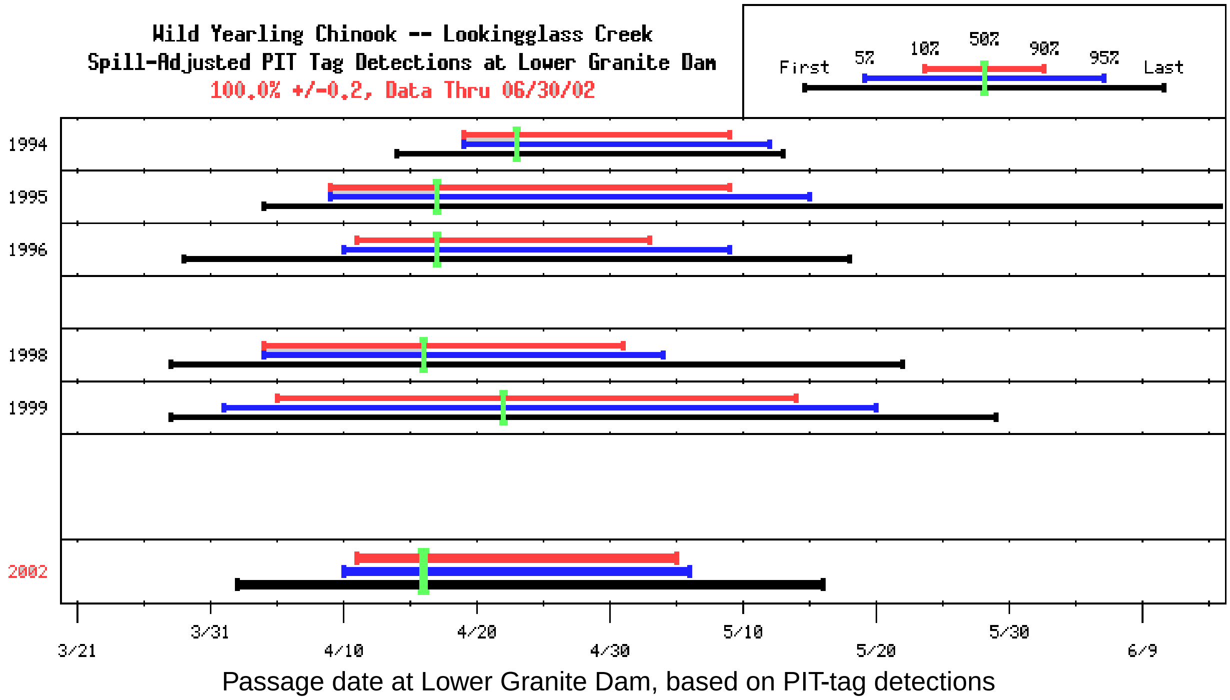


Table B13: Historical Lookingglass Creek outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1994	04/17	04/19	04/19	04/23	05/09	05/12	05/13	21	1159	131	135.1	11.7
1995	04/07	04/09	04/09	04/17	05/09	05/15	06/20	31	3146	244	275.0	8.7
1996	04/06	04/10	04/11	04/17	05/03	05/09	05/18	23	1794	110	304.1	16.9
1998	04/02	04/04	04/04	04/16	05/01	05/04	05/22	28	1383	181	287.8	20.8
1999	03/28	04/01	04/05	04/22	05/14	05/20	05/29	40	2270	111	245.7	10.8
2002	04/09	04/10	04/11	04/16	05/05	05/06	05/16	25	2185	71	157.8	7.2

Figure B14: Historical Lostine River outmigration run-timing at Lower Granite Dam.

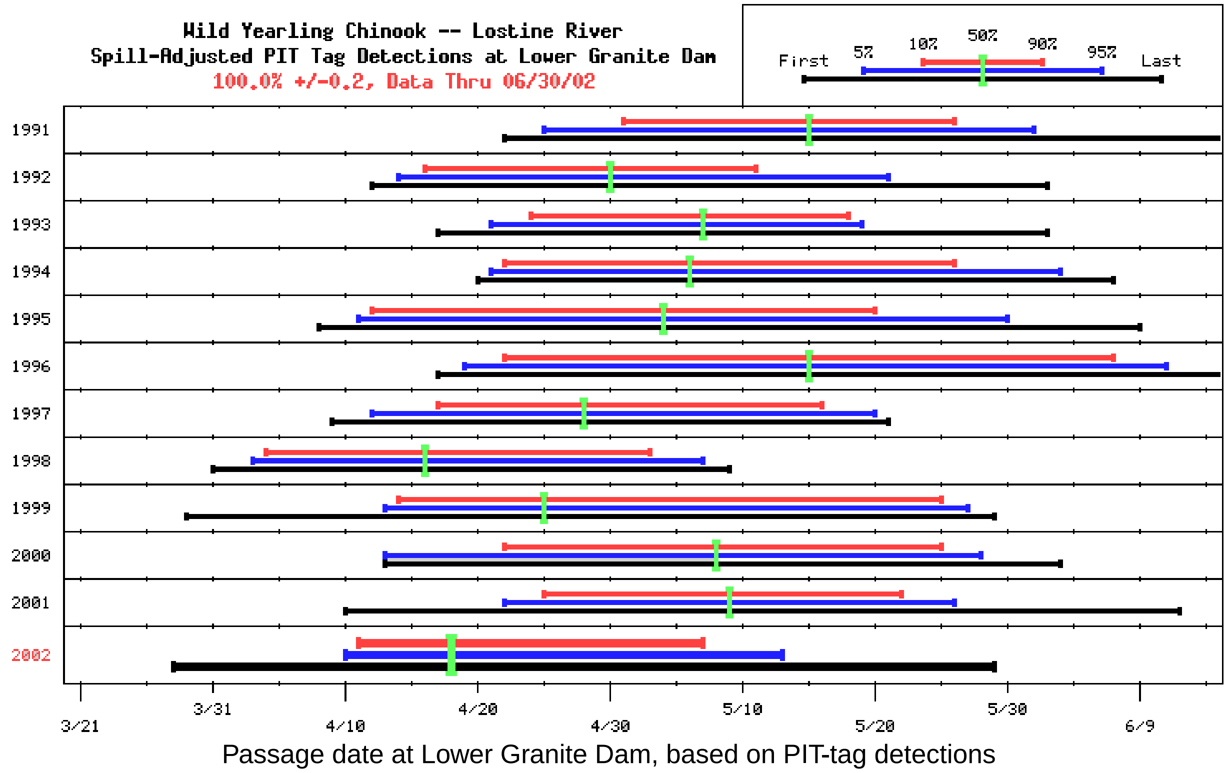


Table B14: Historical Lostine River outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1991	04/22	04/25	05/01	05/15	05/26	06/01	06/18	26	549	51	51.8	9.4
1992	04/12	04/14	04/16	04/30	05/11	05/21	06/02	26	1107	92	92.0	8.3
1993	04/18	04/21	04/24	05/07	05/18	05/19	06/02	25	999	123	156.1	15.6
1994	04/20	04/21	04/22	05/06	05/26	06/03	06/07	35	725	71	87.4	12.1
1995	04/10	04/11	04/12	05/04	05/20	05/30	06/09	39	1002	112	142.0	14.2
1996	04/17	04/19	04/22	05/15	06/07	06/11	06/19	47	978	81	188.2	19.2
1997	04/09	04/12	04/17	04/28	05/16	05/20	05/21	30	527	43	93.0	17.6
1998	03/31	04/03	04/04	04/16	05/03	05/07	05/09	30	236	46	70.5	29.9
1999	03/30	04/13	04/14	04/25	05/25	05/27	05/29	42	823	44	106.6	13.0
2000	04/13	04/13	04/22	05/08	05/25	05/28	06/03	34	509	36	68.8	13.5
2001	04/10	04/22	04/25	05/09	05/22	05/26	06/12	28	489	87	87.0	17.8
2002	03/30	04/10	04/11	04/18	05/07	05/13	05/29	27	903	51	112.4	12.4

Figure B15: Historical Marsh Creek outmigration run-timing at Lower Granite Dam.

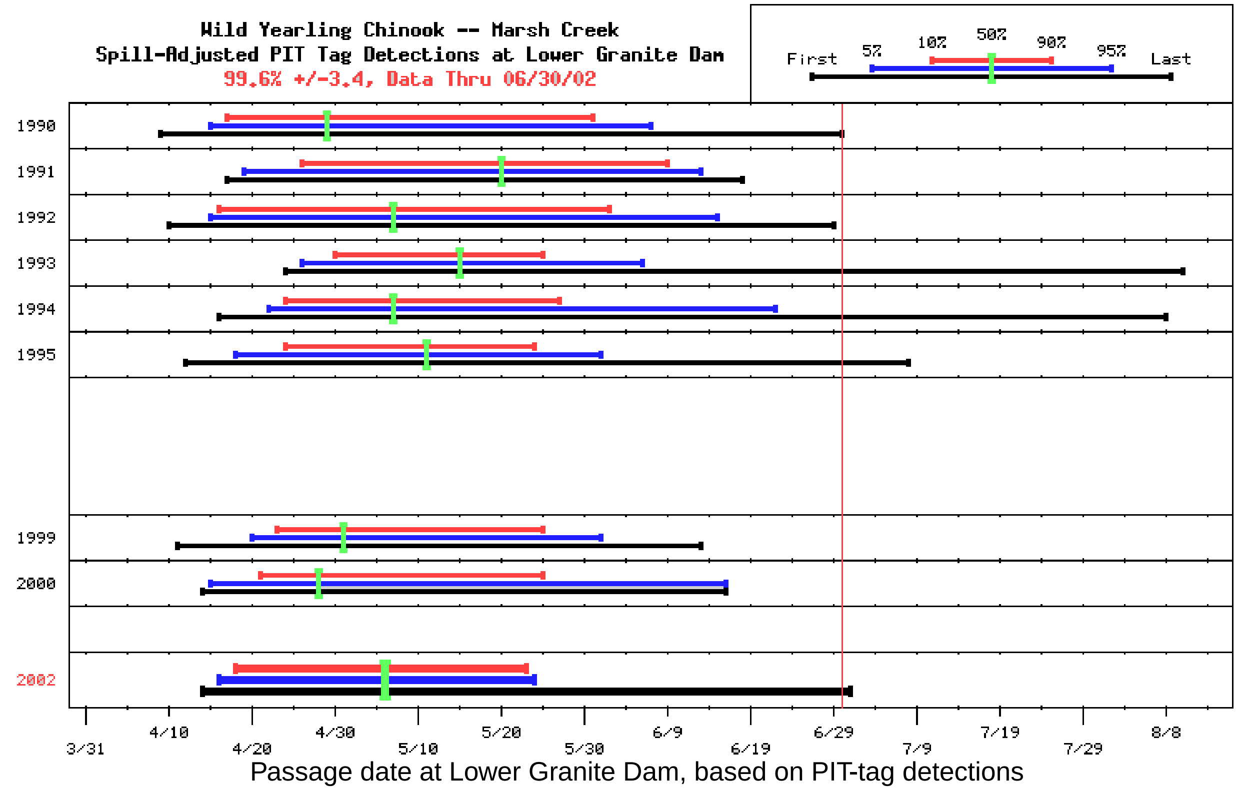


Table B15: Historical Marsh Creek outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1990	04/12	04/15	04/17	04/29	05/31	06/07	06/30	45	2496	179	179.0	7.2
1991	04/17	04/19	04/26	05/20	06/09	06/13	06/18	45	861	59	59.0	6.9
1992	04/10	04/15	04/16	05/07	06/02	06/15	06/29	48	696	46	46.0	6.6
1993	04/25	04/26	04/30	05/15	05/25	06/06	08/10	26	1000	82	126.5	12.6
1994	04/16	04/22	04/24	05/07	05/27	06/22	08/08	34	944	75	90.8	9.6
1995	04/12	04/18	04/24	05/11	05/24	06/01	07/08	31	1095	68	94.8	8.7
1999	04/11	04/20	04/23	05/01	05/25	06/01	06/13	33	769	58	139.2	18.1
2000	04/14	04/15	04/21	04/28	05/25	06/16	06/16	35	554	23	46.6	8.4
2002	04/14	04/16	04/18	05/06	05/23	05/24	07/01	36	1056	42	89.8	8.5

Figure B16: Historical Minam River outmigration run-timing at Lower Granite Dam.

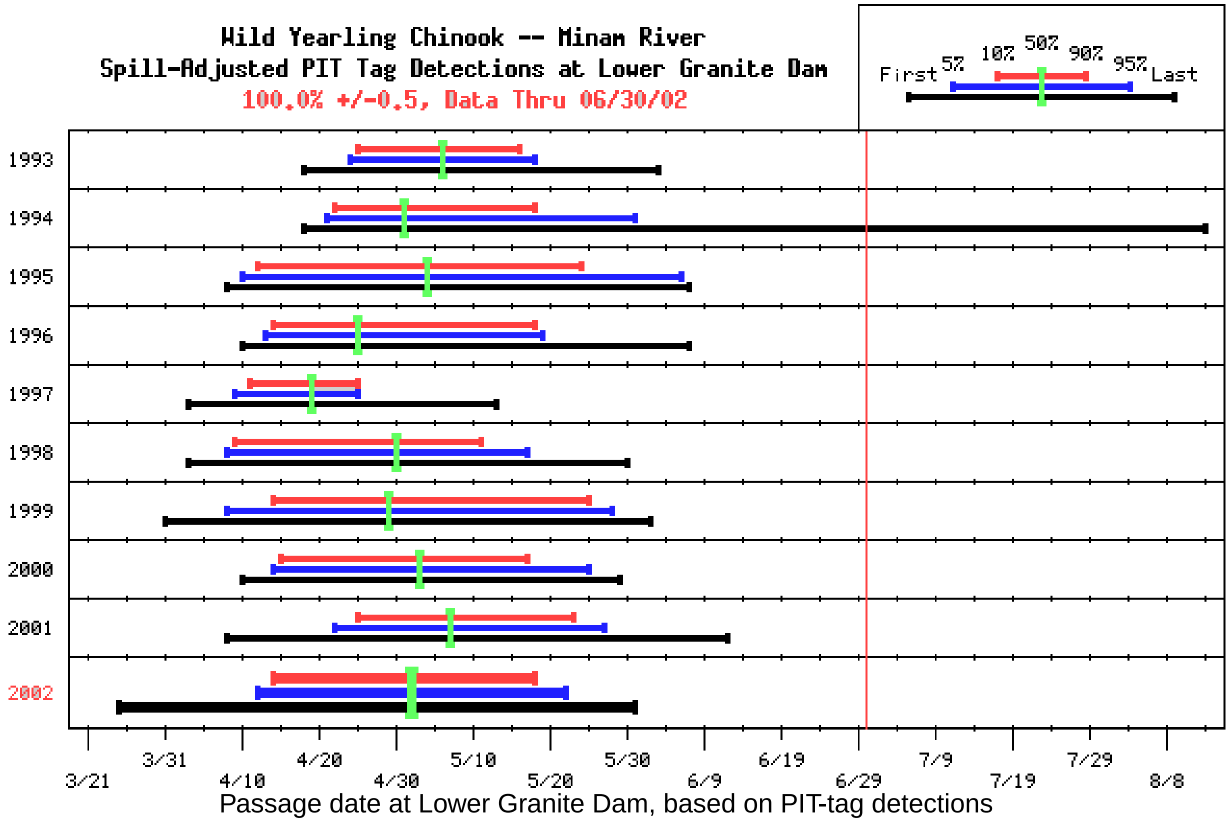


Table B16: Historical Minam River outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1993	04/22	04/24	04/25	05/06	05/16	05/18	06/03	22	1000	105	125.5	12.5
1994	04/20	04/21	04/22	05/01	05/18	05/31	08/13	27	997	112	133.3	13.4
1995	04/08	04/10	04/12	05/04	05/24	06/06	06/07	43	996	70	89.3	9.0
1996	04/10	04/13	04/14	04/25	05/18	05/19	06/07	35	998	68	164.9	16.5
1997	04/03	04/09	04/11	04/19	04/25	04/25	05/13	15	589	49	92.4	15.7
1998	04/04	04/08	04/09	04/30	05/11	05/17	05/30	33	998	123	221.8	22.2
1999	04/03	04/08	04/14	04/29	05/25	05/28	06/02	42	1006	51	120.4	12.0
2000	04/10	04/14	04/15	05/03	05/17	05/25	05/29	33	998	74	142.1	14.2
2001	04/16	04/22	04/25	05/07	05/23	05/27	06/12	29	1000	178	178.0	17.8
2002	04/10	04/12	04/14	05/02	05/18	05/22	05/31	35	1533	65	149.9	9.8

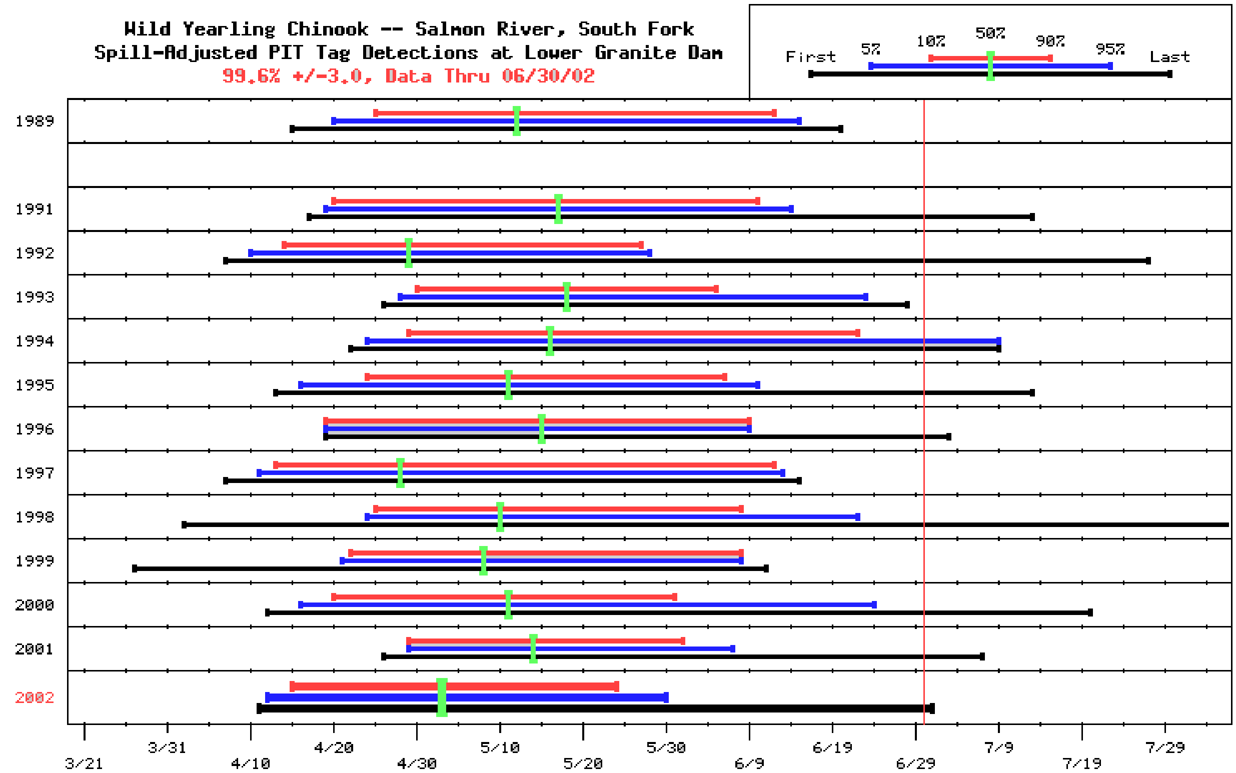


Table B17: Historical Salmon River, SF outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1989	04/15	04/20	04/25	05/12	06/12	06/15	06/20	49	2178	84	84.0	3.9
1991	04/17	04/19	04/20	05/17	06/10	06/14	07/13	52	986	98	98.8	10.0
1992	04/07	04/10	04/14	04/29	05/27	05/28	07/27	44	1027	81	81.0	7.9
1993	04/26	04/28	04/30	05/18	06/05	06/23	06/28	37	723	48	79.4	11.0
1994	04/22	04/24	04/29	05/16	06/22	07/09	07/09	55	803	41	58.1	7.2
1995	04/14	04/16	04/24	05/11	06/06	06/10	07/13	44	1571	78	105.2	6.7
1996	04/19	04/19	04/19	05/15	06/09	06/09	07/03	52	700	16	37.2	5.3
1997	04/07	04/11	04/13	04/28	06/12	06/13	06/15	61	700	36	78.9	11.3
1998	04/06	04/24	04/25	05/10	06/08	06/22	08/07	45	1007	83	155.5	15.4
1999	03/27	04/21	04/22	05/08	06/08	06/08	06/11	48	998	38	87.6	8.8
2000	04/12	04/16	04/20	05/11	05/31	06/24	07/20	42	1010	39	72.0	7.1
2001	04/26	04/29	04/29	05/14	06/01	06/07	07/07	34	1010	116	116.0	11.5
2002	04/11	04/12	04/15	05/03	05/24	05/30	07/01	40	1534	29	70.1	4.6

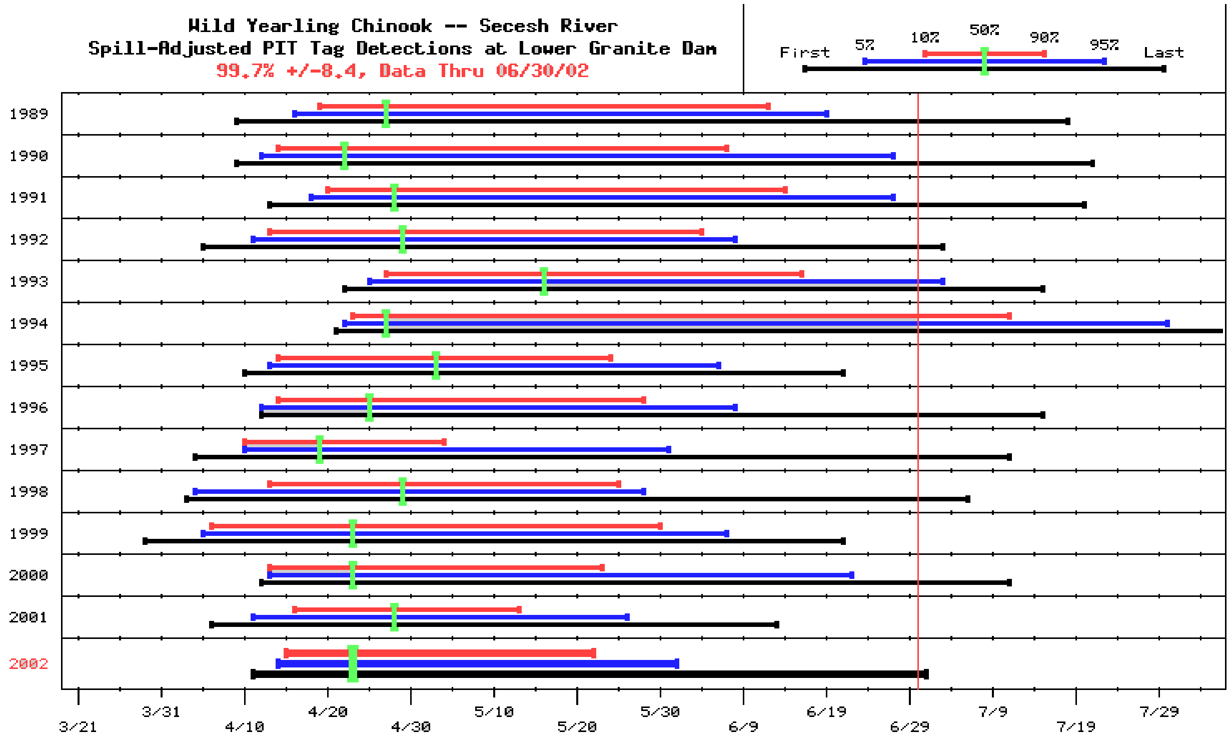
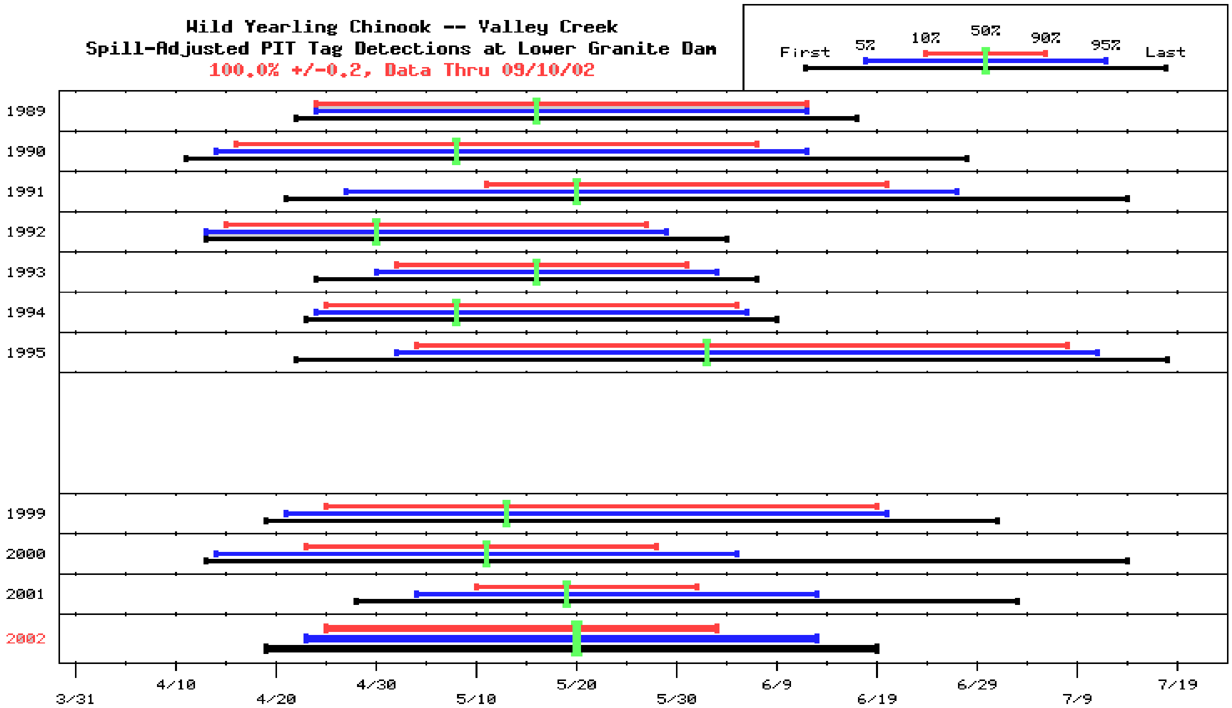


Table B18: Historical Secesh River outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1989	04/12	04/16	04/19	04/27	06/12	06/19	07/18	55	1507	142	142.0	9.4
1990	04/10	04/12	04/14	04/22	06/07	06/27	07/21	55	1545	108	108.0	7.0
1991	04/13	04/18	04/20	04/28	06/14	06/27	07/20	56	1016	71	72.3	7.1
1992	04/05	04/11	04/13	04/29	06/04	06/08	07/03	53	1012	40	40.0	4.0
1993	04/22	04/25	04/27	05/16	06/16	07/03	07/15	51	327	30	37.0	11.3
1994	04/21	04/22	04/23	04/27	07/11	07/30	08/07	80	422	32	33.0	7.8
1995	04/10	04/13	04/14	05/03	05/24	06/06	06/21	41	1213	74	90.6	7.5
1996	04/12	04/12	04/14	04/25	05/28	06/08	07/15	45	571	26	70.0	12.3
1997	04/04	04/10	04/10	04/19	05/04	05/31	07/11	25	260	34	62.7	24.1
1998	04/03	04/04	04/13	04/29	05/25	05/28	07/06	43	588	74	126.1	21.4
1999	03/29	04/05	04/06	04/23	05/30	06/07	06/21	55	936	36	80.4	8.6
2000	04/12	04/13	04/13	04/23	05/23	06/22	07/11	41	907	40	74.2	8.2
2001	04/06	04/11	04/16	04/28	05/13	05/26	06/13	28	586	169	169.0	28.8
2002	04/12	04/14	04/15	04/23	05/22	06/01	07/01	38	4285	149	350.3	8.2

Figure B19: Historical Valley Creek outmigration run-timing at Lower Granite Dam.



Passage date at Lower Granite Dam, based on PIT-tag detections

Table B19: Historical Valley Creek outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1989	04/22	04/24	04/24	05/16	06/12	06/12	06/17	50	1241	43	43.0	3.5
1990	04/11	04/14	04/16	05/08	06/07	06/12	06/28	53	2496	76	76.0	3.0
1991	04/21	04/27	05/11	05/20	06/20	06/27	07/14	41	1024	41	41.0	4.0
1992	04/13	04/13	04/15	04/30	05/27	05/29	06/04	43	969	34	34.0	3.5
1993	04/24	04/30	05/02	05/16	05/31	06/03	06/07	30	1026	32	51.2	5.0
1994	04/23	04/24	04/25	05/08	06/05	06/06	06/09	42	848	45	61.8	7.3
1995	04/22	05/02	05/04	06/02	07/08	07/11	07/18	66	1551	50	64.0	4.1
1999	04/19	04/21	04/25	05/13	06/19	06/20	07/01	56	1001	50	118.3	11.8
2000	04/13	04/14	04/23	05/11	05/28	06/05	07/14	36	1009	51	95.7	9.5
2001	04/30	05/04	05/10	05/19	06/01	06/13	07/03	23	1004	135	135.0	13.4
2002	04/19	04/23	04/25	05/20	06/03	06/13	06/19	40	1497	41	89.8	6.0

Figure B20: Historical RealTime/CRiSP Composite outmigration run-timing to LWG.

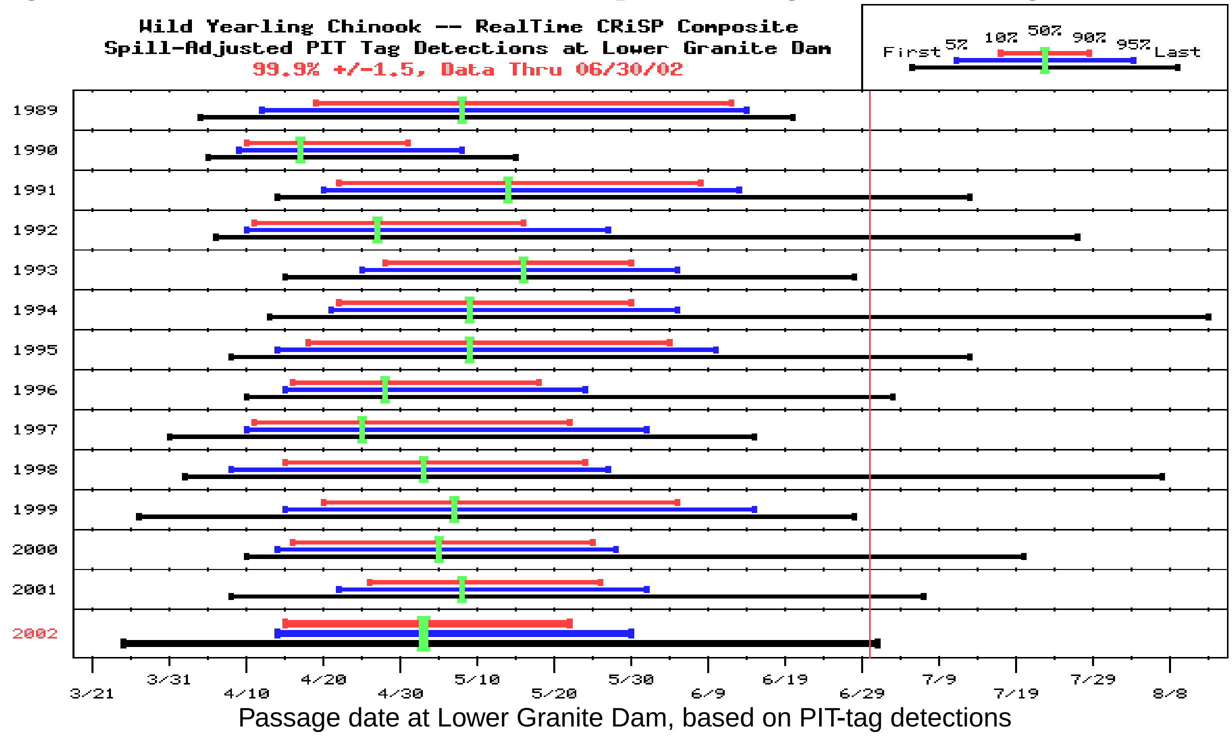


Table B20: Historical RealTime/CRiSP Composite outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1989	04/05	04/12	04/19	05/08	06/12	06/14	06/20	55	2766	120	120.0	4.3
1990	04/05	04/09	04/10	04/17	05/01	05/08	05/15	22	897	69	69.0	7.7
1991	04/17	04/20	04/22	05/14	06/08	06/13	07/13	48	2325	193	194.7	8.4
1992	04/06	04/10	04/11	04/27	05/16	05/27	07/27	36	2725	221	221.0	8.1
1993	04/21	04/25	04/28	05/16	05/30	06/05	06/28	33	3819	318	451.5	11.8
1994	04/16	04/21	04/22	05/09	05/30	06/05	08/13	39	3967	320	406.1	10.2
1995	04/10	04/14	04/18	05/09	06/04	06/10	07/13	48	4864	303	399.1	8.2
1996	04/12	04/15	04/16	04/28	05/18	05/24	07/03	33	3194	221	521.7	16.3
1997	04/06	04/10	04/11	04/25	05/22	06/01	06/15	42	2891	234	482.6	16.7
1998	04/04	04/08	04/15	05/03	05/24	05/27	08/07	40	3515	408	752.2	21.4
1999	03/31	04/15	04/20	05/07	06/05	06/15	06/28	47	3962	174	413.6	10.4
2000	04/11	04/14	04/16	05/05	05/25	05/28	07/20	40	3489	206	390.9	11.2
2001	04/11	04/22	04/26	05/08	05/26	06/01	07/07	31	3511	486	486.0	13.8
2002	04/11	04/14	04/15	05/03	05/22	05/30	07/01	38	5038	145	335.7	6.7

Figure B21: Historical outmigration run-timing of the wild PIT-tagged run-at-large of Yearling Chinook Salmon at Lower Granite Dam.

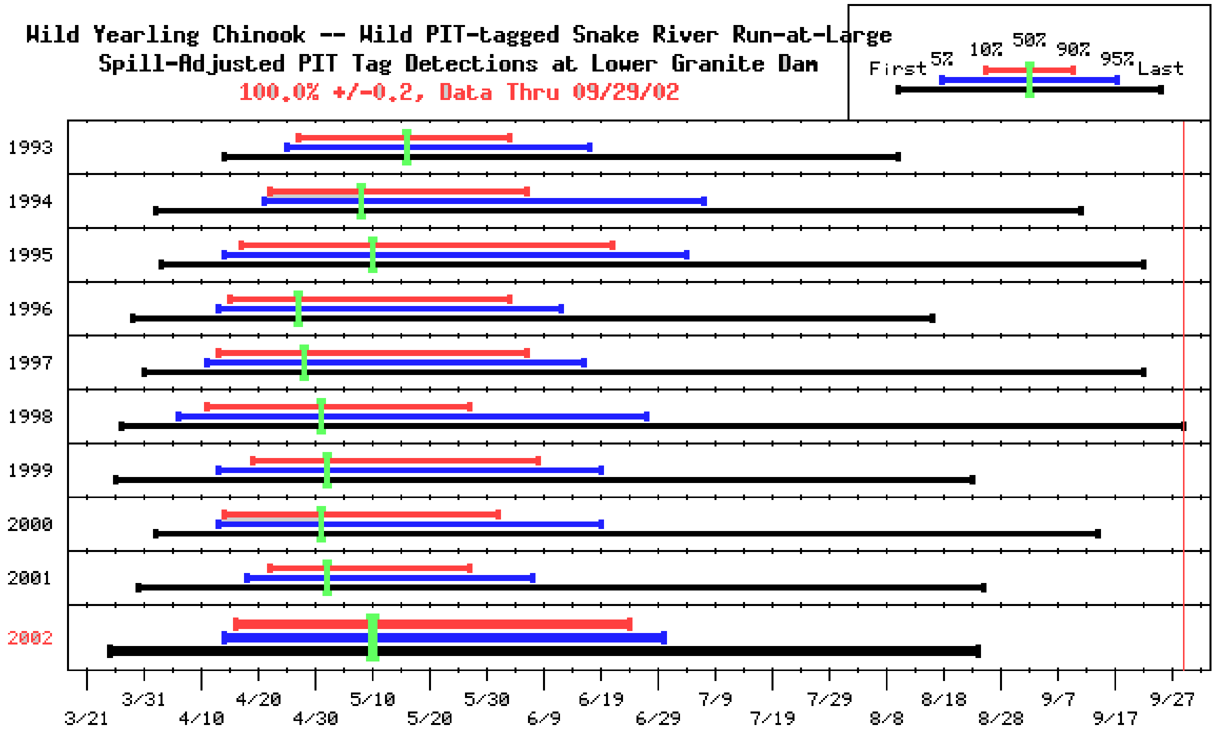


Table B21: Historical PIT-tagged Run-at-Large of Wild Yearling Chinook Salmon outmigration timing characteristics at Lower Granite Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total LGR Passage
	First	5%	10%	50%	90%	95%	Last		
1993	04/21	04/25	04/27	05/16	06/03	06/17	08/10	38	3939
1994	04/19	04/21	04/22	05/08	06/06	07/07	09/11	46	6889
1995	04/10	04/14	04/17	05/10	06/21	07/04	09/22	66	9437
1996	04/11	04/13	04/15	04/27	06/03	06/12	08/16	50	5418
1997	04/07	04/11	04/13	04/28	06/06	06/16	09/22	55	2497
1998	04/03	04/06	04/11	05/01	05/27	06/27	09/29	47	13425
1999	04/02	04/13	04/19	05/02	06/08	06/19	08/23	51	17945
2000	04/10	04/13	04/14	05/01	06/01	06/19	09/14	49	14541
2001	04/11	04/18	04/22	05/02	05/27	06/07	08/25	36	18076
2002	04/10	04/14	04/16	05/10	06/24	06/30	08/24	70	11503

Figure B22: Historical outmigration run-timing of the composite of hatchery PIT-tagged Sockeye Salmon from Alturas Lake Creek, Redfish Lake Creek Trap, and Sawtooth Trap at Lower Granite Dam.

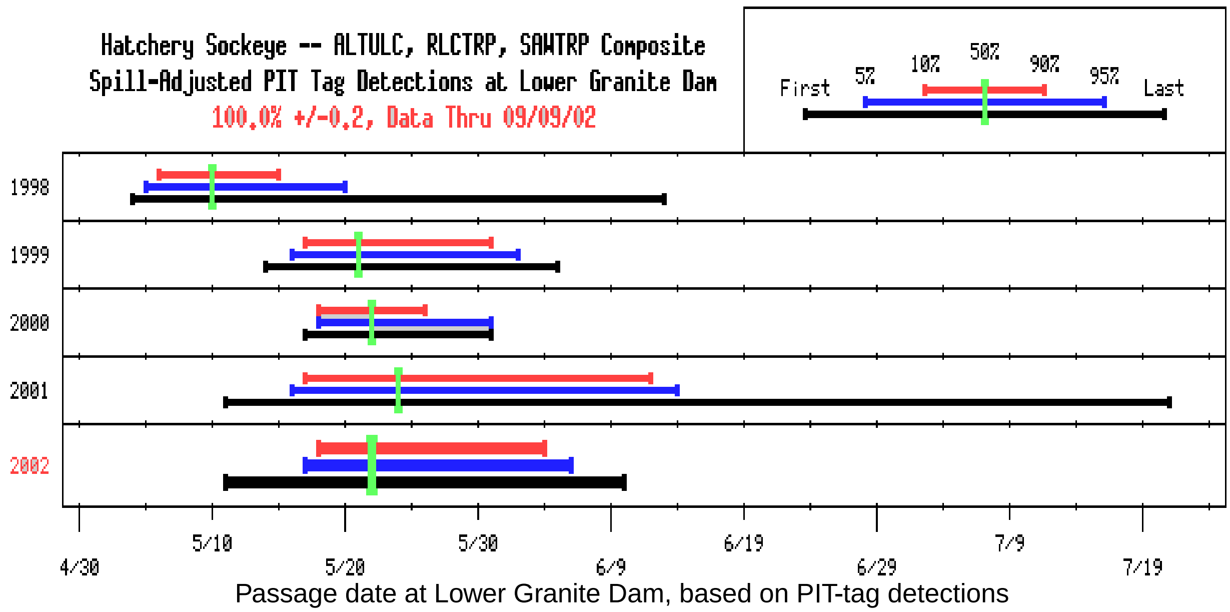


Table B22: Historical Composite of Alturas Lake Creek, Redfish Lake Creek Trap, Sawtooth Trap PIT-tagged hatchery-reared sockeye salmon outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1998	05/04	05/05	05/06	05/10	05/15	05/20	06/13	10	4176	1333	2555.2	61.2
1999	05/14	05/16	05/17	05/21	05/31	06/02	06/05	15	981	72	180.9	18.4
2000	05/17	05/18	05/18	05/22	05/26	05/31	05/31	9	328	22	42.2	12.9
2001	05/13	05/16	05/17	05/24	06/12	06/14	07/21	27	1650	437	437.0	26.5
2002	05/12	05/17	05/18	05/22	06/04	06/06	06/10	18	2836	135	316.5	11.2

Figure B23: Historical outmigration run-timing of the subpopulation of wild PIT-tagged Subyearling Fall Chinook Salmon (SNAKER) at Lower Granite Dam.

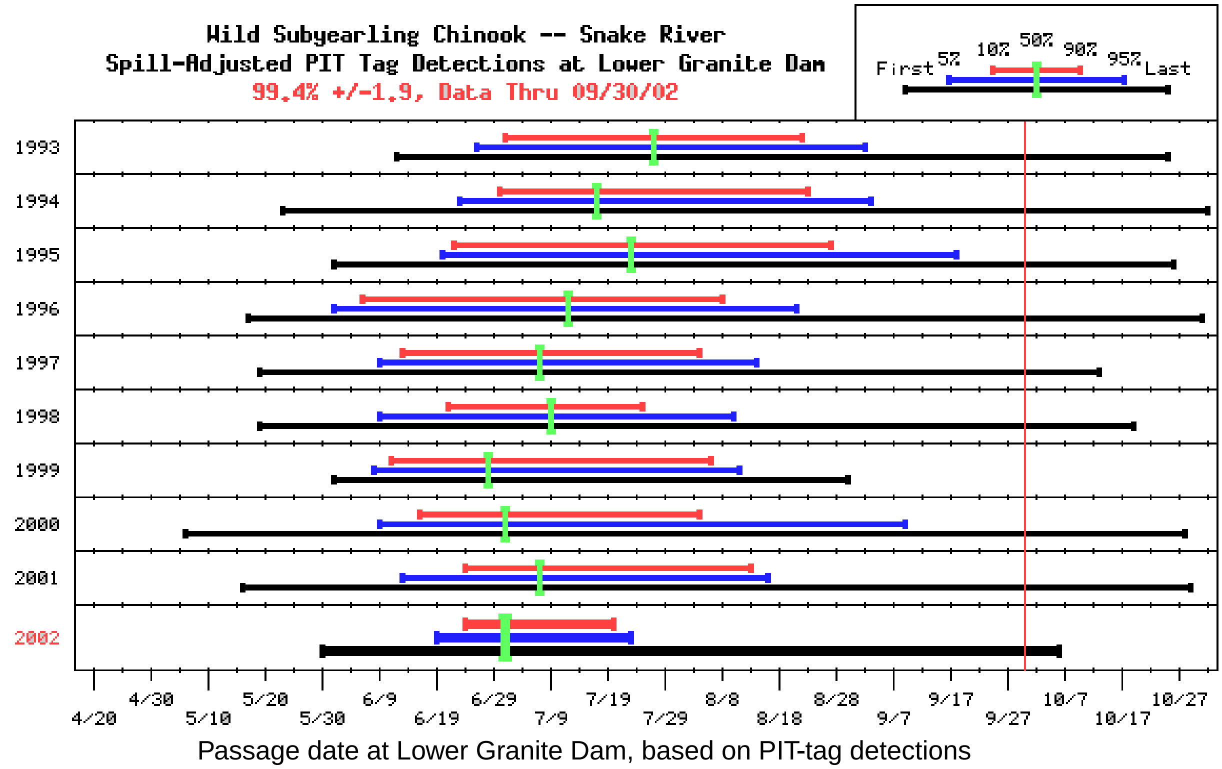


Table B23: Historical Wild PIT-tagged Subyearling Chinook Salmon (SNAKER) outmigration timing characteristics.

Detection Year	Detection Dates							Middle 80% in days	Parr Released (1)	LWG PIT Counts (2)	Adjusted PIT Count (3)	Recovery % (3)/(1) x 100
	First	5%	10%	50%	90%	95%	Last					
1993	06/20	06/26	07/01	07/27	08/22	09/02	10/25	53	1099	172	172.1	15.7
1994	05/23	06/23	06/30	07/17	08/23	09/03	11/01	55	2342	193	199.1	8.5
1995	06/04	06/20	06/22	07/23	08/27	09/18	10/26	67	1374	440	454.0	33.0
1996	05/17	06/01	06/06	07/12	08/08	08/21	10/31	64	463	146	186.1	40.2
1997	05/19	06/09	06/13	07/07	08/04	08/14	10/13	53	641	124	164.3	25.6
1998	05/26	06/09	06/21	07/09	07/25	08/10	10/19	35	2054	549	676.1	32.9
1999	06/03	06/08	06/11	06/28	08/06	08/11	08/30	57	1758	559	802.5	45.6
2000	05/18	06/09	06/16	07/01	08/04	09/09	10/28	50	1209	327	376.0	31.1
2001	06/04	06/13	06/24	07/07	08/13	08/16	10/29	51	1378	195	196.8	14.3
2002	06/02	06/19	06/24	07/01	07/20	07/23	10/06	27	2402	492	789.5	32.9

Figure B24: Historical outmigration run-timing of the wild PIT-tagged Run-at-Large of Steelhead Trout at Lower Granite Dam.

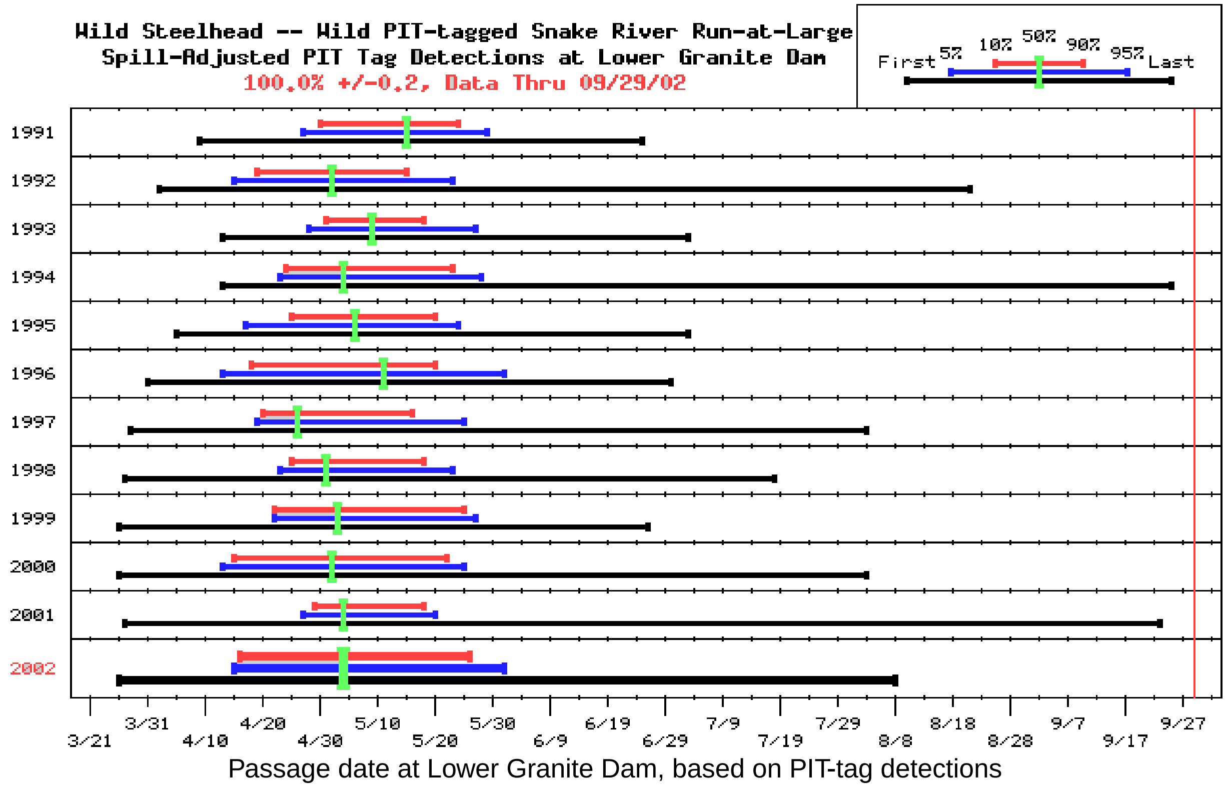


Table B24: Historical PIT-tagged Run-at-Large of Wild Steelhead Trout Outmigration timing characteristics at Lower Granite Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total LGR Passage
	First	5%	10%	50%	90%	95%	Last		
1991	04/18	04/27	04/30	05/15	05/24	05/29	06/25	25	2914
1992	04/10	04/15	04/19	05/02	05/15	05/23	08/21	27	3638
1993	04/20	04/28	05/01	05/09	05/18	05/27	07/03	18	4757
1994	04/21	04/23	04/24	05/04	05/23	05/28	09/25	30	5346
1995	04/12	04/17	04/25	05/06	05/20	05/24	07/03	26	4458
1996	04/11	04/13	04/18	05/11	05/20	06/01	06/30	33	3966
1997	04/06	04/19	04/20	04/26	05/16	05/25	08/03	27	4459
1998	04/05	04/23	04/25	05/01	05/18	05/23	07/18	24	8522
1999	04/03	04/22	04/22	05/03	05/25	05/27	06/26	34	6988
2000	04/08	04/13	04/15	05/02	05/22	05/25	08/03	38	13604
2001	04/22	04/27	04/29	05/04	05/18	05/20	09/23	20	13570
2002	04/12	04/15	04/16	05/04	05/26	06/01	08/08	41	10265

Figure B25: Historical outmigration run-timing at McNary Dam of the wild PIT-tagged Run-at-Large of Snake River Subyearling Fall Chinook Salmon.

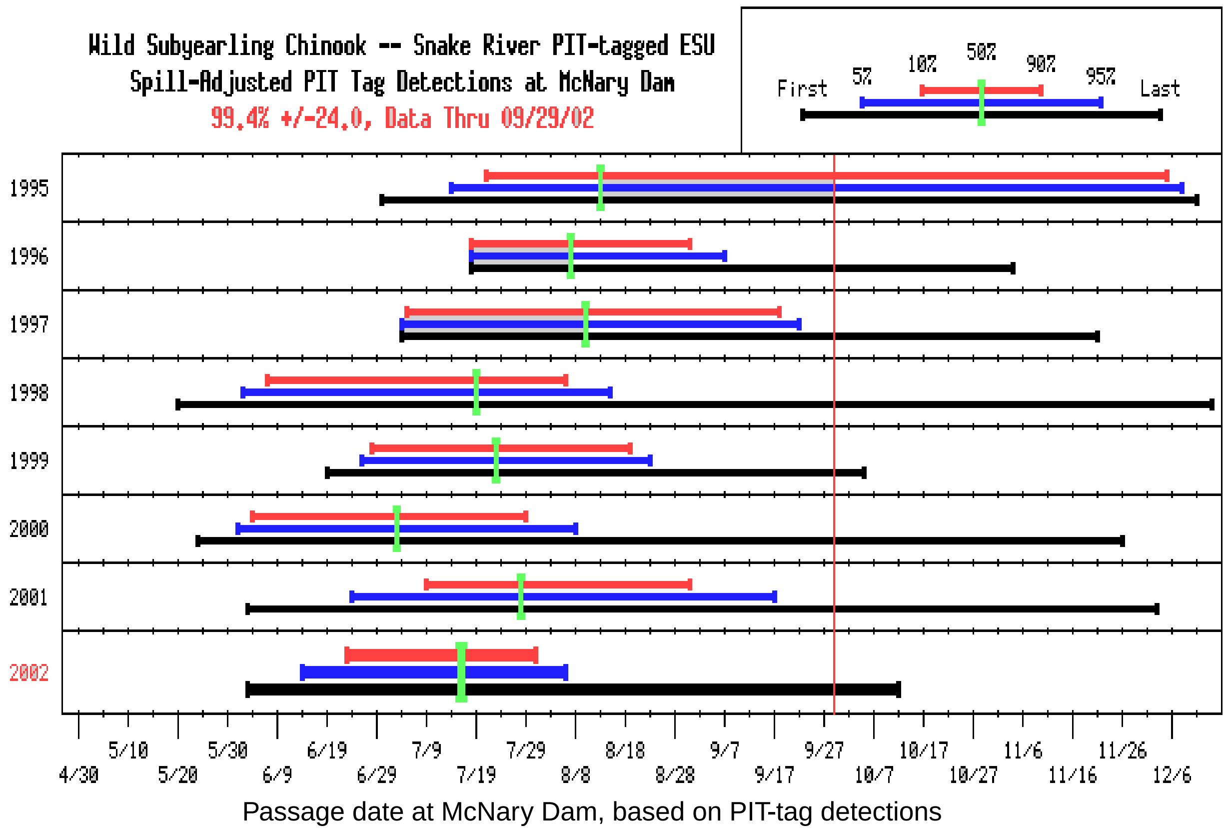


Table B25: Historical outmigration timing characteristics of wild PIT-tagged Snake River Subyearling Fall Chinook Salmon detected at McNary Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total MCN Passage
	First	5%	10%	50%	90%	95%	Last		
1995	07/02	07/14	07/21	08/13	12/05	12/08	12/11	138	183
1996	07/18	07/18	07/18	08/07	08/31	09/07	11/04	45	28
1997	07/04	07/04	07/05	08/10	09/18	09/22	11/21	76	24
1998	05/29	06/02	06/07	07/19	08/06	08/15	12/14	61	439
1999	06/19	06/26	06/28	07/23	08/19	08/23	10/05	53	197
2000	05/27	06/01	06/04	07/03	07/29	08/08	11/26	56	274
2001	06/03	06/24	07/09	07/28	08/31	09/17	12/03	54	55
2002	06/05	06/14	06/23	07/16	07/31	08/06	10/12	39	510

Figure B26: Historical outmigration run-timing at McNary Dam of the wild PIT-tagged Run-at-Large of Upper Columbia River Subyearling Fall Chinook Salmon.

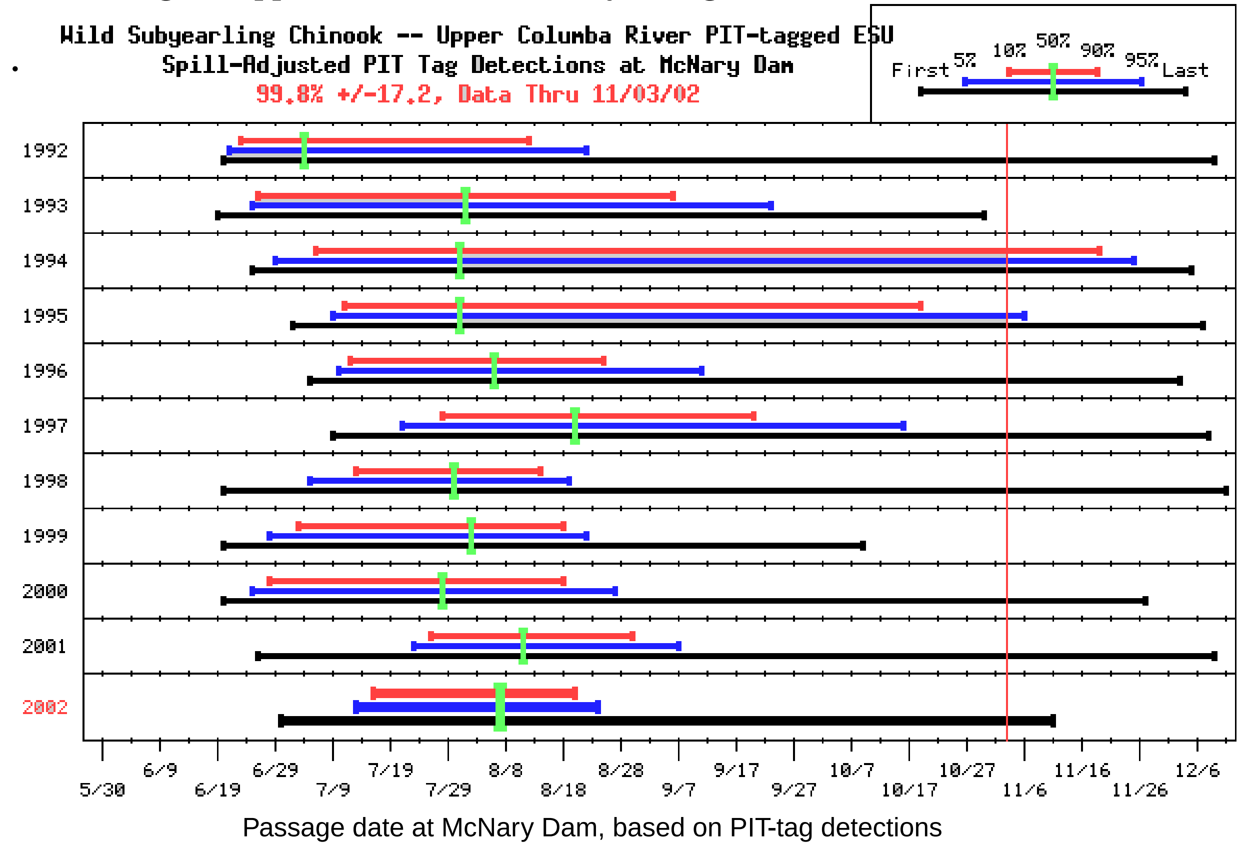


Table B26: Historical outmigration timing characteristics of wild PIT-tagged Columbia River Subyearling Fall Chinook Salmon detected at McNary Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total MCN Passage
	First	5%	10%	50%	90%	95%	Last		
1992	06/20	06/21	06/23	07/04	08/12	08/22	12/09	51	678
1993	06/19	06/25	06/26	08/01	09/06	09/23	10/30	73	585
1994	06/26	06/29	07/06	07/31	11/19	11/25	12/05	137	559
1995	07/03	07/09	07/11	07/31	10/19	11/06	12/07	101	1029
1996	07/06	07/10	07/12	08/06	08/25	09/11	12/03	45	1375
1997	07/13	07/21	07/28	08/20	09/20	10/16	12/08	55	2342
1998	06/22	07/05	07/13	07/30	08/14	08/19	12/11	33	2524
1999	06/21	06/28	07/03	08/02	08/18	08/22	10/09	47	2544
2000	06/21	06/25	06/28	07/28	08/18	08/27	11/27	52	3279
2001	07/01	07/23	07/26	08/11	08/30	09/07	12/09	36	1210
2002	07/07	07/13	07/16	08/07	08/20	08/24	11/21	36	1521

Figure B27: Historical outmigration run-timing at McNary Dam of the wild PIT-tagged Run-at-Large of Snake River Yearling Fall Chinook Salmon.

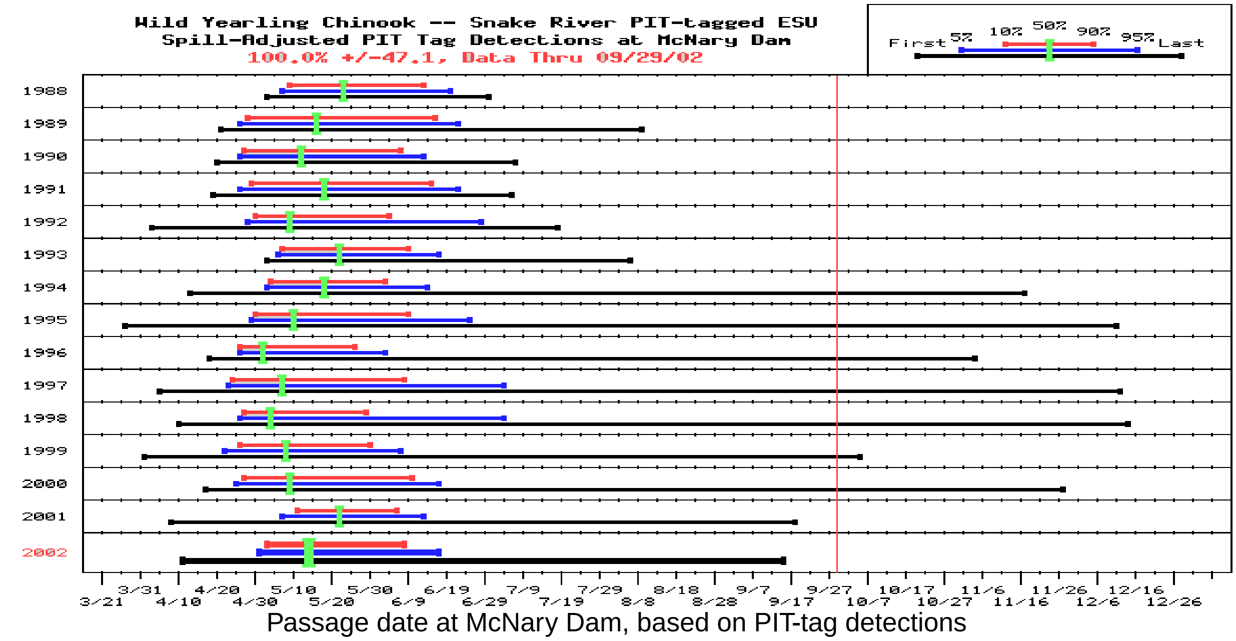


Table B27: Historical outmigration timing characteristics of wild PIT-tagged Snake River Yearling Chinook Salmon detected at McNary Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total MCN Passage
	First	5%	10%	50%	90%	95%	Last		
1988	05/03	05/07	05/09	05/23	06/13	06/20	06/30	36	58
1989	04/22	04/26	04/28	05/16	06/16	06/22	08/09	50	281
1990	04/24	04/26	04/27	05/12	06/07	06/13	07/07	42	213
1991	04/22	04/26	04/29	05/18	06/15	06/22	07/06	48	204
1992	04/23	04/28	04/30	05/09	06/04	06/28	07/18	36	307
1993	05/04	05/06	05/07	05/22	06/09	06/17	08/06	34	1410
1994	05/01	05/03	05/04	05/18	06/03	06/14	11/17	31	6154
1995	04/24	04/29	04/30	05/10	06/09	06/25	12/11	41	20689
1996	04/20	04/26	04/26	05/02	05/26	06/03	11/04	31	4524
1997	04/16	04/23	04/24	05/07	06/08	07/04	12/12	46	676
1998	04/24	04/26	04/27	05/04	05/29	07/04	12/14	33	11126
1999	04/18	04/22	04/26	05/08	05/30	06/07	10/05	35	22487
2000	04/22	04/25	04/27	05/09	06/10	06/17	11/27	45	24905
2001	05/03	05/07	05/11	05/22	06/06	06/13	09/18	27	8782
2002	04/25	05/01	05/03	05/14	06/08	06/17	09/15	37	18235

Figure B28: Historical outmigration run-timing at McNary Dam of the run-at-large of wild PIT-tagged Snake River Sockeye Salmon.

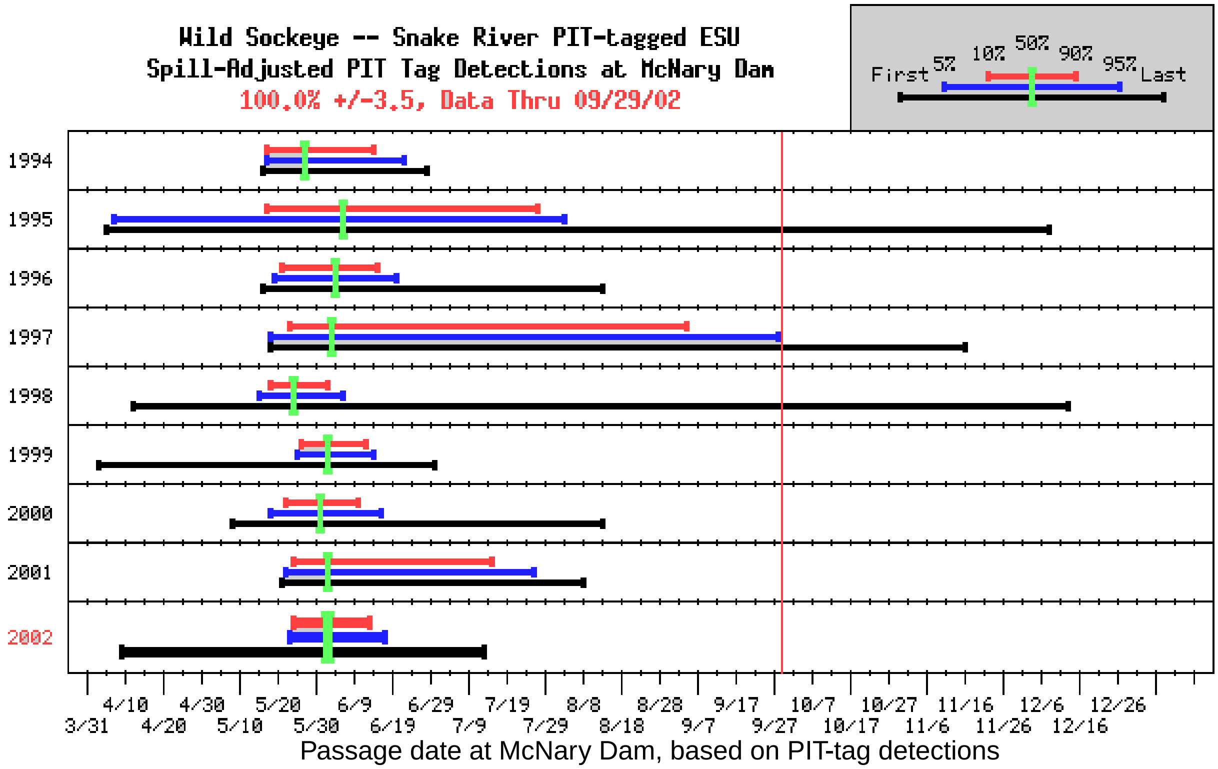


Table B28: Historical outmigration timing characteristics of wild PIT-tagged Snake River Sockeye Salmon detected at McNary Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total MCN Passage
	First	5%	10%	50%	90%	95%	Last		
1994	05/16	05/17	05/17	05/27	06/14	06/22	06/28	29	59
1995	04/05	04/07	05/17	06/06	07/27	08/03	12/08	72	37
1996	05/16	05/19	05/21	06/04	06/15	06/20	08/13	26	119
1997	05/18	05/18	05/23	06/03	09/04	09/28	11/16	105	38
1998	04/24	05/15	05/18	05/24	06/02	06/06	12/13	16	471
1999	05/04	05/25	05/26	06/02	06/12	06/14	06/30	18	347
2000	05/15	05/18	05/22	05/31	06/10	06/16	08/13	20	600
2001	05/21	05/22	05/24	06/02	07/15	07/26	08/08	53	38
2002	05/18	05/23	05/24	06/02	06/13	06/17	07/13	21	418

Figure B29: Historical outmigration run-timing at McNary Dam of Sn. R. Steelhead.

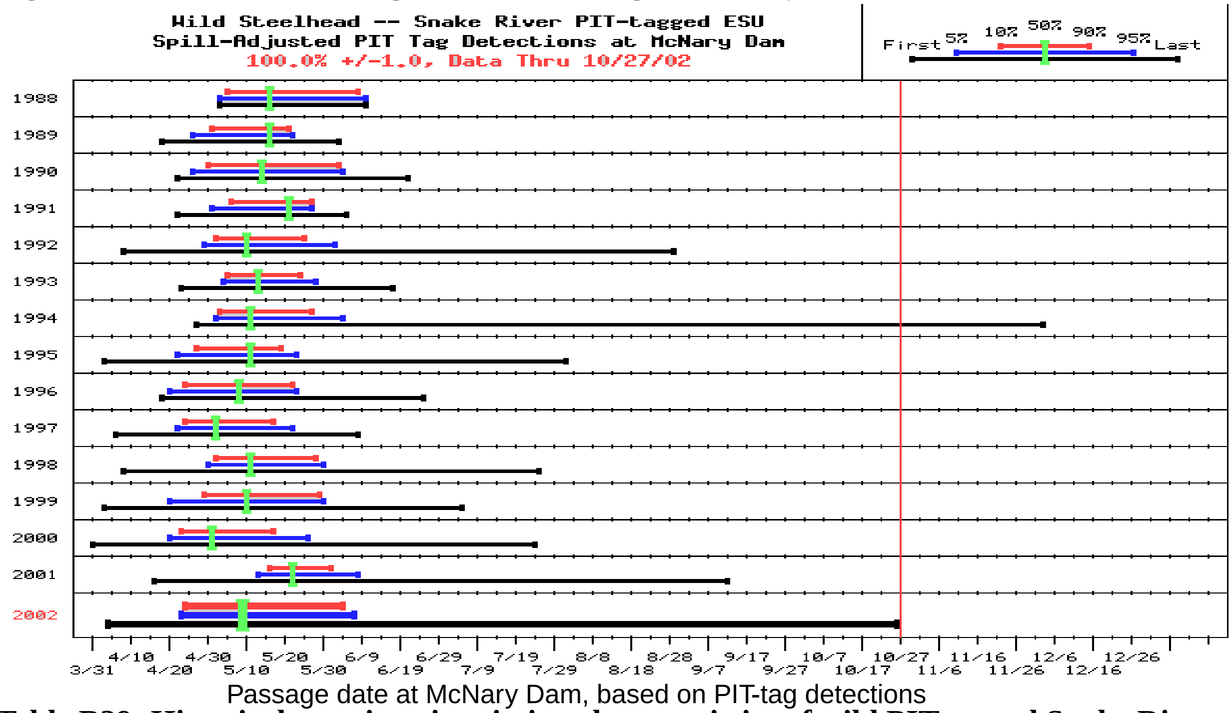


Table B29: Historical outmigration timing characteristics of wild PIT-tagged Snake River Steelhead Trout smolts detected at McNary Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total MCN Passage
	First	5%	10%	50%	90%	95%	Last		
1988	05/03	05/03	05/05	05/16	06/08	06/10	06/10	35	18
1989	04/22	04/26	05/01	05/16	05/21	05/22	06/03	21	166
1990	04/23	04/26	04/30	05/14	06/03	06/04	06/21	35	119
1991	04/26	05/01	05/06	05/21	05/27	05/27	06/05	22	160
1992	04/22	04/29	05/02	05/10	05/25	06/02	08/29	24	479
1993	05/01	05/04	05/05	05/13	05/24	05/28	06/17	20	910
1994	05/01	05/02	05/03	05/11	05/27	06/04	12/03	25	1945
1995	04/08	04/22	04/27	05/11	05/19	05/23	08/01	23	1416
1996	04/18	04/20	04/24	05/08	05/22	05/23	06/25	29	1117
1997	04/09	04/22	04/24	05/02	05/17	05/22	06/08	24	1156
1998	04/19	04/30	05/02	05/11	05/28	05/30	07/25	27	2674
1999	04/12	04/20	04/29	05/10	05/29	05/30	07/05	31	4955
2000	04/16	04/20	04/23	05/01	05/17	05/26	07/24	25	12093
2001	05/07	05/13	05/16	05/22	06/01	06/08	09/12	17	2641
2002	04/18	04/23	04/24	05/09	06/04	06/07	10/26	42	10426

Figure B30: Historical outmigration run-timing at McNary Dam of U. Col. R. Steelhead.

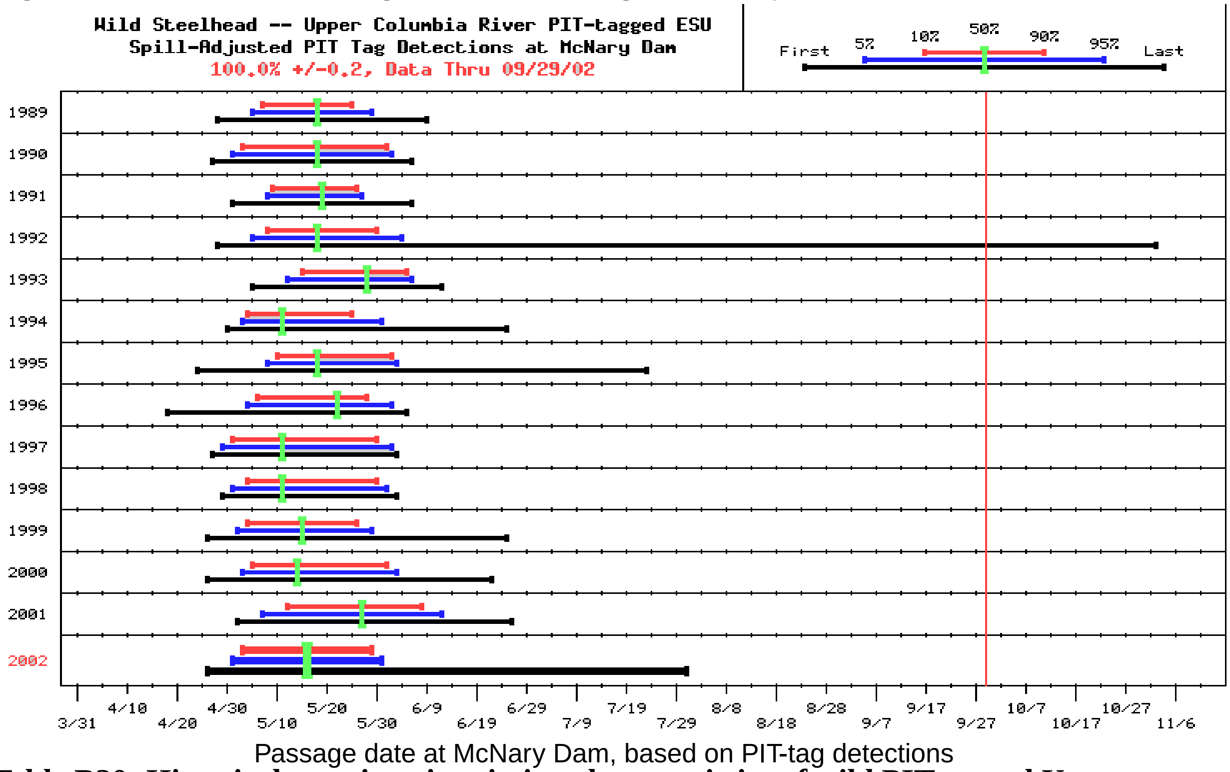


Table B30: Historical outmigration timing characteristics of wild PIT-tagged Upper Columbia River Steelhead Trout smolts detected at McNary Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total MCN Passage
	First	5%	10%	50%	90%	95%	Last		
1989	05/03	05/05	05/07	05/18	05/25	05/29	06/09	19	262
1990	04/28	05/01	05/03	05/18	06/01	06/02	06/06	30	279
1991	05/05	05/08	05/09	05/19	05/26	05/27	06/06	18	352
1992	05/02	05/05	05/08	05/18	05/30	06/04	11/02	23	397
1993	05/07	05/12	05/15	05/28	06/05	06/06	06/12	22	144
1994	05/01	05/03	05/04	05/11	05/25	05/31	06/25	22	367
1995	05/07	05/08	05/10	05/18	06/02	06/03	07/23	24	251
1996	05/02	05/04	05/06	05/22	05/28	06/02	06/05	23	261
1997	04/27	04/29	05/01	05/11	05/30	06/02	06/03	30	193
1998	04/30	05/01	05/04	05/11	05/30	06/01	06/03	27	206
1999	04/28	05/02	05/04	05/15	05/26	05/29	06/25	23	9615
2000	04/30	05/03	05/05	05/14	06/01	06/03	06/22	28	5240
2001	05/03	05/07	05/12	05/27	06/08	06/12	06/26	28	191
2002	04/28	05/01	05/03	05/16	05/29	05/31	07/31	27	329

Figure B31: Historical outmigration run-timing at McNary Dam of Steelhead.

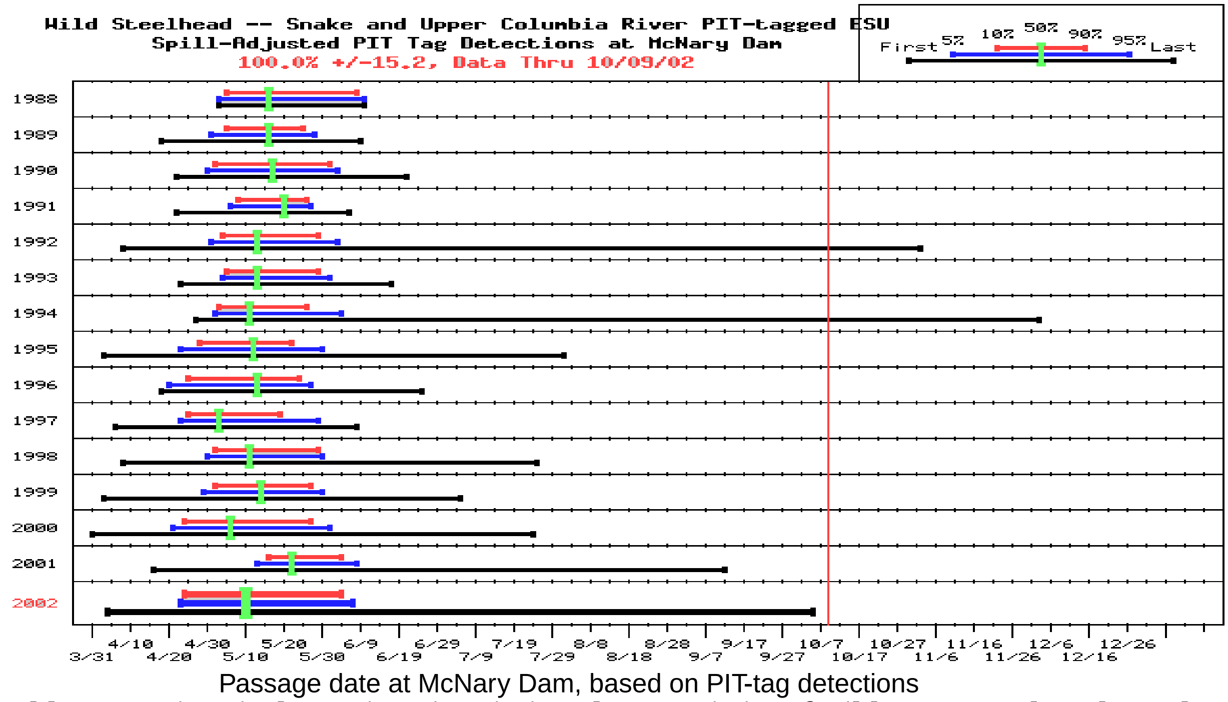


Table B31: Historical outmigration timing characteristics of wild PIT-tagged Snake and Upper Columbia River Steelhead Trout smolts detected at McNary Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total MCN Passage
	First	5%	10%	50%	90%	95%	Last		
1988	05/03	05/03	05/05	05/16	06/08	06/10	06/10	35	18
1989	04/25	05/01	05/05	05/16	05/25	05/28	06/09	21	428
1990	04/26	04/30	05/02	05/17	06/01	06/03	06/21	31	399
1991	04/27	05/06	05/08	05/20	05/26	05/27	06/06	19	513
1992	04/24	05/01	05/04	05/13	05/29	06/03	11/02	26	877
1993	05/01	05/04	05/05	05/13	05/29	06/01	06/17	25	1055
1994	05/01	05/02	05/03	05/11	05/26	06/04	12/03	24	2313
1995	04/10	04/23	04/28	05/12	05/22	05/30	08/01	25	1668
1996	04/18	04/20	04/25	05/13	05/24	05/27	06/25	30	1378
1997	04/10	04/23	04/25	05/03	05/19	05/29	06/08	25	1349
1998	04/19	04/30	05/02	05/11	05/29	05/30	07/25	28	2880
1999	04/16	04/29	05/02	05/14	05/27	05/30	07/05	26	14570
2000	04/16	04/21	04/24	05/06	05/27	06/01	07/24	34	17333
2001	05/06	05/13	05/16	05/22	06/04	06/08	09/12	20	2833
2002	04/18	04/23	04/24	05/10	06/04	06/07	10/05	42	10753

Figure B32: Historical outmigration run-timing at John Day Dam of the Run-at-Large of combined wild and hatchery subyearling chinook salmon.

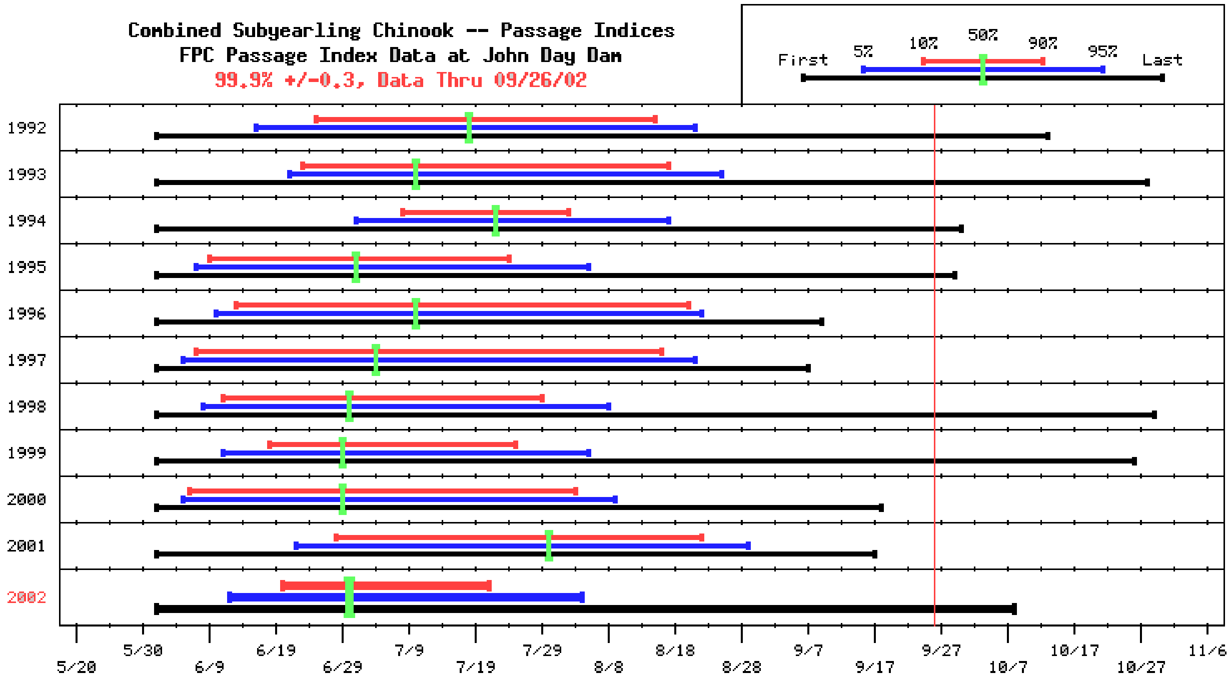


Table B32: Historical Combined Wild and Hatchery Subyearling Chinook Salmon outmigration timing characteristics at John Day Dam.

Year	Passage Dates							Duration Middle 80% (days)	Post-June 1 JDA Passage	Total JDA Passage
	First	5%	10%	50%	90%	95%	Last			
1992	06/13	06/16	06/25	07/18	08/15	08/21	10/13	52	548418	549586
1993	06/06	06/21	06/23	07/10	08/17	08/25	10/28	56	1236816	1252777
1994	06/21	07/01	07/08	07/22	08/02	08/17	09/30	26	1206489	1207389
1995	06/03	06/07	06/09	07/01	07/24	08/05	09/29	46	1214359	1240275
1996	06/06	06/10	06/13	07/10	08/20	08/22	09/09	69	730758	737912
1997	06/02	06/05	06/07	07/04	08/16	08/21	09/07	71	401671	444651
1998	06/02	06/08	06/11	06/30	07/29	08/08	10/29	49	2149197	2155342
1999	06/05	06/11	06/18	06/29	07/25	08/05	10/26	38	3937900	3962629
2000	06/02	06/05	06/06	06/29	08/03	08/09	09/18	59	1651050	1664301
2001	06/12	06/22	06/28	07/30	08/22	08/29	09/17	56	2845195	2849766
2002	06/05	06/12	06/20	06/30	07/21	08/04	10/08	32	3448212	3465700

Figure B33: Historical outmigration run-timing at McNary Dam of the Run-at-Large of Combined Wild and Hatchery Subyearling Chinook Salmon.

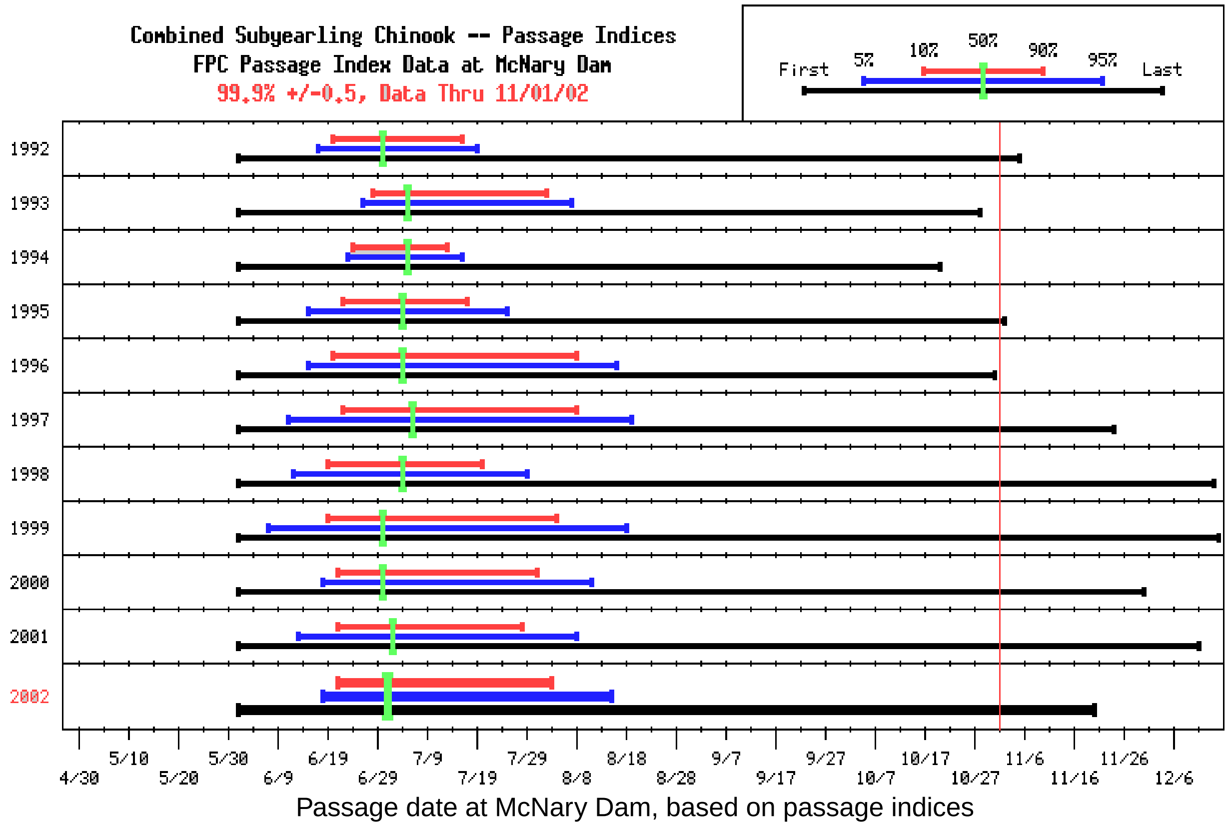


Table B33: Historical Combined Wild and Hatchery Subyearling Chinook Salmon outmigration timing characteristics at McNary Dam.

Year	Passage Dates							Duration Middle 80% (days)	Post-June 1 MCN Passage	Total MCN Passage
	First	5%	10%	50%	90%	95%	Last			
1992	06/12	06/17	06/20	06/30	07/16	07/19	11/05	27	6147233	6179484
1993	06/21	06/26	06/28	07/05	08/02	08/07	10/28	36	4214921	4283813
1994	06/17	06/23	06/24	07/05	07/13	07/16	10/20	20	5028990	5053511
1995	06/02	06/15	06/22	07/04	07/17	07/25	11/02	26	7910297	8223192
1996	06/03	06/15	06/20	07/04	08/08	08/16	10/31	50	5720980	6072944
1997	06/03	06/11	06/22	07/06	08/08	08/19	11/24	48	9571543	10383928
1998	06/03	06/12	06/19	07/04	07/20	07/29	12/14	32	11227207	11440908
1999	06/03	06/07	06/19	06/30	08/04	08/18	12/15	47	7431426	7645173
2000	06/07	06/18	06/21	06/30	07/31	08/11	11/30	41	10576799	10661814
2001	06/03	06/13	06/21	07/02	07/28	08/08	12/11	38	10601435	10777847
2002	06/05	06/18	06/21	07/01	08/04	08/16	11/24	45	8253247	8384676

Figure B34: Historical Passage-Indexed Run-at-Large of Wild and Hatchery Subyearling Chinook Salmon outmigration run-timing at Rock Island Dam.

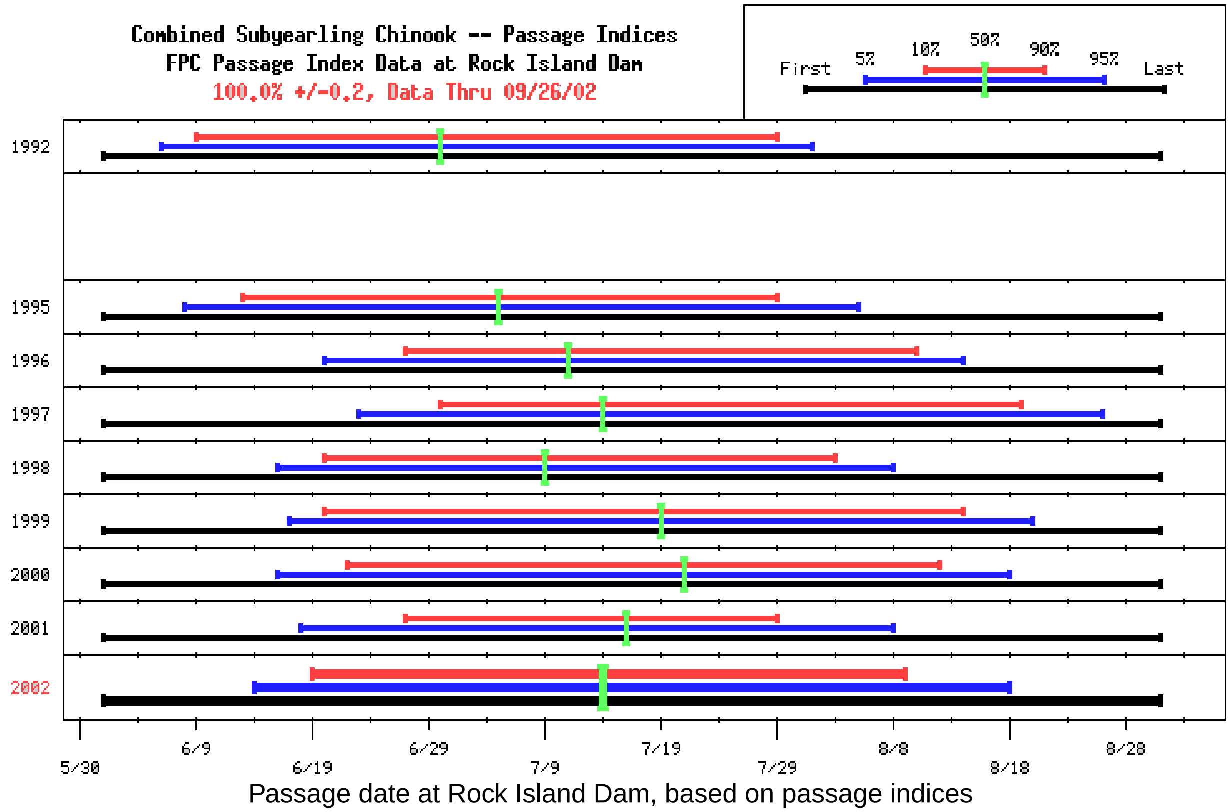


Table B34: Historical Combined Wild and Hatchery Subyearling Chinook Salmon outmigration timing characteristics at Rock Island Dam.

Year	Passage Dates							Duration Middle 80% (days)	Post-June 1 RIS Passabe	Total RIS Passage
	First	5%	10%	50%	90%	95%	Last			
1992	06/02	06/06	06/09	06/30	07/29	08/01	08/31	51	9162	10339
1995	06/02	06/08	06/13	07/05	07/29	08/05	08/31	47	13207	14149
1996	06/08	06/20	06/27	07/11	08/10	08/14	08/31	45	14752	15294
1997	06/08	06/23	06/30	07/14	08/19	08/26	08/31	51	18975	19246
1998	06/09	06/16	06/20	07/09	08/03	08/08	08/31	45	14659	17218
1999	06/04	06/17	06/20	07/19	08/14	08/20	08/31	56	26079	28340
2000	06/05	06/16	06/22	07/21	08/12	08/18	08/31	52	11610	13693
2001	06/04	06/18	06/27	07/16	07/29	08/08	08/31	33	22043	22651
2002	06/04	06/14	06/19	07/14	08/09	08/18	08/31	52	24911	25462

Figure B35: Historical outmigration run-timing at John Day Dam of the Run-at-Large of Combined Wild and Hatchery Yearling Chinook Salmon.

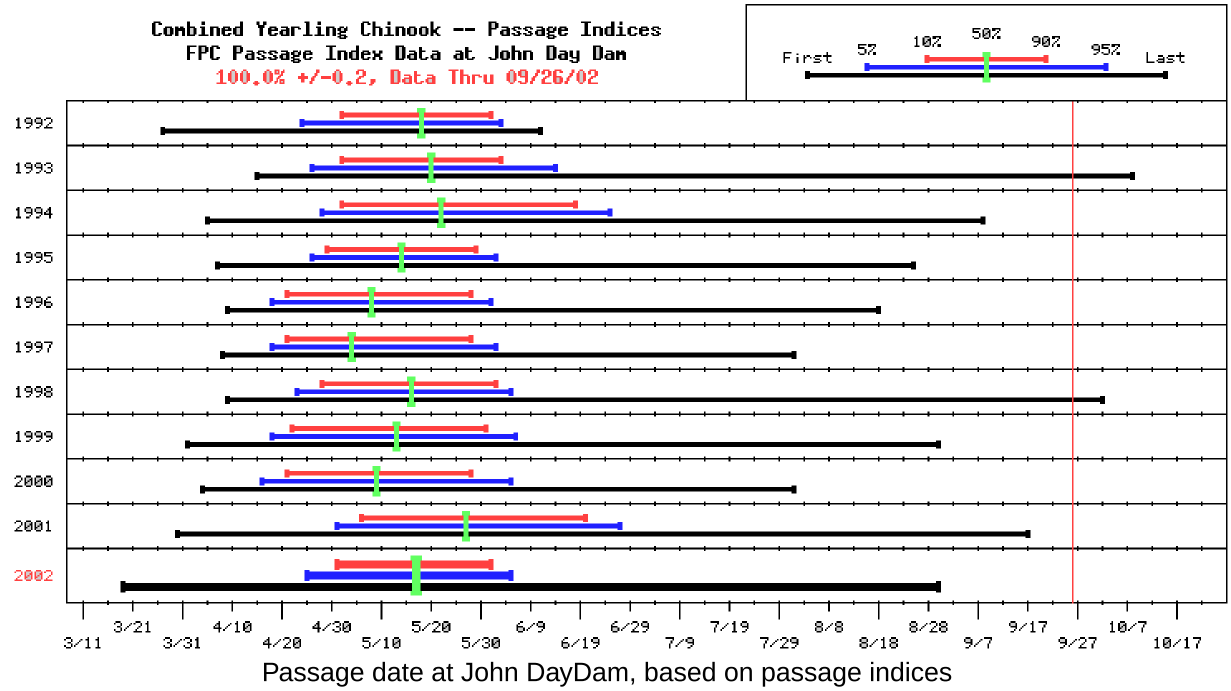


Table B35: Historical Combined Wild and Hatchery Yearling Chinook Salmon outmigration timing characteristics at John Day Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total JDA Passage
	First	5%	10%	50%	90%	95%	Last		
1992	04/14	04/24	05/02	05/18	06/01	06/03	06/11	31	478132
1993	04/19	04/26	05/02	05/20	06/03	06/14	10/08	33	762565
1994	04/18	04/28	05/02	05/22	06/18	06/25	09/08	48	446549
1995	04/16	04/26	04/29	05/14	05/29	06/02	08/25	31	1328883
1996	04/14	04/18	04/21	05/08	05/28	06/01	08/18	38	738453
1997	04/12	04/18	04/21	05/04	05/28	06/02	08/01	38	154493
1998	04/13	04/23	04/28	05/16	06/02	06/05	10/02	36	1147281
1999	04/10	04/18	04/22	05/13	05/31	06/06	08/30	40	2193902
2000	04/10	04/16	04/21	05/09	05/28	06/05	08/01	38	822349
2001	04/21	05/01	05/06	05/27	06/20	06/27	09/17	46	1006078
2002	04/18	04/25	05/01	05/17	06/01	06/05	08/30	32	2112370

Figure B36: Historical outmigration run-timing at McNary Dam of the Run-at-Large of Combined Wild and Hatchery Yearling Chinook Salmon.

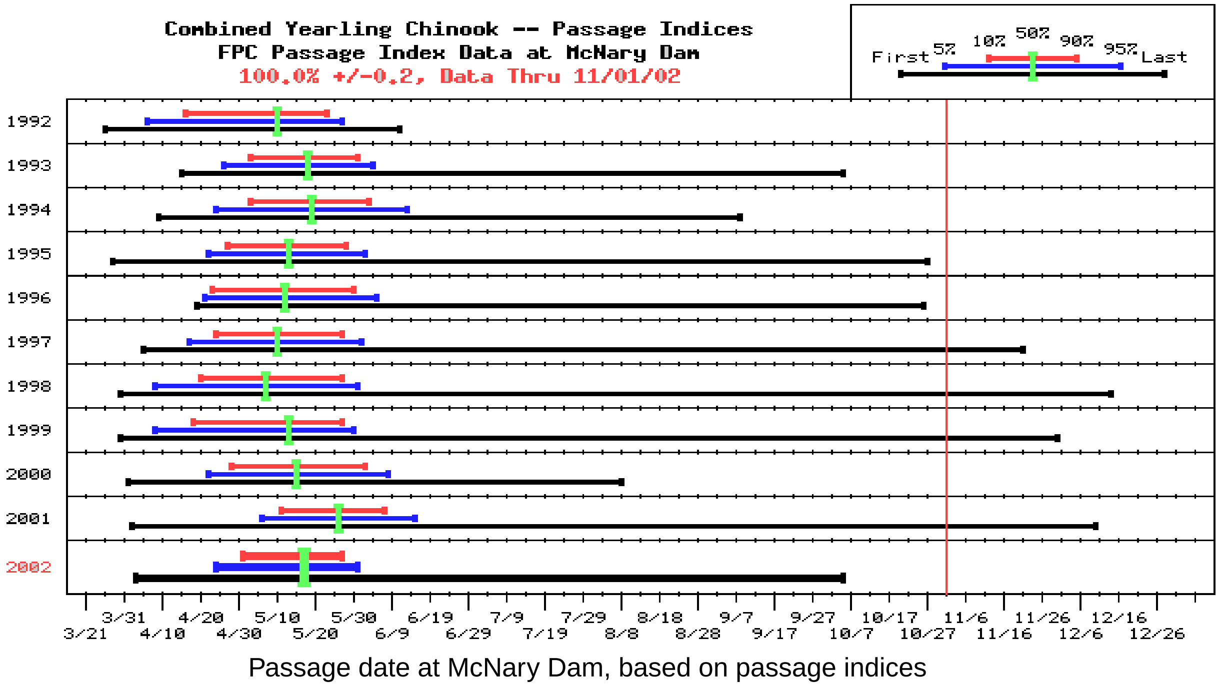


Table B36: Historical Combined Wild and Hatchery Yearling Chinook Salmon outmigration timing characteristics at McNary Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total MCN Passage
	First	5%	10%	50%	90%	95%	Last		
1992	04/04	04/06	04/16	05/10	05/23	05/27	06/11	38	2514319
1993	04/18	04/26	05/03	05/18	05/31	06/04	10/05	29	1729010
1994	04/13	04/24	05/03	05/19	06/03	06/13	09/08	32	2572338
1995	04/08	04/22	04/27	05/13	05/28	06/02	10/27	32	2879069
1996	04/19	04/21	04/23	05/12	05/30	06/05	10/26	38	1240878
1997	04/06	04/17	04/24	05/10	05/27	06/01	11/21	34	1184530
1998	04/05	04/08	04/20	05/07	05/27	05/31	12/14	38	1727071
1999	04/05	04/08	04/18	05/13	05/27	05/30	11/30	40	3692944
2000	04/10	04/22	04/28	05/15	06/02	06/08	08/08	36	1986380
2001	04/26	05/06	05/11	05/26	06/07	06/15	12/10	28	2299563
2002	04/17	04/24	05/01	05/17	05/27	05/31	11/21	27	3519374

Figure B37: Historical outmigration run-timing at Rock Island Dam of the Run-at-Large of Combined Wild and Hatchery Yearling Chinook Salmon.

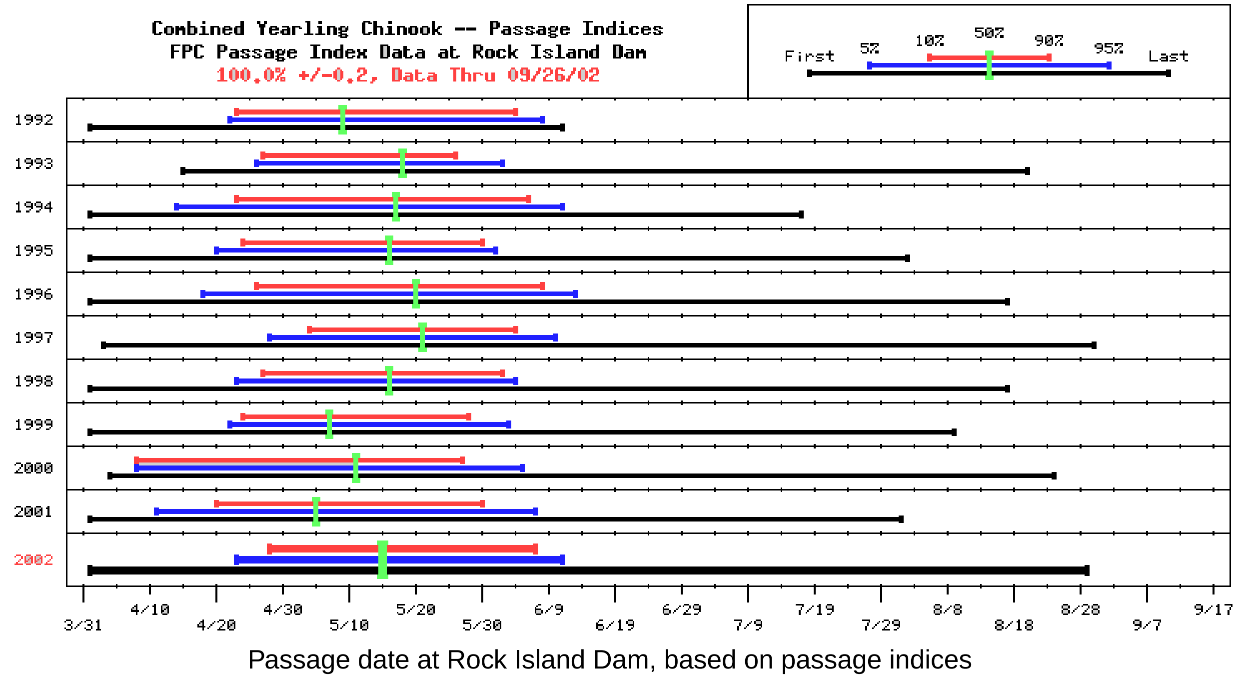


Table B37: Historical Combined Wild and Hatchery Yearling Chinook Salmon outmigration timing characteristics at Rock Island Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total RIS Passage
	First	5%	10%	50%	90%	95%	Last		
1992	04/17	04/22	04/23	05/09	06/04	06/08	06/11	43	16100
1993	04/21	04/26	04/27	05/18	05/26	06/02	08/20	30	13514
1994	04/04	04/14	04/23	05/17	06/06	06/11	07/17	45	12324
1995	04/09	04/20	04/24	05/16	05/30	06/01	08/02	37	30753
1996	04/07	04/18	04/26	05/20	06/08	06/13	08/17	44	42478
1997	04/17	04/28	05/04	05/21	06/04	06/10	08/30	32	53754
1998	04/03	04/23	04/27	05/16	06/02	06/04	08/17	37	24859
1999	04/11	04/22	04/24	05/07	05/28	06/03	08/09	35	40320
2000	04/08	04/08	04/08	05/11	05/27	06/05	08/24	50	32334
2001	04/06	04/11	04/20	05/05	05/30	06/07	08/01	41	6635
2002	04/12	04/23	04/28	05/15	06/07	06/11	08/29	41	28982

Figure B38: Historical outmigration run-timing at John Day Dam of the Run-at-Large of Combined Wild and Hatchery Coho Salmon.

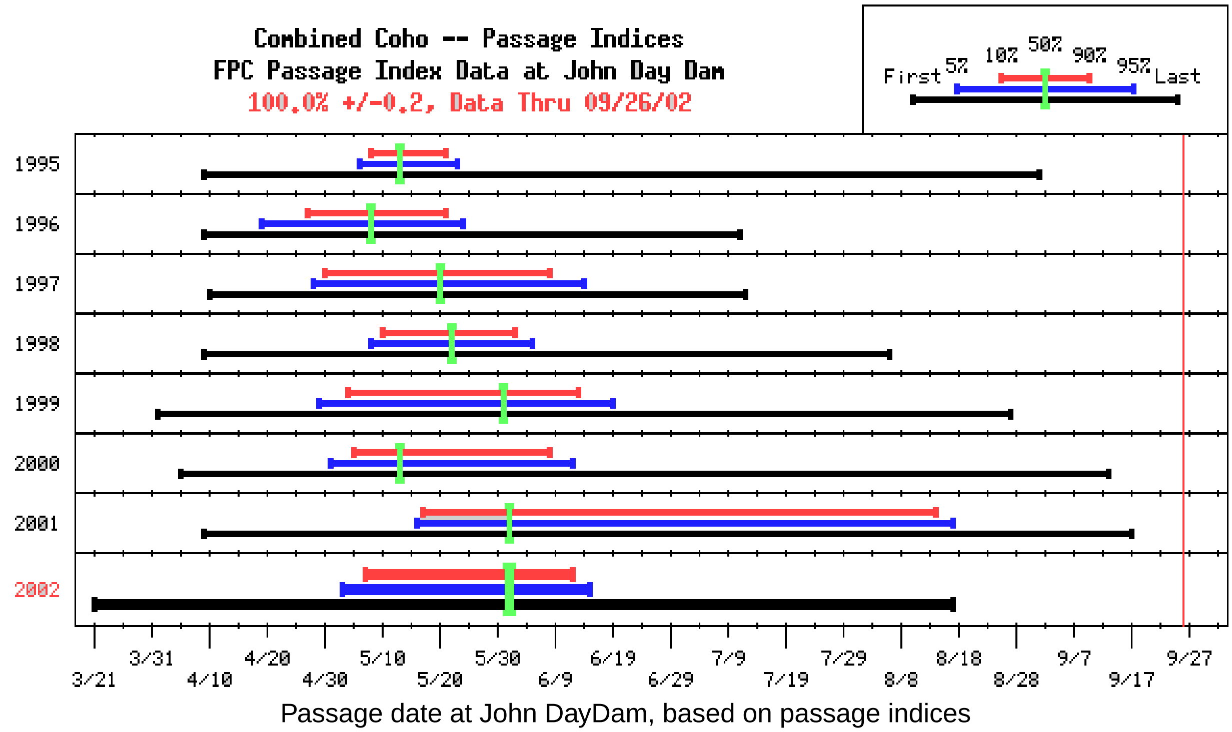


Table B38: Historical Combined Wild and Hatchery Coho Salmon outmigration timing characteristics at John Day Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total JDA Passage
	First	5%	10%	50%	90%	95%	Last		
1995	05/04	05/06	05/08	05/13	05/21	05/23	09/01	14	335903
1996	04/14	04/19	04/27	05/08	05/21	05/24	07/11	25	504884
1997	04/25	04/28	04/30	05/20	06/08	06/14	07/12	40	148139
1998	05/04	05/08	05/10	05/22	06/02	06/05	08/06	24	572290
1999	04/22	04/29	05/04	05/31	06/13	06/19	08/27	41	543321
2000	04/23	05/01	05/05	05/13	06/08	06/12	09/13	35	262656
2001	05/04	05/16	05/17	06/01	08/14	08/17	09/17	90	81644
2002	04/24	05/03	05/07	06/01	06/12	06/15	08/17	37	316507

Figure B39: Historical outmigration run-timing at McNary Dam of the Run-at-Large of Combined Wild and Hatchery Coho Salmon.

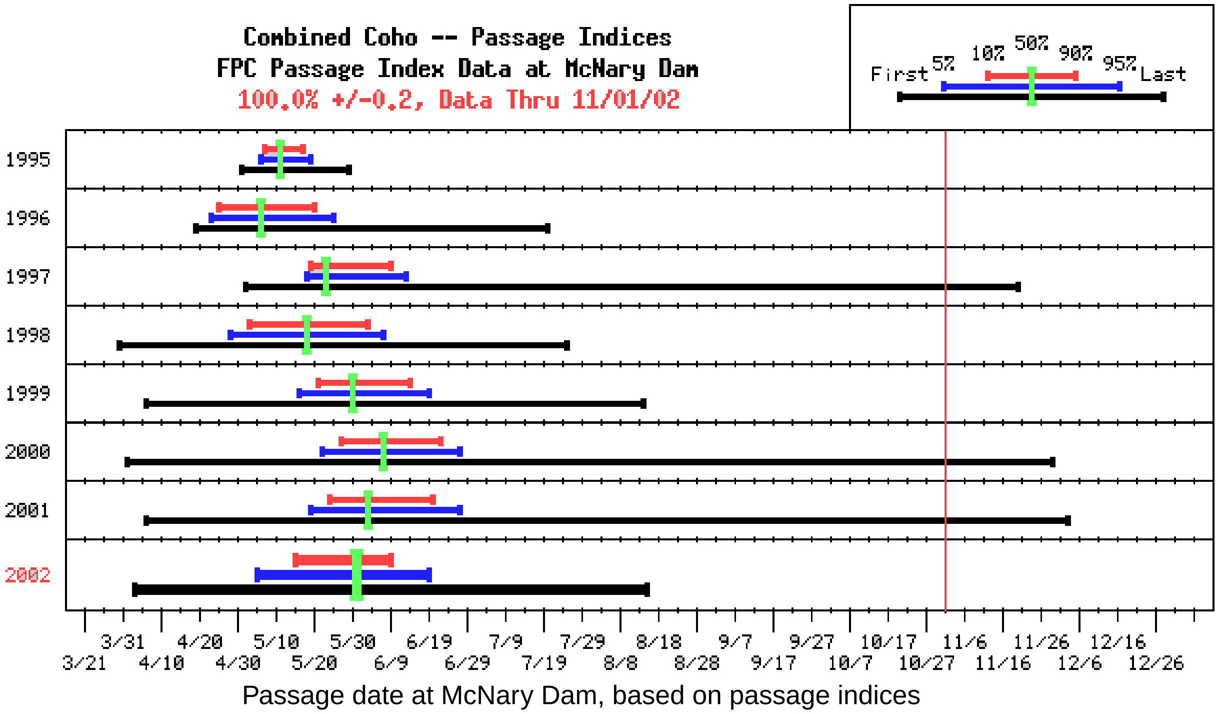


Table B39: Historical Combined Wild and Hatchery Coho Salmon outmigration timing characteristics at McNary Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total MCN Passage
	First	5%	10%	50%	90%	95%	Last		
1995	05/03	05/06	05/07	05/11	05/17	05/19	05/29	11	236480
1996	04/20	04/23	04/25	05/06	05/20	05/25	07/20	26	647586
1997	05/15	05/18	05/19	05/23	06/09	06/13	11/20	22	339949
1998	04/21	04/28	05/03	05/18	06/03	06/07	07/25	32	241239
1999	05/05	05/16	05/21	05/30	06/14	06/19	08/14	25	281977
2000	05/01	05/22	05/27	06/07	06/22	06/27	11/29	27	260058
2001	05/03	05/19	05/24	06/03	06/20	06/27	12/03	28	147063
2002	04/19	05/05	05/15	05/31	06/09	06/19	08/15	26	201998

Figure B40: Historical outmigration run-timing at Rock Island Dam of the Run-at-Large of Combined Wild and Hatchery Coho Salmon.

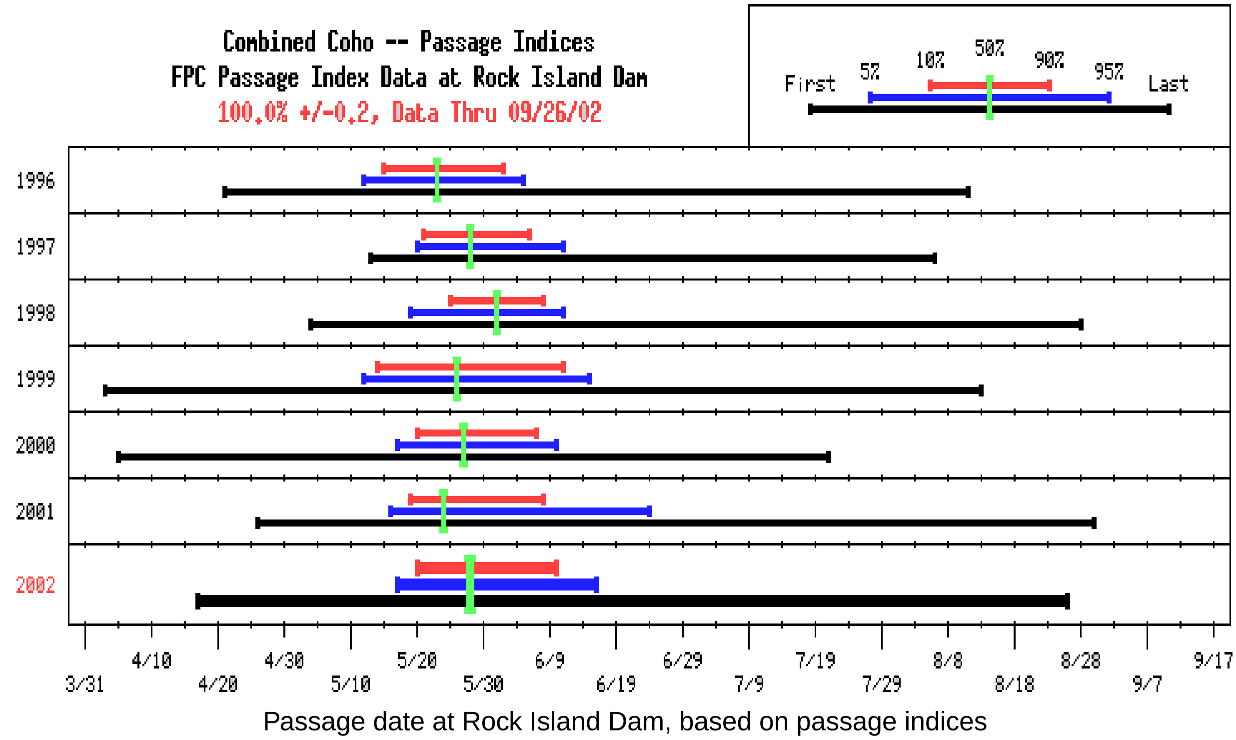


Table B40: Historical Combined Wild and Hatchery Coho Salmon outmigration timing characteristics at Rock Island Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total RIS Passage
	First	5%	10%	50%	90%	95%	Last		
1996	05/03	05/12	05/15	05/23	06/02	06/05	08/11	19	26521
1997	05/18	05/20	05/21	05/28	06/06	06/11	08/06	17	4301
1998	05/07	05/19	05/25	06/01	06/08	06/11	08/28	15	41837
1999	05/03	05/12	05/14	05/26	06/11	06/15	08/13	29	46173
2000	05/08	05/17	05/20	05/27	06/07	06/10	07/21	19	49552
2001	05/12	05/16	05/19	05/24	06/08	06/24	08/30	21	45437
2002	05/12	05/17	05/20	05/28	06/10	06/16	08/26	22	86227

Figure B41: Historical outmigration run-timing at John Day Dam of the Run-at-Large of Combined Wild and Hatchery Sockeye Salmon.

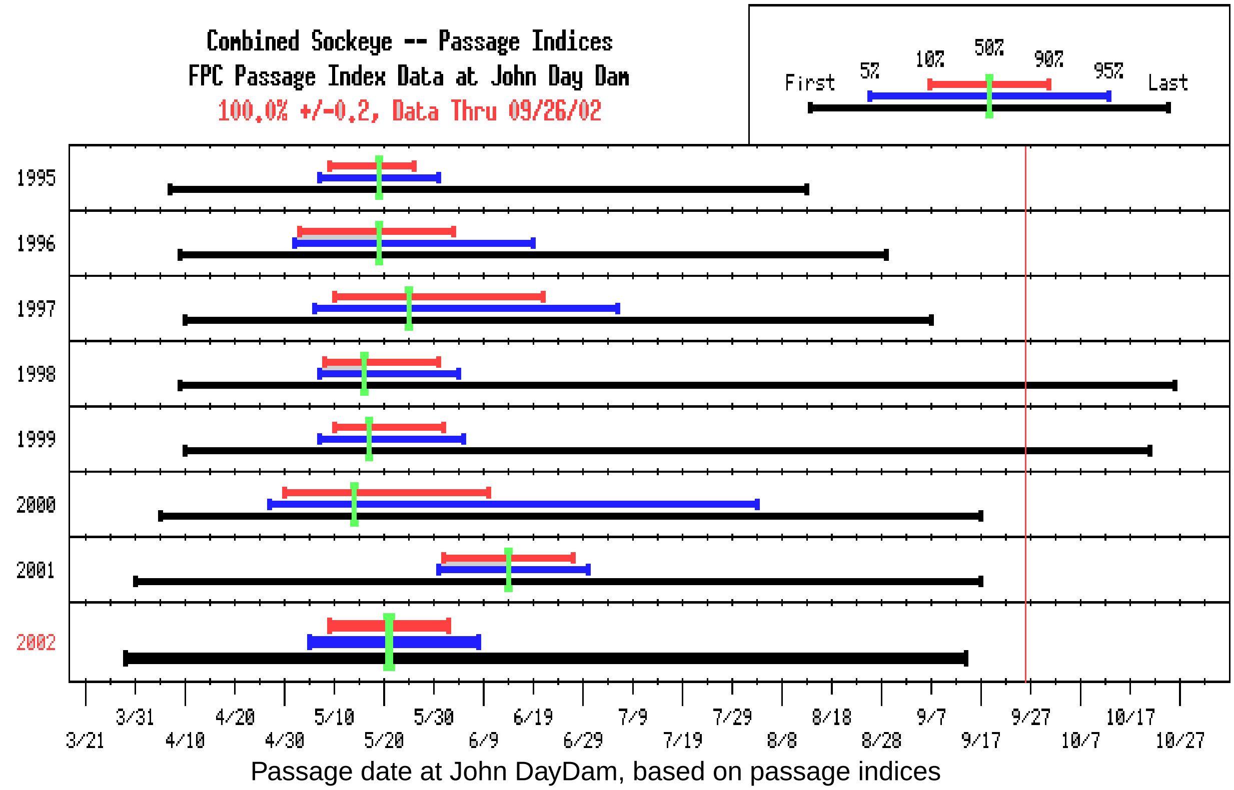


Table B41: Historical Combined Wild and Hatchery Sockeye Salmon outmigration timing characteristics at John Day Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total JDA Passage
	First	5%	10%	50%	90%	95%	Last		
1995	05/04	05/07	05/09	05/19	05/26	05/31	08/13	18	293076
1996	04/24	05/02	05/03	05/19	06/03	06/19	08/29	32	64594
1997	04/30	05/06	05/10	05/25	06/21	07/06	09/07	43	26490
1998	05/06	05/07	05/08	05/16	05/31	06/04	10/26	24	523673
1999	05/01	05/07	05/10	05/17	06/01	06/05	10/21	23	574059
2000	04/25	04/27	04/30	05/14	06/10	08/03	09/17	42	60091
2001	05/22	05/31	06/01	06/14	06/27	06/30	09/17	27	103971
2002	04/28	05/05	05/09	05/21	06/02	06/08	09/14	25	936132

Figure B42: Historical outmigration run-timing at McNary Dam of the Run-at-Large of Combined Wild and Hatchery Sockeye Salmon.

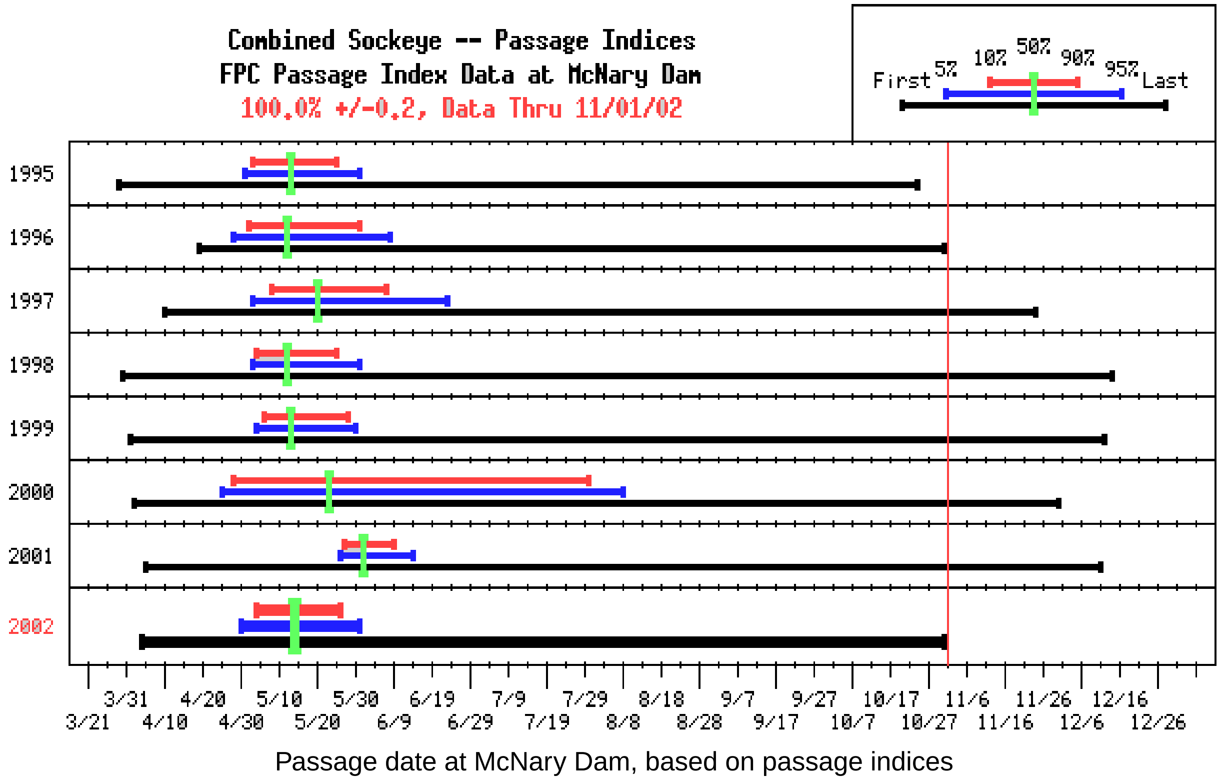


Table B42: Historical Combined Wild and Hatchery Sockeye Salmon outmigration timing characteristics at McNary Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total MCN Passage
	First	5%	10%	50%	90%	95%	Last		
1995	04/28	05/01	05/03	05/13	05/25	05/31	10/24	23	1003494
1996	04/24	04/28	05/02	05/12	05/31	06/08	10/31	30	155094
1997	04/29	05/03	05/08	05/20	06/07	06/23	11/24	31	221166
1998	04/29	05/03	05/04	05/12	05/25	05/31	12/14	22	966549
1999	04/29	05/04	05/06	05/13	05/28	05/30	12/12	23	1446326
2000	04/21	04/25	04/28	05/23	07/30	08/08	11/30	94	139909
2001	05/12	05/26	05/27	06/01	06/09	06/14	12/11	14	285741
2002	04/23	04/30	05/04	05/14	05/26	05/31	11/24	23	1410444

Figure B43: Historical outmigration run-timing at Rock Island Dam of the Run-at-Large of Combined Wild and Hatchery Sockeye Salmon.

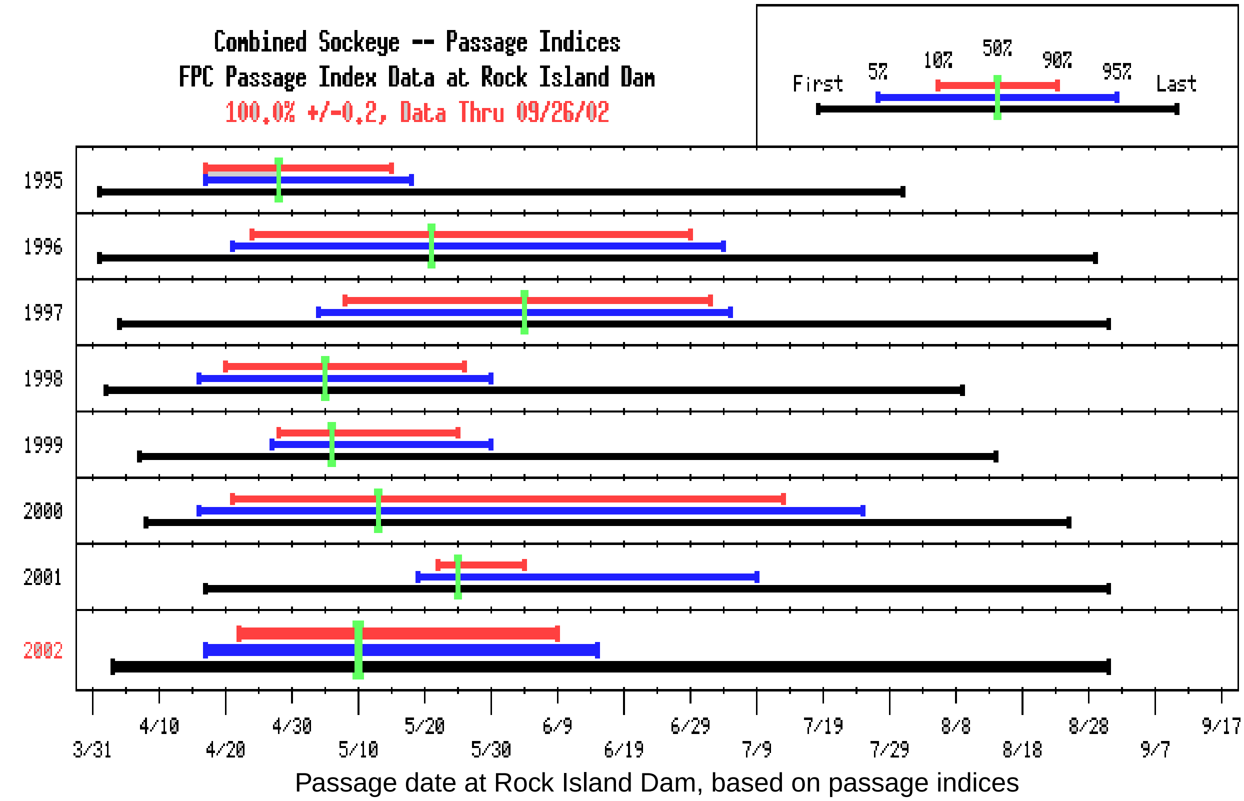


Table B43: Historical Combined Wild and Hatchery Sockeye Salmon outmigration timing characteristics at Rock Island Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total RIS Passage
	First	5%	10%	50%	90%	95%	Last		
1995	04/13	04/17	04/17	04/28	05/15	05/18	07/31	29	27056
1996	04/15	04/21	04/24	05/21	06/29	07/04	08/29	67	9995
1997	04/26	05/04	05/08	06/04	07/02	07/05	08/31	56	13426
1998	04/14	04/16	04/20	05/05	05/26	05/30	08/09	37	16635
1999	04/21	04/27	04/28	05/06	05/25	05/30	08/14	28	23371
2000	04/12	04/16	04/21	05/13	07/13	07/25	08/25	84	2430
2001	04/24	05/19	05/22	05/25	06/04	07/09	08/31	14	3032
2002	04/15	04/17	04/22	05/10	06/09	06/15	08/31	49	20629

Figure B44: Historical outmigration run-timing at John Day Dam of the Run-at-Large of Combined Wild and Hatchery Steelhead Trout.

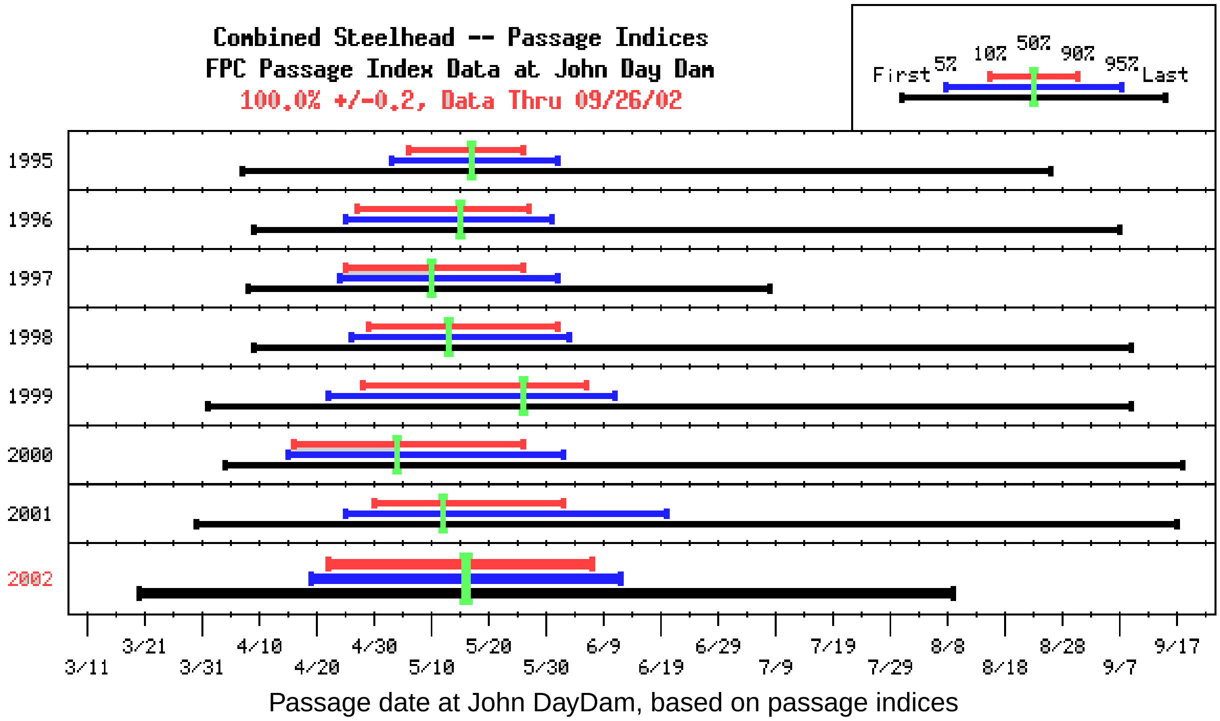


Table B44: Historical Combined Wild and Hatchery Steelhead Trout outmigration timing characteristics at John Day Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total JDA Passage
	First	5%	10%	50%	90%	95%	Last		
1995	04/17	05/03	05/06	05/17	05/26	06/01	08/26	21	1089894
1996	04/18	04/25	04/27	05/15	05/27	05/31	09/07	31	930931
1997	04/21	04/24	04/25	05/10	05/26	06/01	07/08	32	773788
1998	04/22	04/26	04/29	05/13	06/01	06/03	09/09	34	1089156
1999	04/02	04/22	04/28	05/26	06/06	06/11	09/09	40	1238944
2000	04/12	04/15	04/16	05/04	05/26	06/02	09/18	41	517289
2001	04/16	04/25	04/30	05/12	06/02	06/20	09/17	34	191132
2002	04/14	04/19	04/22	05/16	06/07	06/12	08/09	47	547546

Figure B45: Historical outmigration run-timing at McNary Dam of the Run-at-Large of Combined Wild and Hatchery Steelhead Trout.

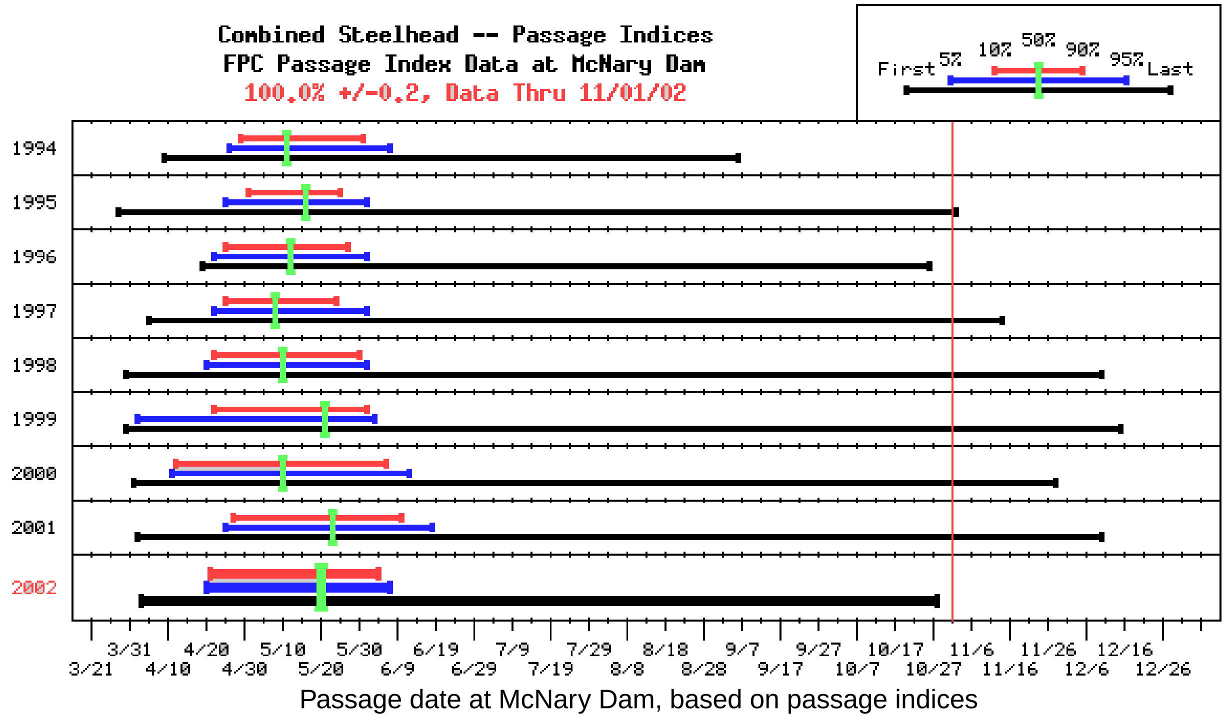


Table B45: Historical Combined Wild and Hatchery Steelhead Trout outmigration timing characteristics at McNary Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total MCN Passage
	First	5%	10%	50%	90%	95%	Last		
1994	04/19	04/26	04/29	05/11	05/31	06/07	09/06	33	106520
1995	04/05	04/25	05/01	05/16	05/25	06/01	11/02	25	734878
1996	04/20	04/22	04/25	05/12	05/27	06/01	10/26	33	792462
1997	04/19	04/22	04/25	05/08	05/24	06/01	11/14	30	1234024
1998	04/16	04/20	04/22	05/10	05/30	06/01	12/10	39	571119
1999	03/30	04/02	04/22	05/21	06/01	06/03	12/15	41	1004348
2000	04/09	04/11	04/12	05/10	06/06	06/12	11/28	56	617482
2001	04/18	04/25	04/27	05/23	06/10	06/18	12/10	45	563299
2002	04/16	04/20	04/21	05/20	06/04	06/07	11/24	45	794572

Figure B46: Historical outmigration run-timing at Rock Island Dam of the Run-at-Large of Combined Wild and Hatchery Steelhead Trout.

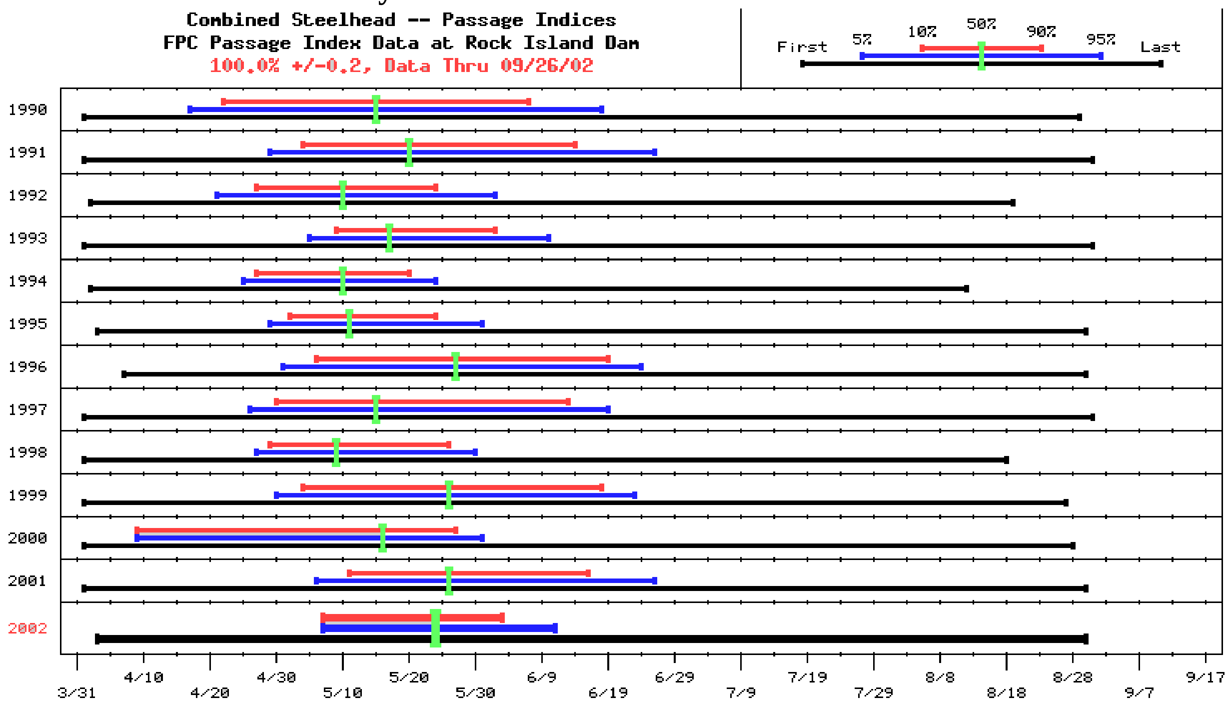


Table B46: Historical Combined Wild and Hatchery Steelhead Trout outmigration timing characteristics at Rock Island Dam.

Year	Passage Dates							Duration Middle 80% (days)	Total RIS Passage
	First	5%	10%	50%	90%	95%	Last		
1990	04/06	04/17	04/22	05/15	06/07	06/18	08/29	47	3739
1991	04/10	04/29	05/04	05/20	06/14	06/26	08/31	42	4953
1992	04/07	04/21	04/27	05/10	05/24	06/02	08/19	28	4906
1993	04/21	05/05	05/09	05/17	06/02	06/10	08/31	25	4032
1994	04/21	04/25	04/27	05/10	05/20	05/24	08/12	24	15323
1995	04/22	04/29	05/02	05/11	05/24	05/31	08/30	23	18084
1996	04/21	05/01	05/06	05/27	06/19	06/24	08/30	45	39650
1997	04/19	04/26	04/30	05/15	06/13	06/19	08/31	45	33979
1998	04/22	04/27	04/29	05/09	05/26	05/30	08/18	28	21390
1999	04/23	04/30	05/04	05/26	06/18	06/23	08/27	46	48192
2000	04/08	04/09	04/09	05/16	05/27	05/31	08/28	49	26297
2001	04/26	05/06	05/11	05/26	06/16	06/26	08/30	37	17914
2002	04/20	05/07	05/07	05/24	06/03	06/11	08/30	28	28714

Appendix C

Daily Expansion Factors for Spill-Adjusted PIT-Tagged Stocks Forecasted by Project RealTime in Migration Year 2002, including Chinook Salmon and Steelhead Trout at Lower Granite Dam and salmonids tracked to McNary Dam

Table C1: Migration year 2002 outflow and spill at Lower Granite Dam and McNary Dam and expansion factors used to upwardly adust PIT detections for spill. See Section 2.1.1 for formulas.

Date	Lower Granite Dam				McNary Dam		
	Outflow (kcfs)	Spill (kcfs)	Expansion Factor (using formulas 2.2a and 2.2b)		Outflow (kcfs)	Spill (kcfs)	Expansion Factor (using formula 2.2c)
			Chinook Salmon	Steelhead Trout			
04/03	60.80	13.40	1.75	1.61	127.90	0.00	1
04/04	53.90	26.80	3.18	2.49	121.80	0.00	1
04/05	55.90	28.50	3.26	2.54	114.70	0.00	1
04/06	66.30	27.10	2.68	2.18	121.80	0.00	1
04/07	72.10	35.30	3.14	2.46	117.90	0.00	1
04/08	71.10	28.60	2.64	2.15	145.60	0.00	1
04/09	70.80	23.20	2.25	1.92	138.20	0.00	1
04/10	74.90	26.20	2.37	1.99	154.00	28.60	1.23
04/11	76.70	26.60	2.35	1.98	170.00	61.00	1.56
04/12	73.20	26.00	2.39	2.01	173.40	65.50	1.61
04/13	76.60	24.50	2.21	1.9	213.90	71.20	1.5
04/14	91.50	23.80	1.93	1.72	199.80	75.60	1.61
04/15	122.10	42.70	2.36	1.99	267.60	134.90	2.02
04/16	112.20	30.00	1.96	1.75	319.20	151.20	1.9
04/17	100.00	32.20	2.22	1.9	320.50	153.00	1.91
04/18	91.10	28.00	2.15	1.86	301.00	147.40	1.96
04/19	85.20	24.70	2.07	1.81	296.30	138.30	1.88
04/20	75.80	25.70	2.31	1.96	282.40	133.80	1.9
04/21	72.30	30.70	2.77	2.23	265.20	117.50	1.8
04/22	67.30	24.40	2.43	2.03	261.90	114.60	1.78
04/23	73.90	18.60	1.89	1.7	275.00	131.90	1.92
04/24	71.80	15.10	1.71	1.58	257.80	129.60	2.01
04/25	62.40	14.40	1.8	1.64	240.50	112.30	1.88
04/26	59.80	19.60	2.25	1.92	232.20	101.70	1.78

Table C1: Migration year 2002 outflow and spill at Lower Granite Dam and McNary Dam and expansion factors used to upwardly adust PIT detections for spill. See Section 2.1.1 for formulas.

Date	Lower Granite Dam				McNary Dam		
	Outflow (kcfs)	Spill (kcfs)	Expansion Factor (using formulas 2.2a and 2.2b)		Outflow (kcfs)	Spill (kcfs)	Expansion Factor (using formula 2.2c)
			Chinook Salmon	Steelhead Trout			
04/27	59.70	18.50	2.16	1.87	205.20	93.80	1.84
04/28	59.30	19.50	2.26	1.93	187.10	77.00	1.7
04/29	61.50	22.10	2.41	2.02	217.20	79.60	1.58
04/30	51.80	23.70	2.95	2.34	224.80	87.30	1.63
05/01	62.60	43.10	4.58	3.45	211.00	76.20	1.57
05/02	74.10	53.60	4.97	3.71	214.70	50.20	1.31
05/03	71.90	56.80	6.03	4.35	224.70	59.00	1.36
05/04	86.70	27.20	2.18	1.88	239.40	68.30	1.4
05/05	76.10	23.60	2.17	1.87	217.50	56.90	1.35
05/06	69.60	17.00	1.86	1.68	212.40	65.00	1.44
05/07	73.00	22.70	2.17	1.87	241.40	88.00	1.57
05/08	68.50	24.60	2.41	2.02	247.30	78.40	1.46
05/09	63.80	24.80	2.57	2.11	201.80	73.20	1.57
05/10	60.90	24.90	2.68	2.18	196.30	72.00	1.58
05/11	56.30	17.90	2.2	1.89	208.00	67.20	1.48
05/12	56.40	22.10	2.59	2.12	156.30	50.80	1.48
05/13	55.70	22.40	2.64	2.15	213.60	77.70	1.57
05/14	64.20	17.00	1.95	1.74	210.00	67.40	1.47
05/15	68.60	22.70	2.27	1.93	211.60	62.10	1.42
05/16	65.00	24.60	2.52	2.08	202.30	60.00	1.42
05/17	66.10	15.50	1.81	1.65	216.80	68.50	1.46
05/18	70.90	19.50	2	1.77	208.40	69.80	1.5
05/19	78.40	22.90	2.08	1.82	209.00	70.90	1.51
05/20	98.20	27.50	2.02	1.78	226.40	73.20	1.48
05/21	109.30	39.90	2.44	2.04	276.50	108.00	1.64

Table C1: Migration year 2002 outflow and spill at Lower Granite Dam and McNary Dam and expansion factors used to upwardly adust PIT detections for spill. See Section 2.1.1 for formulas.

Date	Lower Granite Dam				McNary Dam		
	Outflow (kcfs)	Spill (kcfs)	Expansion Factor (using formulas 2.2a and 2.2b)		Outflow (kcfs)	Spill (kcfs)	Expansion Factor (using formula 2.2c)
			Chinook Salmon	Steelhead Trout			
05/22	112.20	42.00	2.49	2.06	269.10	107.30	1.66
05/23	102.00	34.40	2.3	1.95	273.20	113.40	1.71
05/24	98.90	24.80	1.89	1.7	266.00	111.10	1.72
05/25	92.50	22.30	1.84	1.67	241.80	103.10	1.74
05/26	84.00	23.40	2.01	1.78	230.70	99.30	1.76
05/27	88.80	23.40	1.94	1.73	268.40	119.70	1.8
05/28	95.70	23.30	1.85	1.68	276.30	114.90	1.71
05/29	111.50	37.80	2.31	1.96	295.10	133.30	1.82
05/30	125.50	51.70	2.7	2.19	294.80	122.80	1.71
05/31	136.60	60.50	2.87	2.29	322.20	149.40	1.86
06/01	136.70	61.10	2.89	2.31	345.20	171.00	1.98
06/02	131.50	57.10	2.82	2.26	300.40	129.40	1.76
06/03	133.70	61.10	2.95	2.34	313.10	139.60	1.8
06/04	120.40	60.30	3.2	2.5	358.30	193.20	2.17
06/05	115.10	68.90	3.83	2.93	376.90	221.50	2.43
06/06	109.60	59.90	3.49	2.69	374.00	211.60	2.3
06/07	107.80	53.10	3.15	2.47	344.80	184.10	2.15
06/08	104.90	40.60	2.56	2.1	370.80	212.80	2.35
06/09	89.60	29.20	2.24	1.92	332.60	163.50	1.97
06/10	79.00	55.70	4.76	3.57	294.70	128.40	1.77
06/11	82.10	28.00	2.32	1.96	338.70	168.70	1.99
06/12	75.00	23.10	2.15	1.86	297.80	145.20	1.95
06/13	75.70	22.60	2.11	1.84	308.30	143.80	1.87
06/14	76.20	18.00	1.82	1.66	281.80	121.30	1.76
06/15	77.60	22.90	2.09	1.83	306.08	134.80	1.79

Table C1: Migration year 2002 outflow and spill at Lower Granite Dam and McNary Dam and expansion factors used to upwardly adust PIT detections for spill. See Section 2.1.1 for formulas.

Date	Lower Granite Dam				McNary Dam		
	Outflow (kcfs)	Spill (kcfs)	Expansion Factor (using formulas 2.2a and 2.2b)		Outflow (kcfs)	Spill (kcfs)	Expansion Factor (using formula 2.2c)
			Chinook Salmon	Steelhead Trout			
06/16	82.30	19.80	1.84	1.67	271.00	98.00	1.57
06/17	94.30	27.30	2.07	1.81	297.70	141.10	1.9
06/18	96.90	39.50	2.67	2.17	328.20	166.70	2.03
06/19	99.40	40.50	2.67	2.17	345.70	179.50	2.08
06/20	89.90	29.10	2.23	1.91	361.10	188.70	2.09
06/21	85.90	20.40	1.83	1.66	350.60	176.60	2.01
06/22	79.70	4.90	1.17	1.15	323.10	149.80	1.86
06/23	87.10	11.30	1.4	1.36	305.20	135.00	1.79
06/24	89.50	25.40	2.04	1.79	300.00	129.00	1.75
06/25	91.50	25.20	2	1.77	295.70	121.90	1.7
06/26	83.10	8.00	1.28	1.26	308.10	135.70	1.79
06/27	85.50	29.00	2.31	1.96	312.60	140.00	1.81
06/28	84.40	36.30	2.8	2.25	344.00	181.40	2.12
06/29	81.70	19.50	1.83	1.66	344.20	173.30	2.01
06/30	80.20	21.50	1.96	1.75	304.80	132.00	1.76
07/01	68.70	36.90	3.43	2.65	308.60	139.50	1.82
07/02	59.00	20.50	2.35	1.98	332.10	157.40	1.9
07/03	53.30	14.40	1.97	1.75	322.00	149.50	1.87
07/04	52.30	18.70	2.41	2.01	313.00	140.90	1.82
07/05	46.10	0.00	1	1	248.80	76.70	1.45
07/06	40.10	0.00	1	1	259.90	86.90	1.5
07/07	39.10	0.00	1	1	249.00	75.60	1.44
07/08	38.20	0.00	1	1	239.80	66.90	1.39
07/09	43.00	13.80	2.22	1.9	204.00	36.50	1.22
07/10	40.60	7.60	1.61	1.52	204.50	36.70	1.22

Table C1: Migration year 2002 outflow and spill at Lower Granite Dam and McNary Dam and expansion factors used to upwardly adust PIT detections for spill. See Section 2.1.1 for formulas.

Date	Lower Granite Dam				McNary Dam		
	Outflow (kcfs)	Spill (kcfs)	Expansion Factor (using formulas 2.2a and 2.2b)		Outflow (kcfs)	Spill (kcfs)	Expansion Factor (using formula 2.2c)
			Chinook Salmon	Steelhead Trout			
07/11	42.90	10.90	1.9	1.71	259.70	90.10	1.53
07/12	43.80	27.50	4.05	3.08	248.10	77.10	1.45
07/13	42.10	9.70	1.8	1.64	267.80	97.30	1.57
07/14	38.00	0.00	1	1	263.60	94.30	1.56
07/15	37.10	13.80	2.48	2.06	219.60	55.10	1.33
07/16	37.20	5.40	1.45	1.4	215.40	49.90	1.3
07/17	36.40	0.00	1	1	258.70	85.40	1.49
07/18	36.50	0.00	1	1	242.60	71.70	1.42
07/19	32.20	0.00	1	1	205.30	36.00	1.21
07/20	30.90	0.00	1	1	232.30	60.70	1.35
07/21	33.20	0.00	1	1	225.90	56.20	1.33
07/22	30.40	0.00	1	1	226.60	66.40	1.41
07/23	31.40	0.00	1	1	209.80	53.30	1.34
07/24	31.50	0.00	1	1	195.70	36.70	1.23
07/25	31.40	0.00	1	1	191.40	26.50	1.16
07/26	30.20	0.00	1	1	158.10	4.00	1.03
07/27	27.00	0.00	1	1	161.70	6.70	1.04
07/28	29.00	0.00	1	1	153.50	9.40	1.07
07/29	28.30	0.00	1	1	169.50	14.40	1.09
07/30	26.10	0.00	1	1	180.80	24.20	1.15
07/31	31.60	0.00	1	1	175.10	28.30	1.19
08/01	25.90	0.00	1	1	165.30	4.40	1.03

Appendix D

Historical MADs for RealTime 2002 Stocks With at Least Three Years Inclusion in the Project, Including Fifteen Stocks of Wild Chinook Salmon and Steelhead Trout Monitored and Forecasted at Lower Granite Dam, and Eleven Runs-at-Large of Combined Wild and Hatchery Chinook, Coho, Sockeye Salmon and Steelhead Trout Monitored and Forecasted to Rock Island and McNary Dams.

Table D.1: Historical MADS for all 2002 Realtime Stocks forecasted more than two years to Lower Granite Dam (LWG), Rock Island Dam (RIS) and McNary Dam (MCN).

Stock Name	Dam	Portion of Out-migration	Year								
			1995	1996	1997	1998	1999	2000	2001	**Hist. Avg.**	**2002**
Bear Valley Creek	LWG	First Half	5.6	---	---	8.6	1.4	1.4	7.0	**4.8**	**5.6**
		Last Half	3.9	---	---	7.7	9.6	3.8	10.1	**7.0**	**3.8**
		Entire Run	4.5	---	---	8.0	8.1	3.3	9.1	**6.6**	**4.3**
Catherine Creek	LWG	First Half	2.7	3.3	7.9	7.6	4.0	0.8	10.0	**5.2**	**5.5**
		Last Half	6.6	6.1	7.1	8.8	7.7	7.6	5.4	**7.0**	**3.4**
		Entire Run	5.6	5.4	7.4	8.4	6.2	5.2	6.5	**6.4**	**3.9**
Elk Creek	LWG	First Half	---	---	---	26.8	0.4	2.6	---	**9.9**	**18.0**
		Last Half	---	---	---	6.4	4.9	4.8	---	**5.4**	**12.6**
		Entire Run	---	---	---	12.5	3.6	4.3	---	**6.8**	**13.9**
Imnaha River	LWG	First Half	15.5	6.6	6.3	20.6	3.9	3.3	5.1	**8.8**	**19.4**
		Last Half	7.7	6.8	2.2	4.5	3.2	2.4	5.8	**4.7**	**35.5**
		Entire Run	10.0	6.8	3.2	10.6	3.4	2.6	5.6	**6.0**	**30.5**
Johnson Creek	LWG	First Half	---	---	---	---	---	1.8	6.7	**4.3**	**6.7**
		Last Half	---	---	---	---	---	6.4	9.6	**8.0**	**6.1**
		Entire Run	---	---	---	---	---	4.8	8.7	**6.8**	**6.4**

Table D.1: Historical MADS for all 2002 Realtime Stocks forecasted more than two years to Lower Granite Dam (LWG), Rock Island Dam (RIS) and McNary Dam (MCN).

Stock Name	Dam	Portion of Out-migration	Year								
			1995	1996	1997	1998	1999	2000	2001	**Hist. Avg.**	**2002**
Lake Creek	LWG	First Half	---	---	1.0	19.7	1.7	3.2	---	**6.4**	**9.0**
		Last Half	---	---	11.8	6.1	3.6	3.3	---	**6.2**	**8.3**
		Entire Run	---	---	10.2	8.7	3.2	3.2	---	**6.3**	**8.4**
Lostine River	LWG	First Half	3.4	18.7	5.4	---	4.4	0.9	3.1	**6.0**	**1.8**
		Last Half	3.6	4.3	3.9	---	8.1	2.8	3.0	**4.3**	**3.5**
		Entire Run	3.5	9.5	4.4	---	5.8	2.1	3.0	**4.7**	**3.0**
Marsh Creek	LWG	First Half	---	---	---	---	6.8	2.1	---	**4.5**	**1.5**
		Last Half	---	---	---	---	3.0	3.0	---	**3.0**	**12.7**
		Entire Run	---	---	---	---	4.0	2.8	---	**3.4**	**8.4**
Minam River	LWG	First Half	---	2.7	2.0	16.3	2.8	2.8	2.1	**4.8**	**5.1**
		Last Half	---	2.9	10.9	3.5	7.8	1.9	1.3	**4.7**	**3.3**
		Entire Run	---	2.8	8.3	7.8	5.8	2.2	1.6	**4.8**	**4.1**
Salmon River, SF	LWG	First Half	8.6	9.6	6.0	6.6	0.9	1.5	4.7	**5.4**	**10.0**
		Last Half	8.7	4.9	6.6	3.4	10.2	3.4	5.4	**6.1**	**8.9**
		Entire Run	8.7	6.2	6.5	4.3	5.9	2.9	5.2	**5.7**	**9.3**

Table D.1: Historical MADS for all 2002 Realtime Stocks forecasted more than two years to Lower Granite Dam (LWG), Rock Island Dam (RIS) and McNary Dam (MCN).

Stock Name	Dam	Portion of Out-migration	Year								
			1995	1996	1997	1998	1999	2000	2001	**Hist. Avg.**	**2002**
Secesh River	LWG	First Half	3.8	---	9.1	14.8	1.2	5.2	19.3	**8.9**	**6.4**
		Last Half	2.5	---	7.1	4.5	4.9	3.3	9.6	**5.3**	**2.8**
		Entire Run	2.8	---	7.3	6.5	3.9	3.5	12.1	**6.0**	**3.2**
Valley Creek	LWG	First Half	5.1	---	---	---	7.5	12.9	10.1	**8.9**	**2.1**
		Last Half	8.9	---	---	---	7.4	2.9	10.4	**7.4**	**4.7**
		Entire Run	7.3	---	---	---	7.4	5.5	10.3	**7.6**	**3.7**
RealTime Select Composite	LWG	First Half	2.7	1.9	2.3	6.7	2.7	0.8	3.2	**3.3**	**5.8**
		Last Half	2.0	2.5	1.7	1.5	2.5	1.2	4.9	**2.7**	**5.2**
		Entire Run	2.2	2.4	1.8	2.6	2.5	1.1	4.3	**2.8**	**5.4**
Wild PIT-tagged subyearling chinook salmon (SNAKER)	LWG	First Half	---	---	---	---	9.5	3.2	3.3	**5.2**	**1.8**
		Last Half	---	---	---	---	3.6	5.5	5.4	**4.8**	**6.2**
		Entire Run	---	---	---	---	4.7	4.9	4.8	**4.8**	**5.2**
Wild PIT-tagged yearling chinook salmon	LWG	First Half	---	---	---	---	---	5.0	6.0	**5.5**	**4.5**
		Last Half	---	---	---	---	---	1.0	3.0	**2.0**	**5.5**
		Entire Run	---	---	---	---	---	1.7	3.6	**2.7**	**5.2**

Table D.1: Historical MADS for all 2002 Realtime Stocks forecasted more than two years to Lower Granite Dam (LWG), Rock Island Dam (RIS) and McNary Dam (MCN).

Stock Name	Dam	Portion of Out-migration	Year								
			1995	1996	1997	1998	1999	2000	2001	**Hist. Avg.**	**2002**
Wild PIT-tagged steelhead	LWG	First Half	---	---	---	---	---	10.8	2.7	**6.8**	**9.8**
		Last Half	---	---	---	---	---	2.8	1.6	**2.2**	**5.7**
		Entire Run	---	---	---	---	---	4.8	1.8	**3.3**	**6.8**
Passage-indexed wild and hatchery subyearling chinook salmon	RIS	First Half	---	---	---	---	---	3.97	6.8	**5.4**	**8.67**
		Last Half	---	---	---	---	---	1.94	10.8	**6.4**	**3.70**
		Entire Run	---	---	---	---	---	2.90	9.1	**6**	**5.71**
Passage-indexed wild and hatchery yearling chinook salmon	RIS	First Half	---	---	---	---	---	15.70	13.5	**14.6**	**1.96**
		Last Half	---	---	---	---	---	1.76	5.8	**3.8**	**1.06**
		Entire Run	---	---	---	---	---	5.04	7.7	**6.4**	**1.30**
Passage-indexed wild and hatchery coho salmon	RIS	First Half	---	---	---	---	---	1.77	5.6	**3.7**	**4.77**
		Last Half	---	---	---	---	---	0.50	3.2	**1.8**	**1.10**
		Entire Run	---	---	---	---	---	1.04	3.7	**2.4**	**2.13**
Passage-indexed wild and hatchery sockeye salmon	RIS	First Half	---	---	---	---	---	19.45	3.6	**11.5**	**6.51**
		Last Half	---	---	---	---	---	16.23	15.9	**16.1**	**4.55**
		Entire Run	---	---	---	---	---	16.96	12.8	**14.9**	**4.99**

Table D.1: Historical MADS for all 2002 Realtime Stocks forecasted more than two years to Lower Granite Dam (LWG), Rock Island Dam (RIS) and McNary Dam (MCN).

Stock Name	Dam	Portion of Out-migration	Year								
			1995	1996	1997	1998	1999	2000	2001	**Hist. Avg.**	**2002**
Passage-indexed wild and hatchery steelhead	RIS	First Half	---	---	---	---	---	10.83	9.7	**10.3**	**4.12**
		Last Half	---	---	---	---	---	2.07	1.3	**1.7**	**2.14**
		Entire Run	---	---	---	---	---	4.47	4.1	**4.3**	**2.76**
Passage-indexed wild and hatchery subyearling chinook salmon	MCN	First Half	---	---	---	---	---	3.43	4.9	**4.2**	**1.14**
		Last Half	---	---	---	---	---	1.25	6.6	**3.9**	**1.75**
		Entire Run	---	---	---	---	---	1.57	6.3	**3.9**	**1.66**
Passage-indexed wild and hatchery yearling chinook salmon	MCN	First Half	---	---	---	---	---	0.71	1.21	**1**	**5.27**
		Last Half	---	---	---	---	---	0.55	7.12	**3.8**	**1.1**
		Entire Run	---	---	---	---	---	0.59	5.70	**3.1**	**1.8**
Passage-indexed wild and hatchery coho salmon	MCN	First Half	---	---	---	---	---	0.88	2.84	**1.9**	**1.79**
		Last Half	---	---	---	---	---	0.66	2.43	**1.5**	**1.15**
		Entire Run	---	---	---	---	---	0.72	2.55	**1.6**	**1.40**
Passage-indexed wild and hatchery sockeye salmon	MCN	First Half	---	---	---	---	---	12.73	1.47	**7.1**	**4.37**
		Last Half	---	---	---	---	---	8.66	10.92	**9.8**	**0.77**
		Entire Run	---	---	---	---	---	9.47	8.52	**9**	**1.31**

Table D.1: Historical MADS for all 2002 Realtime Stocks forecasted more than two years to Lower Granite Dam (LWG), Rock Island Dam (RIS) and McNary Dam (MCN).

Stock Name	Dam	Portion of Out-migration	Year								
			1995	1996	1997	1998	1999	2000	2001	**Hist. Avg.**	**2002**
Passage-indexed wild and hatchery steelhead trout	MCN	First Half	---	---	---	---	---	3.80	15.14	**9.5**	**9.96**
		Last Half	---	---	---	---	---	2.68	7.69	**5.2**	**1.25**
		Entire Run	---	---	---	---	---	2.85	9.36	**6.1**	**2.83**