MONITORING AND EVALUATION OF SMOLT MIGRATION IN THE COLUMBIA BASIN

VOLUME XI

Evaluation of the 2003 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 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 Real-Time. Technical Report to BPA, Project 91-051-00, Contract 96BI-91572.

Volume X: Burgess,C., J.R. Skalski. 2002. Evaluation of the 2002 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 Real-Time. 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 thirteenth 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 2003 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 2003 inseason outmigrations via the internet for 33 PIT-tagged stocks of wild ESU chinook salmon and steelhead to Lower Granite and/or McNary dams, two 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. All of the 23 stocks of wild yearling chinook salmon which were captured, PIT-tagged, and released at sites above Lower Granite Dam in 2002, have been monitored at least once before the 2003 migration. These stocks originate in drainages of the Salmon, Grande Ronde and Clearwater Rivers, all tributaries to the Snake River, and are subsequently detected to the tag identification and monitored at Lower Granite Dam. In a continuation from the previous two years, seven wild PIT-tagged runs-at-large of Snake or Upper Columbia River ESU salmon and steelhead were monitored at McNary Dam. Two wild PIT-tagged runs-at-large were monitored at Lower Granite Dam, the yearling and subyearling chinook salmon and the steelhead trout runs. The hatchery-reared PIT-tagged sockeye salmon stocks outmigrating to Lower Granite Dam consisted of a stock from Alturas Lake and one from Redfish Lake. 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 = 8.6%). The run of wild PIT-tagged Upper Columbia subyearling fall chinook salmon monitored at McNary Dam was predicted very well in 2003 (season-wide MAD = 3.3%). The run of wild PIT-tagged Snake River subyearling fall chinook salmon monitored at McNary Dam was also predicted very well (MAD = 2.9%)

The run-at-large of wild PIT-tagged Snake River yearling chinook salmon smolts monitored at McNary Dam was predicted extremely well in 2003, with a season-wide MAD of 2.5%. 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 somewhat poor compared to previous years (MAD = 11.1%). Detection rates for this run were far above average in 2003. Stocks of yearling chinook salmon from specific release sites in the Salmon, Grande Ronde and Clearwater River drainages were predicted well on average (mean MAD over all stocks for the entire season was 10.1%, up from 8.1% in 2002) and the composite of all such stocks was well-predicted (season-wide MAD = 4.4%). Some individual stocks were poorly predicted, with 7 of 23 stocks having season-wide MADs larger than 10%. These larger prediction errors are likely due to the unusually small detection rates of PIT-tagged smolts from these stocks in 2003. Smaller-than-average detection rates observed for 20 out of 23 of these stocks.

The run of wild PIT-tagged Snake River sockeye salmon monitored and forecasted at McNary Dam was fairly well-predicted in 2003 (season-wide MAD = 9.6% compared to 5.6% last year). This stock saw record detections at McNary Dam (688 compared to an average of 214). The season-wide MAD for PIT-tagged hatchery sockeye salmon from the Redfish Lake was 5.7% but for the Alturas Lake stock, the season-wide MAD was extremely large, 77.2%. The poor predictions were traceable to the fact that only 4 fish were detected at Lower Granite Dam. There were 1481 of these smolts tagged and released in 2002.

RealTime predictions of the run-timing of wild PIT-tagged Snake River steelhead trout to Lower Granite and McNary Dams were poorer than last year (season-wide MADs were larger than 10% at both dams). These larger errors may also be attributable to larger-than-expected counts at both dams. The season-wide MAD for Upper Columbia River steelhead trout outmigrating to McNary Dam was 5.5%. This run was very large in 2003.

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, 2 of 15 stocks had season-wide MADs near 7%, 13 of the remaining had MADs less than 4%, 9 less than 3%, and 5 had season-wide MADs within 2% of the true end-of-season distribution.

Executive Summary

2003 Objectives

1. Apply program RealTime to provide in-season predictions of the run-timing of Fish Passage Center (FPC) passage-index counts of runs-at-large of subyearling and yearling chinook salmon, sockeye salmon, coho salmon and steelhead trout to Rock Island, McNary and John Day Dams (15 stocks total) and to provide in-season predictions of the run-timing of PIT-tagged stocks to Lower Granite and McNary Dams (35 stocks total). The 35 PIT-tagged stocks include 9 wild runs-at-large of yearling and subyearling chinook salmon, sockeye salmon and steelhead trout, 24 wild release/recovery stocks of yearling and subyearling chinook salmon, and 2 hatchery-reared stocks of sockeye salmon from the Salmon River drainage. Specific tasks were to predict and report in real-time the "percent run-to-date" and "date to specified percentiles" of the outmigrations to the dams.
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

Runs-at-large of FPC passage indices of combined hatchery and wild salmon and steelhead were monitored and forecasted by Program RealTime in 2003 to Rock Island, McNary and John Day dams. Runs-at-large of wild PIT-tagged salmon and steelhead were monitored and forecasted by Program RealTime in 2003 to Lower Granite and McNary dams. These runs included Snake River steelhead trout, Upper Columbia steelhead trout, the composite of these two steelhead runs, Snake River yearling chinook salmon, Snake River sockeye salmon, Snake River subyearling chinook salmon, and Upper Columbia River subyearling chinook salmon. The release/recovery stocks of wild PIT-tagged yearling chinook salmon tracked to Lower Granite Dam included Bear Valley Creek, Big Creek, Camas Creek, Cape Horn Creek, Catherine Creek, Chamberlain Creek-West Fork, Elk Creek, Grande Ronde River, Herd Creek, Imnaha River, Johnson Creek, Lake Creek, Lemhi River, Lolo Creek, Lookingglass Creek, Loon Creek, Lostine River, Marsh Creek, Minam River, South Fork Salmon River, Secesh River, Sulfur Creek and Valley Creek (23 total). The release/recovery stock of wild PIT-tagged subyearling chinook salmon tracked to Lower

Granite Dam is a stock marked and released by William Connor (Dvorshak Fish Complex) between river kilometers 224 and 268 on the mainstem Snake River. The release/recovery stocks of hatchery-reared PIT-tagged sockeye salmon tracked to Lower Granite Dam are from Alturas Lake and Redfish Lake.

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 sub-populations of salmon and steelhead to Lower Granite Dam, and beginning in 2001, to McNary Dam.

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 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).

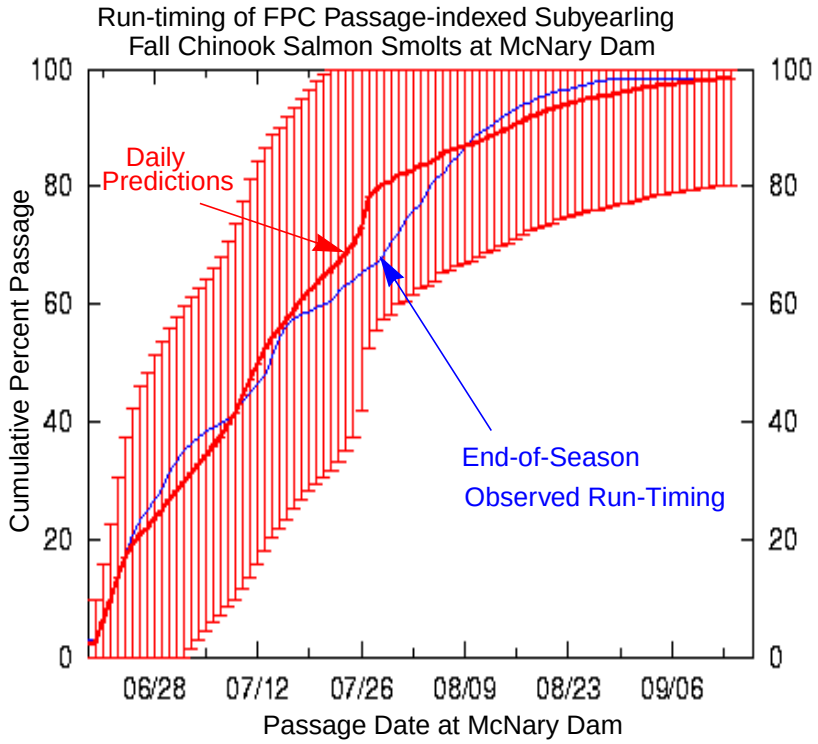
Findings

Program RealTime performance is evaluated using MADs (*mean absolute differences*, the average over 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 = 8.6%). The run of wild PIT-tagged Upper Columbia subyearling fall chinook salmon monitored at McNary Dam was predicted very well in 2003 (season-wide MAD = 3.3%). The run of wild PIT-tagged Snake River subyearling fall chinook salmon monitored at McNary Dam was also predicted very well (MAD = 2.9%).

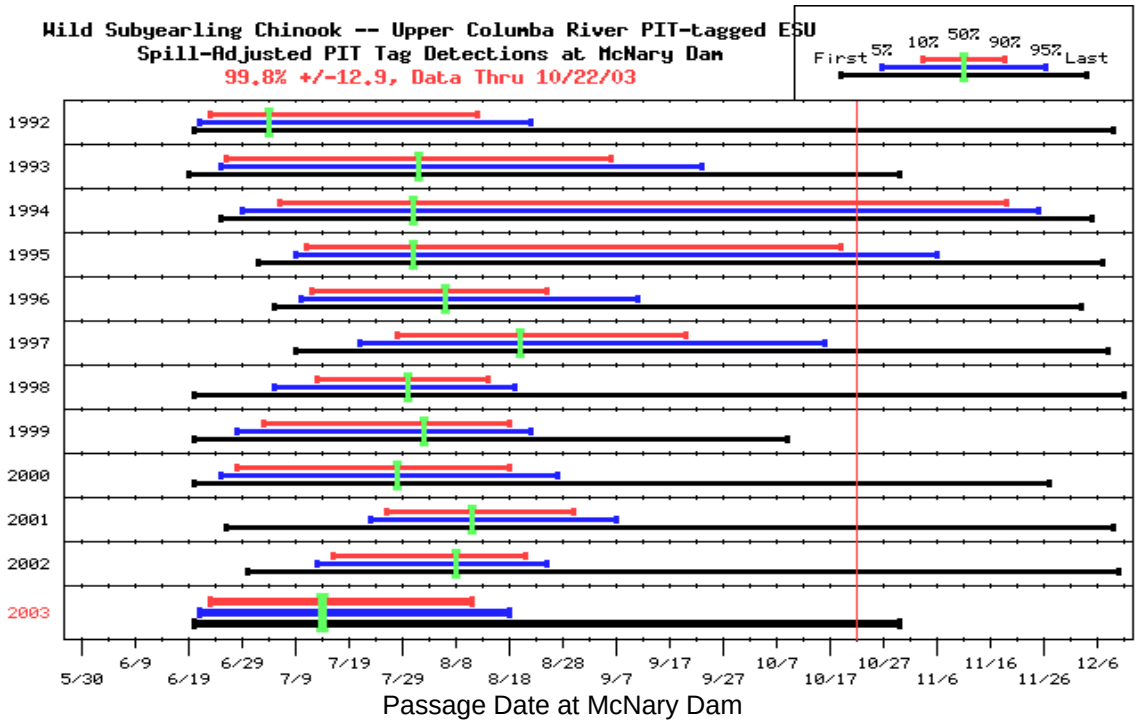
The run-at-large of wild PIT-tagged Snake River yearling chinook salmon smolts monitored at McNary Dam was predicted extremely well in 2003, with a season-wide MAD of 2.5%. Program RealTime predictions for the run-at-large of wild PIT-tagged yearling chinook salmon from the Snake River drainage outmigrating to Lower Granite Dam were somewhat poor compared to previous years (MAD = 11.1%). Detection rates for this run were far above average in 2003. Stocks

Figure 1: Example of two types of graphical displays available for all stocks in the RealTime project. (a) Program RealTime 2003 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)



from release sites that were monitored individually by Program RealTime in 2003 were predicted fairly well based on the composite (season-wide MAD = 4.4%), and on the average (mean MAD over all stocks for the entire season was 10.1%, up from 8.1% in 2002), but 7 of 23 stocks had season-wide MADs larger than 10%. These larger prediction errors can probably be traced to very unusual detection rates, much smaller than average. Indeed, as in migration year 2002, detection rates in 2003 were smaller than expected overall, with 20 out of 23 stocks recording lower-than-average rates.

The run of wild PIT-tagged Snake River sockeye salmon monitored and forecasted at McNary Dam was fairly well-predicted in 2003 (season-wide MAD = 9.6% compared to 5.6% last year). This stock saw record detections at McNary Dam (688 compared to an average of 214). The season-wide MAD for PIT-tagged hatchery sockeye salmon from the Redfish Lake was 5.7% but that for Alturas Lake fish was 77.2%, a very poor prediction record traceable to a mere 4 raw detections at Lower Granite Dam, relative to release numbers (1481).

RealTime predictions of the run-timing of wild PIT-tagged Snake River steelhead trout to Lower Granite and McNary Dams were poorer than last year (season-wide MADs larger than 10% at both dams compared to less than 7% last year). These larger errors may also be attributable to larger-than-expected counts at both dams. The numbers of Upper Columbia River steelhead trout outmigrating to McNary Dam were far above expected, however this run was fairly well-predicted this year (season-wide MAD was 5.5% compared to 10.6% in 2002).

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, 2 of 15 stocks had season-wide MADs near 7%, 13 of the remaining had MADs less than 4%, 9 less than 3%, and 5 had season-wide MADs within 2% of the true end-of-season distribution.

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 indi-

vidual and aggregates of listed threatened and endangered Snake River salmon stocks, and, since 2000, of listed Mid-Columbia River stocks. These predictions have been made publically available to the fisheries community to assist in-season river management in real time throughout the course of the smolt outmigration.

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Acknowledgments

We wish to express thanks to the many fisheries agencies, Tribes and other institutions that have expended considerable resources in the generation, assembly, analysis and sharing of Columbia River biological, hydrologic, operational and other related information. Deserving particular thanks are the staff of the agencies and Tribes responsible for conducting the annual Columbia River Smolt Monitoring Program, the Fish Passage Center, and the Pacific States Marine Fisheries Commission PIT-Tag Information System (PTAGIS), primary database centers for providing timely in-season access to fish passage and PIT-tag information; and the University of Washington second-tier database DART (Data Access in Real Time) information system which receives, processes and provides access to biological, hydrologic and operational information via the Internet.

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 2.4.1). 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 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 2003. 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 200. 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 2.4). Appendix D displays the record of RealTime performance since 1995 of all stocks included in the 2003 project for which there are at least two other years of data for 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 (PTAGIS) project. In 2003 we monitored and prepared forecasts for 27 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-six release-recovery stocks, all monitored at Lower Granite Dam. These were 1) twenty-three stocks of wild spring/summer yearling chinook salmon captured, tagged and released into streams above Lower Granite during the spring, summer and fall of 2002, 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) two hatchery-reared, summer-run sockeye salmon stocks outmigrating from Alturas Lake and Redfish Lake in Idaho. Table 2.1 displays the U.S. Geological Survey hydrounit numbers for these release sites. Figure 2.1 shows the locations of the 25 sites from which wild smolts were sampled, PIT-tagged and released.

Release-recovery stocks originating from tag/release sites have special data requirements that index-count stocks do not. 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 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,

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.

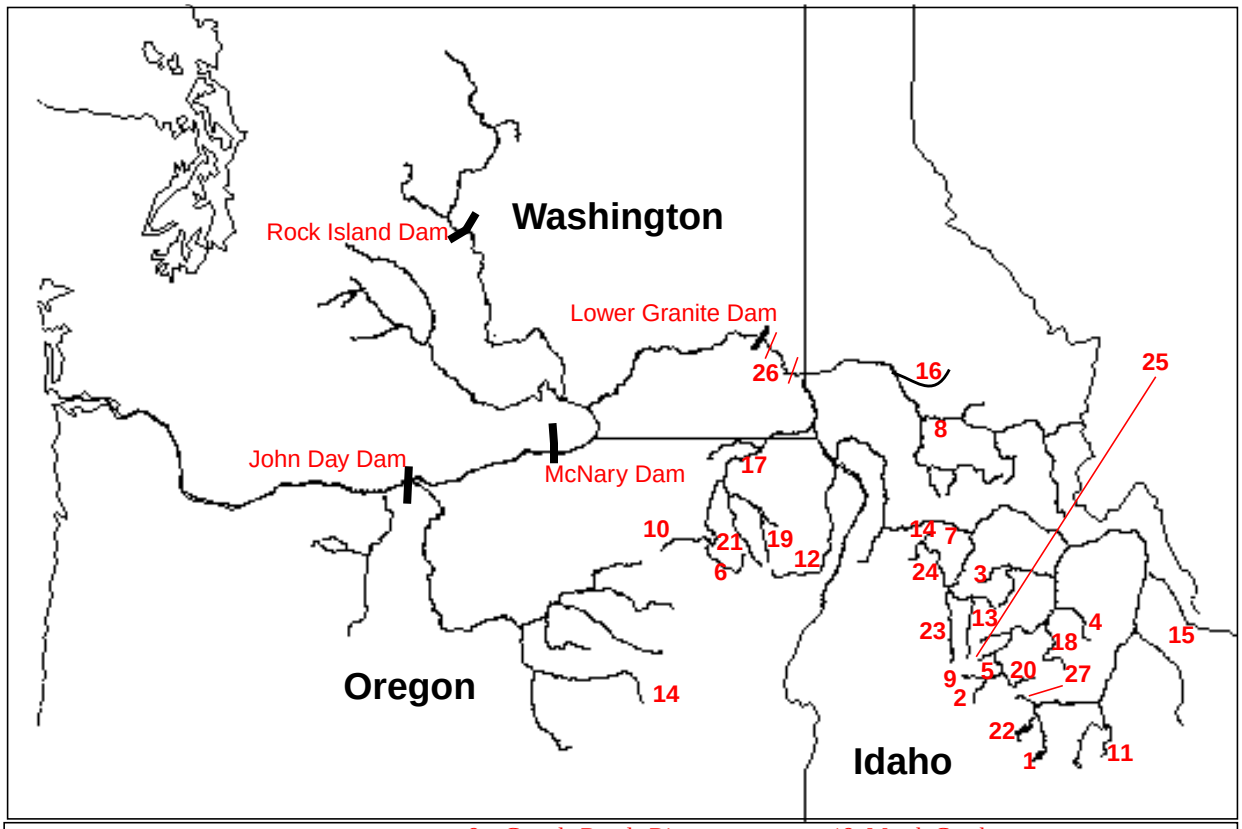
Table 2.1: The GIS hydrounits of the 23 PIT-tag/release sites for spring/summer yearling chinook salmon, the single PIT-tag/release site for fall subyearling chinook salmon, and the 2 PIT-tag release sites for sockeye salmon. These are all release sites for the 26 release-recovery stocks included in the 2003 Program RealTime forecasting project, monitored at Lower Granite Dam.

Release Site		Rearing	Run	Species	GIS Hydrounit[a]
Abbreviation	Long Name				
ALTURL	Alturas Lake	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
CAMASC	Camas Creek	W	Sp/Su	Chinook	17060206
CAPEHC	Cape Horn Creek	W	Sp/Su	Chinook	17060205
CHAMWF	West Fork Chamberlain Creek	W	Sp/Su	Chinook	17060207
ELKC	Elk Creek	W	Sp/Su	Chinook	17060205
GRANDR	Grande Ronde River	W	Sp/Su	Chinook	17060106
HERDC	Herd Creek	W	Sp/Su	Chinook	17060201
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
LOONC	Loon Creek	W	Sp/Su	Chinook	17060205
LOSTIR	Lostine River	W	Sp/Su	Chinook	17060105
MARSHC	Marsh Creek	W	Sp/Su	Chinook	17060205
MINAMR	Minam River	W	Sp/Su	Chinook	17060106
REDFL	Redfish Lake	H	Su	Sockeye	17060201
SALRSF	Salmon River, South Fork	W	Sp/Su	Chinook	17060208
SECESR	Secesh River	W	Sp/Su	Chinook	17060208
SNAKER	Snake River (RK 224 to 268)	W	Fall	Chinook	17060110
SULFUC	Sulfur Creek	W	Sp/Su	Chinook	17060205
VALEYC	Valley Creek	W	Sp/Su	Chinook	17060201

a. Geographical Information System (GIS) designations established by the U.S. Geological Survey.

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 all those spring/

Figure 2.1: Map showing release sites for the 26 release-recovery stocks (Table 2.1) monitored by Program RealTime in 2003 to Lower Granite Dam.



Release Sites

1. Alturas Lake
2. Bear Valley Creek
3. Big Creek
4. Camas Creek
5. Cape Horn Creek
6. Catherine Creek
7. Chamberlain Creek, WF
8. Elk Creek
9. Grande Ronde River
10. Herd Creek
11. Imnaha River
12. Johnson Creek
13. Lake Creek
14. Lemhi River
15. Lolo Creek
16. Lookingglass Creek
17. Loon Creek
18. Lostine River
19. Marsh Creek
20. Minam River
21. Redfish Lake
22. Salmon River, South Fork
23. Secesh River
24. Sulfur Creek
25. Snake River, kilometer 224-268
26. Valley Creek

summer yearling chinook stocks displayed in Table 2.1. The third composite, the RealTime All-Stocks composite, includes all sites and this year was identical to the Select composite (Figure 2.1, Table 2.1).

Further data criteria for choosing yearling chinook release/recovery 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 expe-

rienced taggers Steve Achord or Paul Sankovitch were included in the project. This criterion was dropped for the 2002 RealTime Project because these taggers did not tag fish in the summer and fall of 2001. In 2003, the seasonal criteria alone was kept in place.

Numbers of yearling chinook parr released in 2002 at the sites illustrated in Figure 2.1 are displayed in Table 2.2. Historical releases are given in Appendix B.

Included in 2003 for the fifth consecutive year was the subpopulation of PIT-tagged wild fall subyearling chinook salmon, monitored to provide run-timing information about the wild run-at-large of Snake River fall subyearling chinook salmon. FPC passage indices for the wild run were 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, subyearling fall chinook salmon smolts have been sampled, PIT-tagged and released into the Snake River between river kilometers 224 and 268. These smolts are tagged and released at regular intervals, from April into July or until water temperatures approach 20^{o}C or catches near zero. They begin to appear in the detection facility at Lower Granite Dam around June 1 and continue through September or October. The subpopulation mimics passage of the run-at-large well during the first and middle portions of the run. There were 4739 PIT-tagged smolts released for this migration year into the Snake River (Table 2.2). Historical releases are given in Appendix B.

The hatchery-reared summer-run sockeye salmon from Alturas and Redfish Lakes were monitored in 2003 after an abeyance of tagging at these sites in 2001 and 2002 (Townsend et al. 1998, Burgess et al. 1999, Burgess and Skalski 2000a, b). There were 1481 PIT-tagged smolts released into Alturas Lake and 2022 into Redfish Lake between August and December of 2002 (Table 2.2). Historical releases are given in Table Appendix B.

Table 2.2: Numbers of salmon smolts tagged for each release/recovery stock forecasted in 2003 by Program RealTime to Lower Granite Dam[a].

Tagging Location	Number Parr Tagged/Release in 2002-03
Bear Valley Creek	1022
Big Creek	1724
Camas Creek	976
Cape Horn Creek	562
Catherine Creek	2501
Chamberlain Creek, West Fork	761
Elk Creek	975
Grande Ronde River	463
Herd Creek	799
Imnaha River	1003
Johnson Creek	1041
Lake Creek	709
Lemhi River	700
Lolo Creek	2005
Lookingglass Creek	707
Loon Creek	830
Lostine River	1772
Marsh Creek	997
Minam River	1598
Salmon River, South Fork	1035
Secesh River	1040
Sulfur Creek	560
Valley Creek	2266
Sockeye from Alturas Lake	1481
Sockeye from Redfish Lake	2022
Wild Subyearling Fall Chinook Salmon Tagged and Release between Snake River km 224 and 268	4739

a. Data Sources: PTAGIS and FPC Smolt Index Databases and RealTime program output as of 15 October 2003.

Index-Count Stocks

As in 2002, 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., Snake and Columbia fish 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 fourth consecutive year in 2003. 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 do not overwhelm the normal signature pattern of fish passage run-timing (Burgess and Skalski, 2000).

2.2 Preprocessing of Data

Raw PIT-tag detections 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 through them to encourage that route of passage. However, fish that pass through the spillway are not detected by PIT-tag interrogation systems, so formulas are devised to upwardly adjust the raw counts of PIT-detections. Daily numbers 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

$$\frac{1}{1-SE}, \tag{2.1}$$

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

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

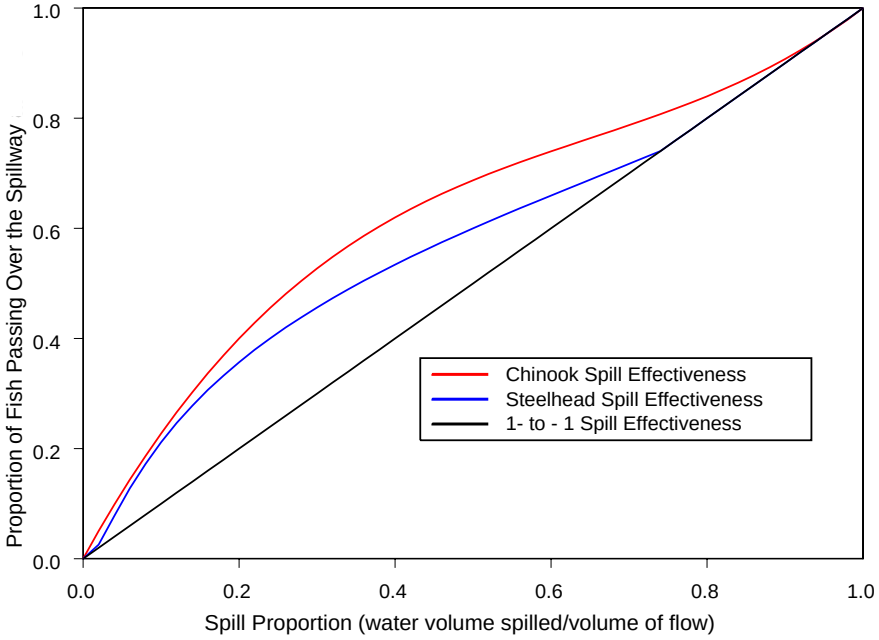
(Figure 2.2, red), and the formula for steelhead is given by Skalski and Perez-Comas (1998) as

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

(Figure 2.2, blue). In the figure, S is the daily volume of water spilled and F is daily outflow volume. In the 2003 RealTime project, the 2003 formulation of SE as a function of spill proportion at McNary Dam was a one-to-one function (NMFS, 2000) of SE to spill proportion. Spill proportion is volume of water spilled divided by volume of outflow (Figure 2.2, black),

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

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 2003 RealTime spill effectiveness curves as functions of spill proportion (S/F, the proportion of spill, S, relative to outflow, F) at Lower Granite Dam (red, blue) and at McNary Dam (black).



2.3.2 FPC Passage-Indexed Stocks See Section 2.1.2

2.4 The RealTime Forecaster

2.4.1 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, $j = 1, \ldots, 100$, using the measure

$$\sum_j (s_j - s_{ijp})^2 \ , \tag{2.3}$$

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 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 outmi-

Table 2.3: Data used by Program RealTime in 2003 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 2003 migration year.

Tagging Location	(1) Parr released, N	(2) Average Historical%, $\bar{r}$	(3) $\hat{E}(S)$
Bear Valley Creek	1022	12.0	122.58
Big Creek	1724	12.1	209.07
Camas Creek	976	11.1	108.74
Catherine Creek	562	11.8	66.52
Chamberlain Creek, West Fork	2501	12.2	304.59
Elk Creek	975	13.5	131.34
Grande Ronde River	463	13.6	63.01
Herd Creek	799	12.1	96.35
Imnaha River	1003	11.7	116.90
Johnson Creek	1041	13.7	143.08
Lake Creek	709	10.5	74.51
Lemhi River	700	14.5	101.65
Lolo Creek	2005	15.5	310.95
Lookingglass Creek	707	12.7	89.80
Loon Creek	830	13.6	112.80
Lostine River	1772	15.3	270.31
Marsh Creek	997	9.6	95.90
Minam River	1598	14.3	228.68
Salmon River, South Fork	1035	8.5	88.11
Secesh River	1040	11.8	123.14
Sulfur Creek	560	9.6	53.73
Valley Creek	2266	6.5	146.63
Sockeye from Alturas Lake	1481	21.7	321.71
Sockeye from Redfish Lake	2022	4.7	95.65
Wild Subyearling Fall Chinook Salmon Tagged and Release between Snake River km 224 and 268	4739	28.0	1326.37

a.Data Sources: PTAGIS Databases and RealTime program output as of 15 November 2003.

Table 2.4: Data used by Program RealTime in 2003 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 2003 are used to predict current year expected numbers of counts, $E(\hat{S})$, (Section 2.4.1) 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	10367.43
		Steelhead		6875.18
		Snake River Subyearling Chinook Salmon	McNary Dam	214.35
		Upper Columbia River Subyearling Chinook Salmon		1605.44
		Snake River Yearling Chinook Salmon		8004.43
		Snake River Sockeye Salmon		236.84
		Snake River Steelhead		2685.37
		Upper Columbia River Steelhead		1292.36
		Snake and Upper Columbia River Steelhead		3891.54
Combined Wild and Hatchery	FPC Passage Indices	Subyearling Chinook Salmon	Rock Island Dam	17266.44
		Yearling Chinook Salmon		27459.36
		Coho Salmon		42864.00
		Sockeye Salmon		14571.75
		Steelhead		20551.77
		Subyearling Chinook Salmon	McNary Dam	7881520.55
		Yearling Chinook Salmon		2304134.91
		Coho Salmon		294543.75
		Sockeye Salmon		703596.88
		Steelhead		713190.22
		Subyearling Chinook Salmon	John Day Dam	1760915.00
		Yearling Chinook Salmon		1017368.64
		Coho Salmon		345668.00
		Sockeye Salmon		322760.75
		Steelhead		797335.00

a.Data Sources: PTAGIS and FPC Smolt Index Databases and RealTime program output as of 15 November 2003.

gration 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.

2.4.2 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 2.4.1). 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.

2.4.3 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 2.4.3) are given for the first and last halves of the outmigration, and for the entire outmigration (Table 3.1). Like last year, the first half of the migration was very well-predicted (MAD = 2.0%) but the last half (also like last year) was not as well-predicted.

Table 3.1: Mean absolute deviations (MADs) for the 2002 and 2003 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	2002			2003		
	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	5.16	1.80	6.17	8.58	1.96	11.12
All Wild PIT-tagged Snake River Subyearling Chinook Salmon Detected at McNary Dam	7.20	15.68	4.68	2.92	4.78	2.09
All Wild PIT-tagged Upper Columbia River Subyearling Chinook Salmon Detected at McNary Dam.	3.42	1.61	3.92	3.34	2.72	3.56

Index-Count Stocks Monitored at McNary Dam

Both Snake and Upper Columbia River subyearling chinook salmon runs to McNary Dam were predicted better in 2003 than last year. There were more Snake River wild PIT-tagged subyearlings detected at McNary than in any previously recorded year (688 smolts, Appendix B). The season-wide MAD for this stock was 2.9% compared to 7.2% in 2002. This year's season-wide MAD for the Upper Columbia run (3.3%) was nearly the same as last year (3.4%). Passage

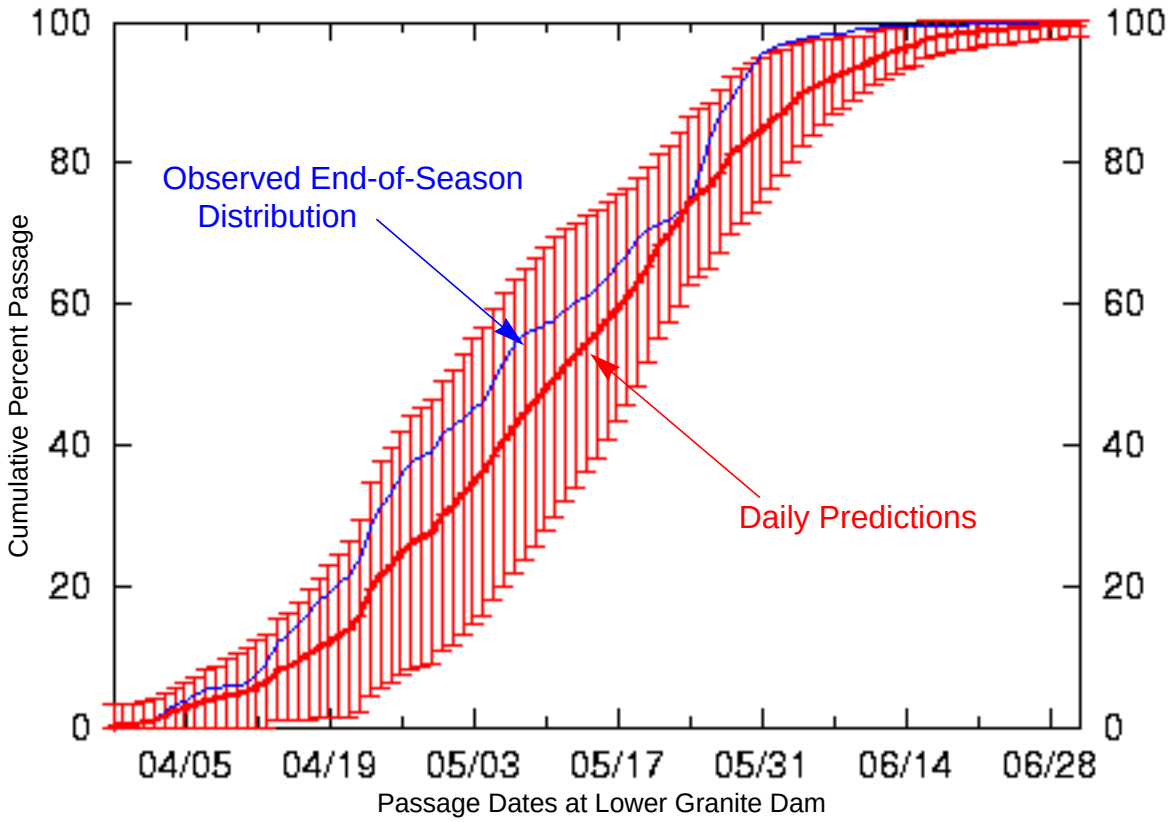
characteristics and detection rates were close to average.

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 23 wild PIT-tagged yearling chinook salmon release-recovery stocks is the RealTime Select composite stock (Figure 3.1, see section 2.1.1 for definition). This year's RealTime Select composite included all

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 23 PIT-tagged spring/summer yearling chinook release-recovery stocks.



23 stocks. The RealTime Select Composite had smaller MADs this year than last, in spite of the some unusually large error observed for a small number of individual-stocks. Table 3.2 displays MADs for the yearling chinook salmon release/recovery stocks tracked at Lower Granite Dam, for the average MADs of all these stocks, and for the RealTime Select Composite stock. The sea

Table 3.2: Mean absolute differences (MADs, section 2.4.3) for the 2002 and 2003 outmigrations to Lower Granite Dam of 23 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	2002			2003		
	Entire Run, %	First 50%, %	Last 50%, %	Entire Run, %	First 50%, %	Last 50%, %
Bear Valley Creek	4.29	5.58	3.80	6.36	6.86	6.14
Big Creek	9.26	6.01	10.37	12.40	9.43	15.37
Camas Creek	---	---	---	3.42	3.20	3.59
Catherine Creek	3.91	5.45	3.37	4.09	3.27	5.06
Chamberlain Creek, West Fk	10.31	7.90	11.28	14.91	9.48	22.41
Elk Creek	13.85	17.97	12.59	14.10	8.43	19.34
Grande Ronde River	3.41	1.17	6.25	7.52	6.23	8.27
Herd Creek	---	---	---	6.09	2.20	8.65
Imnaha River	30.46	19.40	35.46	2.92	4.17	2.23
Johnson Creek	6.35	6.65	6.10	2.86	1.63	4.33
Lake Creek	8.44	8.99	8.28	14.23	21.21	8.89
Lemhi River	7.57	11.69	5.83	39.68	9.42	51.78
Lolo Creek	8.95	5.10	9.95	9.75	12.85	8.26
Lookingglass Creek	7.75	4.09	8.89	4.67	11.27	2.15
Loon Creek	---	---	---	8.04	6.00	10.09
Lostine River	3.04	1.81	3.50	4.49	1.44	6.08
Marsh Creek	8.38	1.48	12.72	7.78	4.94	9.89
Minam River	4.12	5.10	3.28	5.14	3.48	6.00
Salmon River, South Fork	9.25	9.98	8.94	27.70	23.44	32.34
Secesh River	3.23	6.39	2.78	16.89	13.24	18.12
Sulfur Creek	---	---	---	2.49	2.20	2.72
Valley Creek	3.67	2.13	4.74	6.47	2.92	13.15
mean MAD[a]	8.12	6.88	8.77	10.1	7.5	12.1
Select Composite Run[b]	5.36	5.80	5.19	4.37	5.03	3.99

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.

son-wide MAD for the Select Composite was 4.4% in 2003, compared to 5.4% in 2002.

The mean first-half MAD over all 23 spring/summer chinook salmon release/recovery stocks was 7.5%, the mean last-half MAD was 12.1% and the mean season-wide MAD was 10.1%. These statistics are consistent with the 2002 analogs, though slightly larger.

Several stocks that were poorly predicted this year (e.g. Camas Creek, Chamberlain Creek WF, Elk Creek, Lake Creek, Lemhi River, South Fork Salmon River, and Secesh River, stocks which had season-wide MADs of over 10%) had one feature in common, that the detection rate for 2003 was far below the average detection rate, historically (Table 3.3). The South Fork Salmon River stock, for example, had by season's end, a 2.4% detection rate, compared to a historical average over 13 years, of 8.5%. Why so many yearling chinook stocks failed to be detected at normal rates at Lower Granite Dam is unclear.

Index-Count Stocks Monitored at Lower Granite and McNary Dams

Similarly to last year, although the individual release-recovery ESUs of wild Snake River yearling chinook salmon had smaller-than-average rates of detection, the wild PIT-tagged run-at-large of these fish to Lower Granite Dam had a larger rate of detection in 2003 than expected and the observed outmigration distribution was later than predicted (Appendix A). The MADs for this stock were around twice as large as last year. This year's season-wide MAD was 11.1% compared to 5.2% last year. The run-at-large of wild PIT-tagged Snake River yearling chinook salmon monitored at McNary was very well-predicted, though not quite as well as last year’s season-wide MAD of 0.8%, with a MAD of 2.5%.

Table 3.3: 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 2003, 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 2.4). Most stocks showed smaller-than-average recapture percentages (fewer than expected fish) in 2003.

Tagging Location	(1) Observed Detections	(2) Expected No. Detections $\hat{E}(S)$	(3) Observed Recapture Percentage	(4) Average Historical %, $\bar{r}$
Bear Valley Creek	83.4	122.58	8.2	12.0
Big Creek	205.8	209.07	11.9	12.1
Camas Creek	58.7	108.74	6.0	11.1
Catherine Creek	52.2	66.52	9.3	11.8
Chamberlain Creek, West Fork	217.5	304.59	8.7	12.2
Clear Creek	33.1	60.88	4.3	8.0
Elk Creek	55.5	131.34	5.7	13.5
Grande Ronde River	77.9	63.01	16.8	13.6
Herd Creek	75.8	96.35	9.5	12.1
Imnaha River	87.5	116.90	8.7	11.7
Johnson Creek	118.6	143.08	11.4	13.7
Lake Creek	23.4	74.51	3.3	10.5
Lemhi River	24.8	101.65	3.5	14.5
Lolo Creek	122.1	310.95	6.1	15.5
Lookingglass Creek	149.3	89.80	21.1	12.7
Loon Creek	129.4	112.80	15.6	13.6
Lostine River	224.7	270.31	12.7	15.3
Marsh Creek	103.9	95.90	10.4	9.6
Minam River	159.2	228.68	10.0	14.3
Salmon River, South Fork	24.4	88.11	2.4	8.5
Secesh River	31.7	123.14	3.0	11.8
Sulfur Creek	50.4	53.73	9.0	9.6
Valley Creek	104.2	146.63	4.6	6.5

Table 3.4: Mean absolute deviations (MADs) for the 2002 and 2003 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	2002			2003		
	Entire Run	First 50%	Last 50%	Entire Run	First 50%	Last 50%
All Wild PIT-tagged Yearling Chinook Salmon Detected:						
at Lower Granite Dam	5.20	4.49	5.46	11.14	10.49	11.32
at McNary Dam	0.80	3.79	0.36	2.49	3.69	2.16

3.1.3 PIT-tagged Sockeye Salmon

Predictions for the wild PIT-tagged run-at-large of Snake River sockeye salmon smolts (an index stock) forecasted to McNary Dam were not as good as last year. The season-wide MAD was 9.6% compared to 5.6% last year (Table 3.5). A possible explanation is that there were record detections at McNary Dam this year (615, Table 3.6). See the discussion section for a more complete explanation.

Table 3.5: Mean absolute deviations (MADs) for the 2002 and 2003 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.

Stock	2002			2003		
	Entire Run	First 50%	Last 50%	Entire Run	First 50%	Last 50%
All Wild PIT-tagged Sockeye Salmon Detected at McNary Dam	5.63	3.91	7.29	9.56	9.52	9.57

Table 3.6: Comparison of expected number of detections or passage indices and the observed numbers for all index-count stocks monitored by Program RealTime in 2003.

Rearing/ Type of Data	Salmon Stock	Detection Facility	Expected 2002 Counts	Observed 2002 Counts
Wild/ PIT-tag	Spring/Summer Yearling Chinook	Lower Granite Dam	10367	20782
	Steelhead		6875	10466
	Snake River Subyearling Chinook	McNary Dam	214	688
	Columbia River Subyearling Chinook		1605	1354
	Snake River Yearling Chinook		8004	24878
	Snake River Sockeye		236	615
	Snake River Steelhead		2685	6367
	Columbia River Steelhead		1292	29860
	Snake, Columbia River Steelhead		3891	36227
Combined Wild and Hatchery/ FPC Passage Indices	Subyearling Chinook	Rock Island Dam	17266	25916
	Yearling Chinook		27459	15355
	Coho		42864	41690
	Sockeye		14571	10312
	Steelhead		20551	15507
	Subyearling Chinook	McNary Dam	7881520	7494364
	Yearling Chinook		2304134	1624087
	Coho Salmon		294543	113584
	Sockeye		703596	841734
	Steelhead		713190	245583
	Subyearling Chinook	John Day Dam	1760915	2679137
	Yearling Chinook		1017368	2074457
	Coho Salmon		345668	258239
	Sockeye		322760	725830
	Steelhead		797335	553495

3.1.4 PIT-tagged Steelhead Trout

The run-timing of wild PIT-tagged Snake River steelhead, detected at Lower Granite Dam, was predicted too early and the errors were fairly large on average (season-wide MAD was 16.2%, Table 3.7) and considerably up from 2002 (MAD=6.8%). There were more than expected detections this year although this number was similar to last year (between 10,000 and 10,500 smolts detected).

The stock of Snake River wild PIT-tagged steelhead forecast at McNary Dam were not well-predicted this year, there was a very large first-half MAD (26.4%), resulting in a season-wide MAD of 13.9%, compared to 4.6% in 2002 (Table 3.7). The detections for this stock, while down from last year, were greater than expected. There was considerable error in RealTime predictions which were too early most of the season.

Table 3.7: Mean absolute deviations (MADs) for the 2002 and 2003 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.

	2002			2003		
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	6.79	9.83	5.72	16.16	12.55	17.93
All Wild PIT-tagged Snake River Steelhead Detected at McNary Dam	4.64	8.95	3.82	13.98	26.41	9.68
All Wild PIT-tagged Upper Columbia River Steelhead Detected at McNary Dam	10.55	14.03	9.79	5.51	14.66	1.62
All Wild PIT-tagged Steelhead Detected at McNary Dam	4.33	8.22	3.57	11.94	18.03	9.78

The PIT-tagged run-at-large of Upper Columbia wild steelhead was predicted fairly well, with about half the size of season-wide MAD this year (5.5%) as last (10.6%) although the first-half

MAD was quite large (14.7%), similar to last year. This stock saw a big jump in detections (36,229) compared to the historical average (3891). It was predicted too early during the first half of the season but was very well-predicted the last half (1.6%)

3.2 Hatchery-reared ESUs

The only hatchery-reared PIT-tagged stocks monitored by Program RealTime have been summer-run sockeye reared and released in the Redfish Lake area (Figure 2.1). In 2001 and in 2002, the stock was a composite of smolts released into Alturas Lake Creek, Redfish Lake Creek Trap and Sawtooth Trap. This year, as in 1998-2000, two stocks were tracked, one from Alturas Lake and the other from Redfish Lake. The Alturas Lake stock was predicted with nearly unprecedented inaccuracy (season-wide MAD = 77.2%, Table 3.8) in the RealTime Project. The reason is probably related to the fact that only 4 fish (spill-adjusted, 10) were detected at Lower Granite Dam in 2003. With 1481 fish released and PIT-tagged, this number was much smaller than the expected (spill-adjusted) 322.

Table 3.8: Mean absolute deviations (MADs, section 2.4.3) for the 2003 outmigration to Lower Granite Dam of the PIT-tagged hatchery-reared stocks from Alturas Lake and Redfish Lake. Columns show MADs for the entire run, the first 50% of the run, and the last 50% of the run.

	2003		
Stock	Entire Run	First 50%	Last 50%
Alturas Lake	77.21	26.18	86.09
Redfish Lake	5.69	3.68	6.04

3.3 Combined Wild and Hatchery Runs-At-Large

The runs of yearling chinook, sockeye, and coho salmon and steelhead trout forecasted to Rock Island Dam were extremely well-predicted in 2003, all to within 3% of the year-end distribution on average, season-wide, results in keeping with last year. Similarly to last year the subyearling chinook salmon run had the largest MAD, this year MAD (7.1%) season-wide was larger than last year (MAD = 5.7% in 2002). At McNary Dam steelhead were not predicted as well as last year (season-wide MAD was 6.9% compared to 2.8% in 2002. But the other four runs, yearling and subyearling chinook salmon, and sockeye and coho salmon were predicted extremely accurately (MADs were less than 2% for chinook and sockeye salmon runs. RealTime performance at John Day Dam was very close to last year, with subyearling chinook salmon not predicted quite as well as the other runs. All five runs were, on average, predicted to within 4% of the true distribution, season-wide.

Table 3.9: Mean absolute deviances (MADs, section 2.4.3) for the 2002 and 2003 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	2002			2003			Forecast to
	Entire Run	First 50%	Last 50%	Entire Run	First 50%	Last 50%	
Subyearling Chinook Salmon	5.71	8.67	3.70	7.13	11.61	4.63	Rock Island Dam
Yearling Chinook Salmon	1.30	1.96	1.06	2.54	5.01	1.81	
Coho Salmon	2.13	4.77	1.10	1.19	1.16	1.20	
Sockeye Salmon	4.99	6.51	4.55	2.86	1.82	3.17	
Steelhead	2.76	4.12	2.14	1.97	1.50	2.21	
Subyearling Chinook Salmon	1.66	1.14	1.75	1.89	1.41	2.02	McNary Dam
Yearling Chinook Salmon	1.8	5.27	1.1	1.54	2.36	1.29	
Coho Salmon	1.40	1.79	1.15	3.40	3.10	3.57	
Sockeye Salmon	1.31	4.37	0.77	1.39	2.76	1.02	
Steelhead	2.83	9.96	1.25	6.90	7.70	6.44	
Subyearling Chinook Salmon	6.47	8.66	5.79	3.90	9.80	2.29	John Day Dam
Yearling Chinook Salmon	2.80	4.53	1.95	3.18	5.52	2.23	
Coho Salmon	3.34	4.99	2.05	2.04	1.26	2.50	
Sockeye Salmon	3.03	6.09	1.80	3.38	3.70	3.24	
Steelhead	3.67	2.72	4.21	2.56	3.47	2.09	

4.0 Discussion

Program RealTime 2003 performance in predicting run-timing of 15 FPC passage-indexed stocks and 35 PIT-tagged stocks was consistent with previous years. As previous experience has shown, the larger stocks, consisting of thousands or hundreds of thousands of smolts are generally easier to predict run-timing behavior than runs of stocks with few fish and from highly specific geographical origins. This was observed again this year, with runs-at-large of combined hatchery and wild fish of five salmonid species migrating to Rock Island, McNary, and John Day Dams having very good run-timing predictions, with a mean season-wide MAD, over all 15 stocks, of 3.1%. The smaller runs-at-large and the even smaller individual release/recovery stocks of PIT-tagged wild fish were predicted with more variable results, as expected. Run-timing of wild PIT-tagged Snake River steelhead tracked at Lower Granite Dam and McNary Dam was predicted too early and the errors were fairly large (>10% MADs). Other wild PIT-tagged runs were predicted well over-all, both to Lower Granite Dam and to McNary Dam. Individual release/recovery stocks of wild yearling chinook salmon from the Snake River drainage were predicted well in terms of summary statistics and prediction of composite stocks, though a few stocks were predicted poorly. A pattern of small detection rates compared to historically was observed for all the release/recovery stocks, and those worst predicted had the smallest detection rates relative to expected. In addition, as we saw last year, detections for the wild run-at-large of PIT-tagged Snake River yearling chinook salmon were up at Lower Granite this year, even while fewer fish were detected from the individual stocks monitored, which exist at some distance upriver from the dam.

In general, poor RealTime predictions during any migration year 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, section 2.4.1) will be adversely affected. Secondly if the run-timing of the outmigration is unusual, the accuracy of the mid-season predictions (LS or pattern-matching model predictions, sections 2.4.1) will be affected. These sorts of anomalies fall in two categories, either unusually long or short migrations (often best measured by the middle 80% period of passage) or unexpected surges or lulls occurring at any time. Last year the majority of the poorer predictions were traceable to unusual middle 80% passage, either unusually short (wild subyearling chinook) or unusually long (wild steelhead

trout). This year, passage characteristics were generally close to historical average. The errors of prediction in 2003 were generally due to smaller-than-expected detection rates.

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 2003.

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. On average, season-wide, 13 of 15 stocks were predicted to within 4% of the true end-of-season distribution, nine were predicted to within 3% and five were prediction to with 2% of the true distribution.

Realtime predictive performance for the 33 PIT-tagged ESUs of wild salmon and steelhead trout monitored by Program RealTime in 2003 to Lower Granite and McNary dams was mixed but consistent with previous years. The quality of predictions for the wild PIT-tagged runs-at-large of subyearling and yearling chinook salmon to Lower Granite and McNary Dams warrants no special remarks except to note that detection rates were generally up in 2003, for Snake River yearling chinook and sockeye salmon, and for Upper Columbia steelhead especially.

Finally, even while the 2003 outmigration saw many more fish coming down the Snake River overall, detection rates for individual release/recovery stocks, located far upriver from the dams, were generally down, and in some cases achieving record lows, resulting in suboptimal conditions for good RealTime predictions.

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Appendix A

Performance Plots for the 2003 Outmigration Season

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

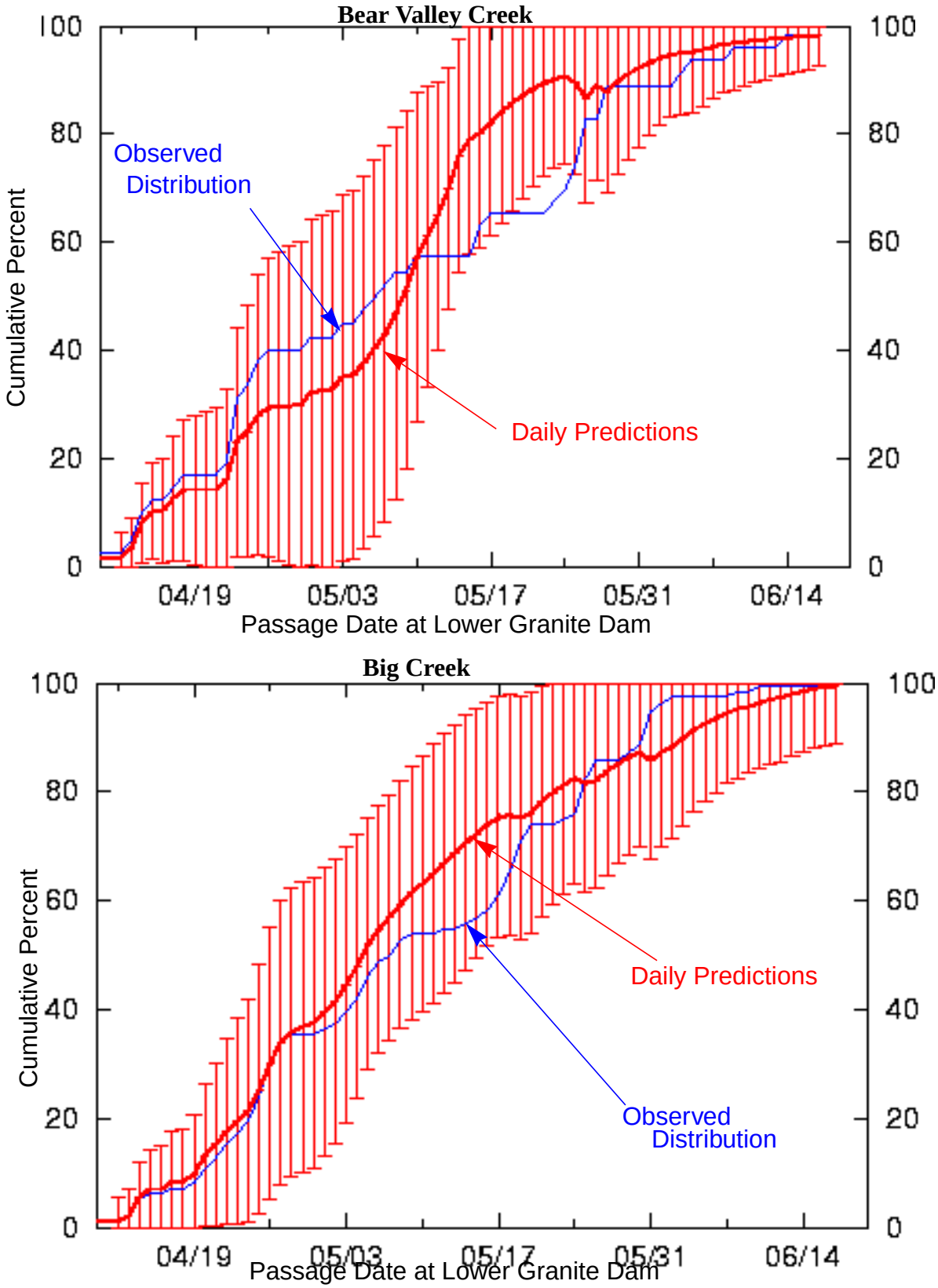


Figure A2: Daily predictions of the PIT-tagged spring chinook from Camas Creek and Cape Horn Creek.

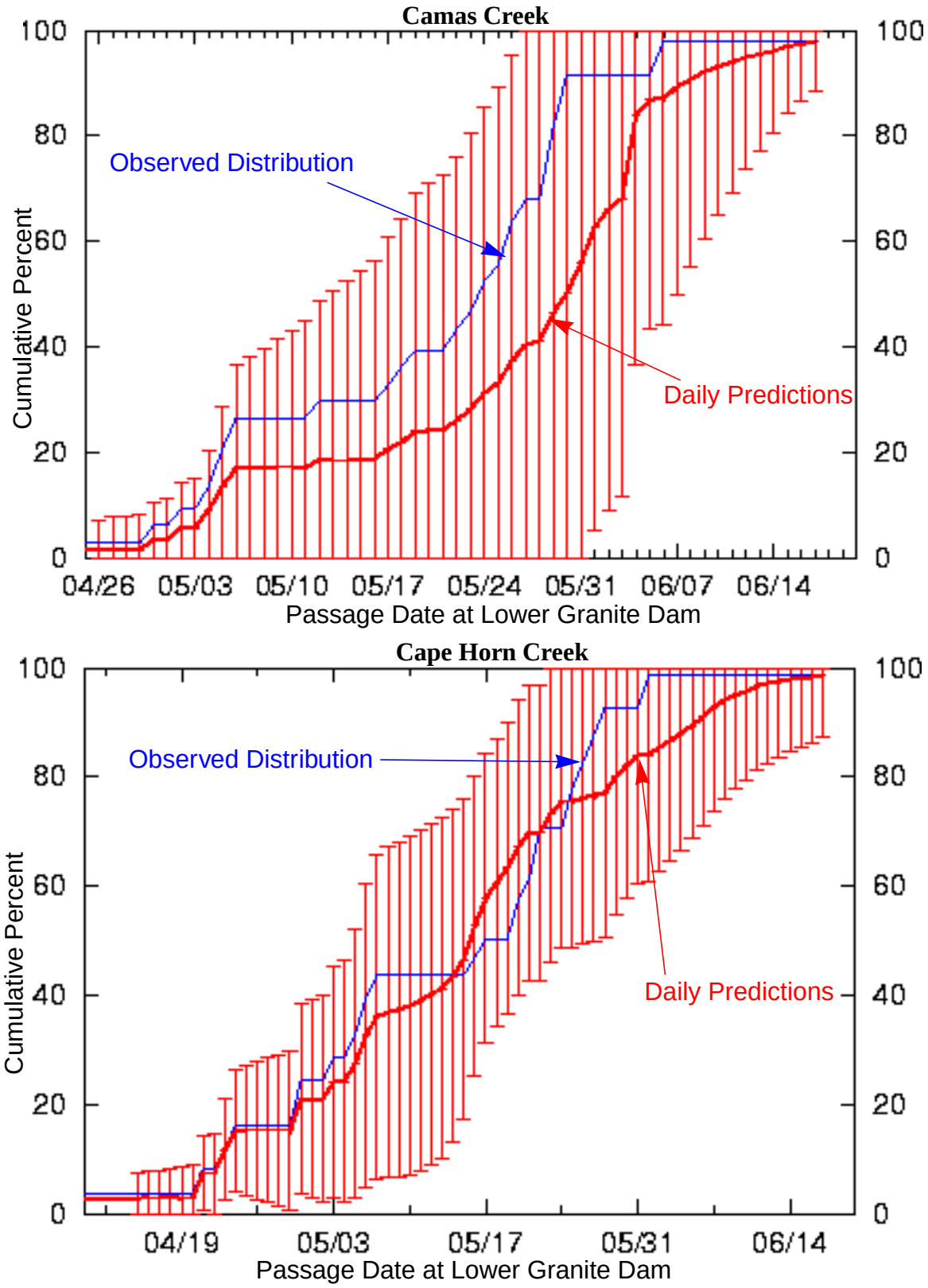


Figure A3: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from Catherine Creek and West Fork Chamberlain Creek.

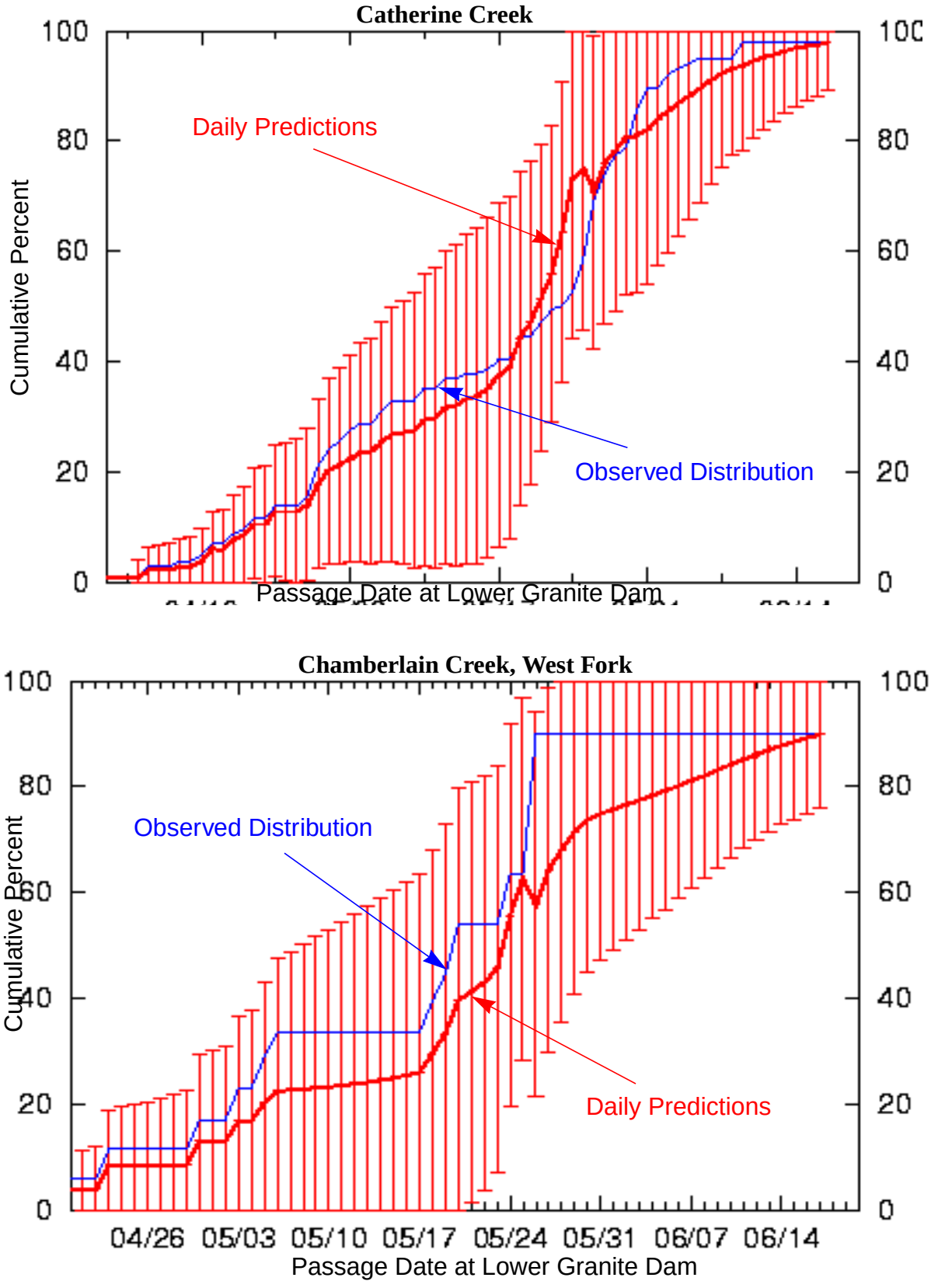


Figure A4: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from Clear Creek and Elk Creek.

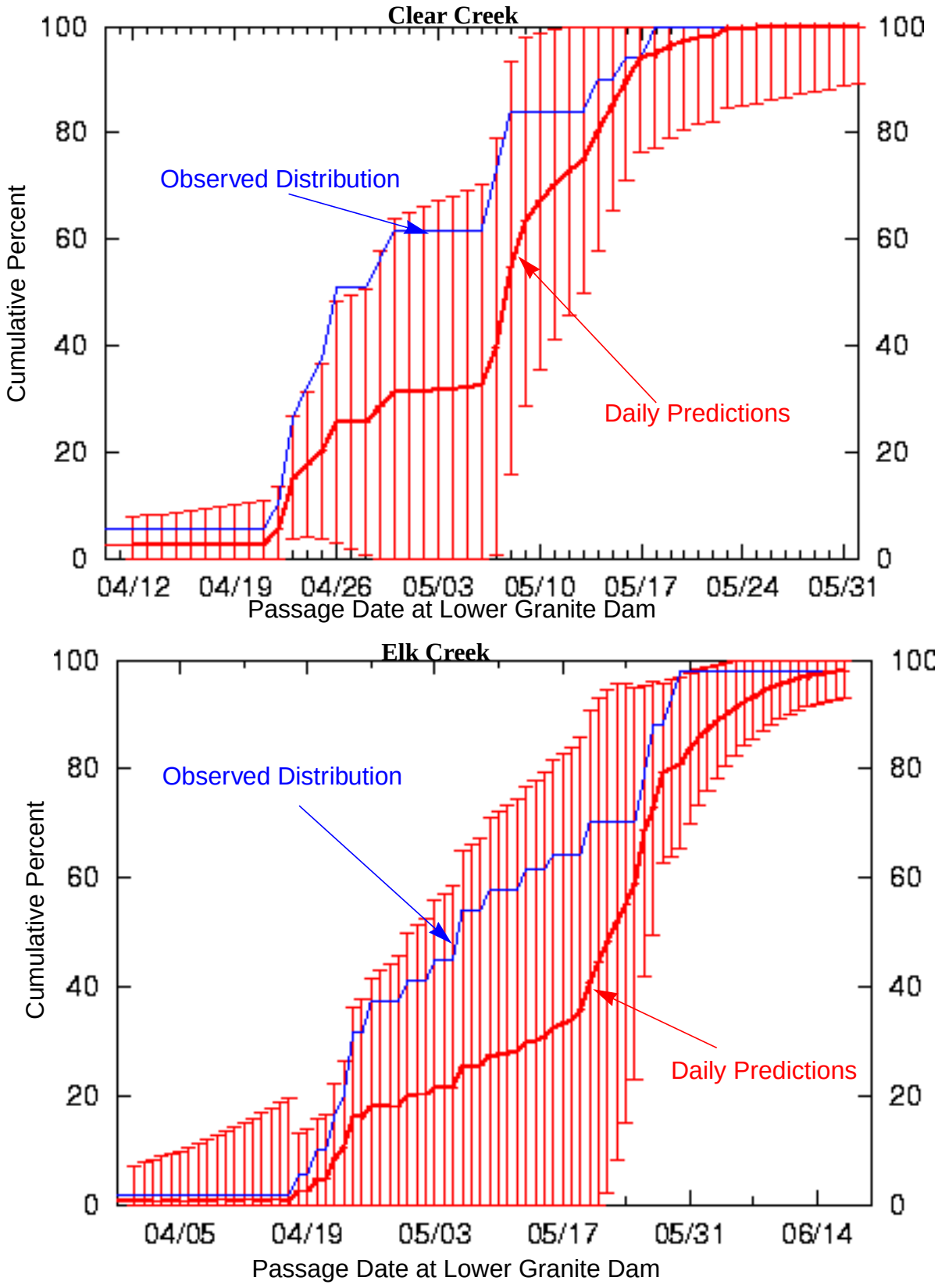


Figure A5: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from Grande Ronde River and Herd Creek.

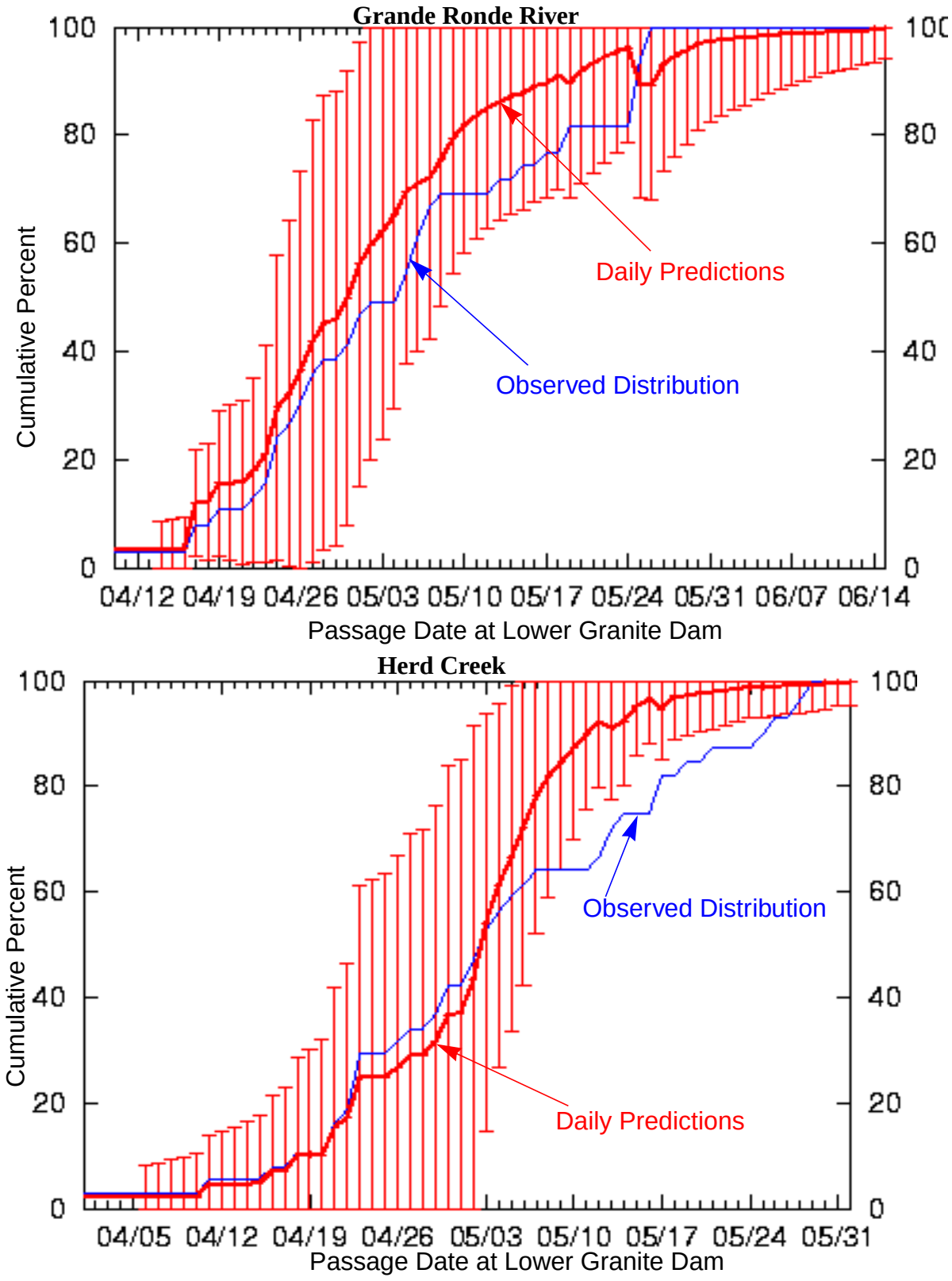


Figure A6: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from Imnaha River and Johnson Creek.

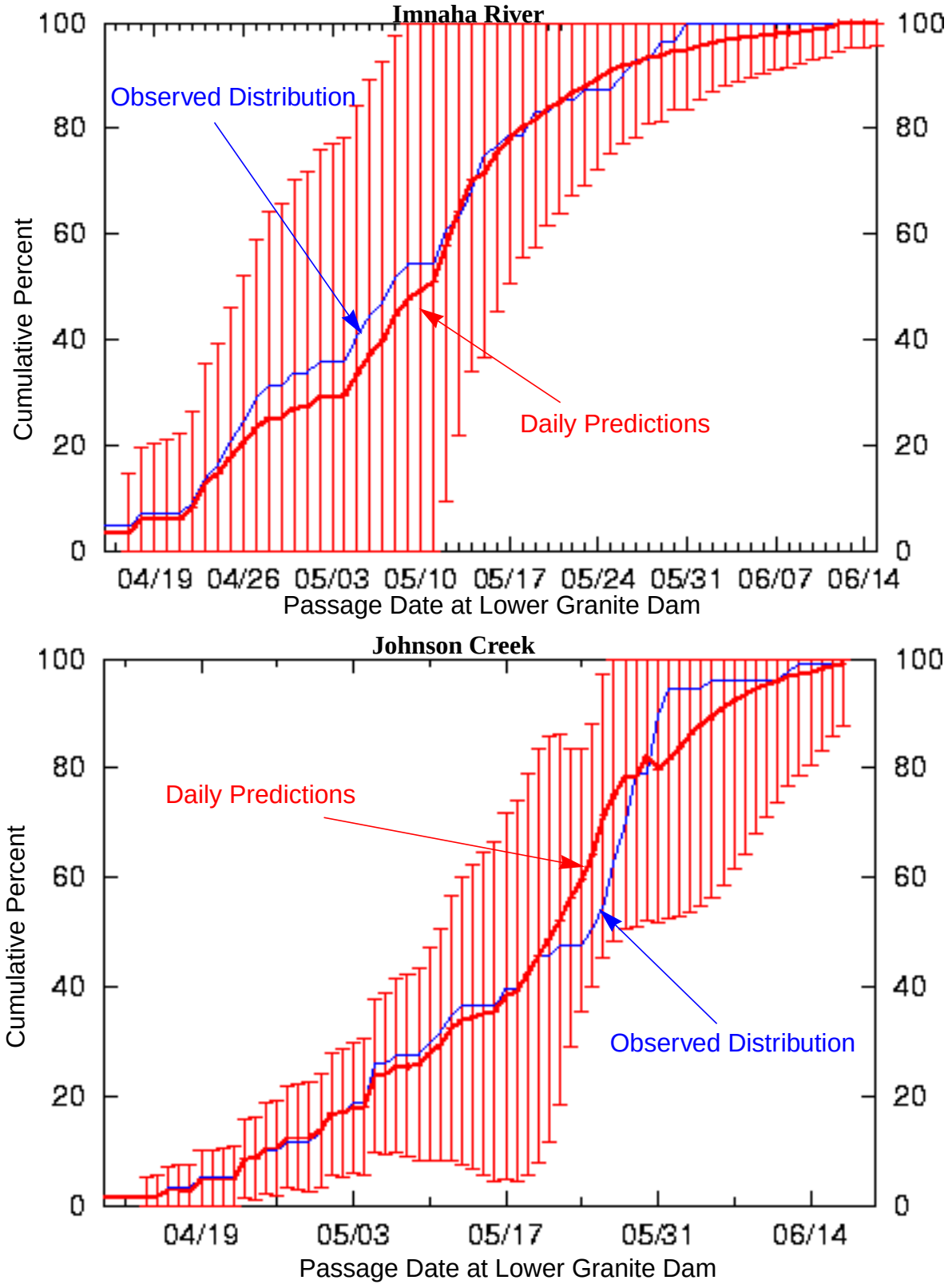


Figure A7: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from Lake Creek and Lemhi River.

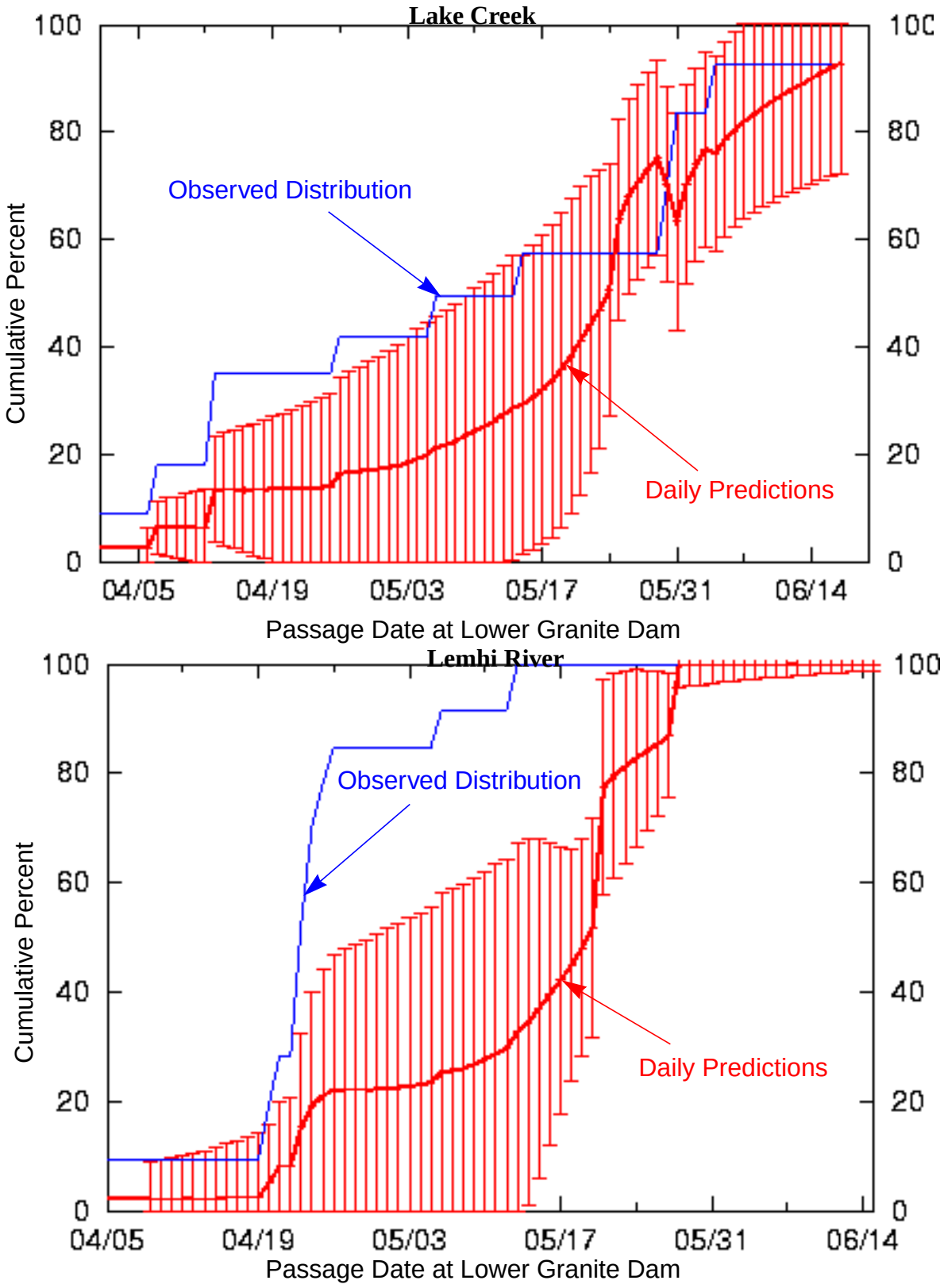


Figure A8: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from Lolo Creek and Lookingglass Creek.

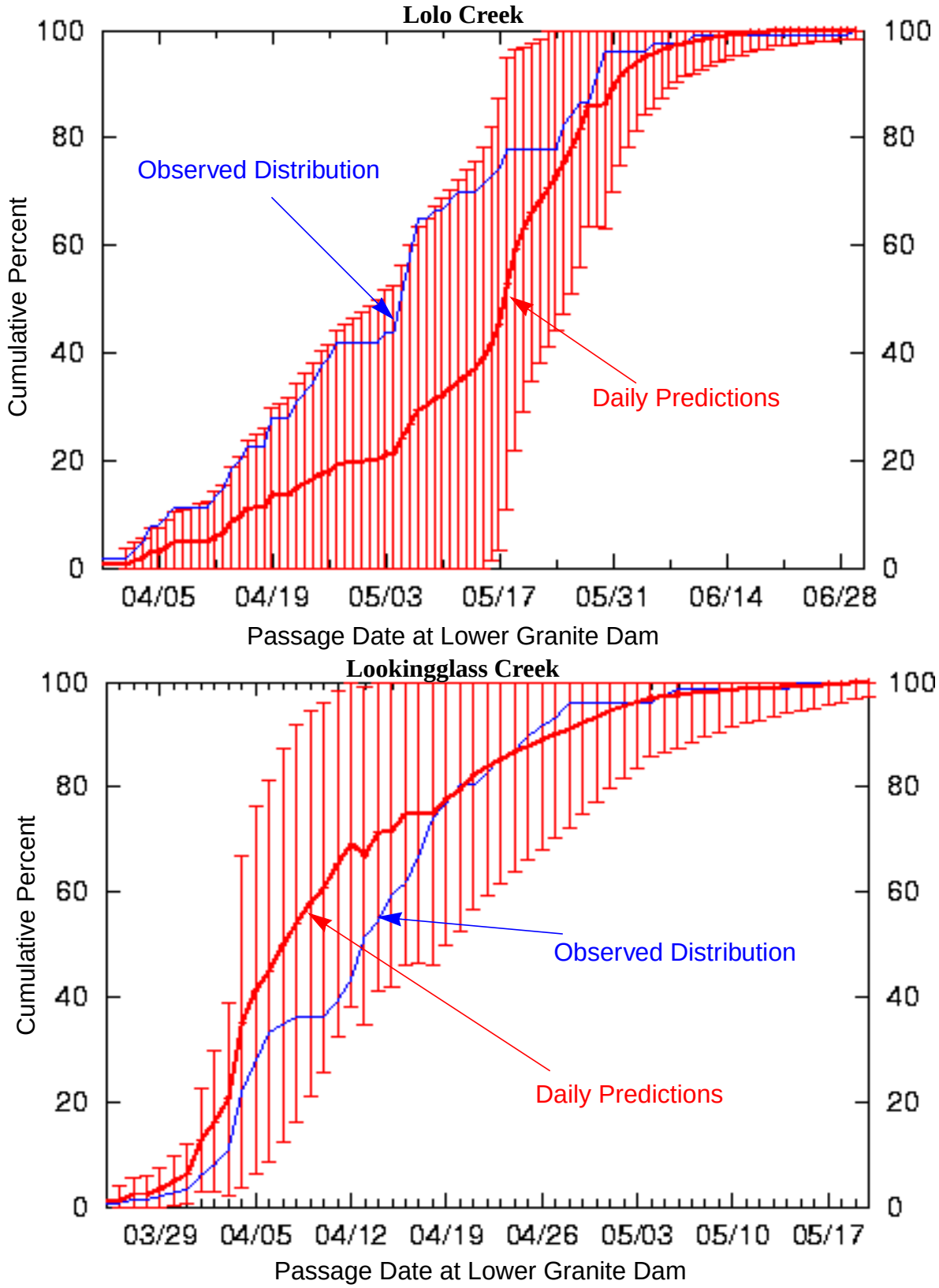


Figure A9: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from Loon Creek and Lostine River.

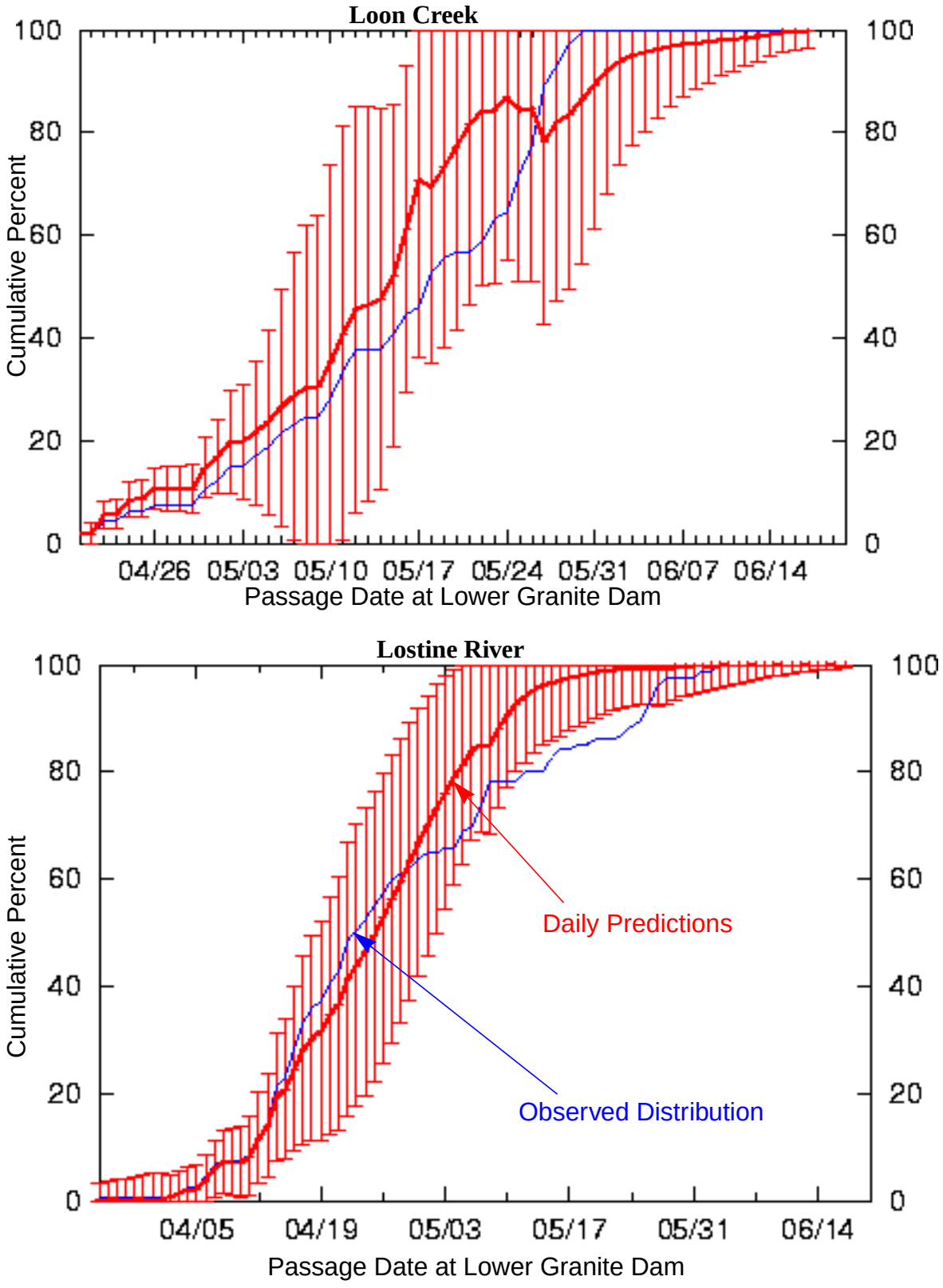


Figure A10: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from Marsh Creek and Minam River.

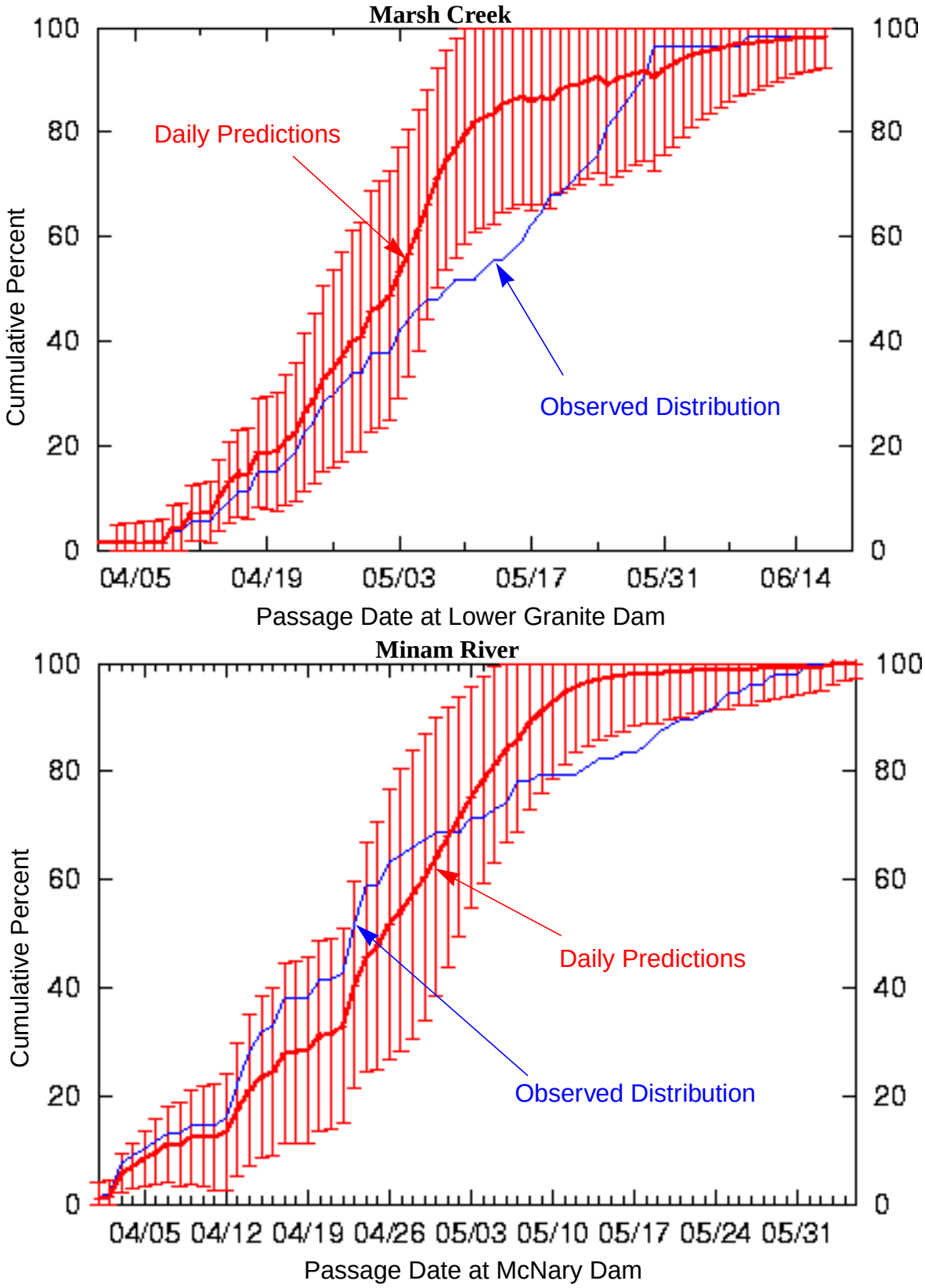


Figure A11: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from South Fork Salmon River and Secesh River.

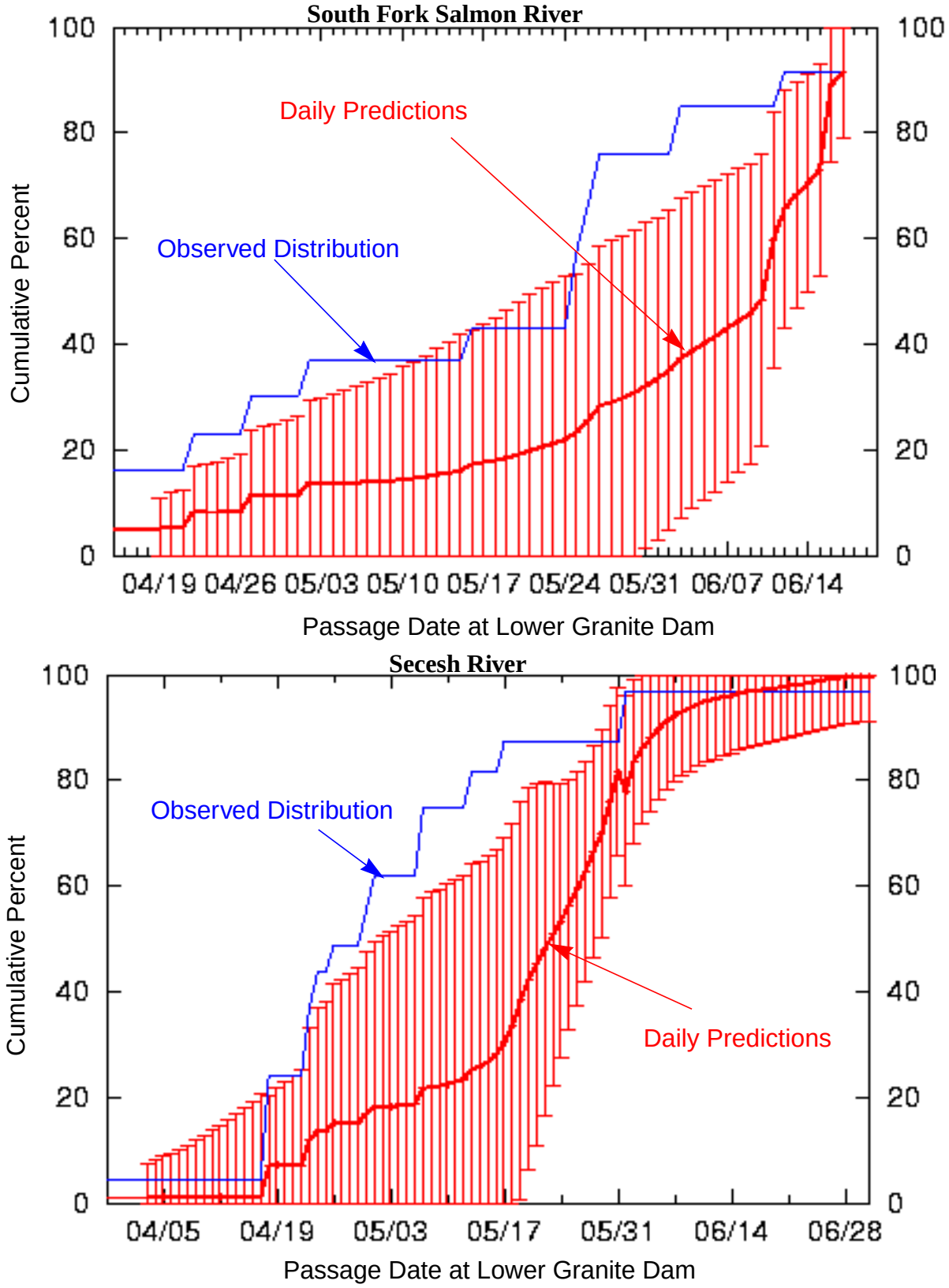


Figure A12: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from Sulfur Creek and Valley Creek.

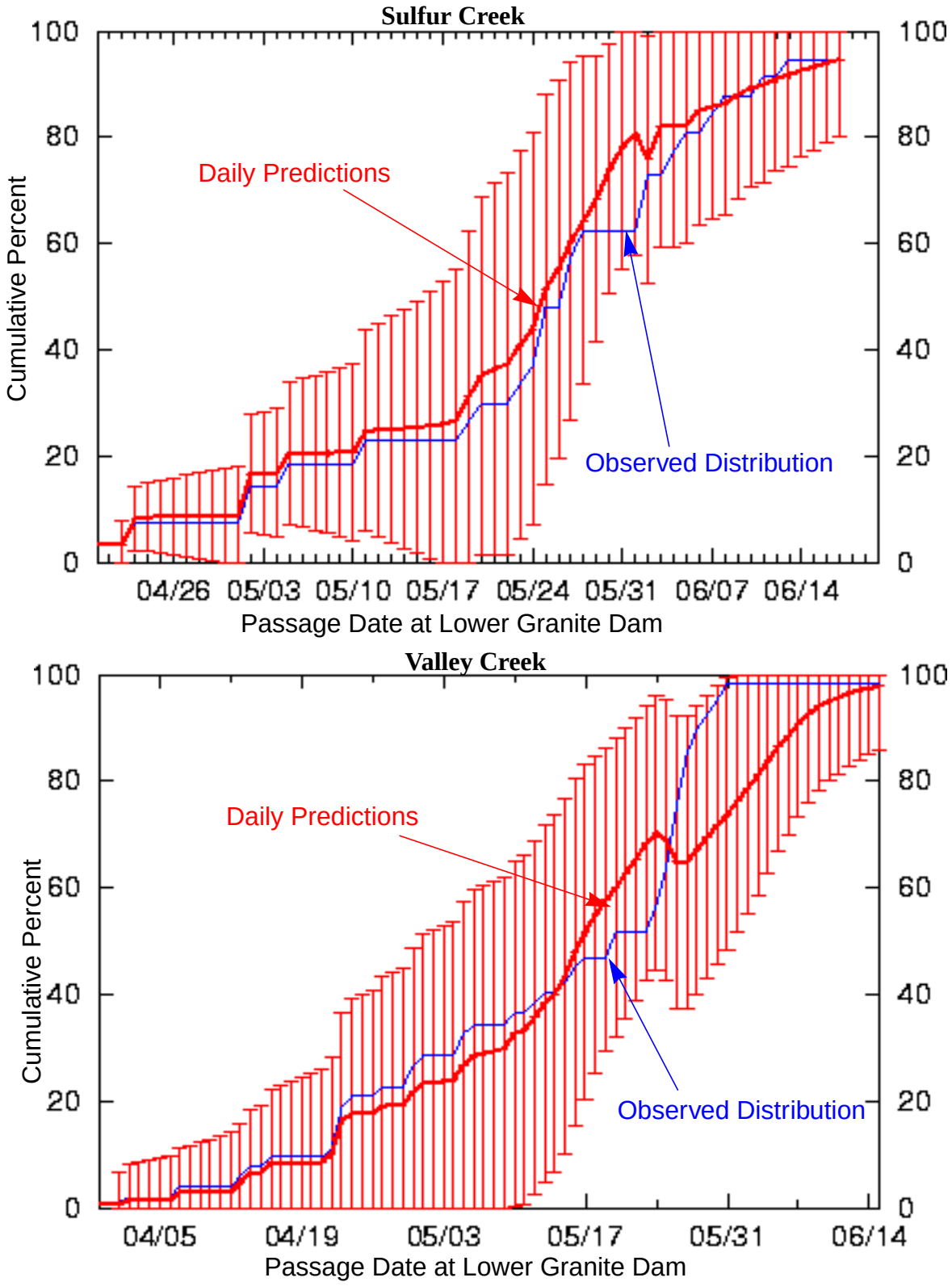
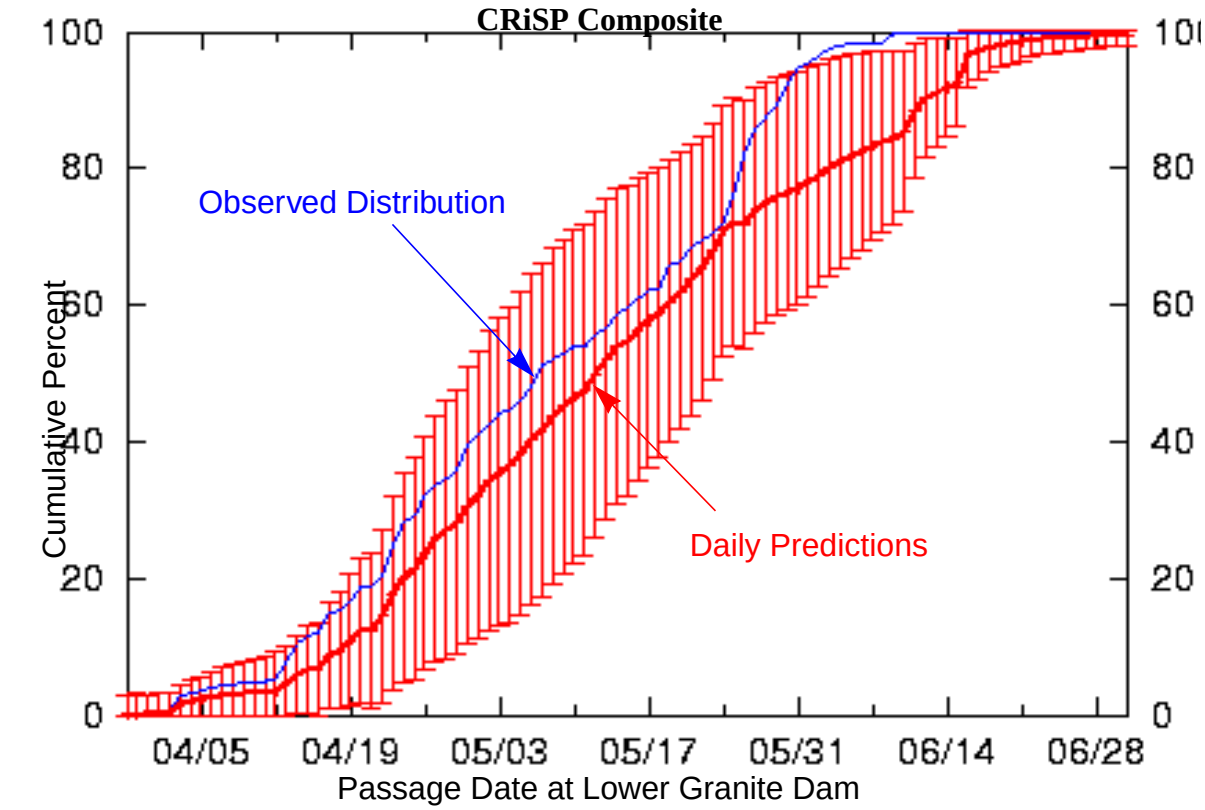


Figure A13: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from streams composing the CRiSP Composite.



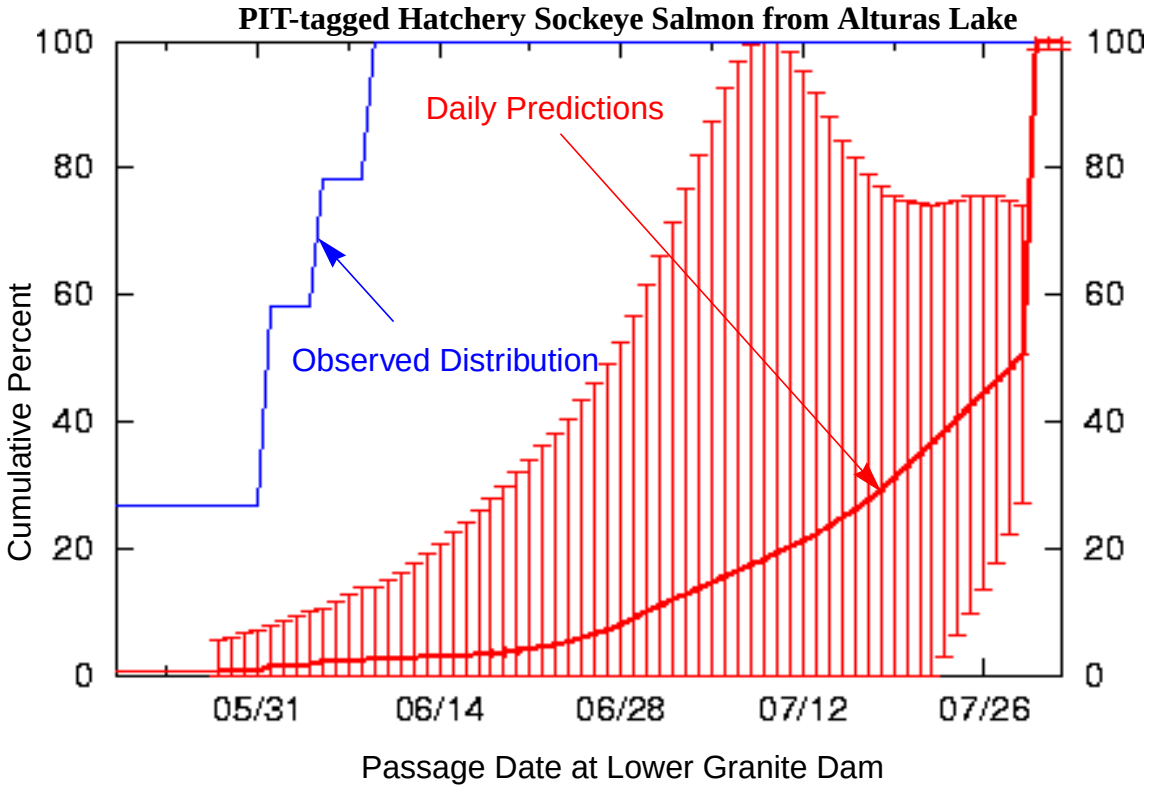


Figure A14: Daily Predictions of run-timing of hatchery-reared PIT-tagged sockeye salmon from Redfish Lake, wild PIT-tagged steelhead from the Snake River drainage.

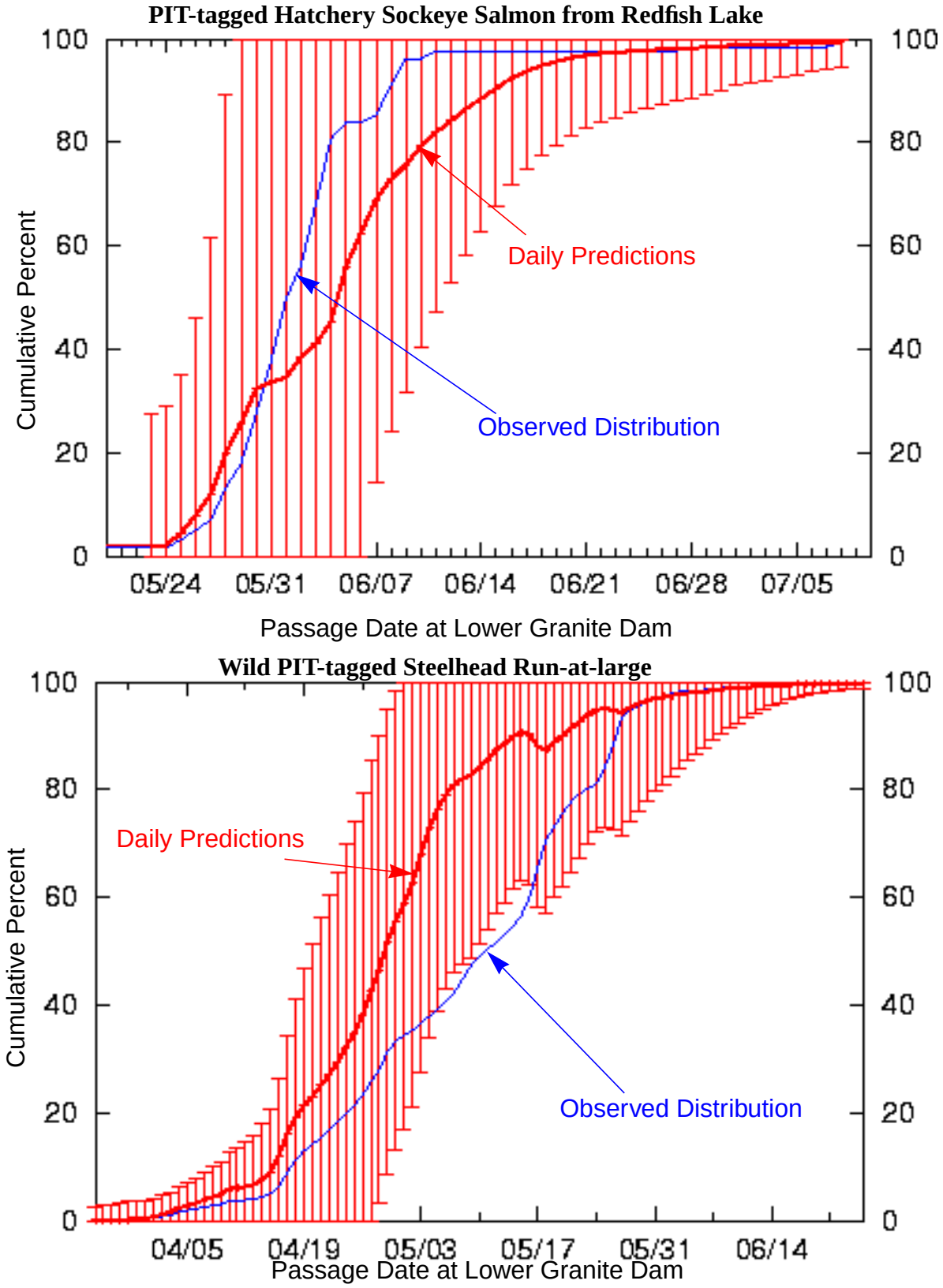
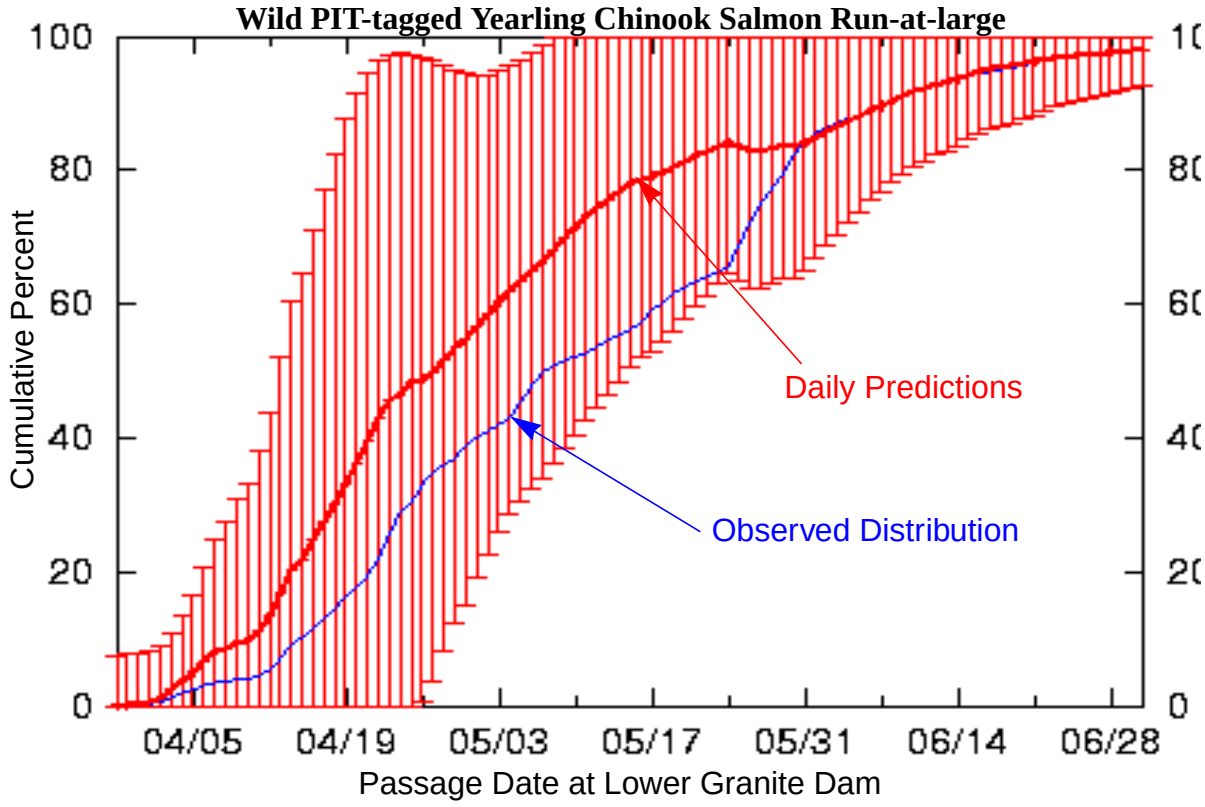


Figure A15: Daily predictions of run-timing of wild PIT-tagged yearling chinook salmon from the Snake River drainage and subyearling chinook salmon from the Snake River.



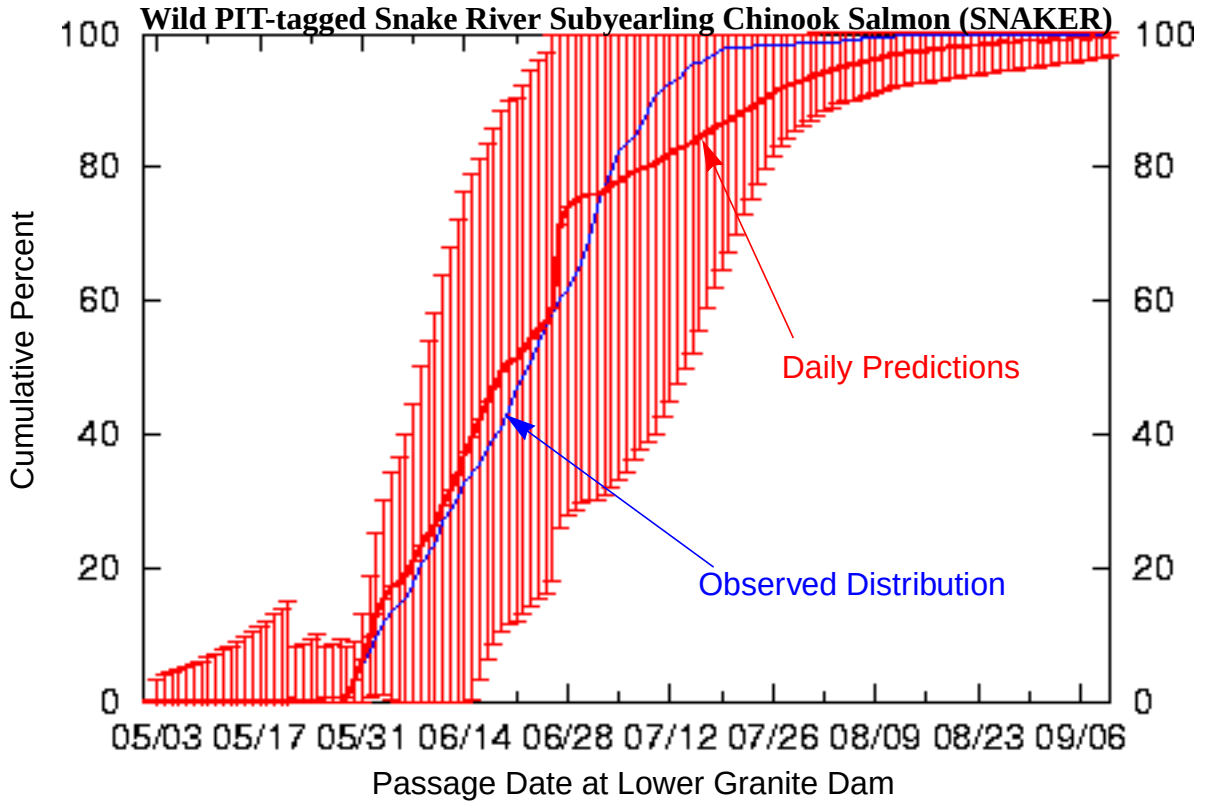


Figure A16: Daily predictions of the run-timing of wild PIT-tagged runs-at-large of Snake River and Upper Columbia subyearling chinook salmon at McNary Dam.

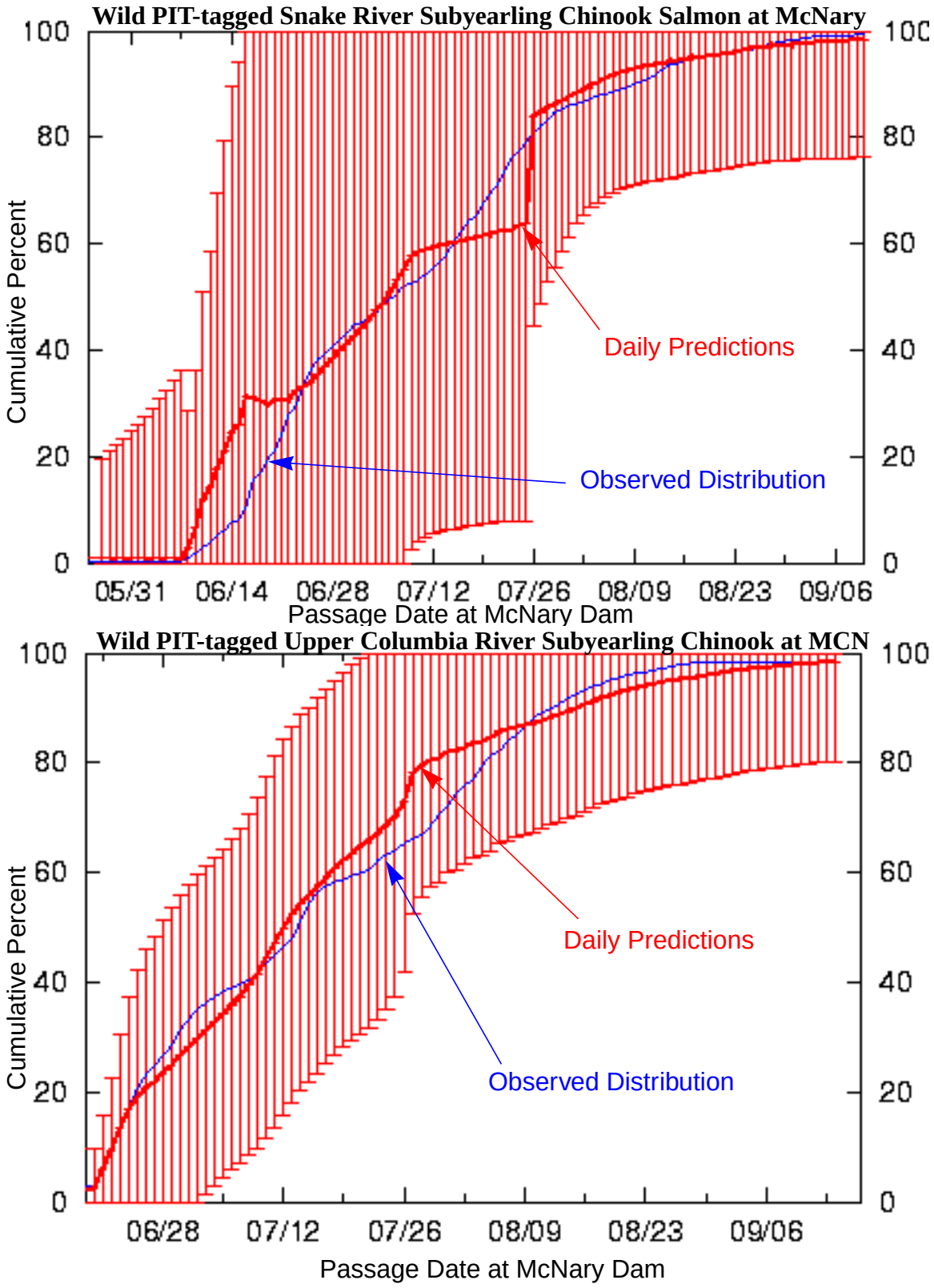


Figure A17: Daily predictions of the run-timing of wild PIT-tagged runs-at-large of Snake River yearling chinook salmon and steelhead trout at McNary Dam.

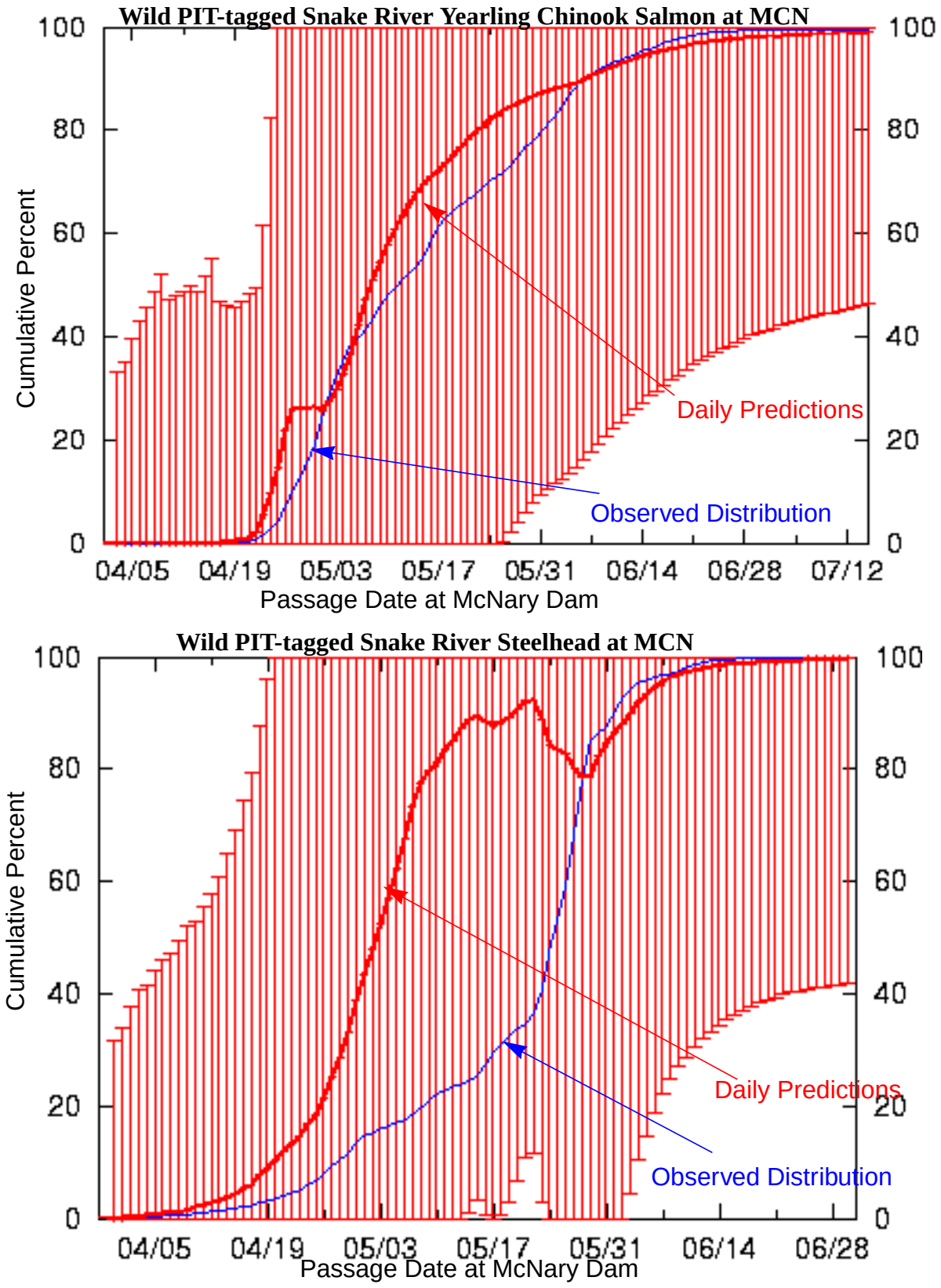
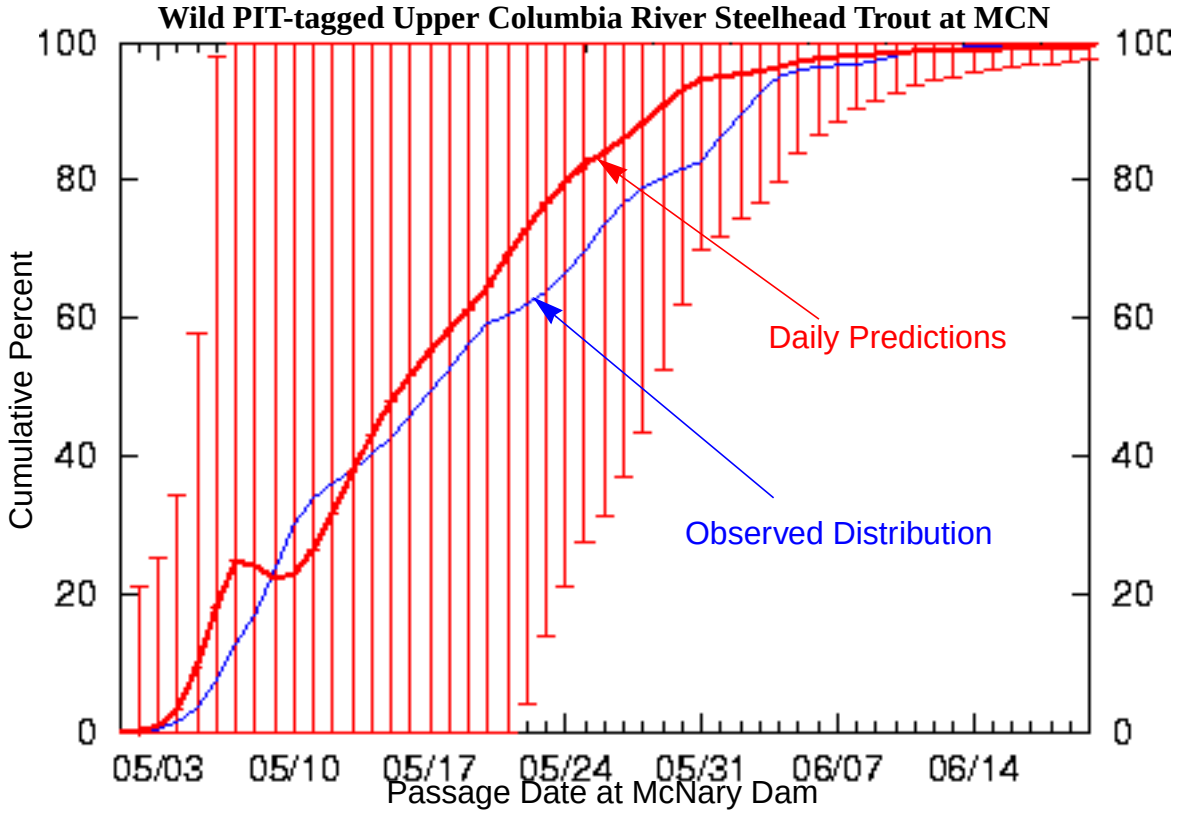


Figure A18: Daily predictions of the run-timing of wild PIT-tagged runs-at-large of Upper Columbia River steelhead trout and Snake River sockeye salmon at McNary Dam.



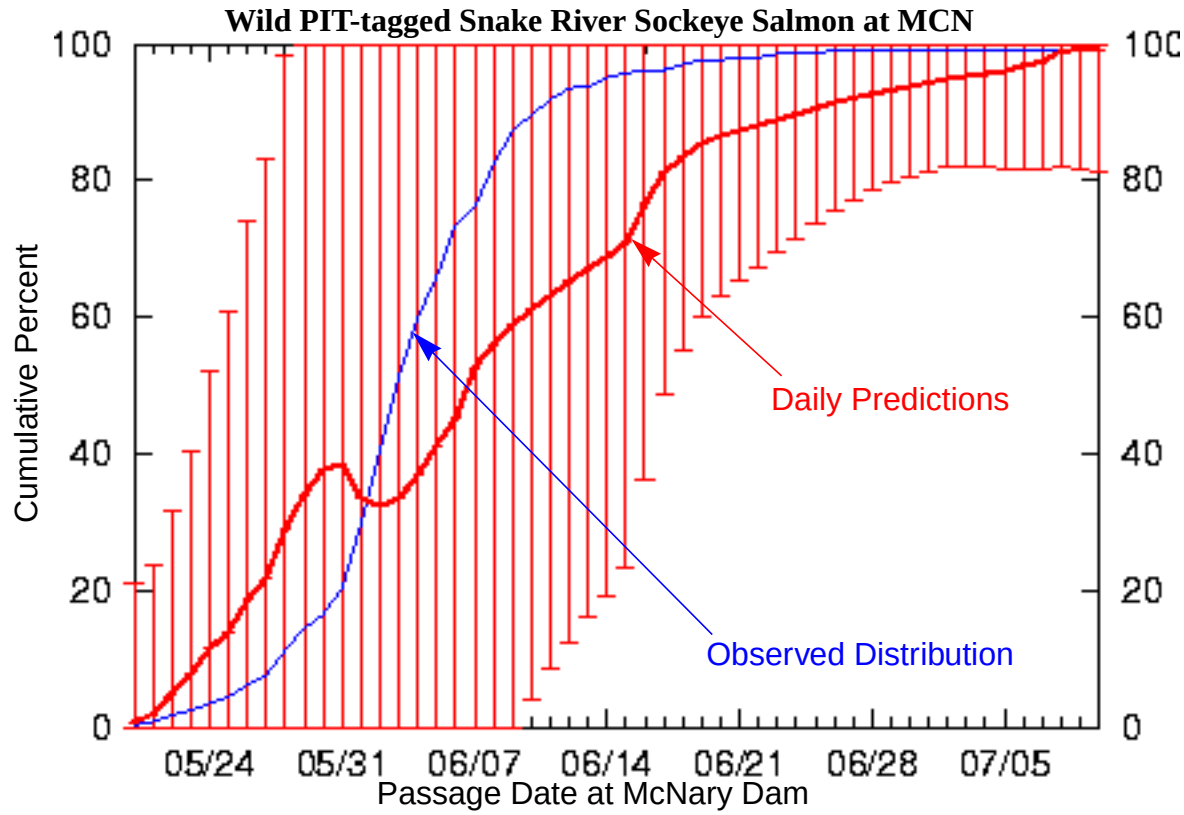
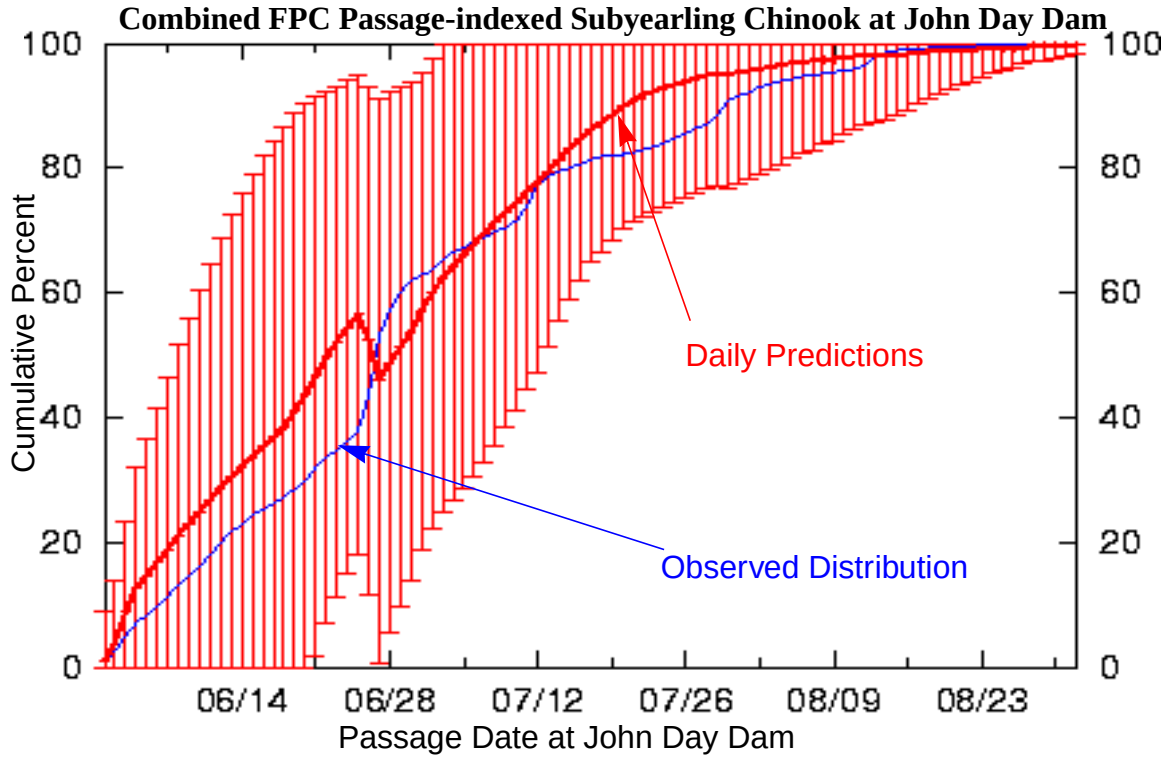


Figure A19: Daily predictions of the run-timing of FPC passage-indexed combined wild and hatchery runs-at-large of subyearling chinook salmon at John Day and McNary Dam.



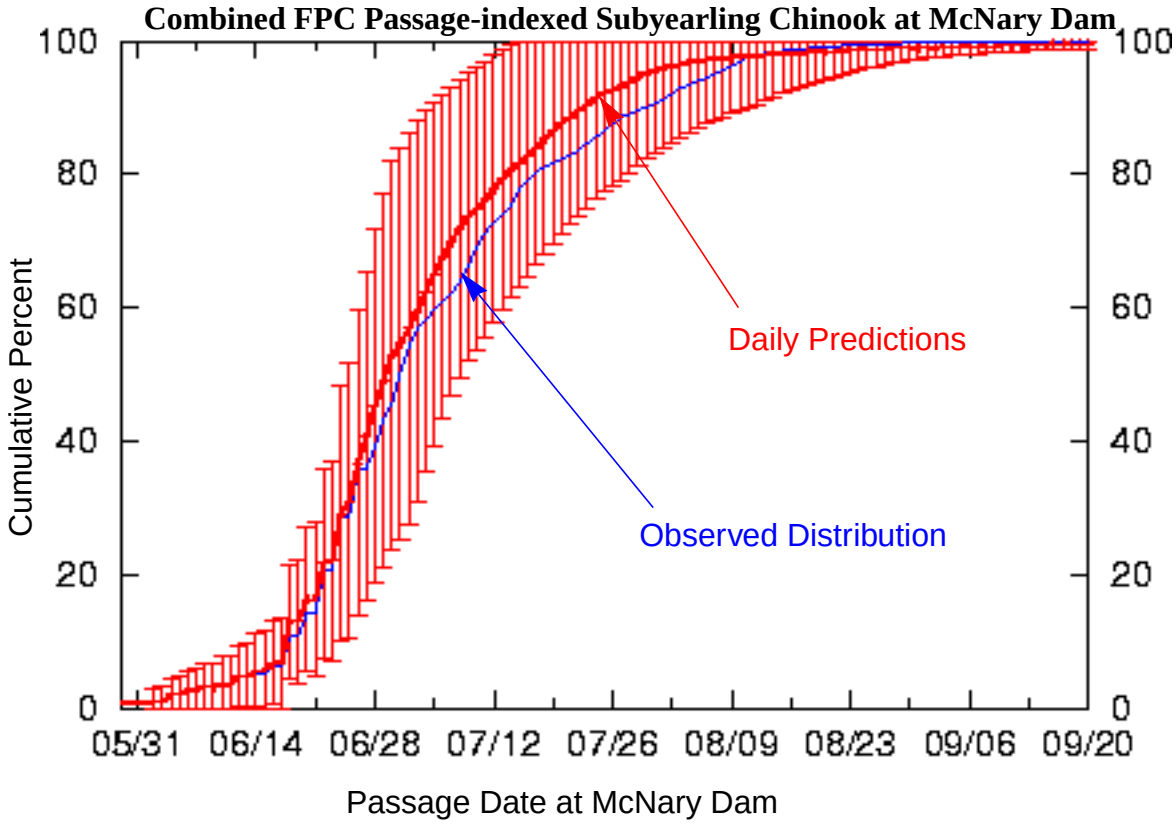


Figure A20: Daily predictions of the run-timing of the FPC passage-indexed combined wild and hatchery run-at-large of subyearling chinook salmon at Rock Island Dam and of yearling chinook salmon at John Day Dam.

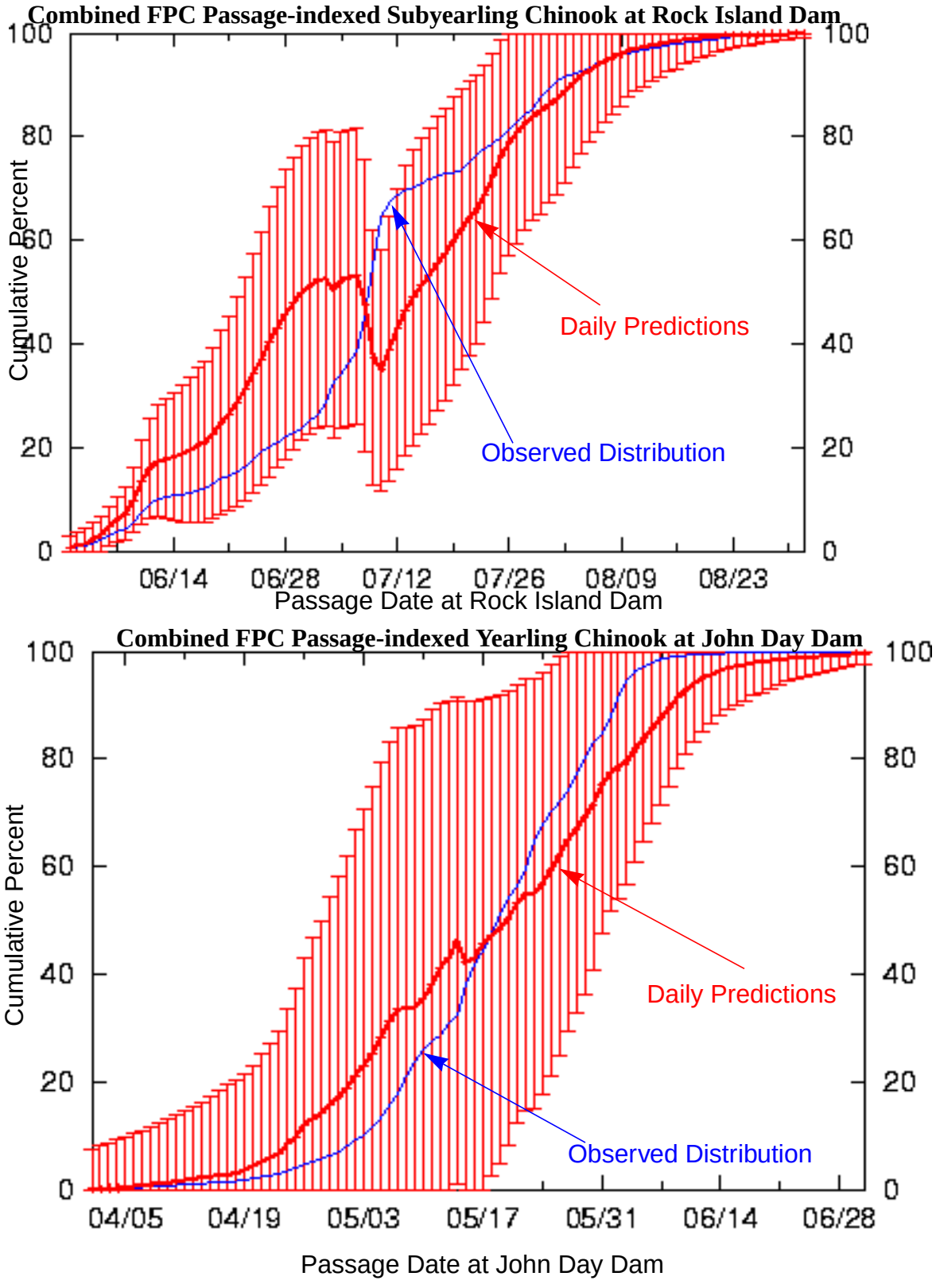


Figure A21: Daily predictions of the run-timing of FPC passage-indexed combined wild and hatchery runs-at-large of yearling chinook salmon at McNary and Rock Island Dams.

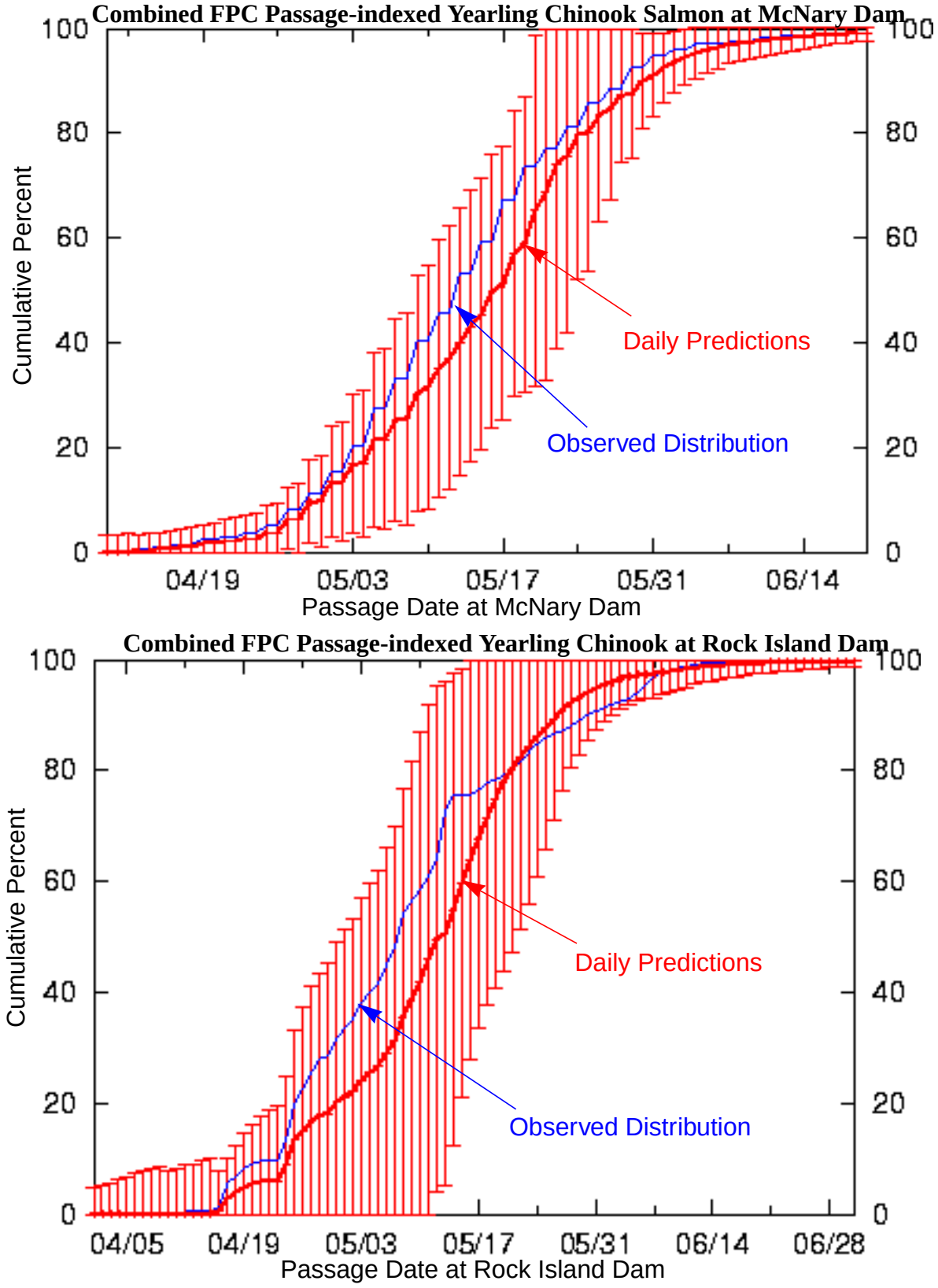


Figure A22: Daily predictions of the run-timing of FPC passage-indexed combined wild and hatchery runs-at-large of coho salmon at John Day and McNary Dams.

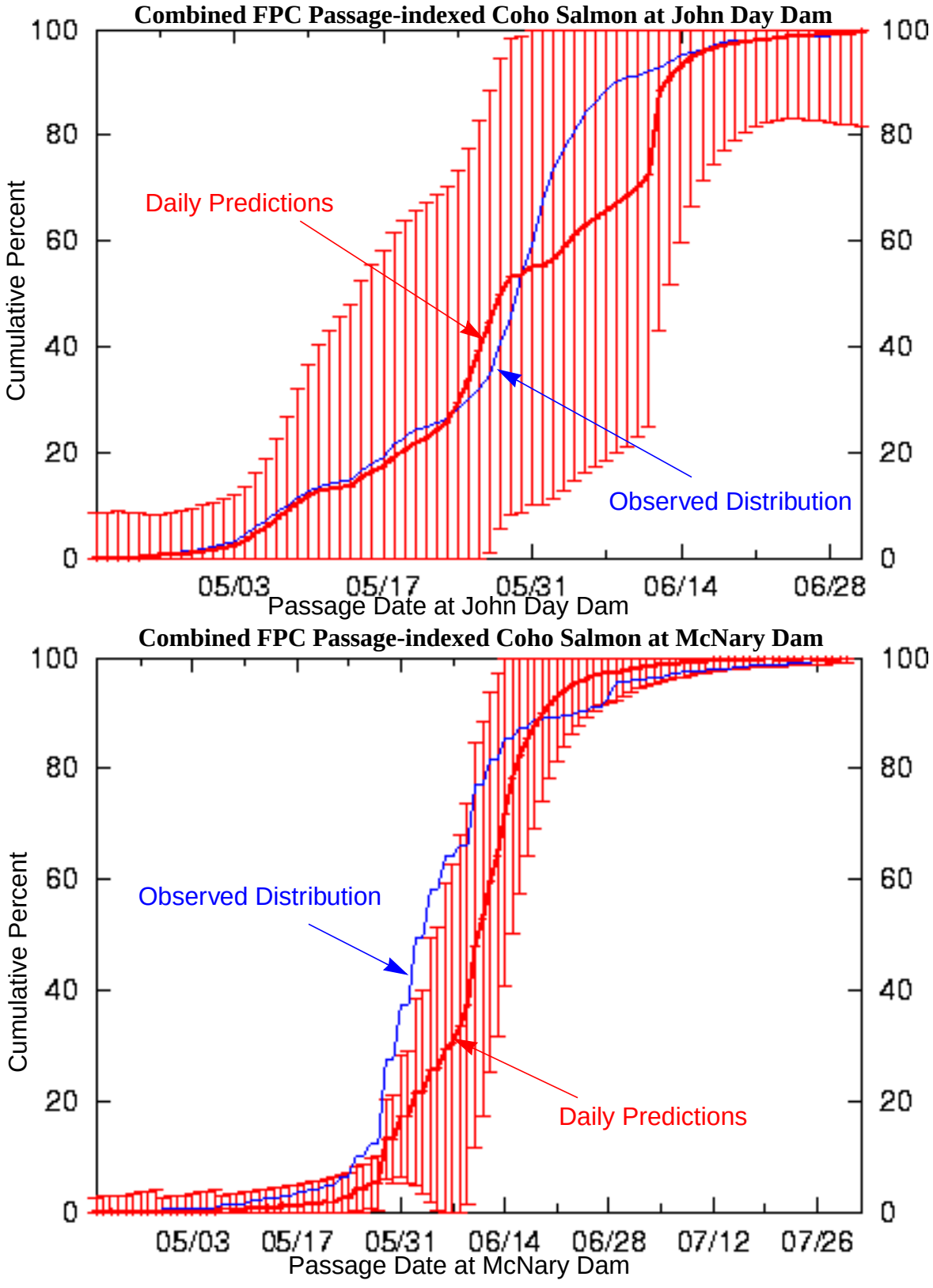


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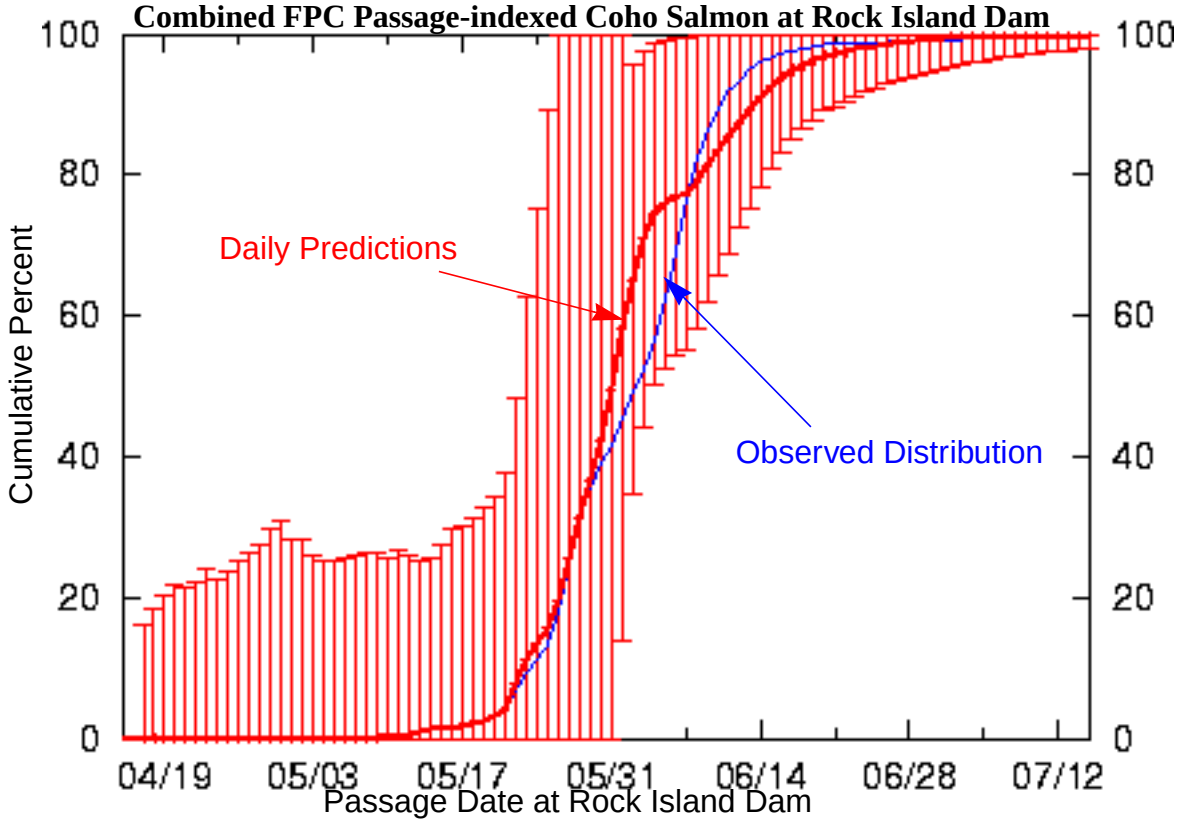
Figure A23: Daily predictions of the FPC passage-indexed combined wild and hatchery run-at-large of coho salmon at Rock Island Dam and of sockeye salmon at John Day Dam.



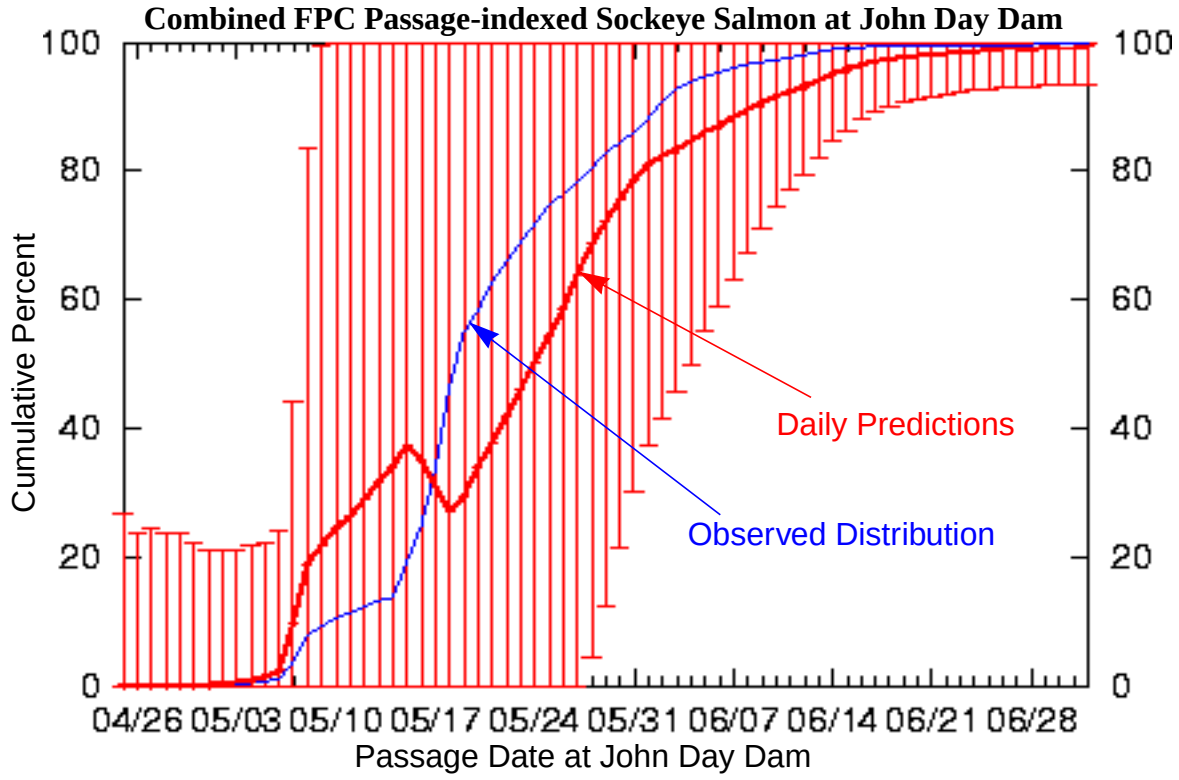
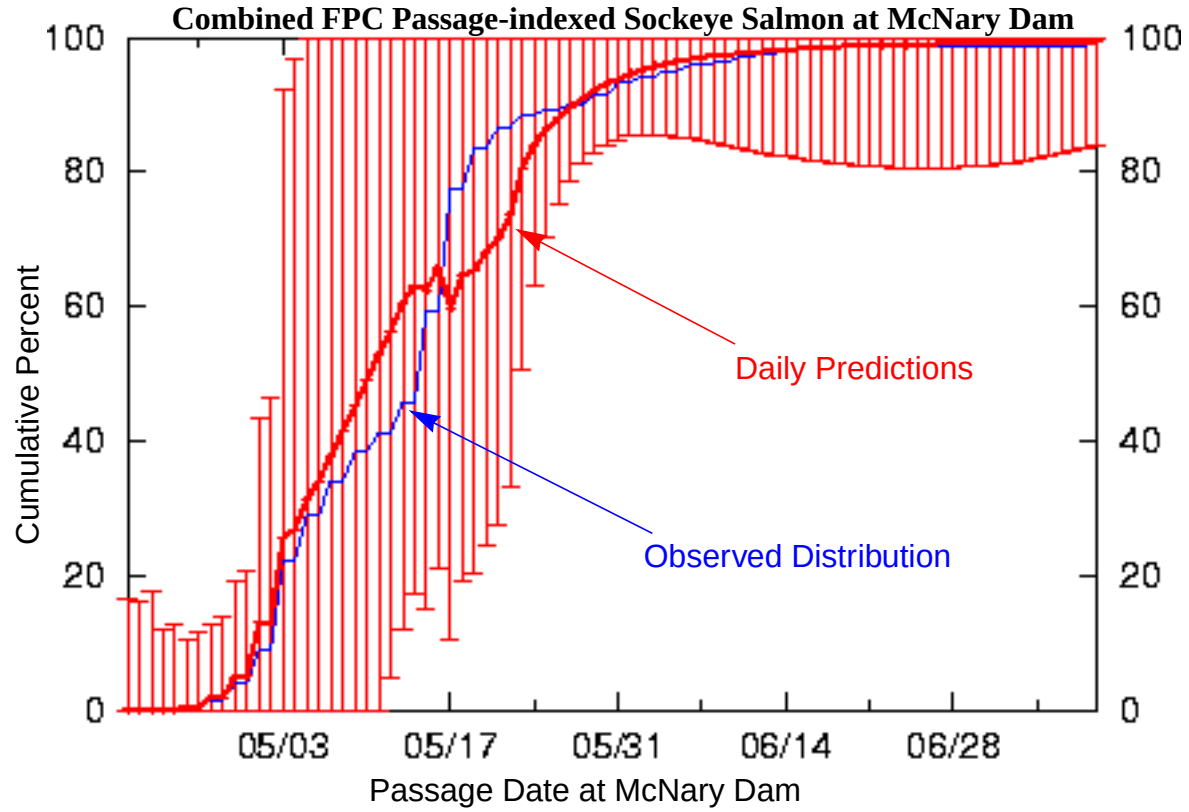


Figure A24: Daily predictions of the FPC passage-indexed combined wild and hatchery runs-at-large of sockeye salmon at McNary and Rock Island Dams.



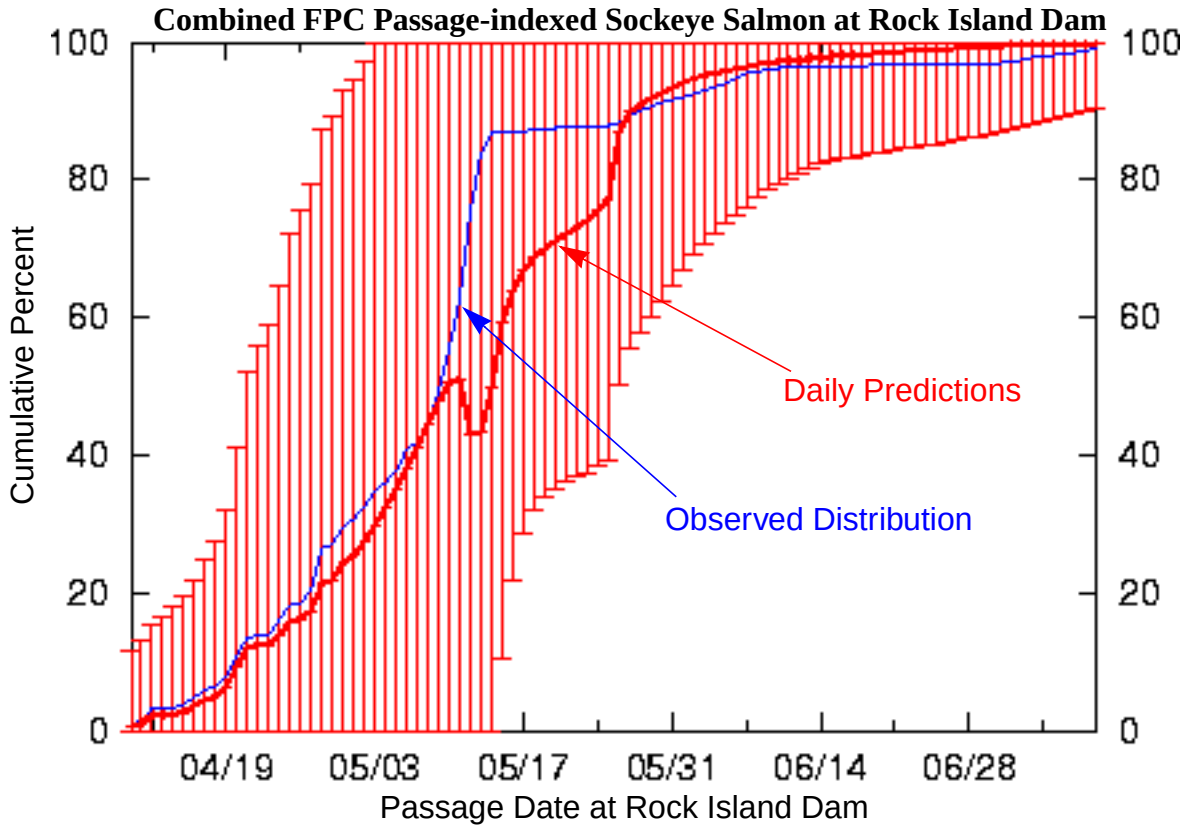
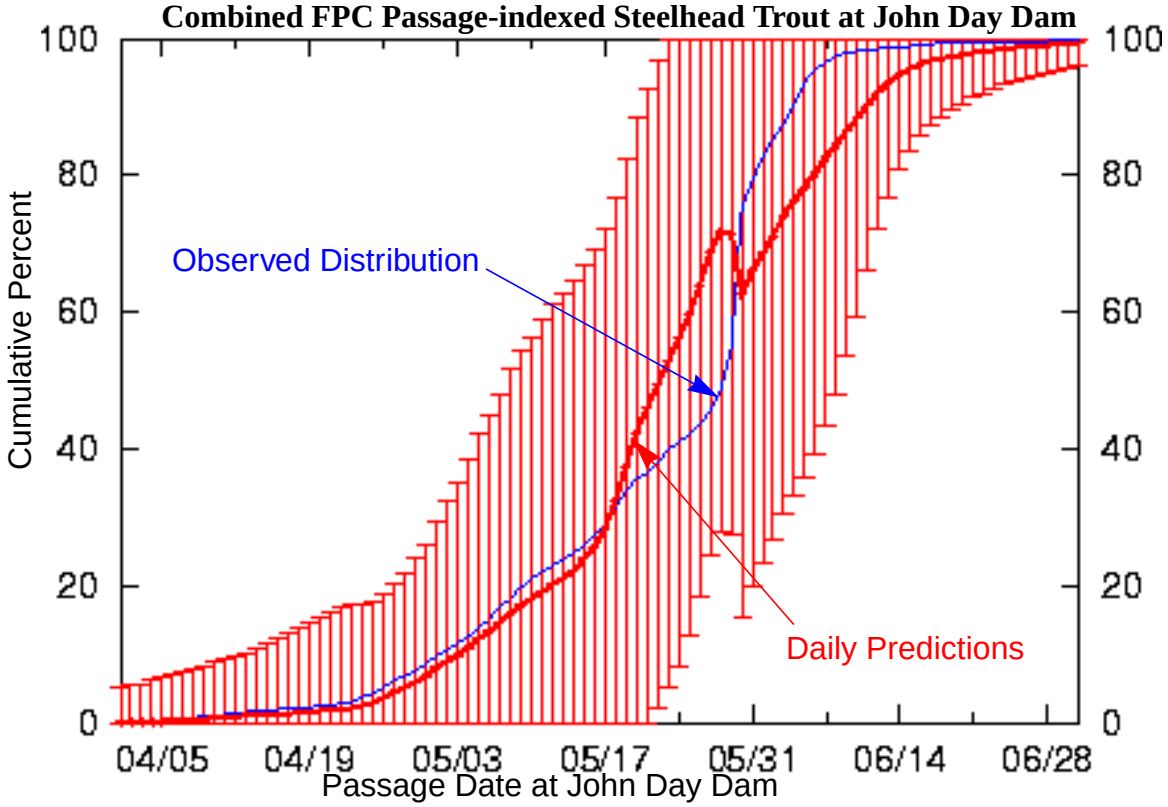


Figure A25: Daily predictions of the FPC passage-indexed combined wild and hatchery runs-at-large of steelhead trout at John Day and McNary Dams.



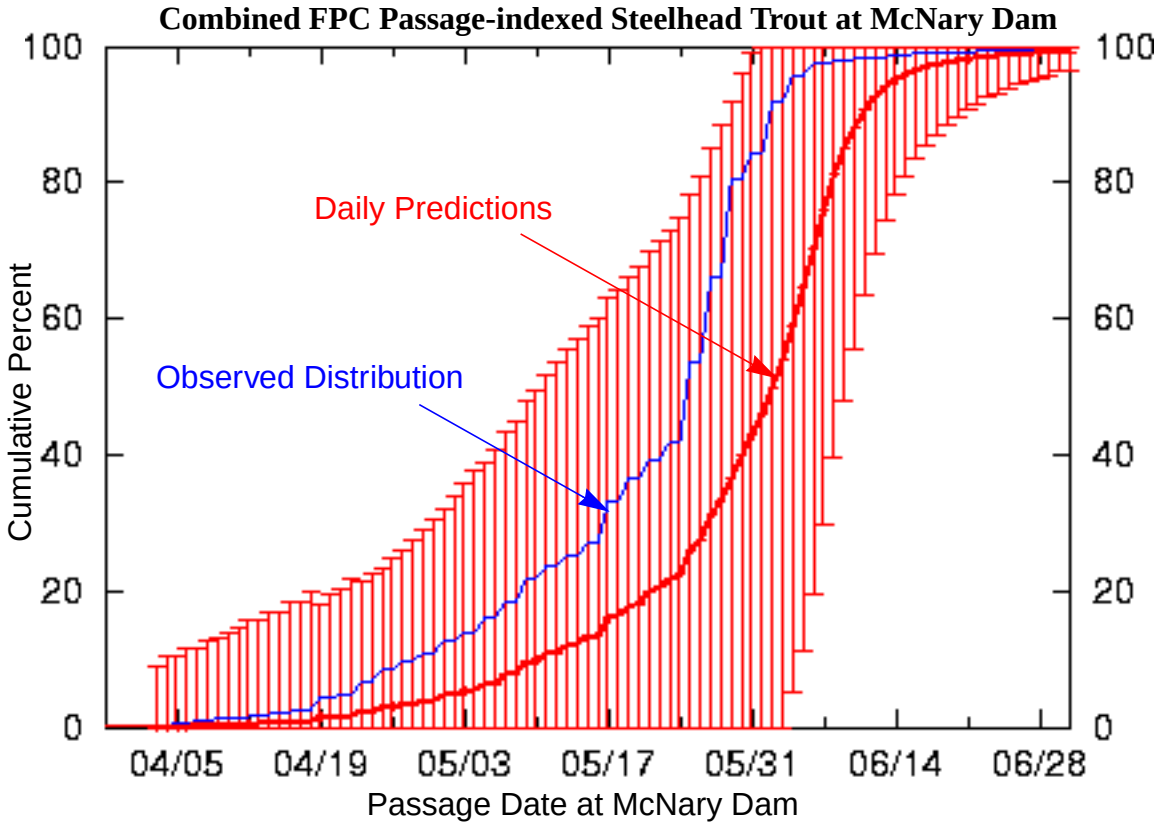


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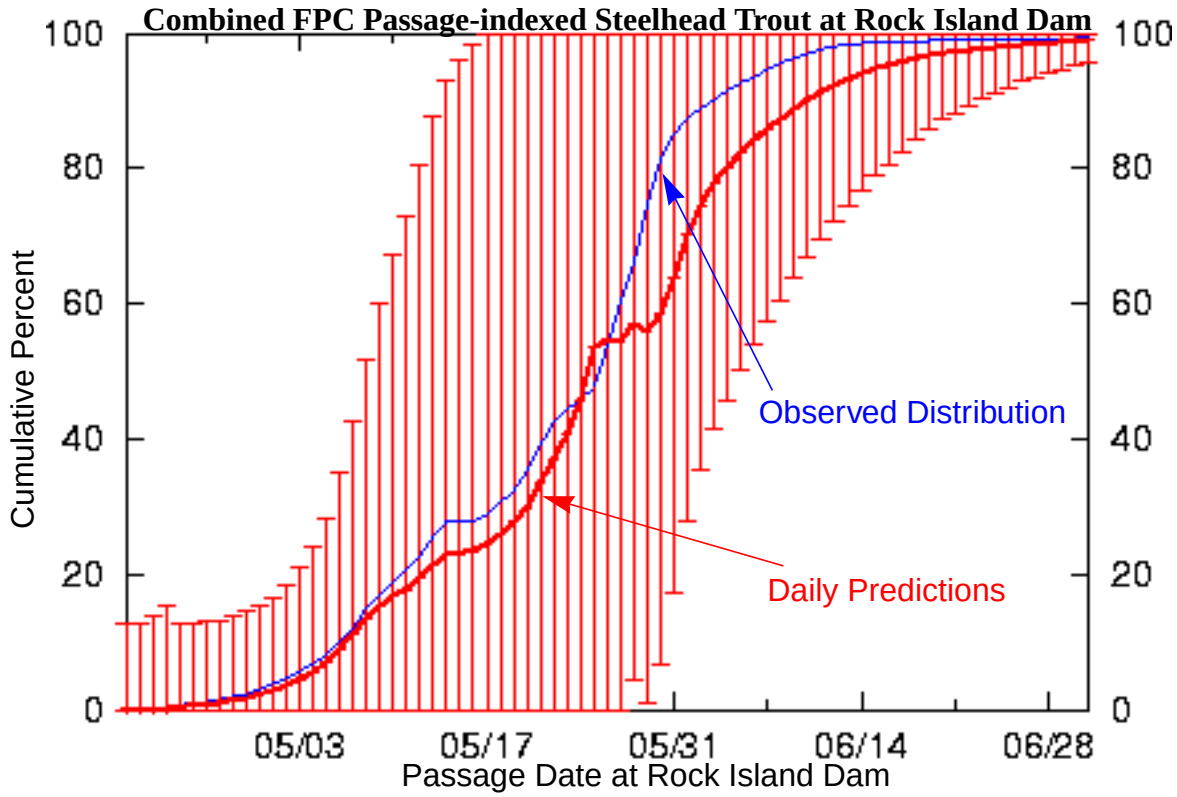
Figure A26: Daily predictions of the FPC passage-indexed combined wild and hatchery run-at-large of steelhead trout at Rock Island Dam.



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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 2003 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.

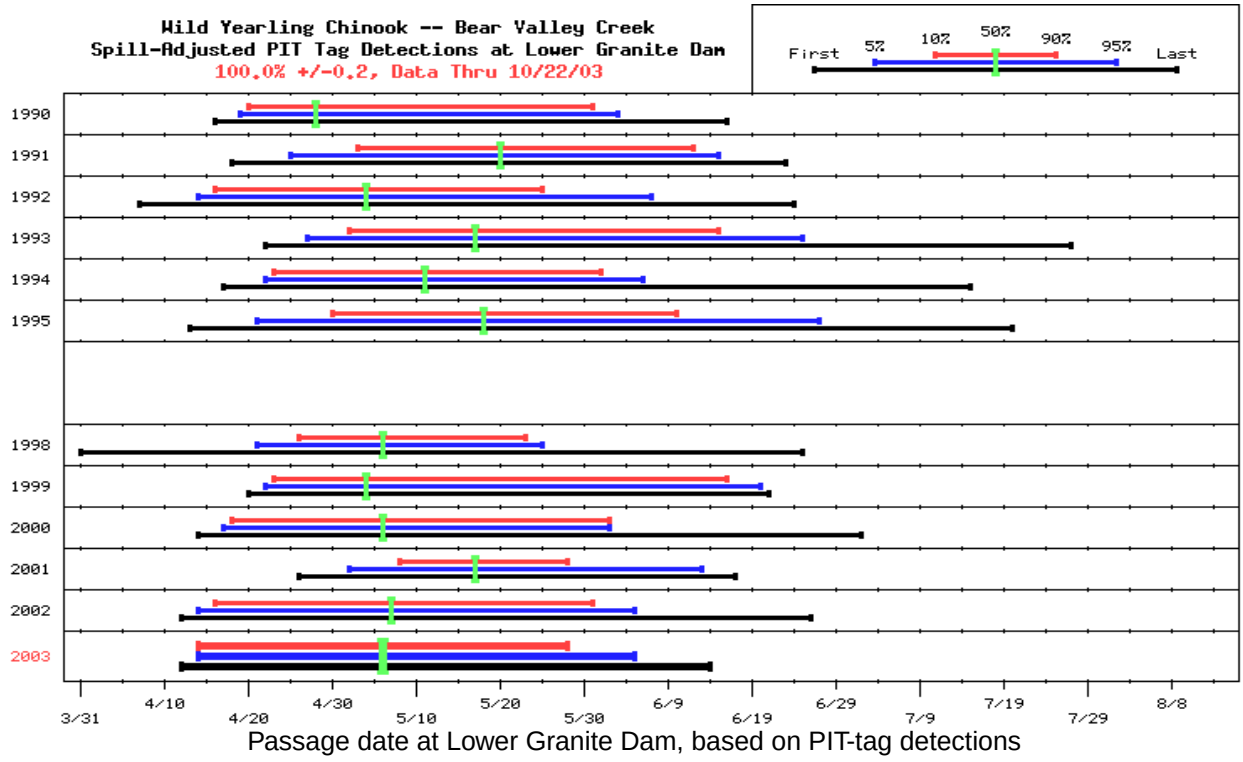


Table B1: Historical Bear Valley Creek outmigration timing characteristics.

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
2003	04/12	04/14	04/14	05/06	06/04	06/09	06/25	52	1022	41	83.4	8.2

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

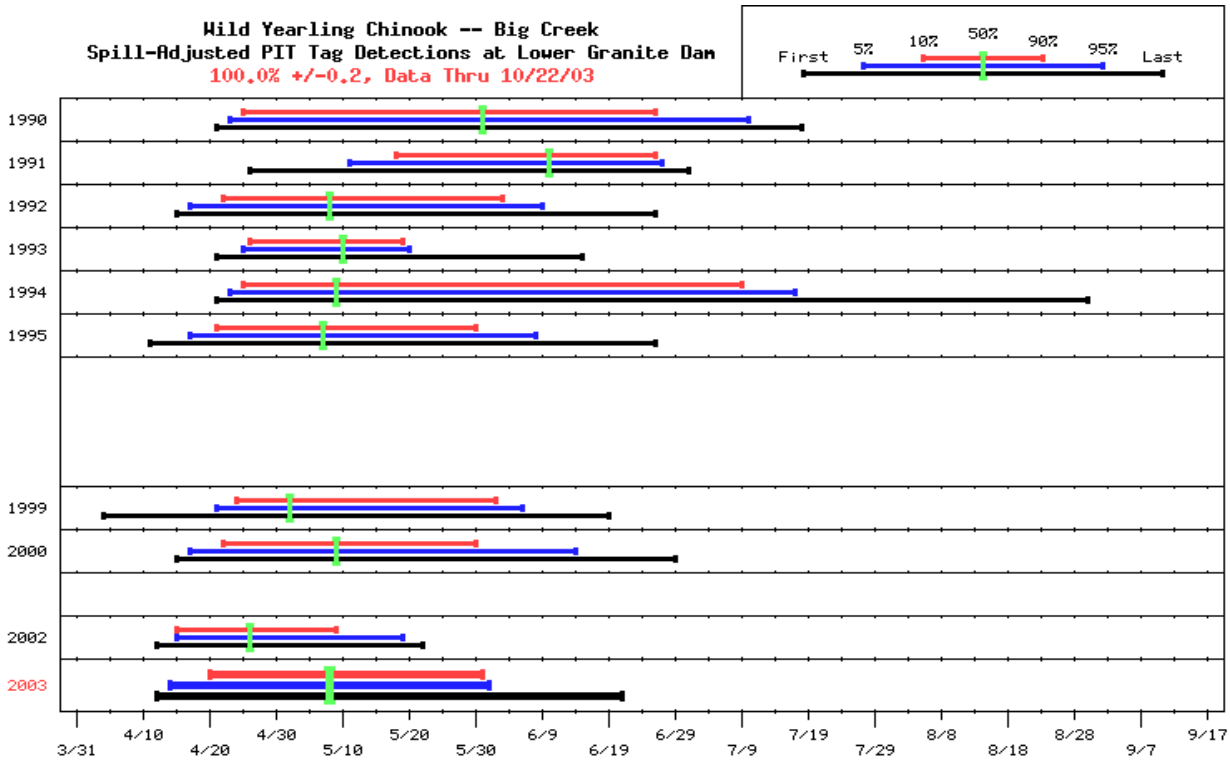
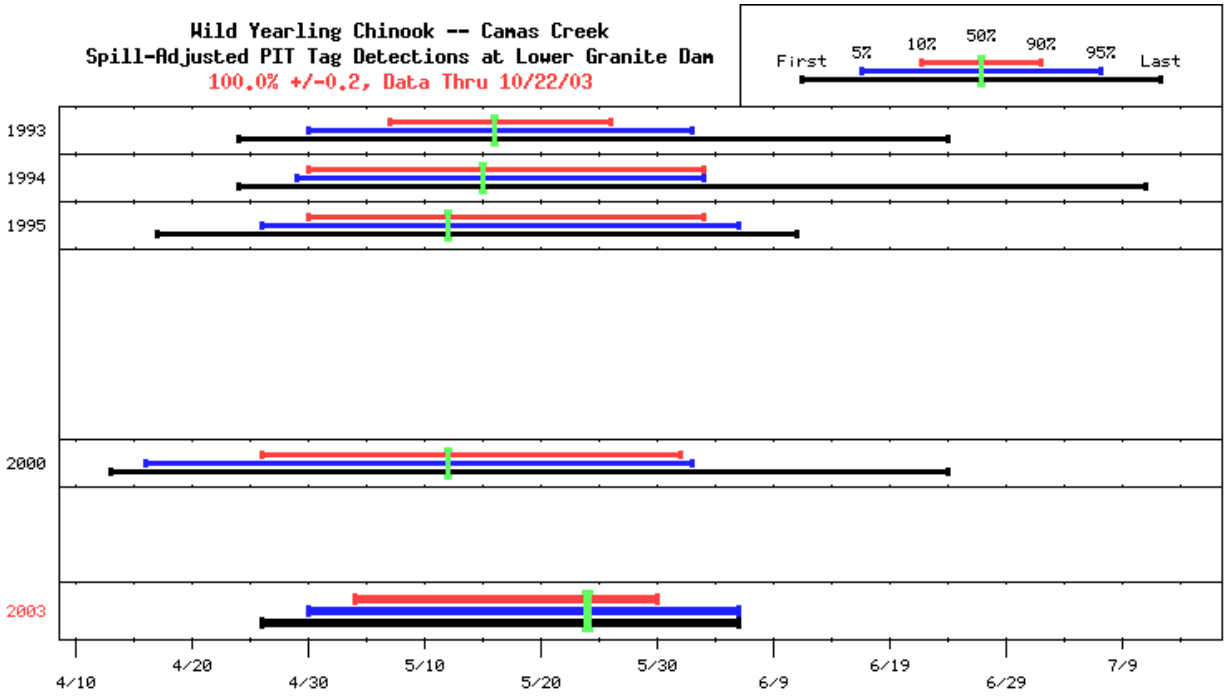


Table B2: Historical Big Creek outmigration timing characteristics.

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
2003	04/12	04/14	04/20	05/08	05/31	06/01	06/25	42	1724	100	205.8	11.9

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

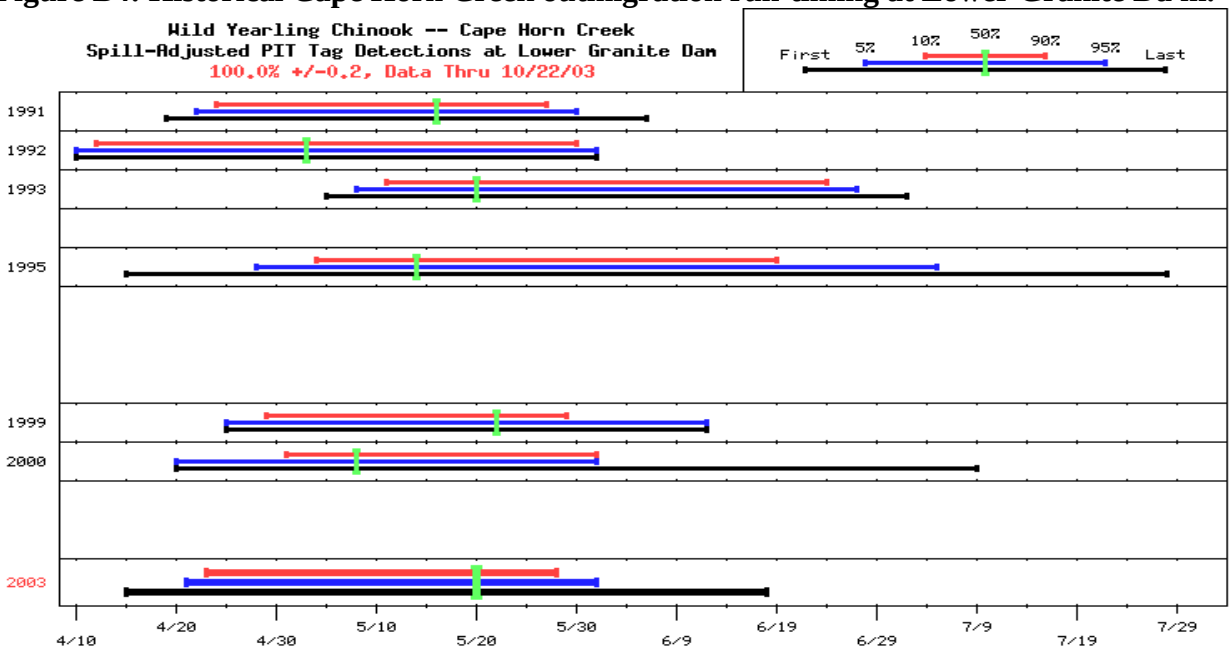


Passage date at Lower Granite Dam, based on PIT-tag detections

Table B3: Historical Camas 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	04/24	04/30	05/07	05/16	05/26	06/02	06/24	20	1013	66	109.2	10.8
1994	04/24	04/29	04/30	05/15	06/03	06/03	07/11	35	215	20	31.3	14.5
1995	04/17	04/26	04/30	05/12	06/03	06/06	06/11	35	1528	59	86.3	5.6
2000	04/13	04/16	04/26	05/12	06/01	06/02	06/24	37	763	53	103.7	13.6
2003	04/26	04/30	05/04	05/24	05/30	06/06	06/22	27	976	27	58.7	6.0

Figure B4: Historical Cape Horn Creek outmigration run-timing at Lower Granite Da m.



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

Table B4: Historical Cape Horn 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	04/19	04/22	04/24	05/16	05/27	05/30	06/06	34	164	25	25.4	15.5
1992	04/10	04/10	04/12	05/03	05/30	06/01	06/01	49	209	19	19.0	9.1
1993	05/05	05/08	05/11	05/20	06/24	06/27	07/02	45	205	22	34.4	16.8
1995	04/15	04/28	05/04	05/14	06/19	07/05	07/28	47	983	58	84.6	8.6
1999	04/25	04/25	04/29	05/22	05/29	06/12	06/12	31	270	15	35.8	13.3
2000	04/20	04/20	05/01	05/08	06/01	06/01	07/09	32	423	17	32.9	7.8
2003	04/15	04/21	04/23	05/17	05/28	06/01	06/19	36	562	24	50.3	9.0

Figure B5: Historical Catherine Creek outmigration run-timing at Lower Granite Dam.

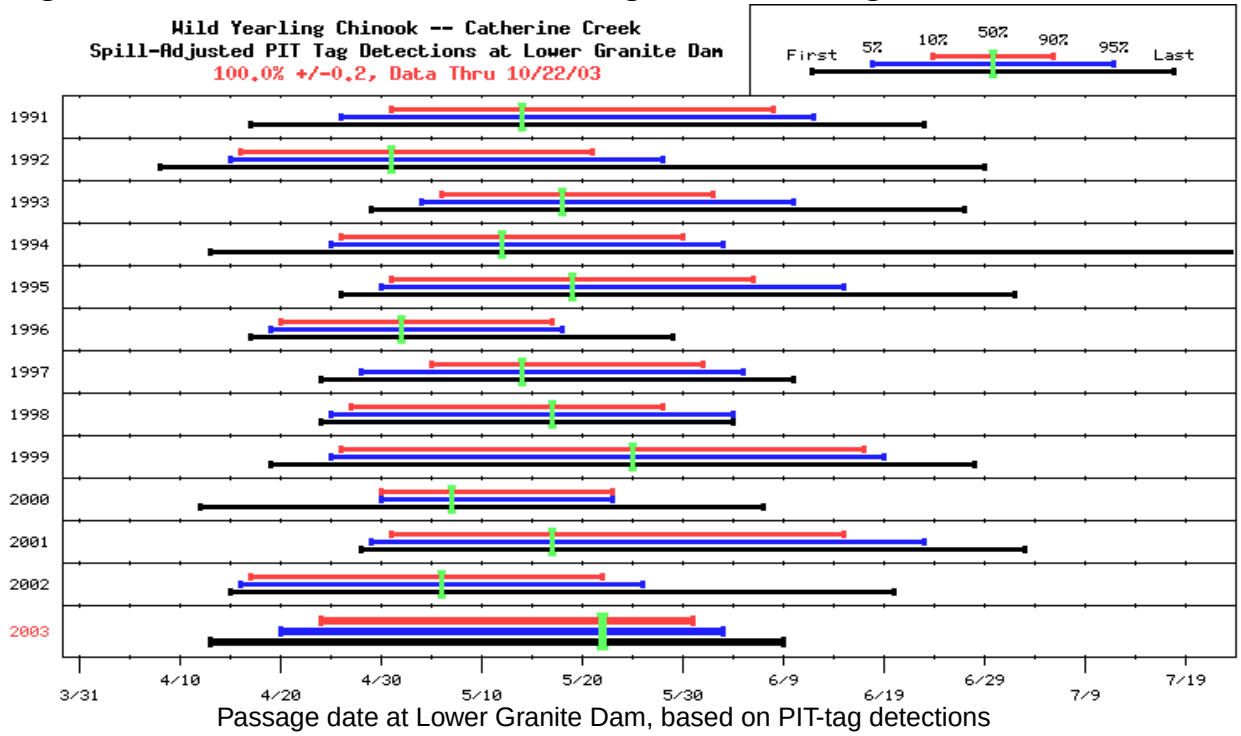


Table B5: Historical Catherine Creek outmigration timing characteristics.

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
2003	04/13	04/20	04/24	05/22	05/31	06/04	06/25	38	2501	99	217.5	8.7

Figure B6: Historical Chamberlain Creek (WF) outmigration run-timing at L.Granite Dam

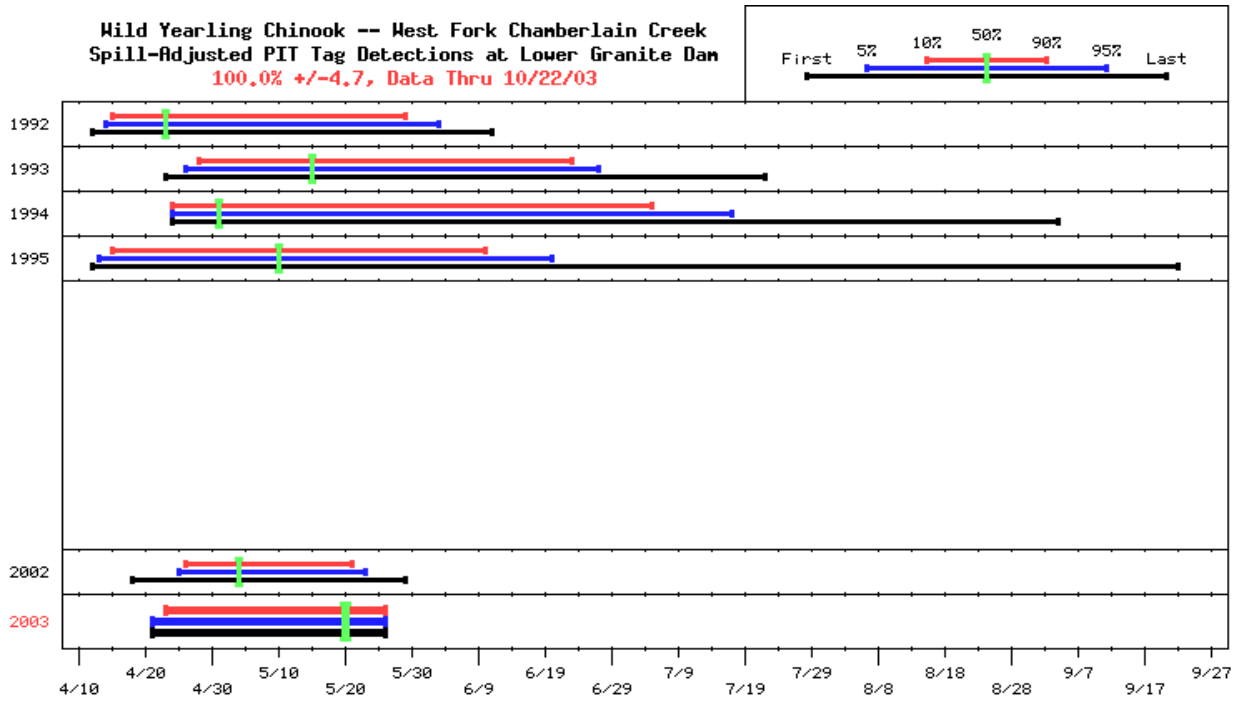


Table B6: Historical Chamberlain Creek (WF) outmigration timing characteristics.

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	26	527	24	56.7	10.8
2003	04/21	04/21	04/23	05/20	06/18	06/24	07/31	38	2501	99	217.5	8.7

Figure B7: Historical Elk Creek outmigration run-timing at L.Granite Dam.

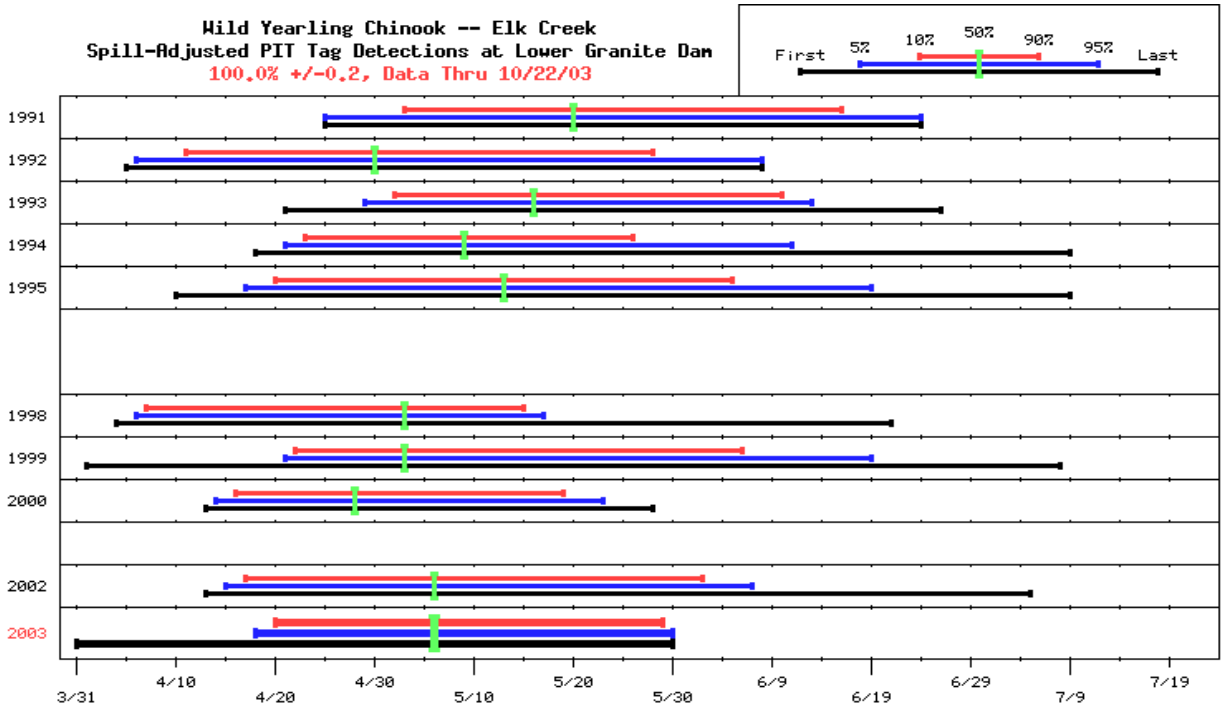


Table B7: Historical Elk Creek outmigration timing characteristics.

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
2003	03/31	04/18	04/20	05/06	05/29	05/30	06/26	40	975	27	55.5	5.7

Figure B8: Historical Grande Ronde River outmigration run-timing at L.Granite Dam.

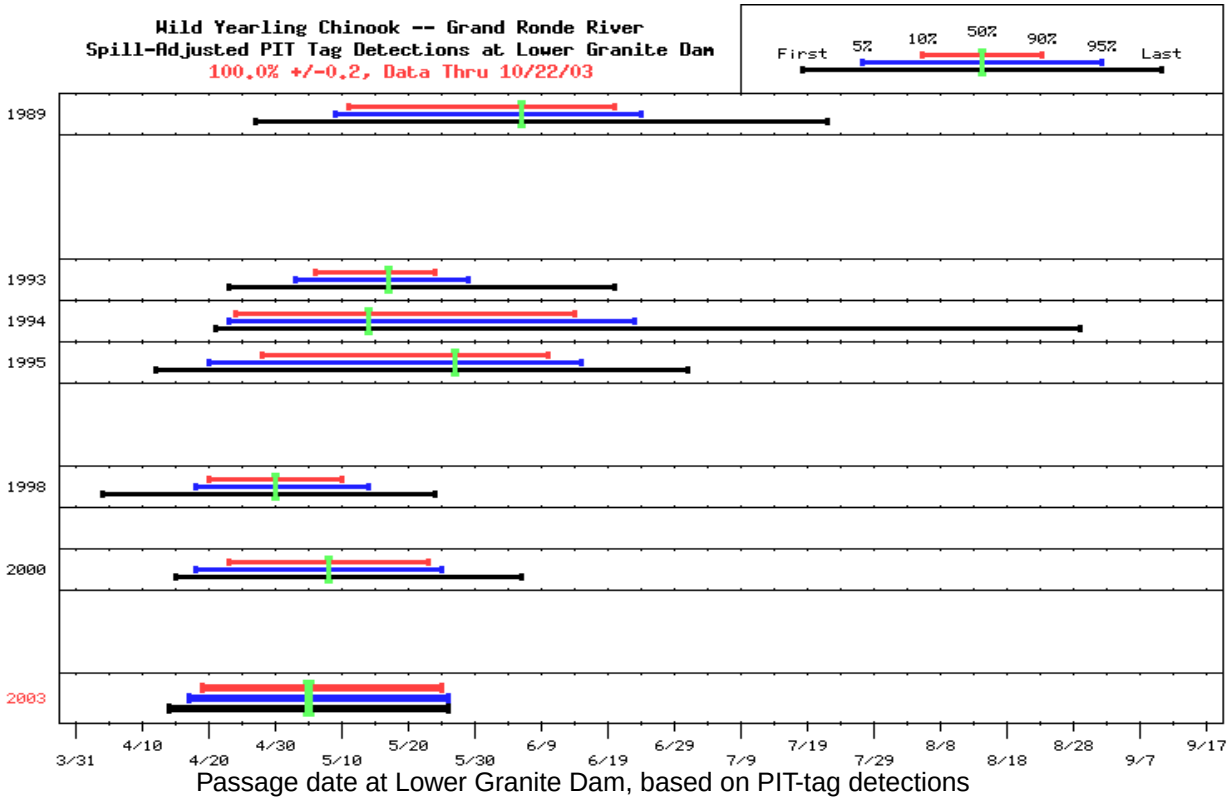
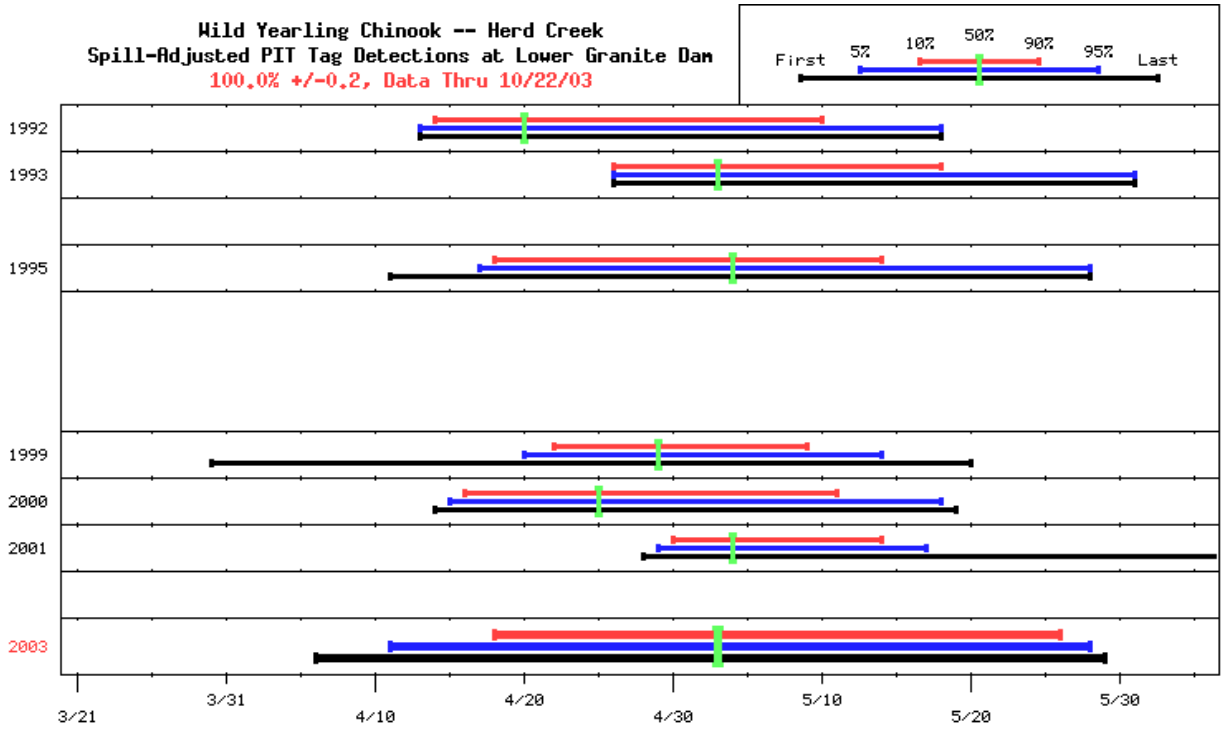


Table B8: Historical Grande Ronde River outmigration timing characteristics.

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
2003	04/14	04/17	04/19	05/05	05/25	05/26	05/26	37	463	39	77.9	16.8

Figure B9: Historical Herd Creek outmigration run-timing at Lower Granite Da m.



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

Table B9: Historical Herd 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					
1992	04/13	04/13	04/14	04/20	05/10	05/18	05/18	27	310	17	17.0	5.5
1993	04/26	04/26	04/26	05/03	05/18	05/31	05/31	23	224	16	19.5	8.7
1995	04/11	04/17	04/18	05/04	05/14	05/28	05/28	27	534	36	46.2	8.7
1999	03/30	04/20	04/22	04/29	05/09	05/14	05/20	18	959	58	136.2	14.2
2000	04/14	04/15	04/16	04/25	05/11	05/18	05/19	26	315	23	44.3	14.1
2001	04/28	04/29	04/30	05/04	05/14	05/17	06/07	15	311	66	66.0	21.2
2003	04/06	04/11	04/18	05/03	05/26	05/28	05/29	39	799	37	75.8	9.5

Figure B10: Historical Imnaha River outmigration run-timing at Lower Granite Dam.

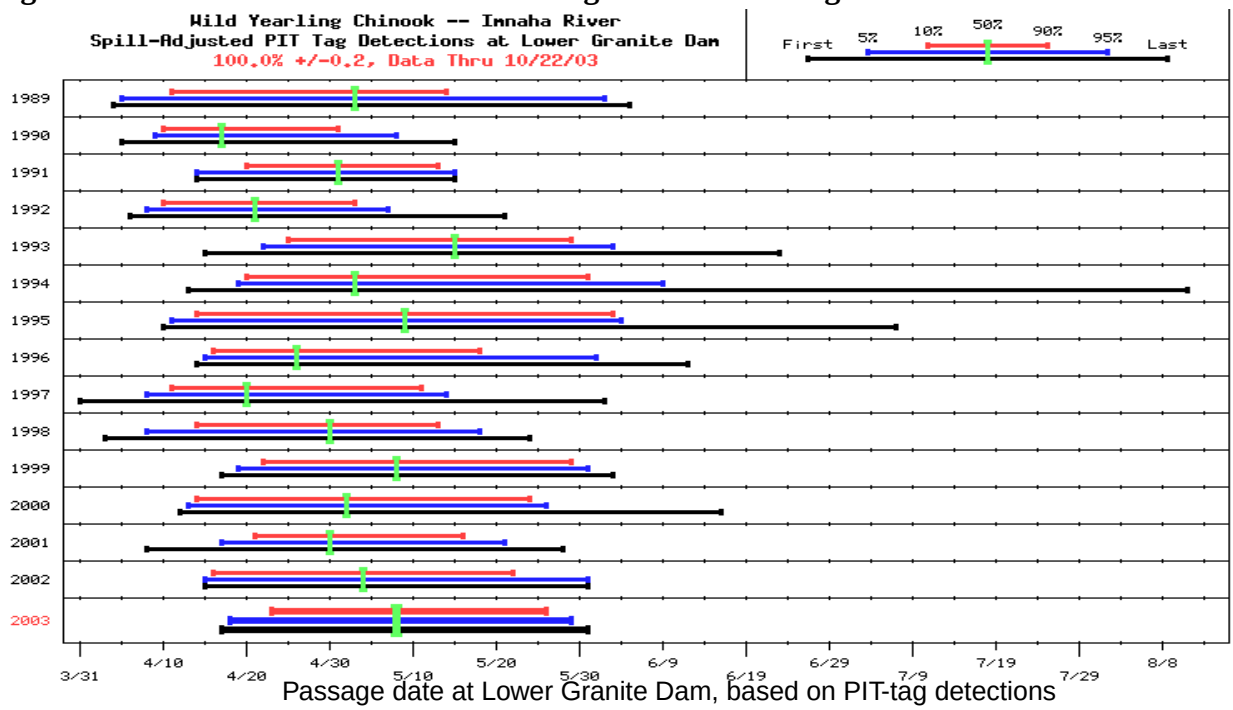


Table B10: Historical Imnaha River outmigration timing characteristics.

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
2003	04/17	04/18	04/23	05/08	05/26	05/29	05/31	34	1003	43	87.5	8.7

Figure B11: Historical Johnson Creek outmigration run-timing at Lower Granite Dam.

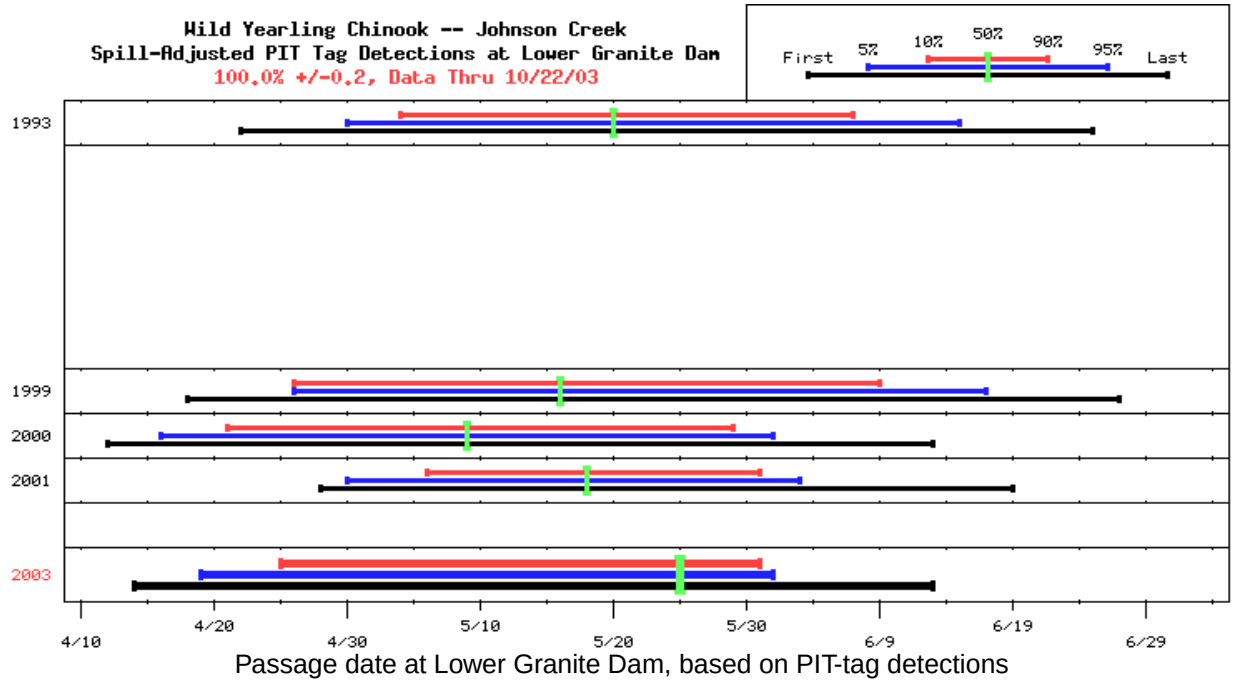


Table B11: Historical Johnson Creek outmigration timing characteristics.

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
2003	04/14	04/19	04/25	05/25	05/31	06/01	06/25	37	1041	52	118.6	11.4

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

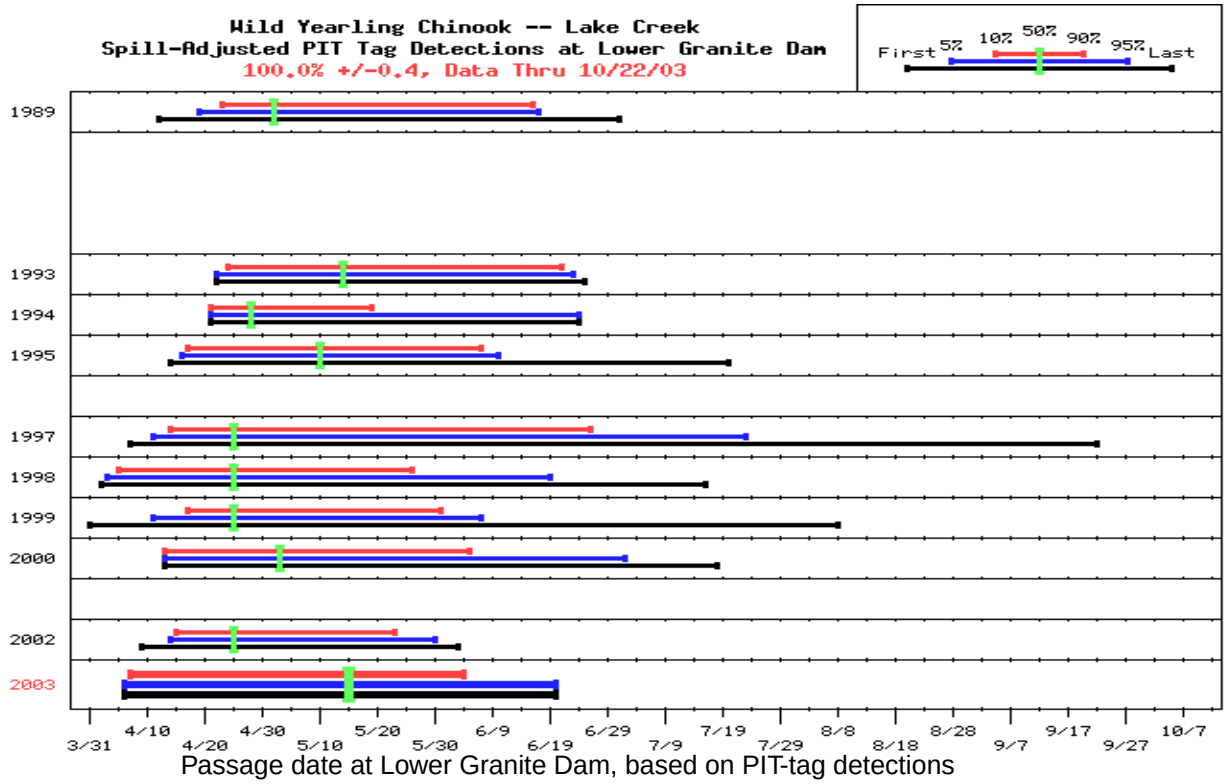
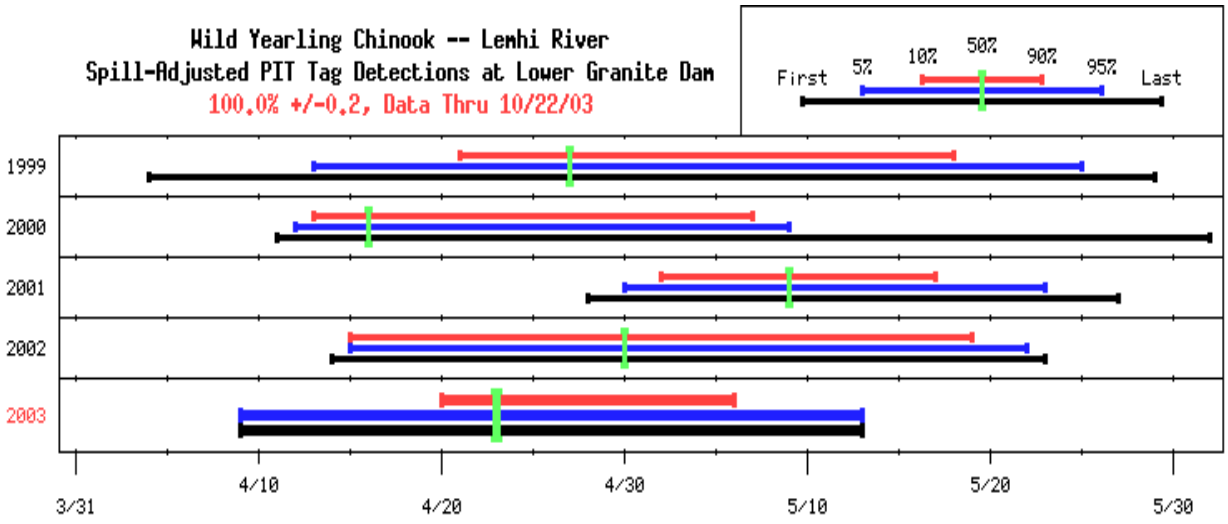


Table B12: Historical Lake Creek outmigration timing characteristics.

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
2003	04/06	04/06	04/07	05/15	06/20	06/20	07/19	59	709	11	23.4	3.3

Figure B13: Historical Lemhi River outmigration run-timing at Lower Granite Dam.



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

Table B13: 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
2003	04/09	04/09	04/20	04/23	05/06	05/13	05/13	17	700	12	24.8	3.5

Figure B14: Historical Lolo Creek outmigration run-timing at Lower Granite Dam.

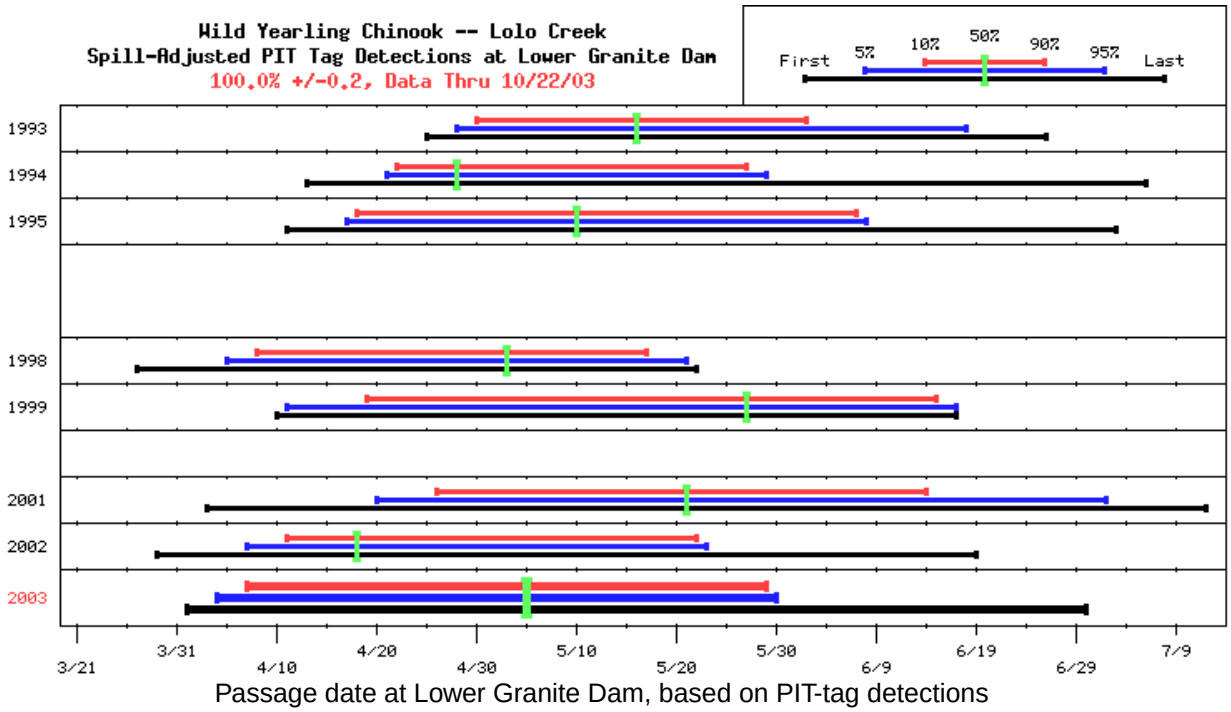


Table B14: Historical Lolo Creek outmigration timing characteristics.

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
2003	04/01	04/04	04/07	05/05	05/29	05/30	06/30	53	2005	62	122.1	6.1

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

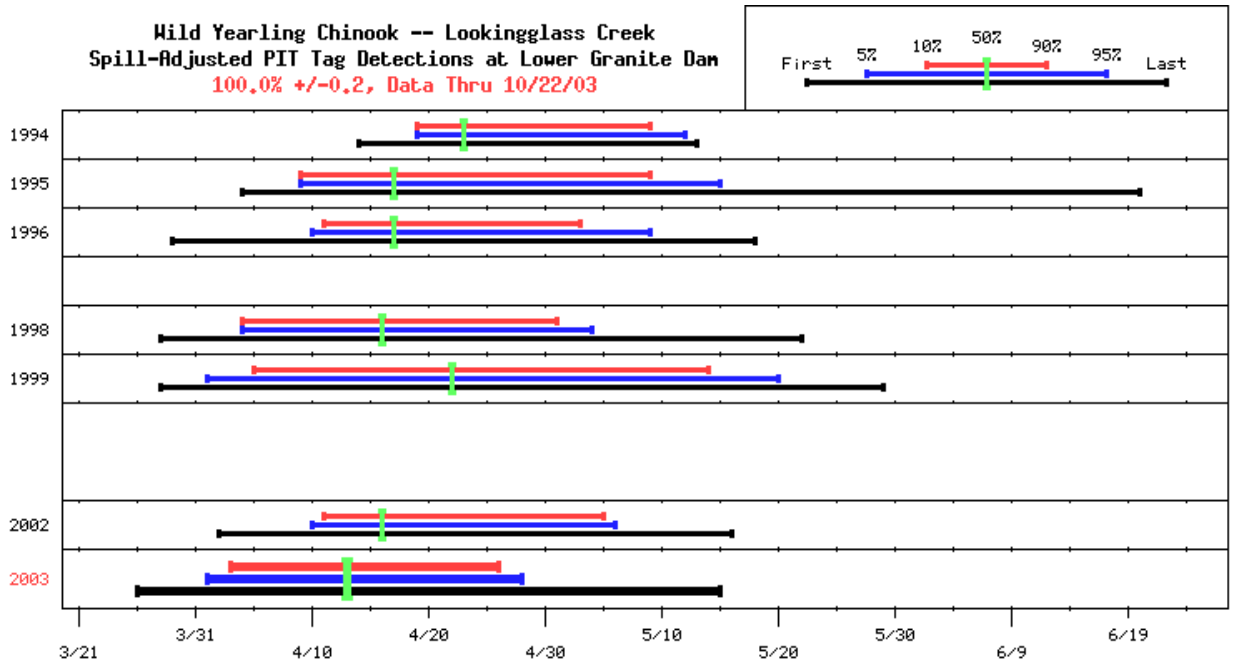


Table B15: Historical Lookingglass Creek outmigration timing characteristics.

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
2003	03/26	04/01	04/03	04/13	04/26	04/28	05/15	24	707	80	149.3	21.1

Figure B16: Historical Loon Creek outmigration run-timing at Lower Granite Da m.

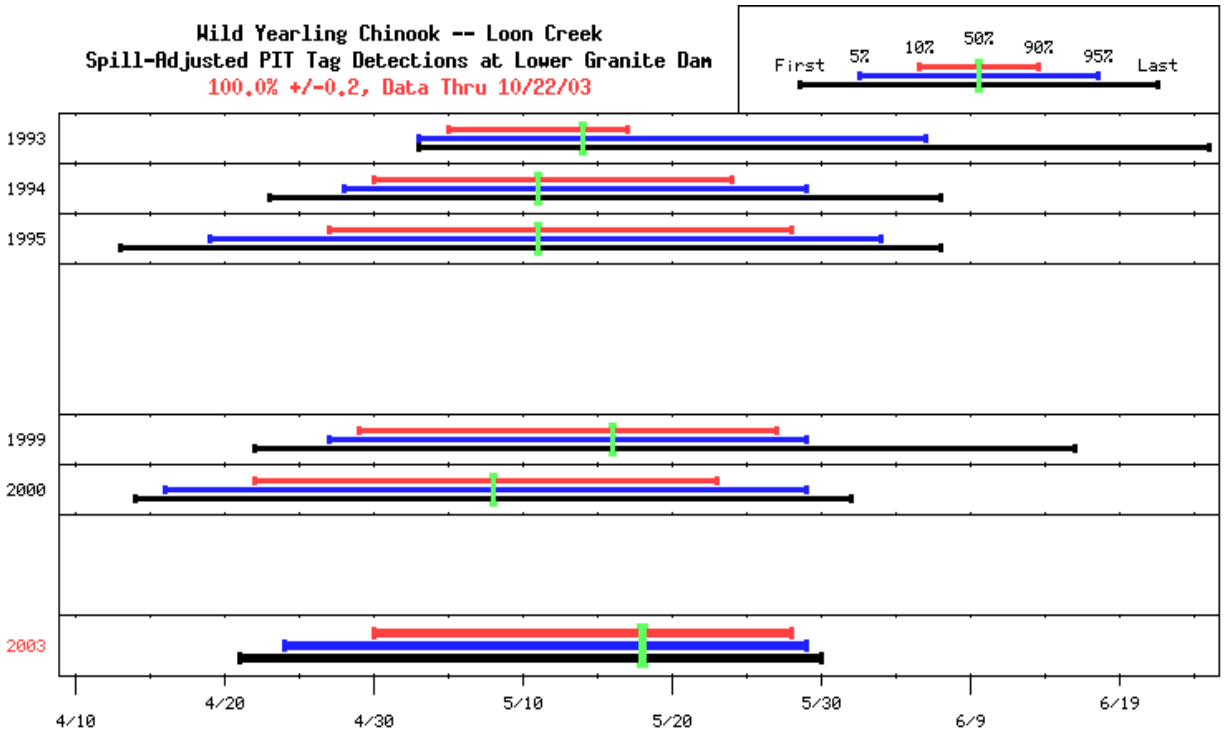


Table B16: Historical Loon Creek outmigration timing characteristics.

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	05/03	05/03	05/05	05/14	05/17	06/06	06/25	13	261	24	35.3	13.5
1994	04/23	04/28	04/30	05/11	05/24	05/29	06/07	25	396	37	50.8	12.8
1995	04/13	04/19	04/27	05/11	05/28	06/03	06/07	32	964	83	117.8	12.2
1999	04/22	04/27	04/29	05/16	05/27	05/29	06/16	29	1029	71	173.4	16.9
2000	04/14	04/16	04/22	05/08	05/23	05/29	06/01	32	719	47	90.0	12.5
2003	04/21	04/24	04/30	05/18	05/28	05/29	06/18	29	830	61	129.4	15.6

Figure B17: Historical Lostine River outmigration run-timing at Lower Granite Dam.

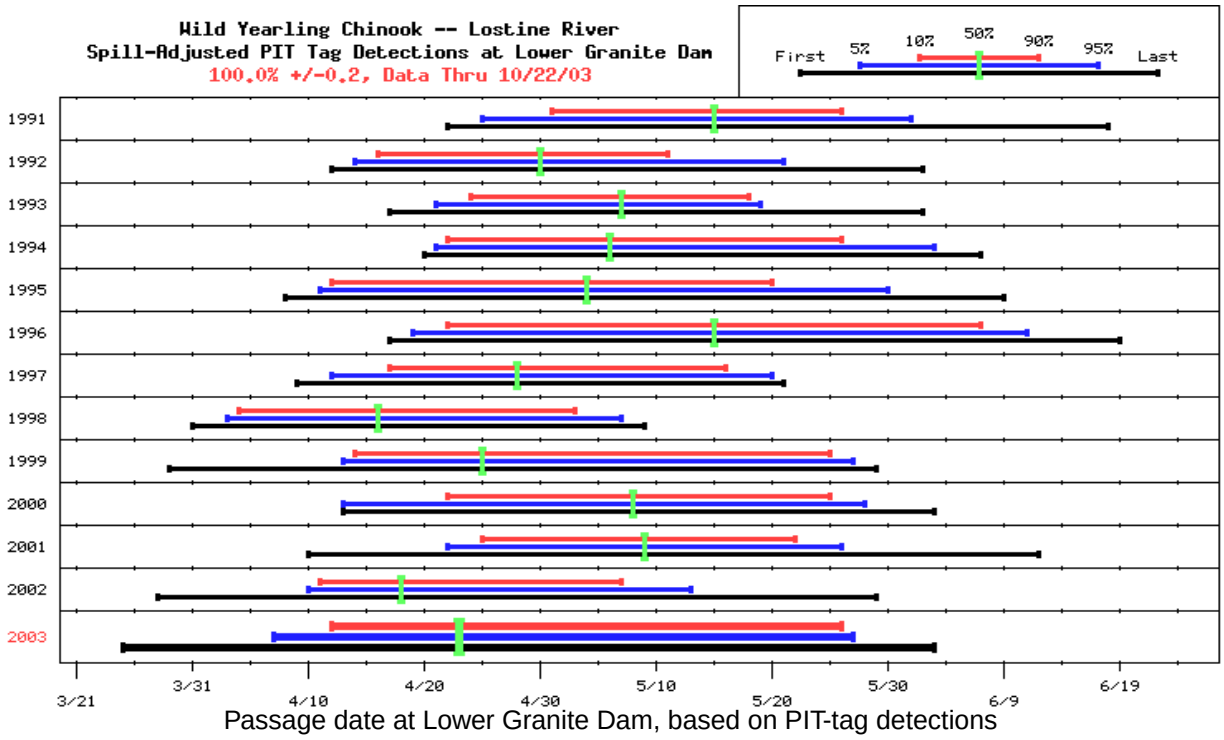


Table B17: Historical Lostine River outmigration timing characteristics.

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
2003	03/25	04/07	04/12	04/23	05/26	05/27	06/03	45	1772	111	224.7	12.7

Figure B18: Historical Marsh Creek outmigration run-timing at Lower Granite Dam.

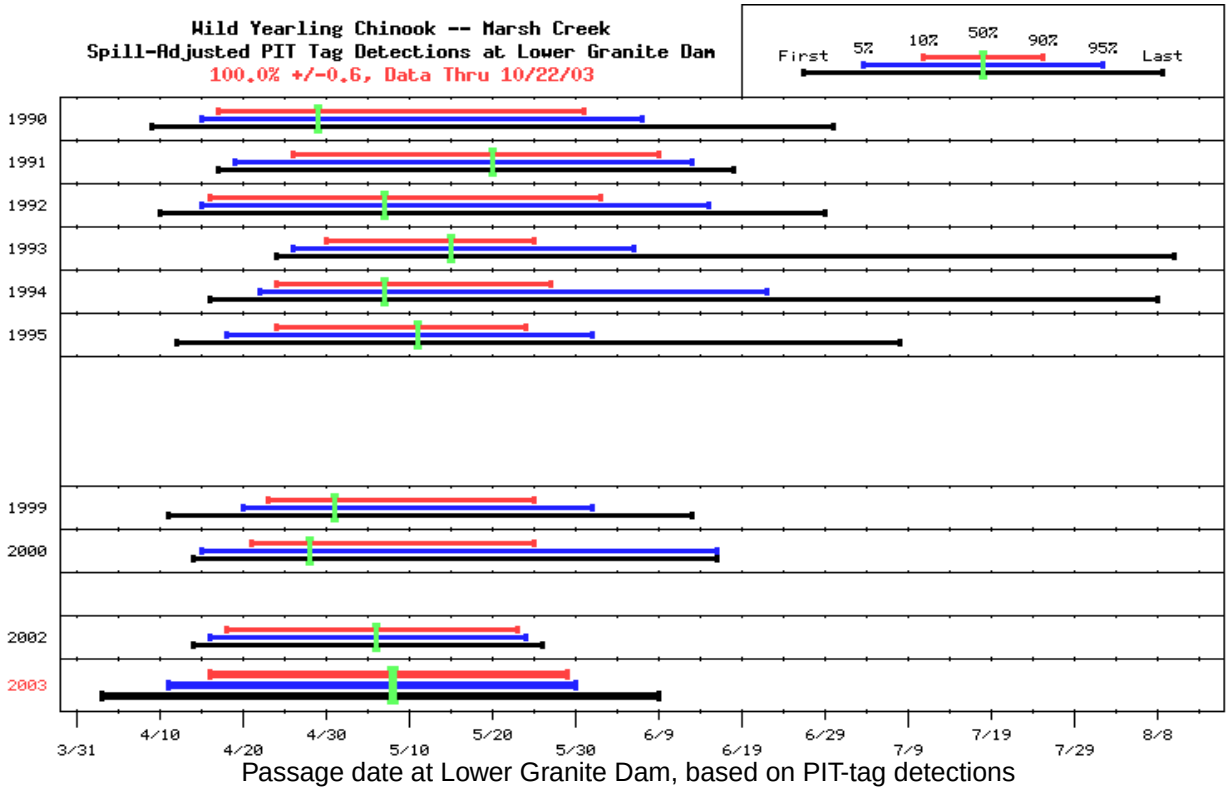


Table B18: Historical Marsh Creek outmigration timing characteristics.

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
2003	04/03	04/11	04/16	05/08	05/29	05/30	07/01	38	2501	99	217.5	8.7

Figure B19: Historical Minam River outmigration run-timing at Lower Granite Dam.

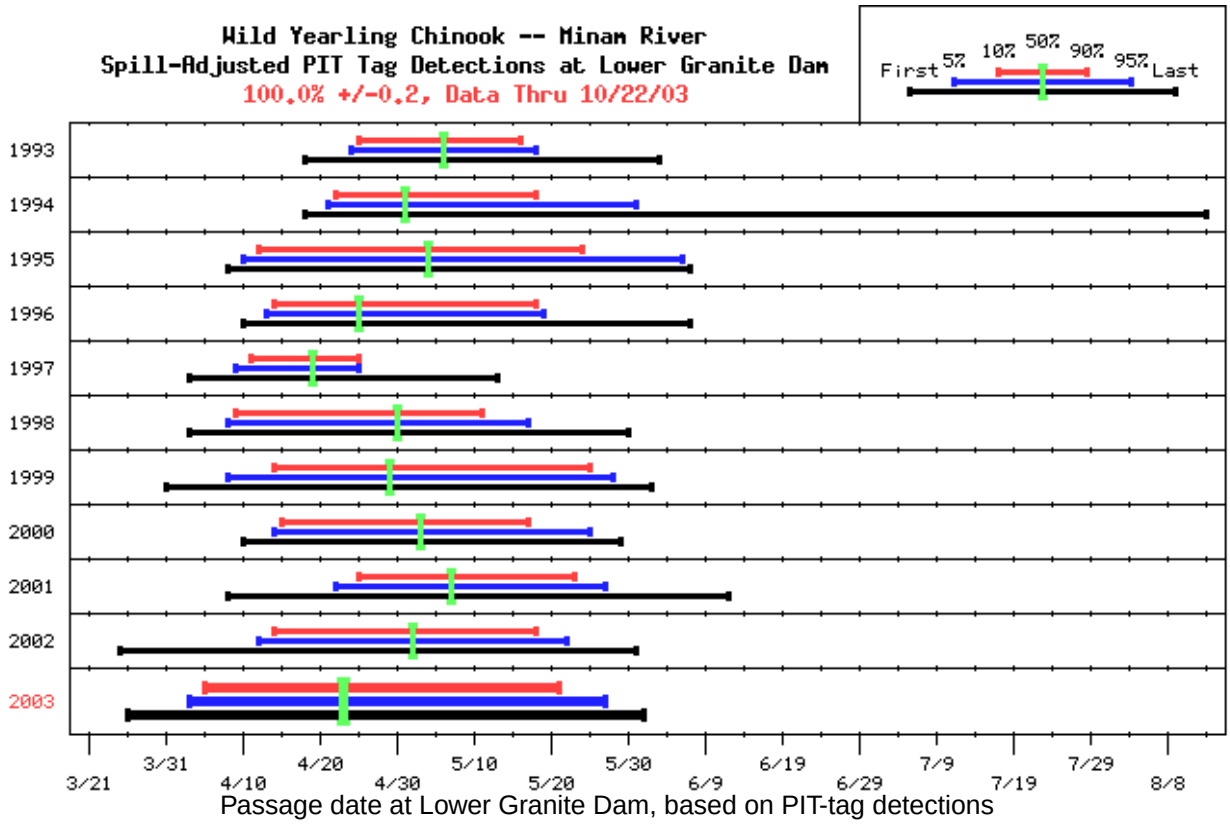


Table B19: Historical Minam River outmigration timing characteristics.

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
2003	03/26	04/03	04/05	04/23	05/23	05/27	06/01	47	1598	81	159.2	10.0

Figure B20: Historical Salmon River SF outmigration run-timing at Lower Granite Dam. f

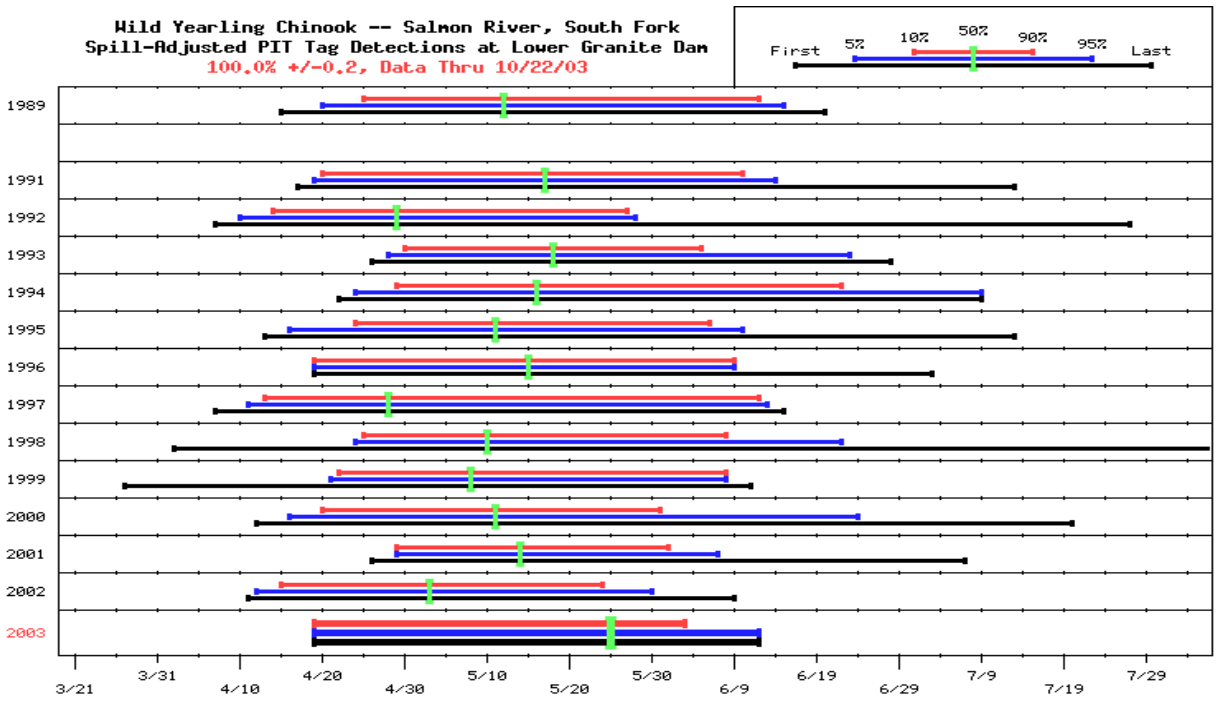


Table B20: Historical Salmon River, SF outmigration timing characteristics.

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
2003	04/19	04/19	04/19	05/25	06/03	06/12	07/09	46	1035	12	24.4	2.4

Figure B21: Historical Secesh River outmigration run-timing at Lower Granite Dam

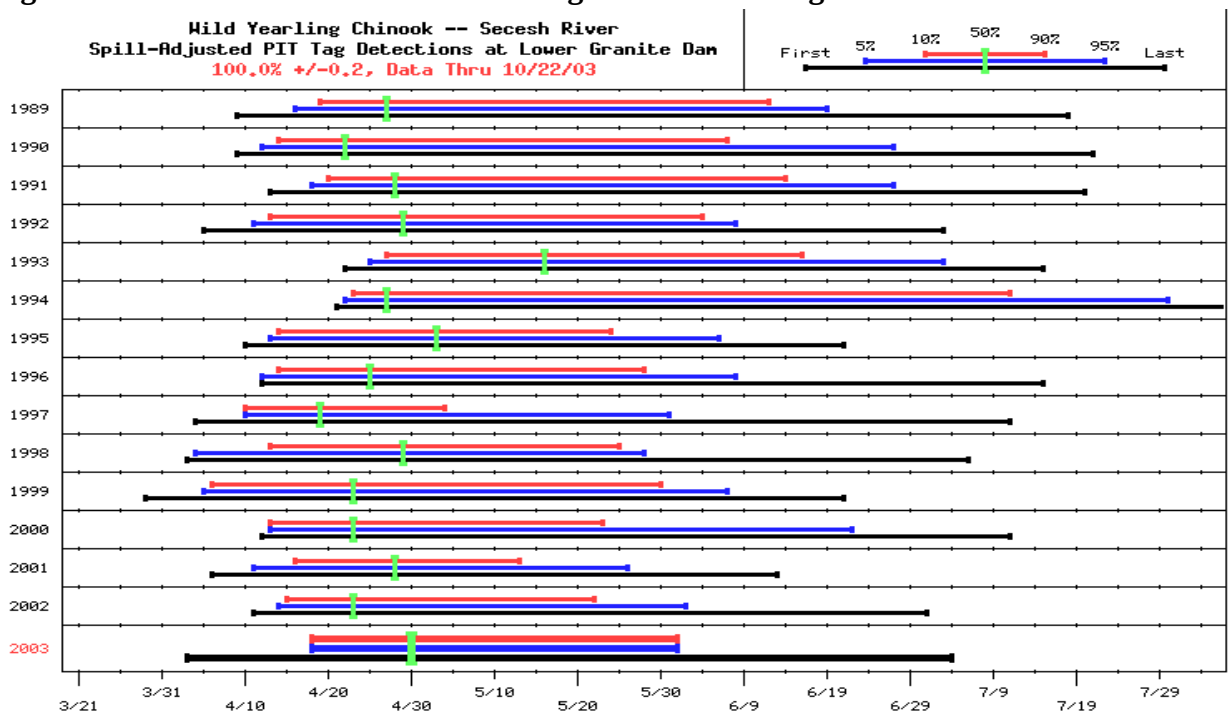
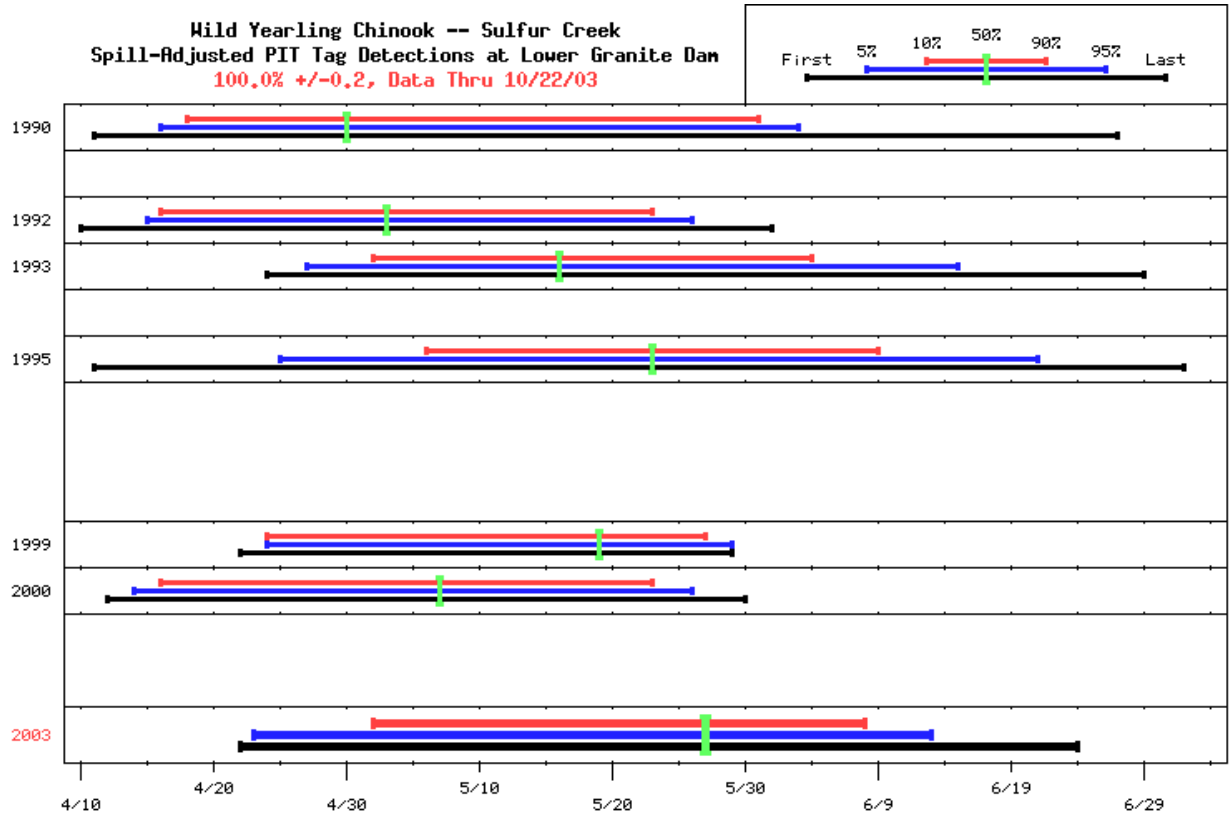


Table B21: Historical Secesh River outmigration timing characteristics.

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
2003	04/03	04/18	04/18	04/30	06/01	06/01	07/04	45	1040	16	31.7	3.0

Figure B22: Historical Sulfur Creek outmigration run-timing at Lower Granite Da m.

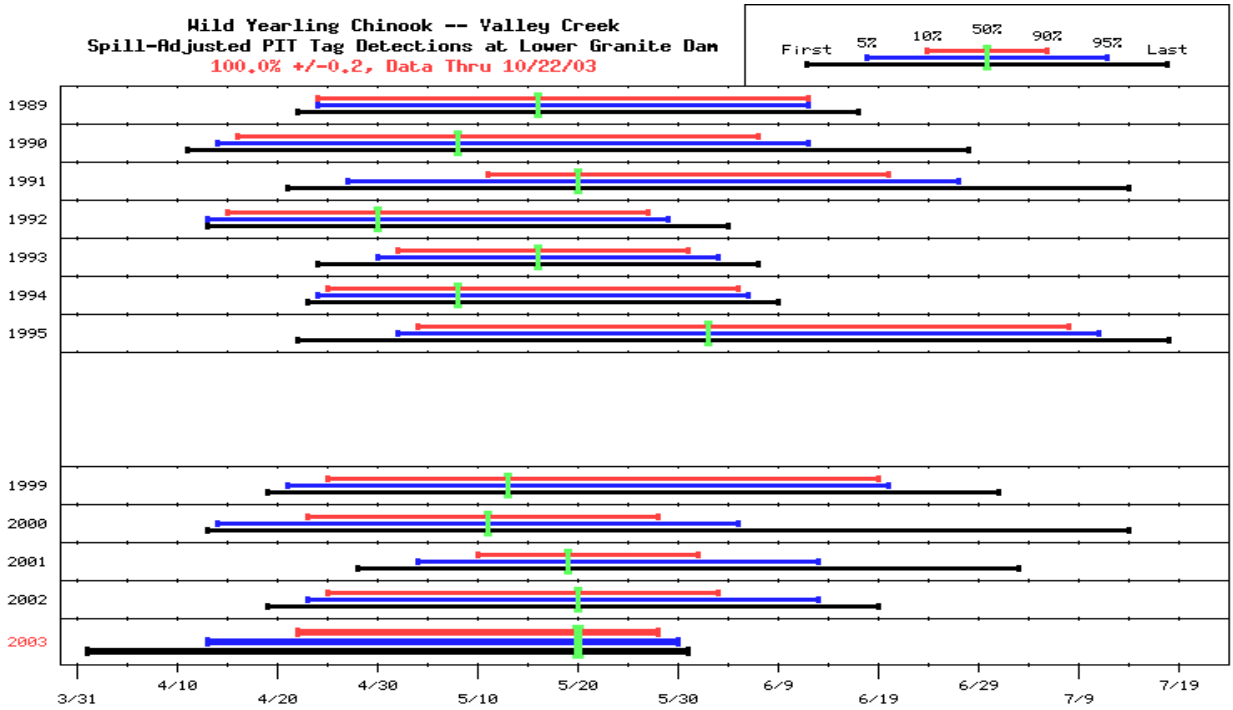


Passage date at Lower Granite Dam, based on PIT-tag detections

Table B22: Historical Sulfur 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	04/11	04/16	04/18	04/30	05/31	06/03	06/27	44	1043	83	83.0	8.0
1992	04/10	04/15	04/16	05/03	05/23	05/26	06/01	38	210	24	24.0	11.4
1993	04/24	04/27	05/02	05/16	06/04	06/15	06/29	34	712	28	41.6	5.8
1995	04/11	04/25	05/06	05/23	06/09	06/21	07/02	35	728	56	80.2	11.0
1999	04/22	04/24	04/24	05/19	05/27	05/29	05/29	34	443	17	42.1	9.5
2000	04/12	04/14	04/16	05/07	05/23	05/26	05/30	38	838	52	99.0	11.8
2003	04/22	04/23	05/02	05/27	06/11	06/13	06/30	38	560	25	50.4	9.0

Figure B23: Historical Valley Creek outmigration run-timing at Lower Granite Dam.



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

Table B23: 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
2003	04/01	04/13	04/22	05/20	05/28	05/30	05/31	37	2266	50	104.2	4.6

Figure B24: Historical RealTime/CRiSP Composite outmigration run-timing to LWG.

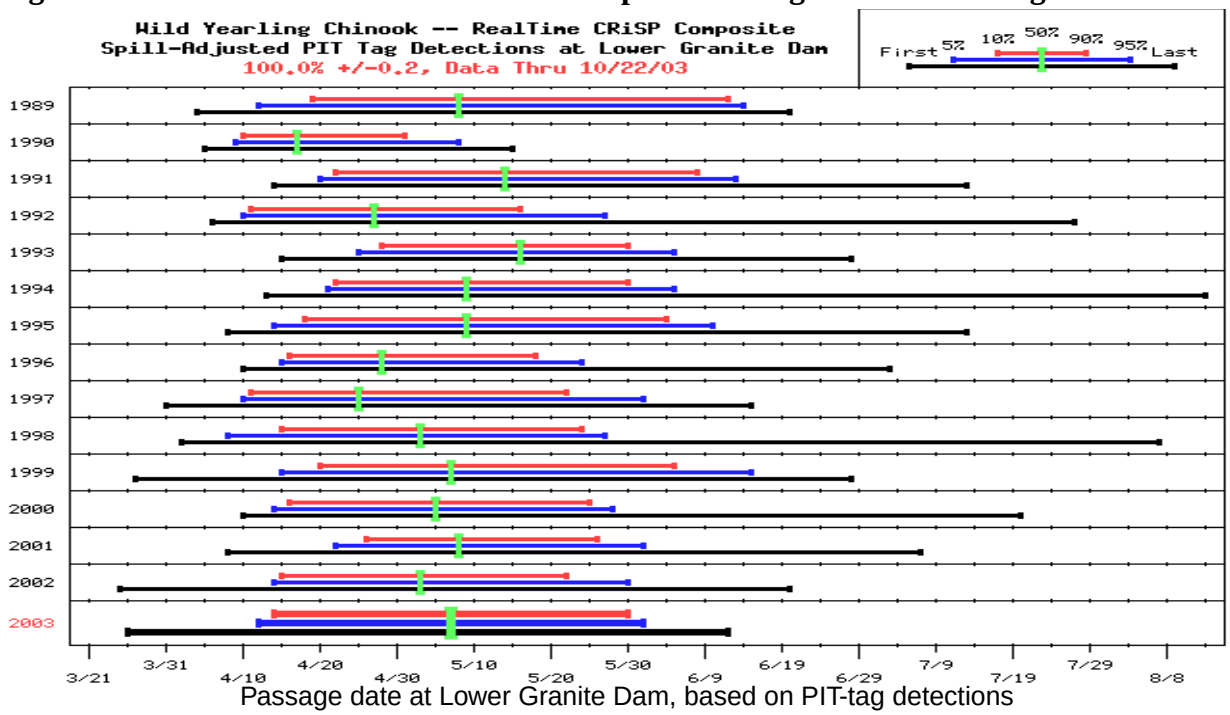


Table B24: Historical RealTime/CRiSP Composite outmigration timing characteristics.

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
2003	03/26	04/12	04/14	05/07	05/30	06/01	06/12	47	6137	235	488.6	8.0

Figure B25: Historical outmigration run-timing of the wild PIT-tagged run-at-large of Yearling Chinook Salmon at Lower Granite Dam.

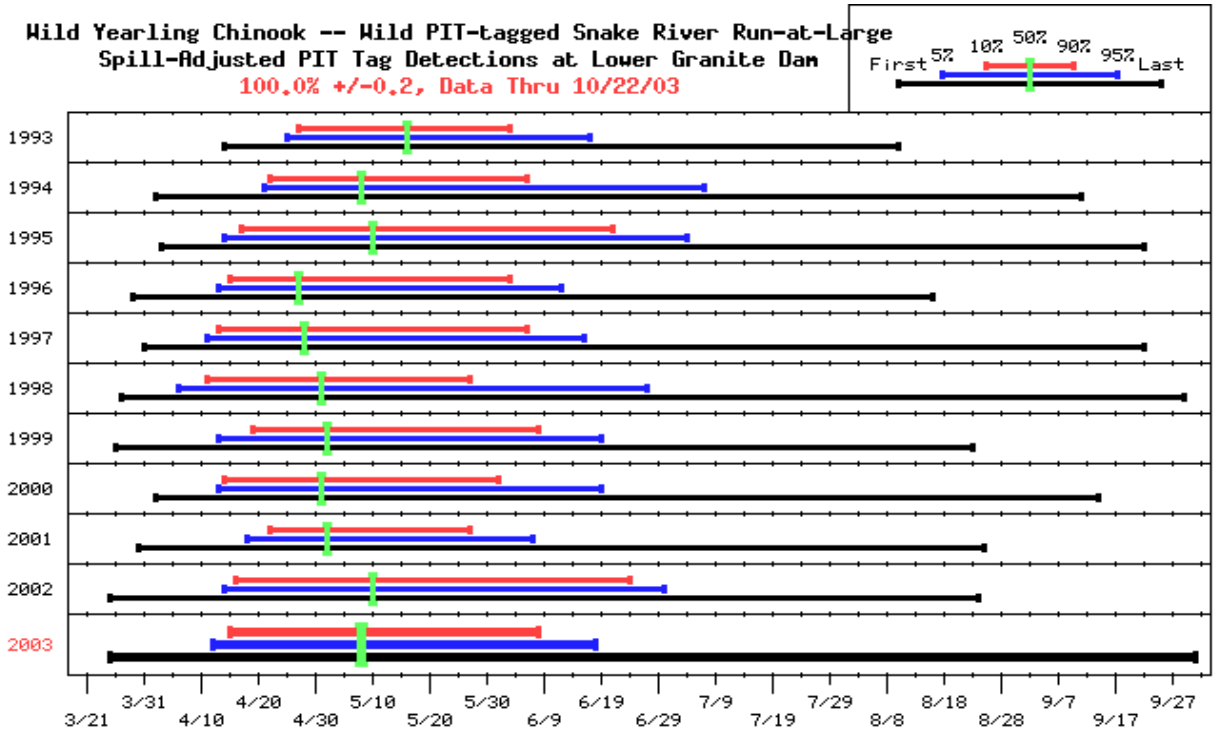


Table B25: Historical PIT-tagged Run-at-Large of Wild Yearling Chinook Salmon outmigration timing characteristics at Lower Granite Dam.

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
2003	03/25	04/12	04/15	05/08	06/08	06/18	10/01	55	20782

Figure B26: Historical outmigration run-timing of the composite of hatchery PIT-tagged Sockeye Salmon from Redfish Lake at Lower Granite Dam.

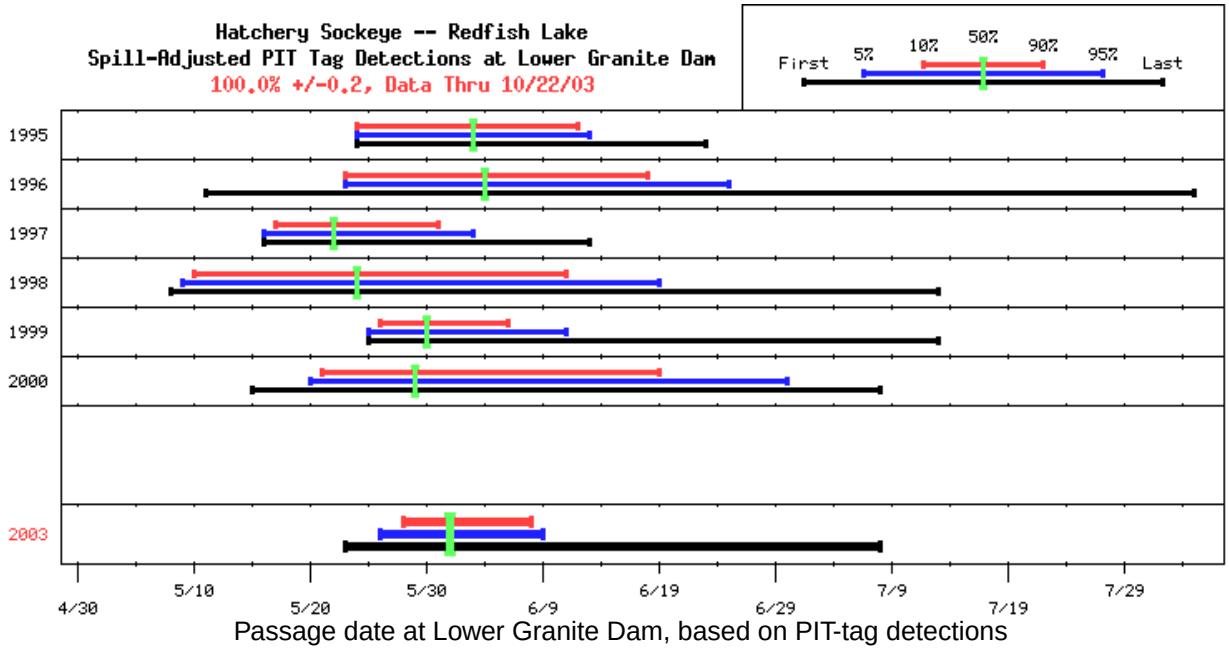


Table B26: Historical Composite of Redfish Lake PIT-tagged hatchery-reared sockeye salmon outmigration timing characteristics.

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
2003	05/23	05/26	05/28	06/01	06/08	06/09	07/08	12	2022	51	123.1	6.1

Figure B27: Historical Alturas Lake outmigration run-timing at Lower Granite Da m.

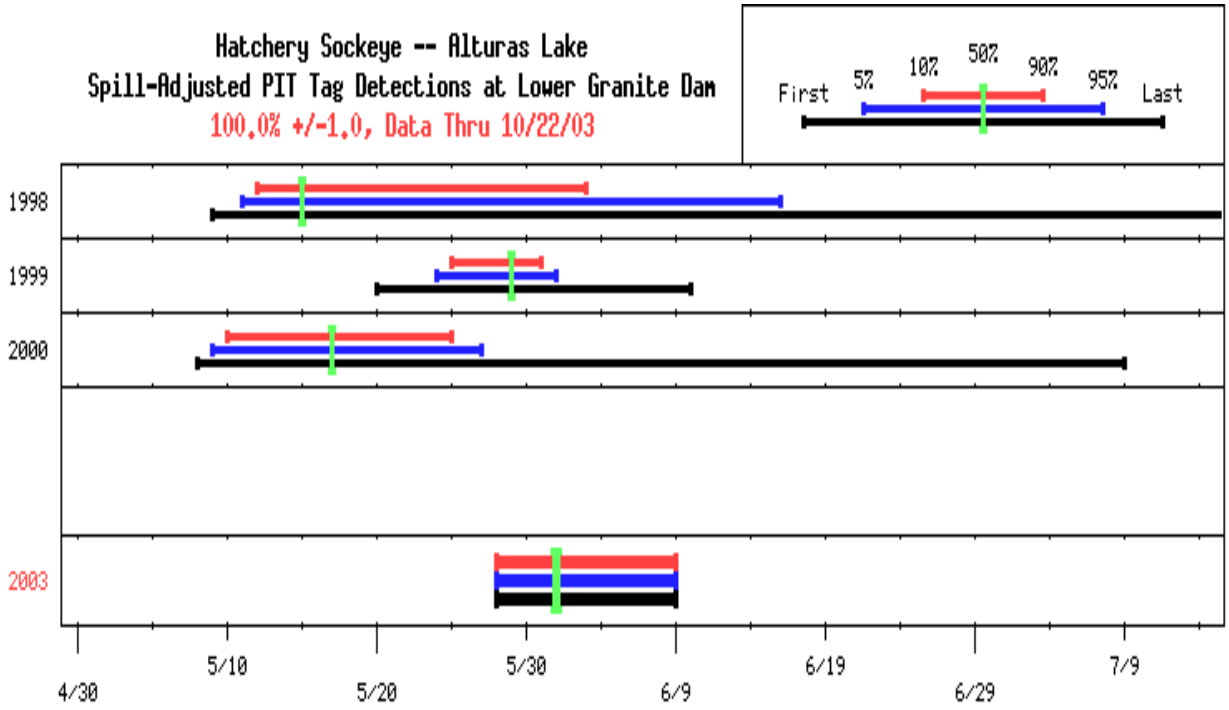


Table B27: Historical Alturas Lake outmigration timing characteristics.

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	05/09	05/11	05/12	05/15	06/03	06/16	07/19	23	1860	220	423.2	22.8
1999	05/20	05/24	05/25	05/29	05/31	06/01	06/10	7	1246	140	350.3	28.1
2000	05/08	05/09	05/10	05/17	05/25	05/27	07/09	16	1554	117	222.3	14.3
2003	05/28	06/01	06/01	07/12	07/22	07/27	08/25	13	1481	4	9.6	0.6

Figure B28: Historical outmigration run-timing of the subpopulation of wild PIT-tagged Subyearling Fall Chinook Salmon (SNAKER) at Lower Granite Dam.

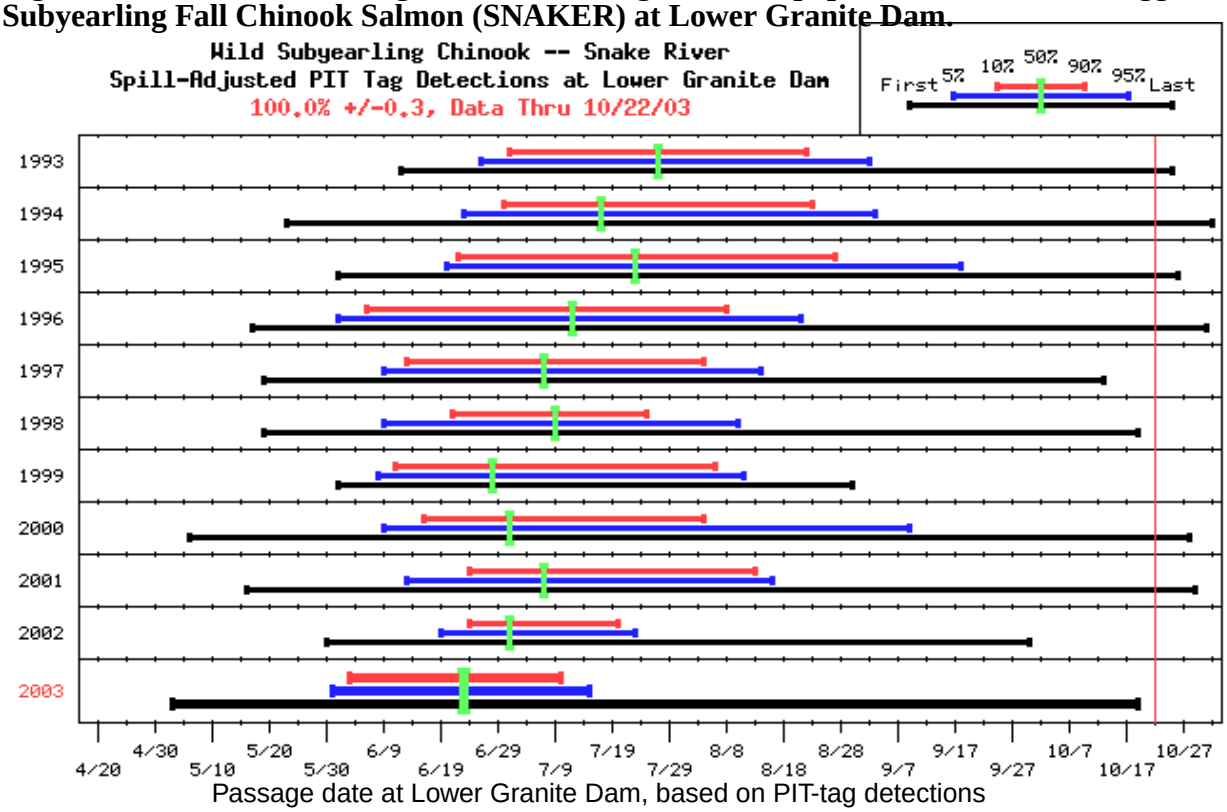


Table B28: Historical Wild PIT-tagged Subyearling Chinook Salmon (SNAKER) outmigration timing characteristics.

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
2003	05/03	05/31	06/03	06/23	07/10	07/15	10/16	38	4739	1130	1459	30.8

Figure B29: Historical outmigration run-timing of the wild PIT-tagged Run-at-Large of Steelhead Trout at Lower Granite Dam.

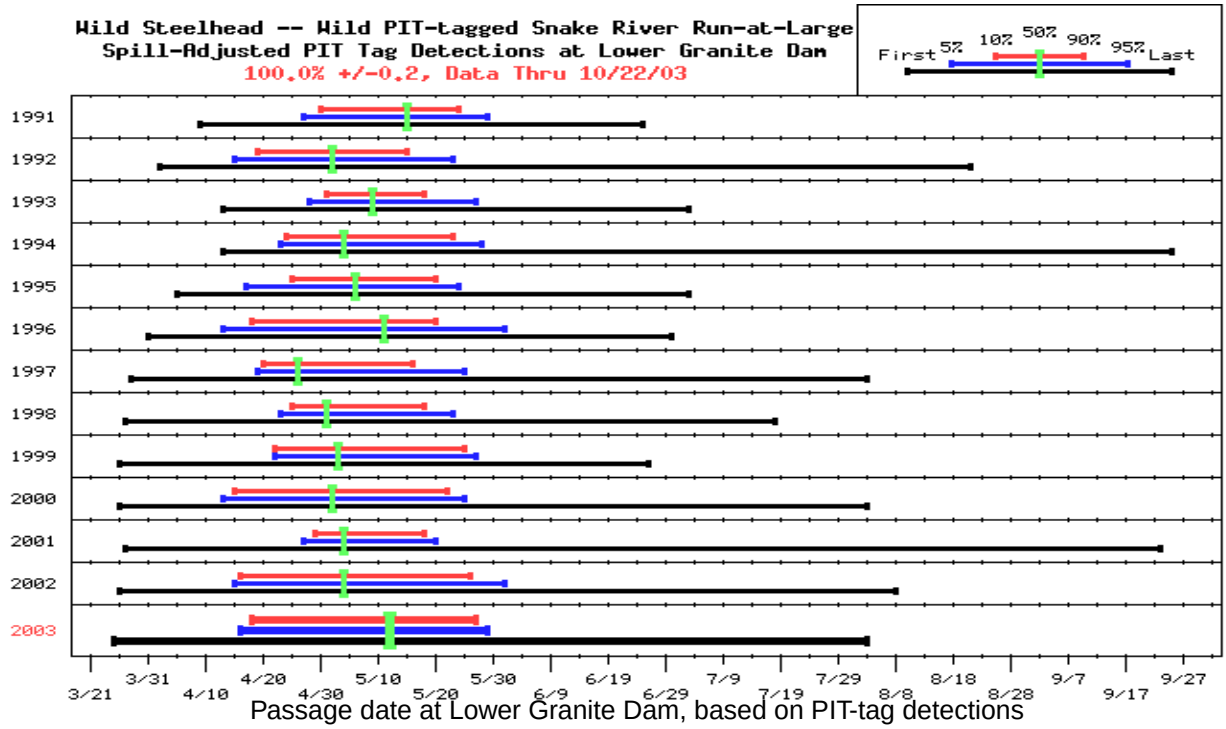


Table B29: Historical PIT-tagged Run-at-Large of Wild Steelhead Trout Outmigration timing characteristics at Lower Granite Dam.

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
2003	03/25	04/16	04/18	05/12	05/27	05/29	08/03	40	10466

Figure B30: Historical outmigration run-timing at McNary Dam of the wild PIT-tagged Run-at-Large of Snake River Subyearling Fall Chinook Salmon.

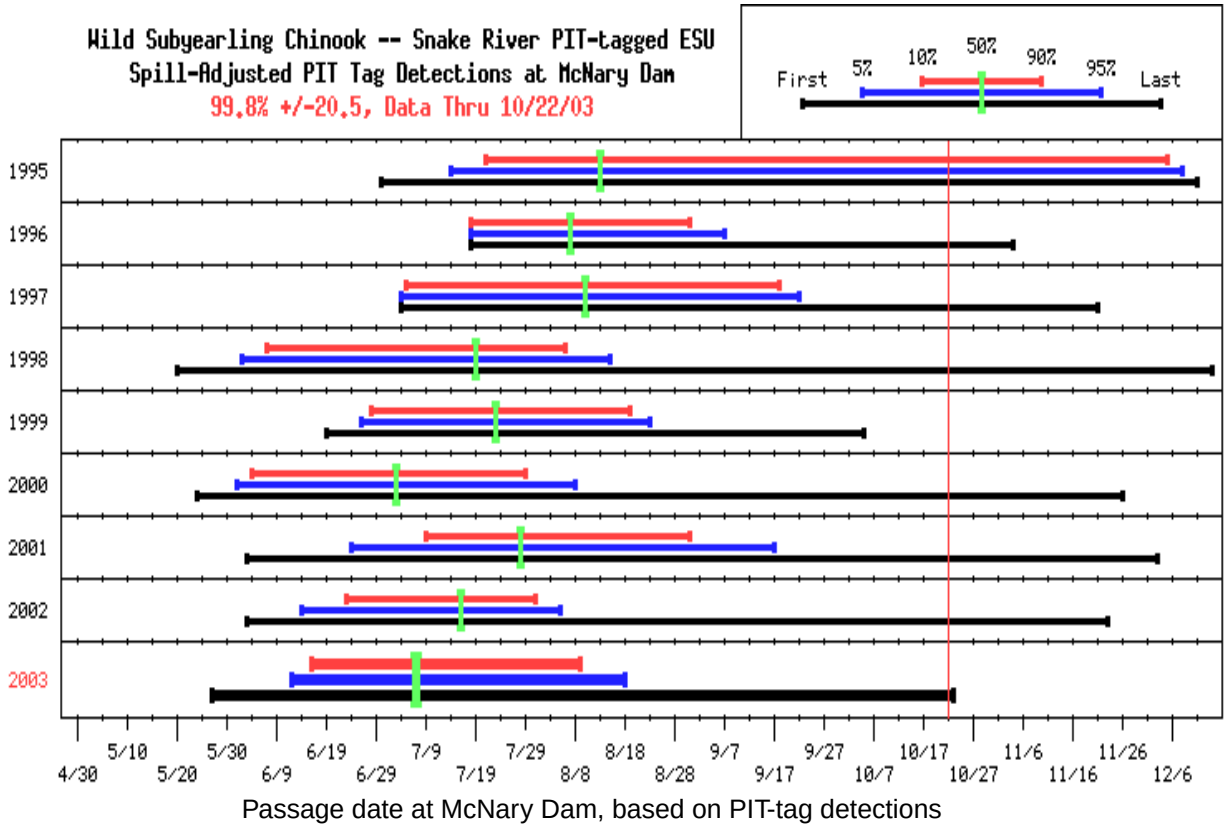


Table B30: Historical outmigration timing characteristics of wild PIT-tagged Snake River Subyearling Fall Chinook Salmon detected at McNary Dam.

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
2003	05/27	06/12	06/16	07/07	08/09	08/18	09/06	55	688

Figure B31: Historical outmigration run-timing at McNary Dam of the wild PIT-tagged Run-at-Large of Upper Columbia River Subyearling Fall Chinook Salmon.

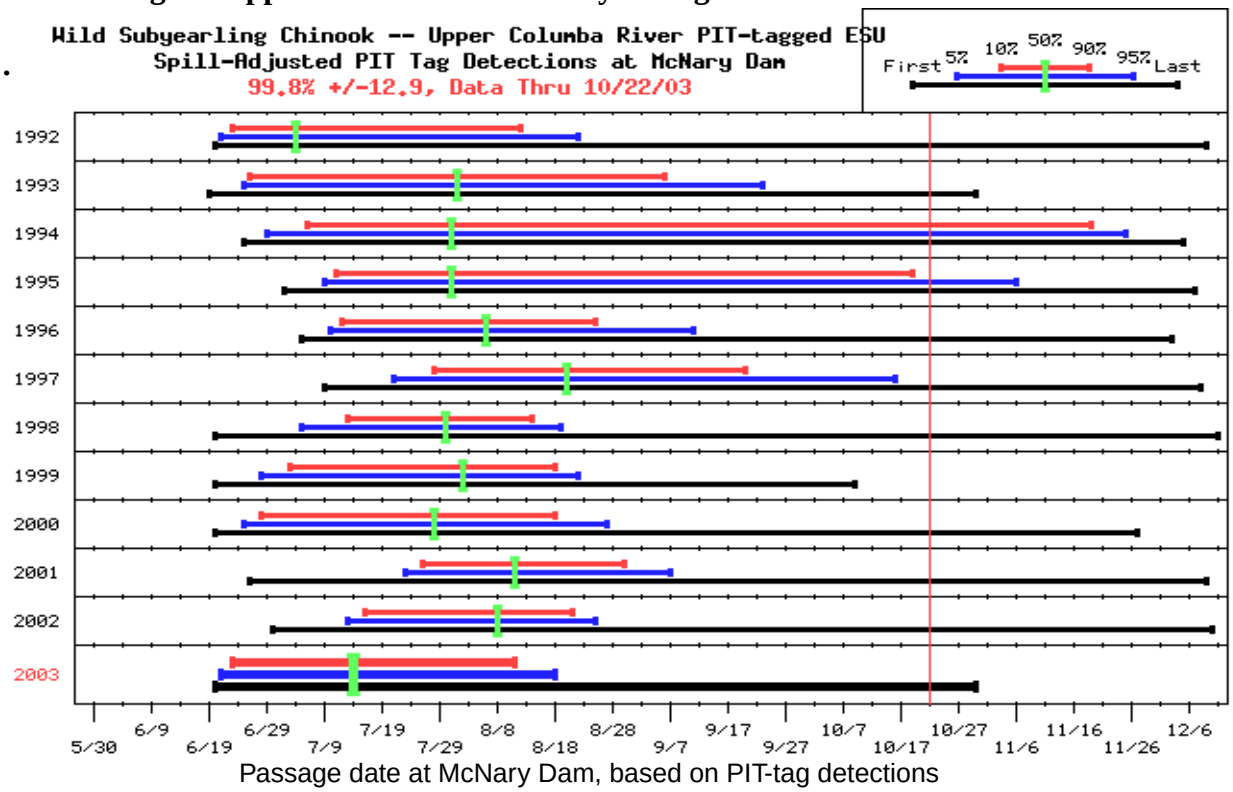


Table B31: Historical outmigration timing characteristics of wild PIT-tagged Columbia River Subyearling Fall Chinook Salmon detected at McNary Dam.

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
2003	06/20	06/21	06/23	07/14	08/13	08/19	10/24	50	1354

Figure B32: Historical outmigration run-timing at McNary Dam of the wild PIT-tagged Run-at-Large of Snake River Yearling Chinook Salmon.

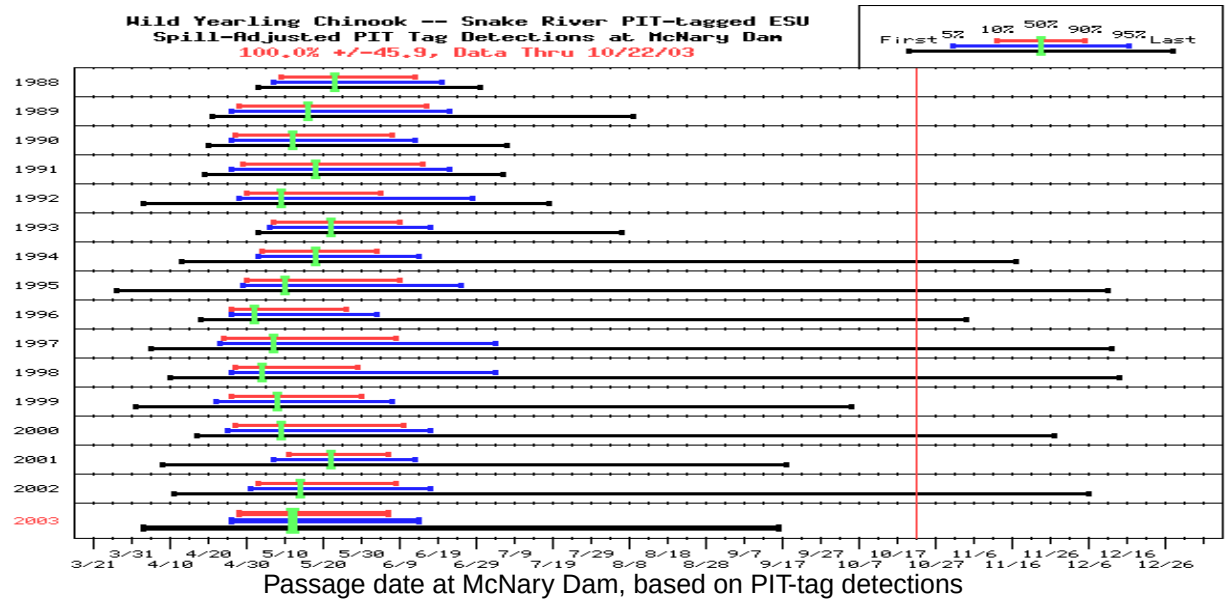


Table B32: Historical outmigration timing characteristics of wild PIT-tagged Snake River Yearling Chinook Salmon detected at McNary Dam.

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
2003	04/03	04/26	04/28	05/12	06/06	06/14	10/17	40	24878

Figure B33: Historical outmigration run-timing at McNary Dam of the run-at-large of wild PIT-tagged Snake River Sockeye Salmon.

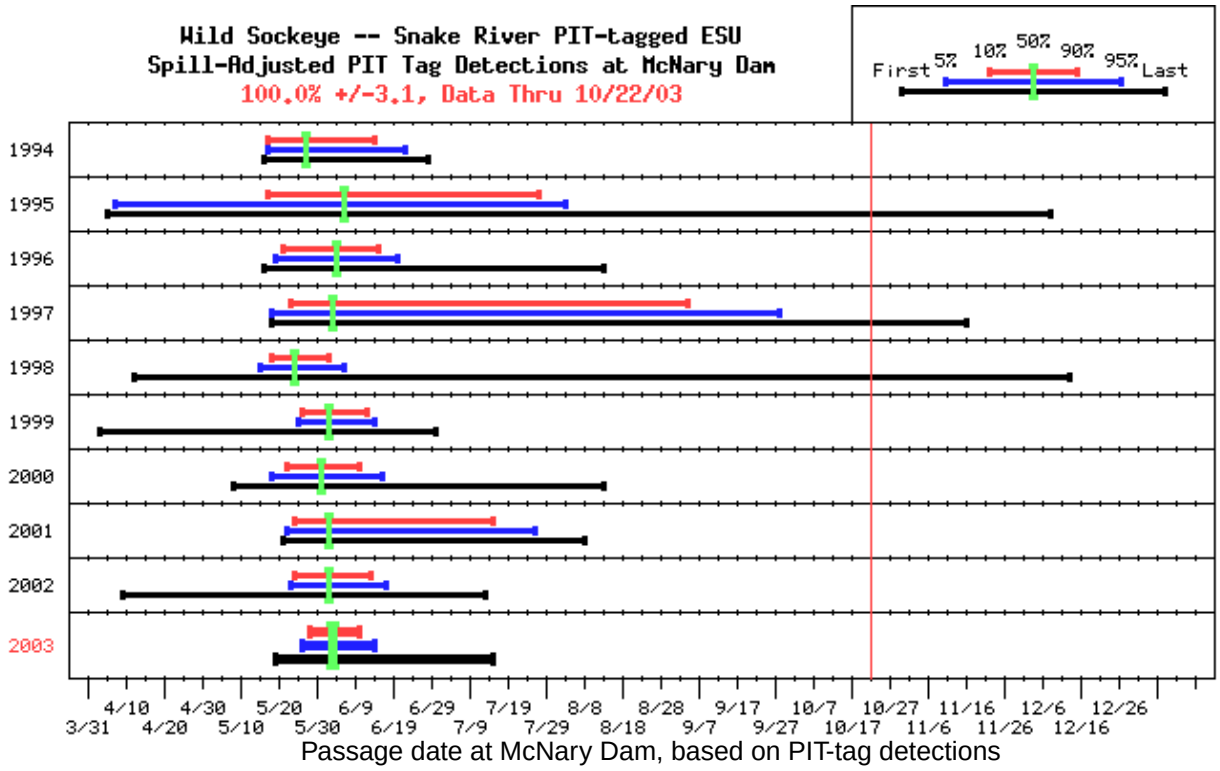


Table B33: Historical outmigration timing characteristics of wild PIT-tagged Snake River Sockeye Salmon detected at McNary Dam.

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
2003	05/19	05/26	05/28	06/03	06/11	06/14	08/09	14	615

Figure B34: Historical timing at McNary Dam of wild PIT-tagged Snake River Steelhead.

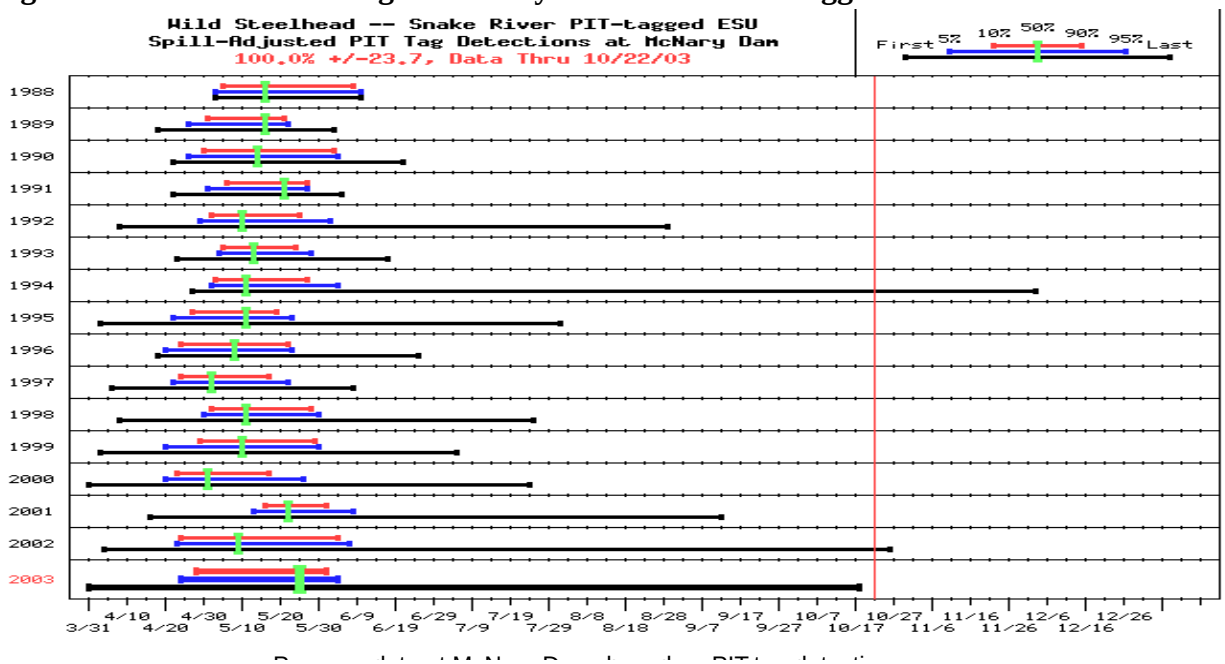


Table B34: Historical outmigration timing characteristics of wild PIT-tagged fish.

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
2003	03/31	04/24	04/28	05/25	06/01	06/04	10/16	35	6367

Figure B35: Historical run-timing at McNary Dam of Upper. Col. R. Steelhead.

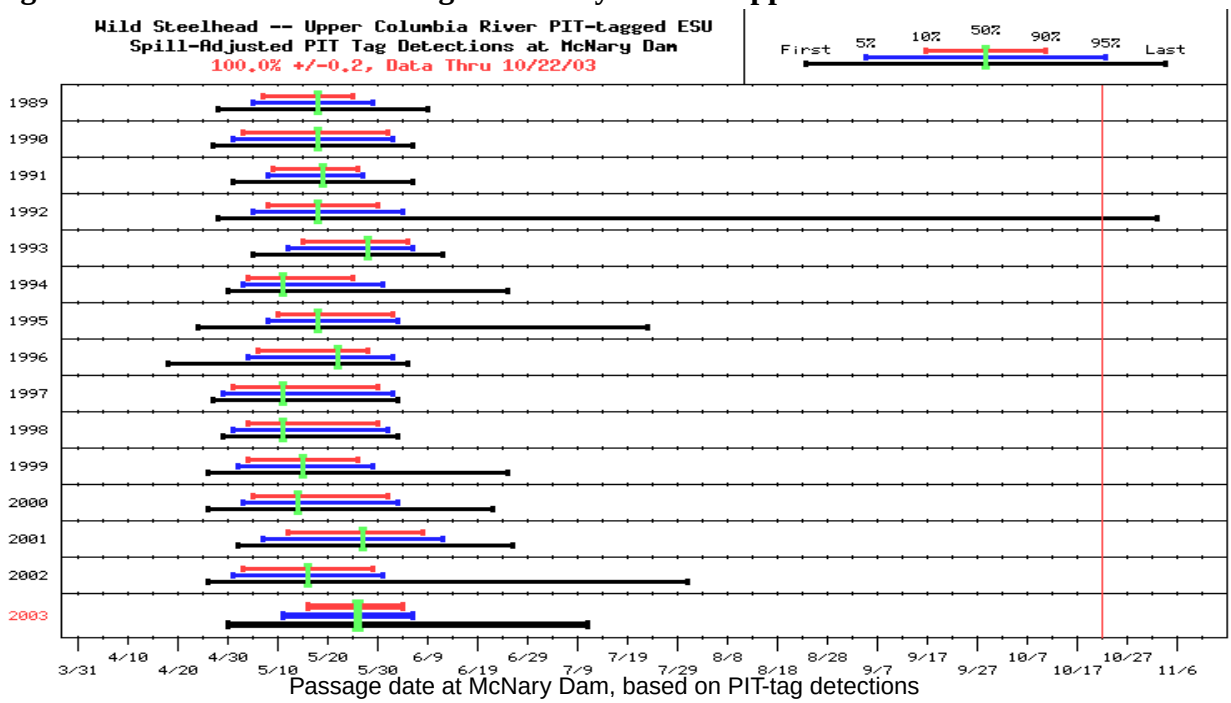


Table B35: Historical outmigration timing characteristics.

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
2003	04/30	05/10	05/15	05/26	06/04	06/06	07/11	20	29860

Figure B36: Historical outmigration run-timing at McNary Dam of Steelhead.

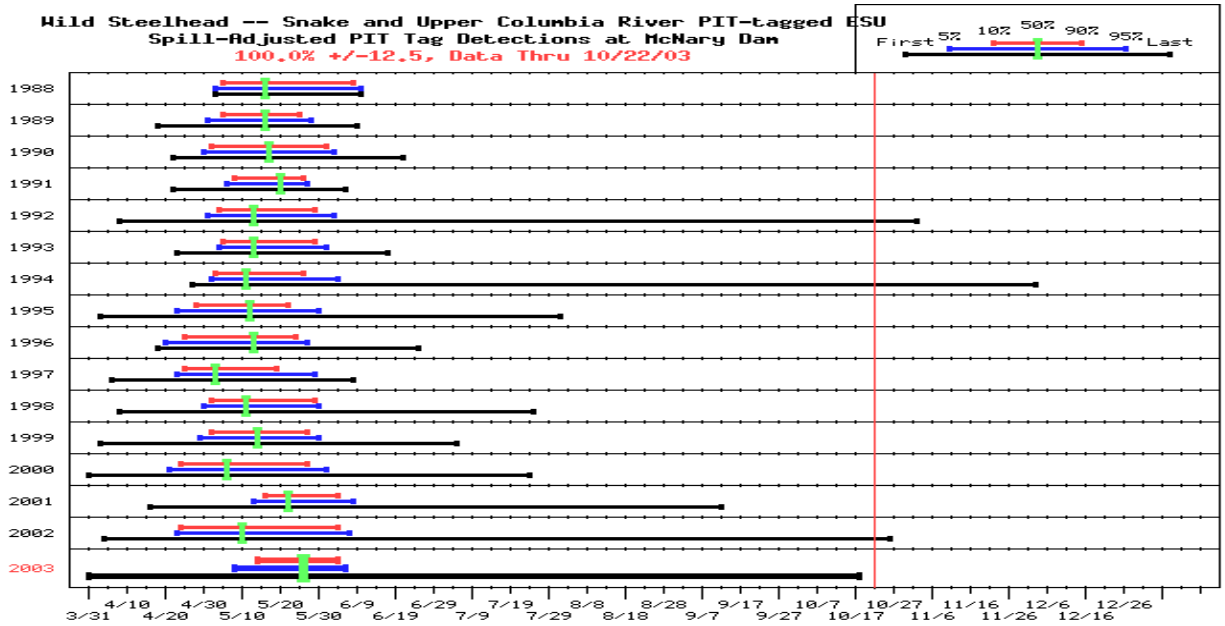


Table B36: Historical outmigration timing characteristics (Sn. and U.Col. R. steelhead.

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
2003	03/31	05/08	05/14	05/26	06/04	06/06	10/16	22	36227

Figure B37: Historical outmigration run-timing at John Day Dam of the Run-at-Large of combined wild and hatchery subyearling chinook salmon.

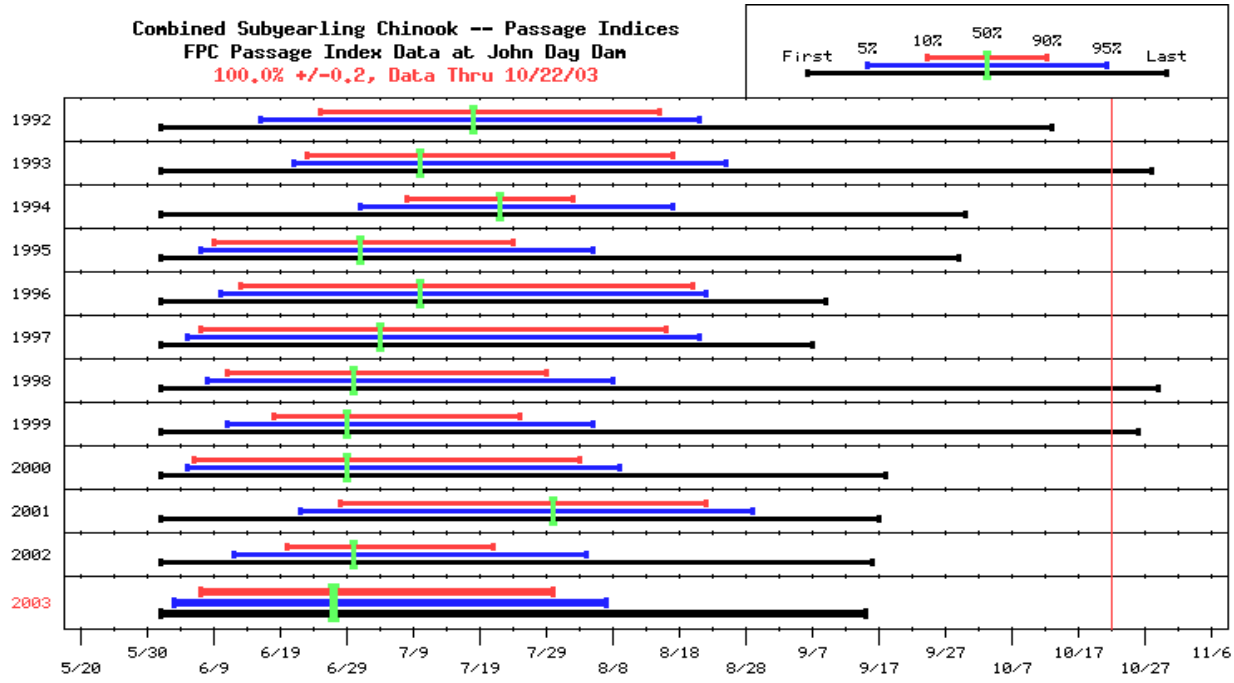


Table B37: Historical Combined Wild and Hatchery Subyearling Chinook Salmon outmigration timing characteristics at John Day Dam.

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
2003	06/01	06/03	06/07	06/27	07/30	08/07	09/15	54	2679137	2713873

Figure B38: Historical outmigration run-timing at McNary Dam of the Run-at-Large of Combined Wild and Hatchery Subyearling Chinook Salmon.

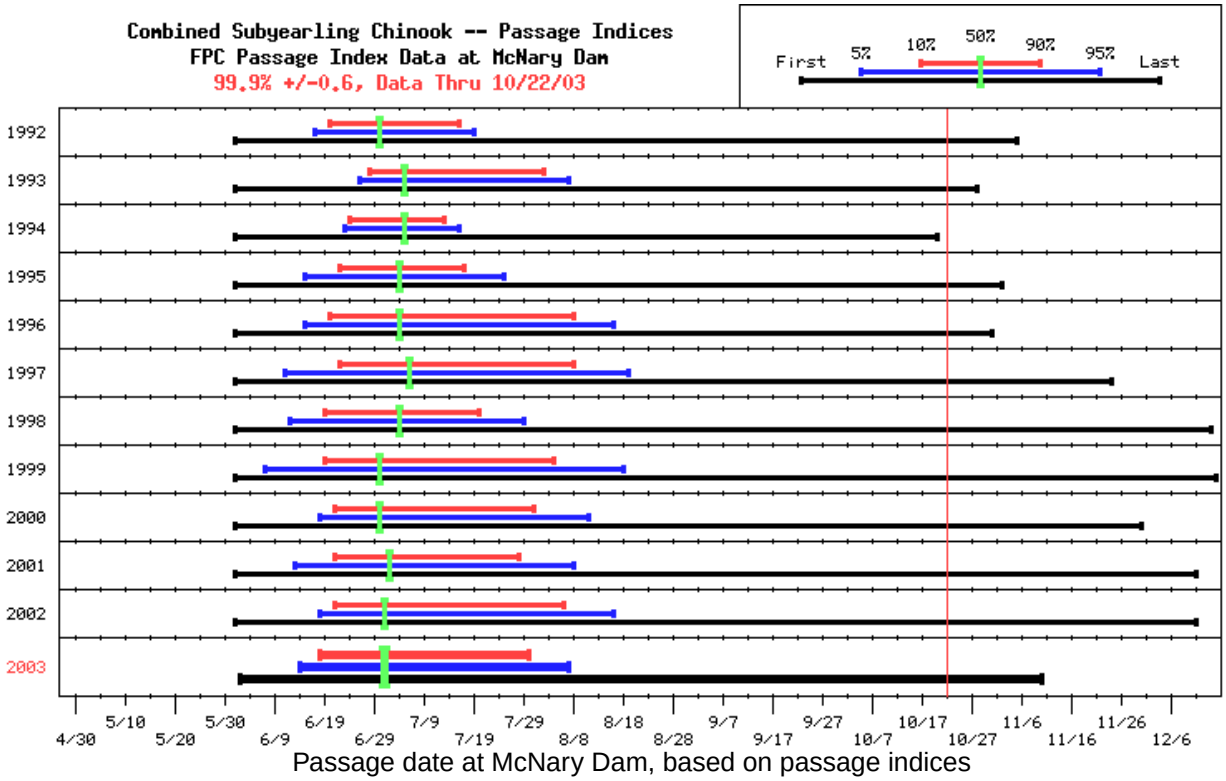


Table B38: Historical Combined Wild and Hatchery Subyearling Chinook Salmon outmigration timing characteristics at McNary Dam.

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
2003	06/02	06/14	06/18	07/01	07/30	08/08	11/13	43	7494364	7682087

Figure B39: Historical Passage-Indexed Run-at-Large of Wild and Hatchery Subyearling Chinook Salmon outmigration run-timing at Rock Island Dam.

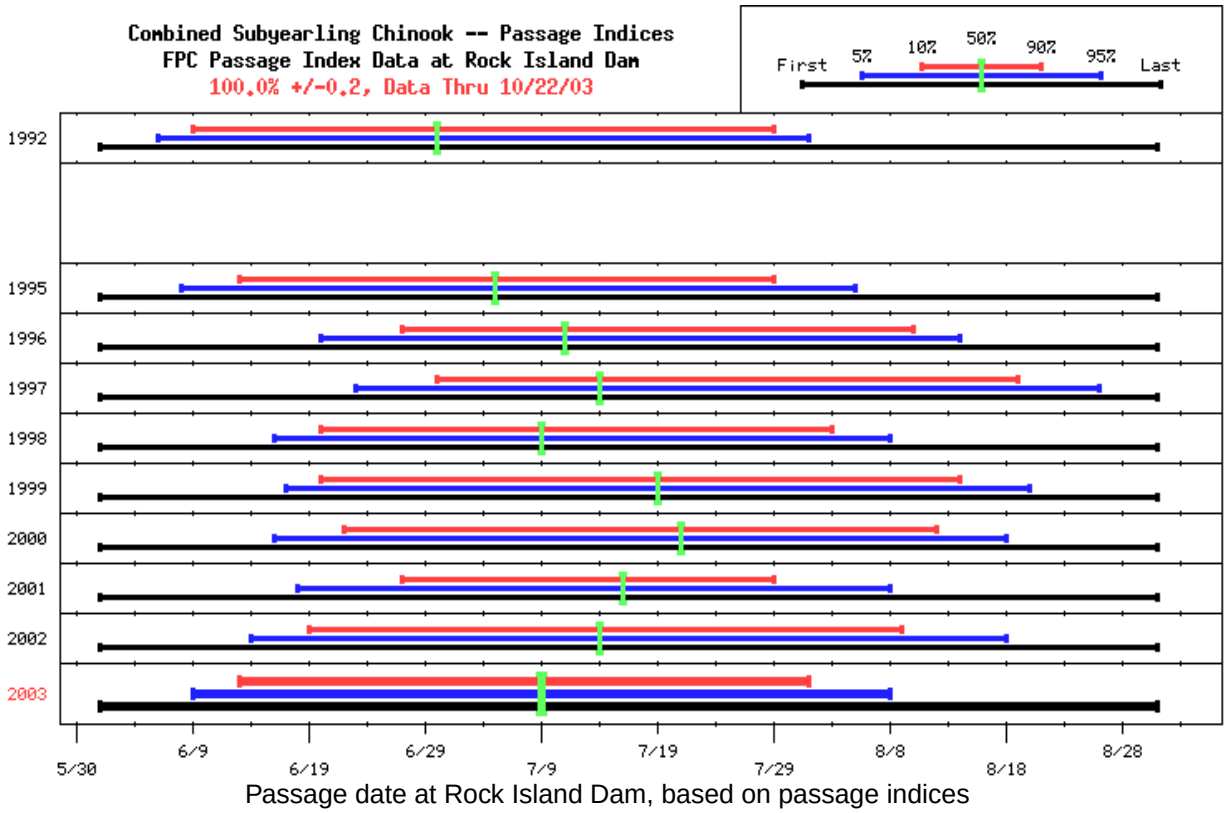
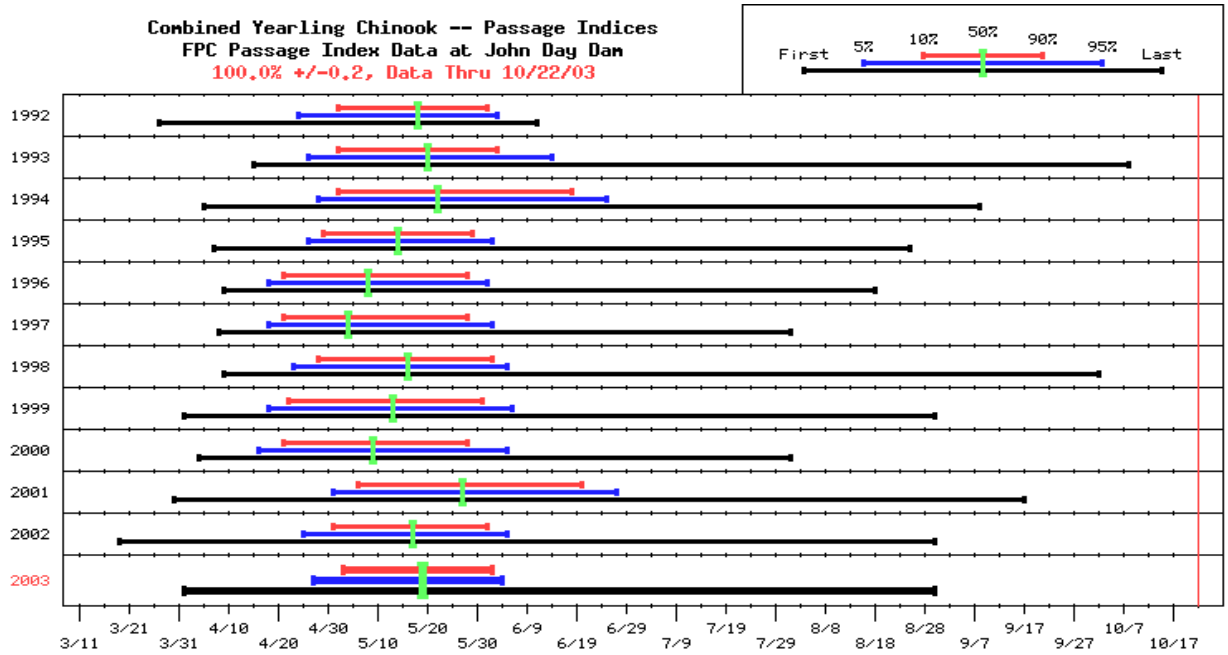


Table B39: Historical Combined Wild and Hatchery Subyearling Chinook Salmon outmigration timing characteristics at Rock Island Dam.

Year	Passage Dates							Duration Middle 80% (days)	Post-June 1 RIS Passage	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
2003	06/01	06/09	06/13	07/09	08/01	08/08	08/31	50	25916	28113

Figure B40: Historical outmigration run-timing at John Day Dam of the Run-at-Large of Combined Wild and Hatchery Yearling Chinook Salmon.



Passage date at John DayDam, based on passage indices

Table B40: 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
2003	04/01	04/27	05/03	05/19	06/02	06/04	08/30	31	2074457

Figure B41: Historical outmigration run-timing at McNary Dam of the Run-at-Large of Combined Wild and Hatchery Yearling Chinook Salmon.

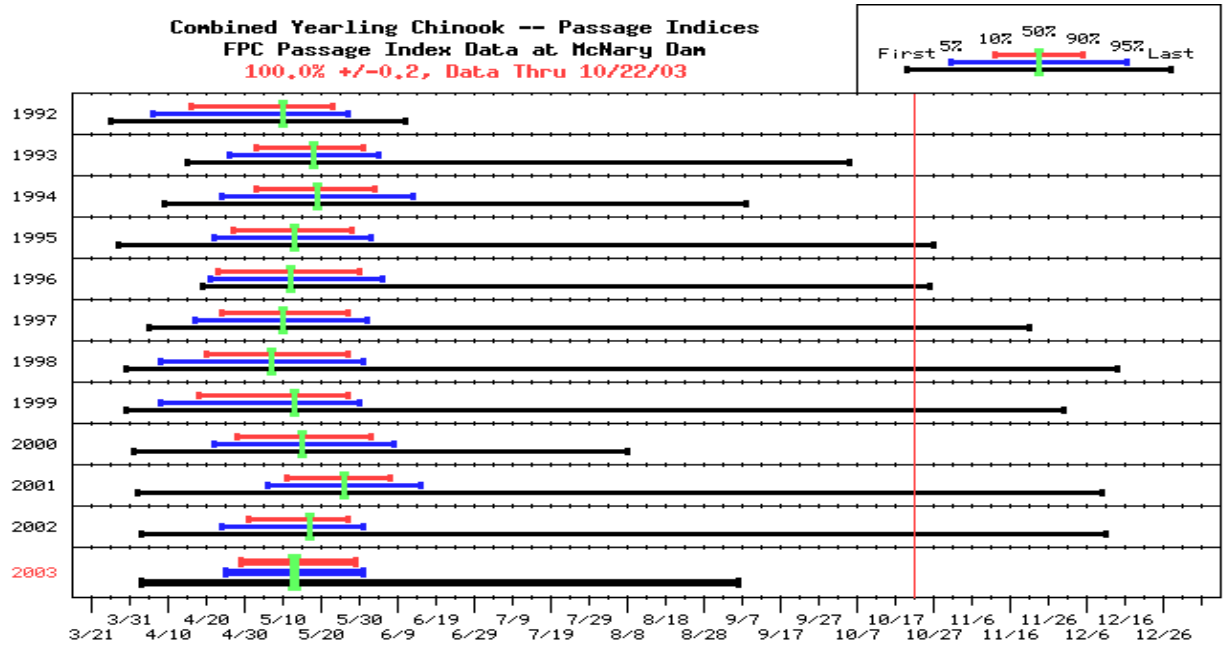
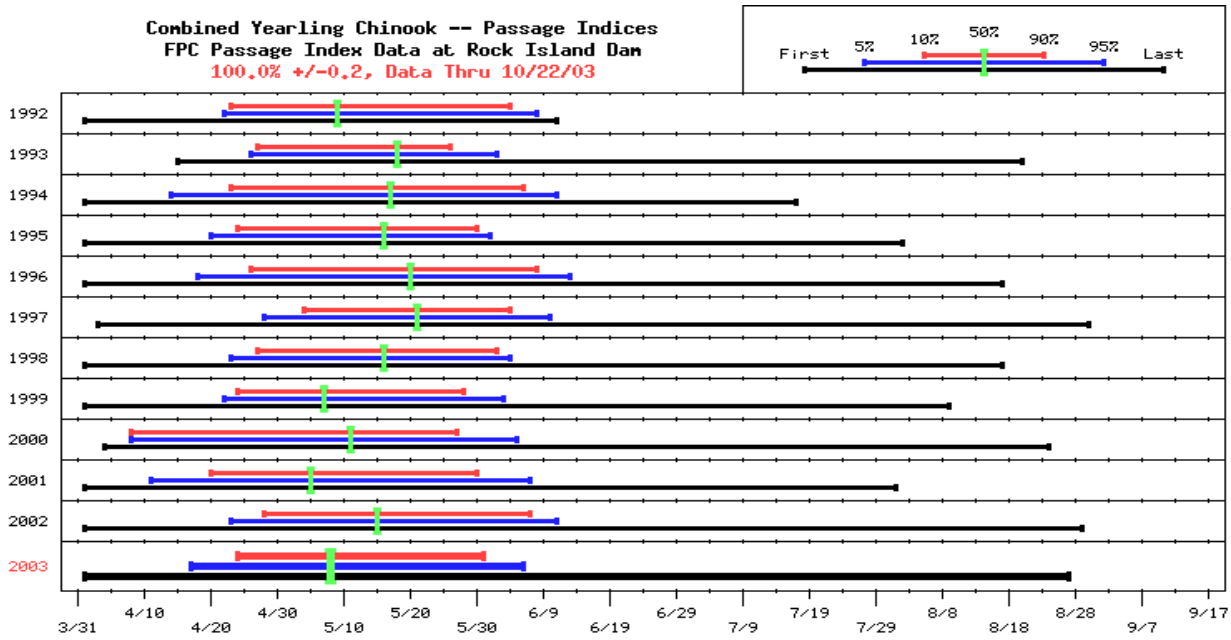


Table B41: Historical Combined Wild and Hatchery Yearling Chinook Salmon outmigration timing characteristics at McNary Dam.

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
2003	04/03	04/25	04/29	05/13	05/29	05/31	09/06	31	1624087

Figure B42: Historical outmigration run-timing at Rock Island Dam of the Run-at-Large of Combined Wild and Hatchery Yearling Chinook Salmon.



Passage date at Rock Island Dam, based on passage indices

Table B42: 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
2003	04/01	04/17	04/24	05/08	05/31	06/06	08/27	38	15355

Figure B43: Historical outmigration run-timing at John Day Dam of the Run-at-Large of Combined Wild and Hatchery Coho Salmon.

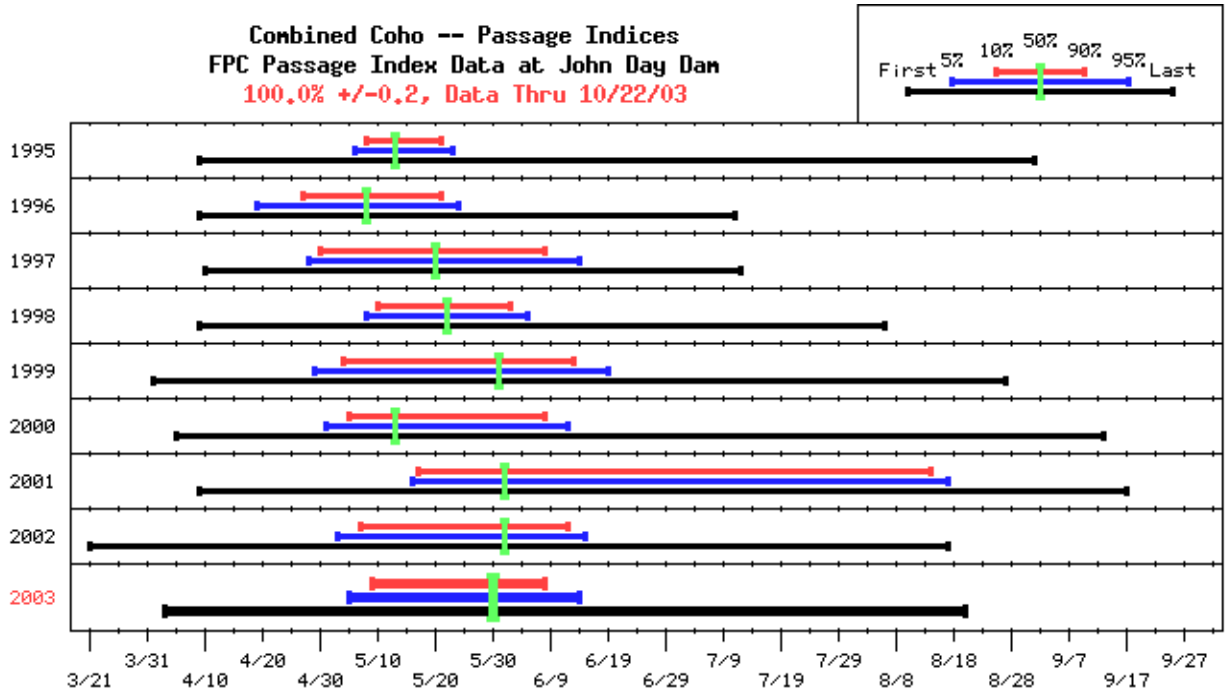


Table B43: Historical Combined Wild and Hatchery Coho Salmon outmigration timing characteristics at John Day Dam.

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
2003	04/03	05/05	05/09	05/30	06/08	06/14	08/20	31	258239

Figure B44: Historical outmigration run-timing at McNary Dam of the Run-at-Large of Combined Wild and Hatchery Coho Salmon.

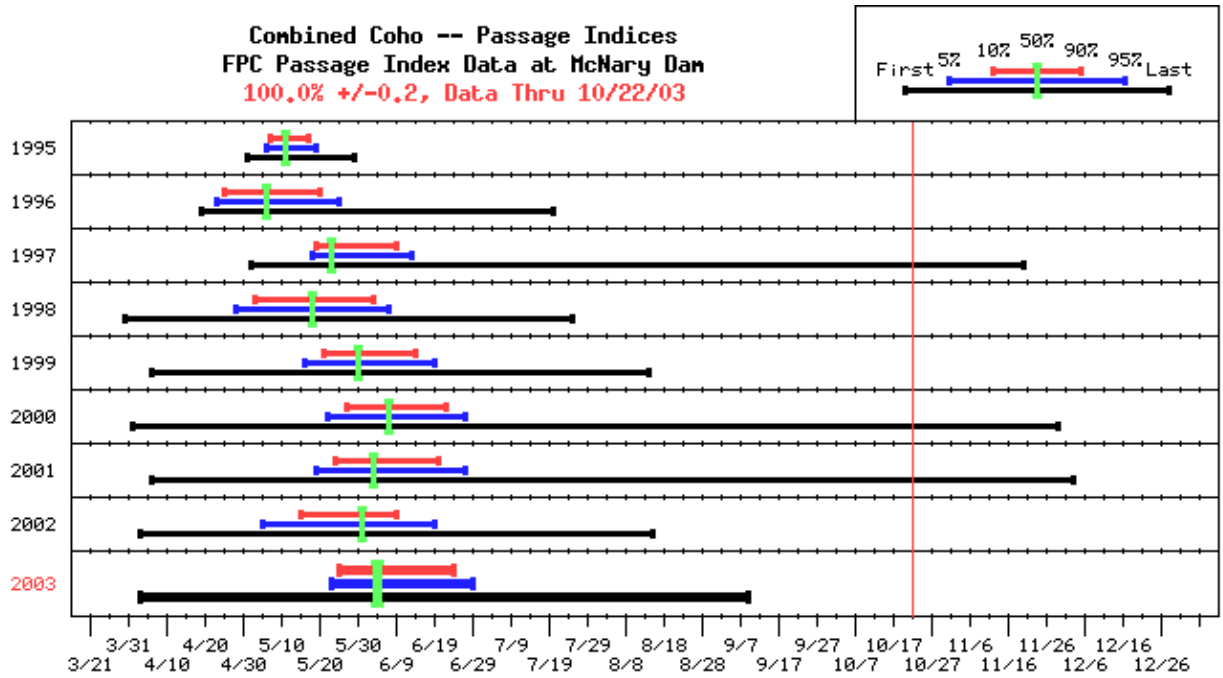


Table B44: Historical Combined Wild and Hatchery Coho Salmon outmigration timing characteristics at McNary Dam.

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
2003	04/03	05/23	05/25	06/04	06/24	06/29	09/09	31	113584

Figure B45: Historical outmigration run-timing at Rock Island Dam of the Run-at-Large of Combined Wild and Hatchery Coho Salmon.

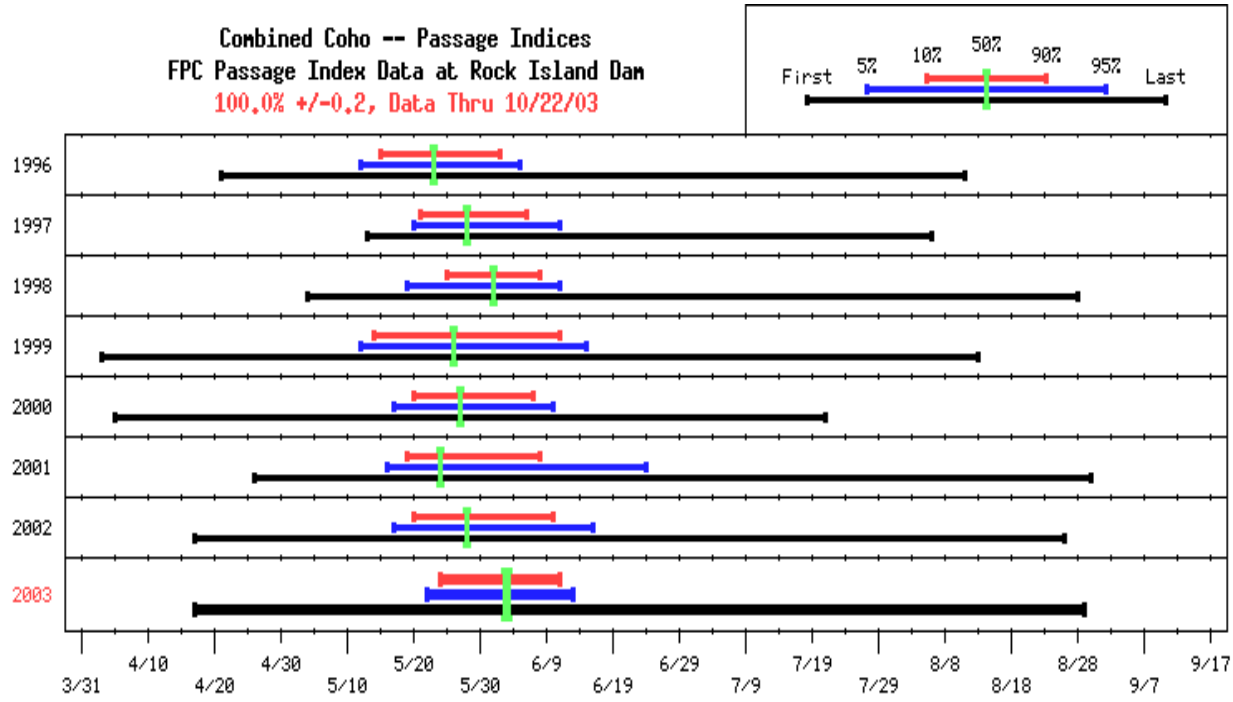


Table B45: Historical Combined Wild and Hatchery Coho Salmon outmigration timing characteristics at Rock Island Dam.

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
2003	04/17	05/22	05/24	06/03	06/11	06/13	08/29	19	41690

Figure B46: Historical outmigration run-timing at John Day Dam of the Run-at-Large of Combined Wild and Hatchery Sockeye Salmon.

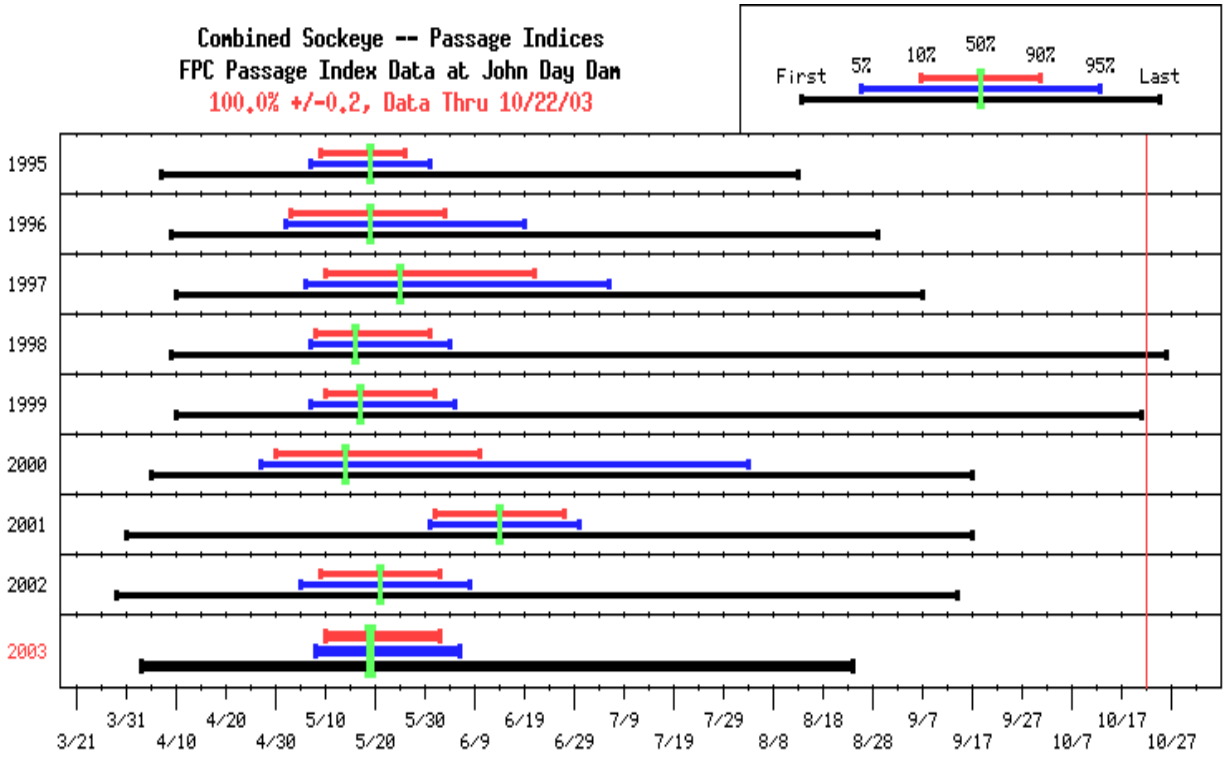
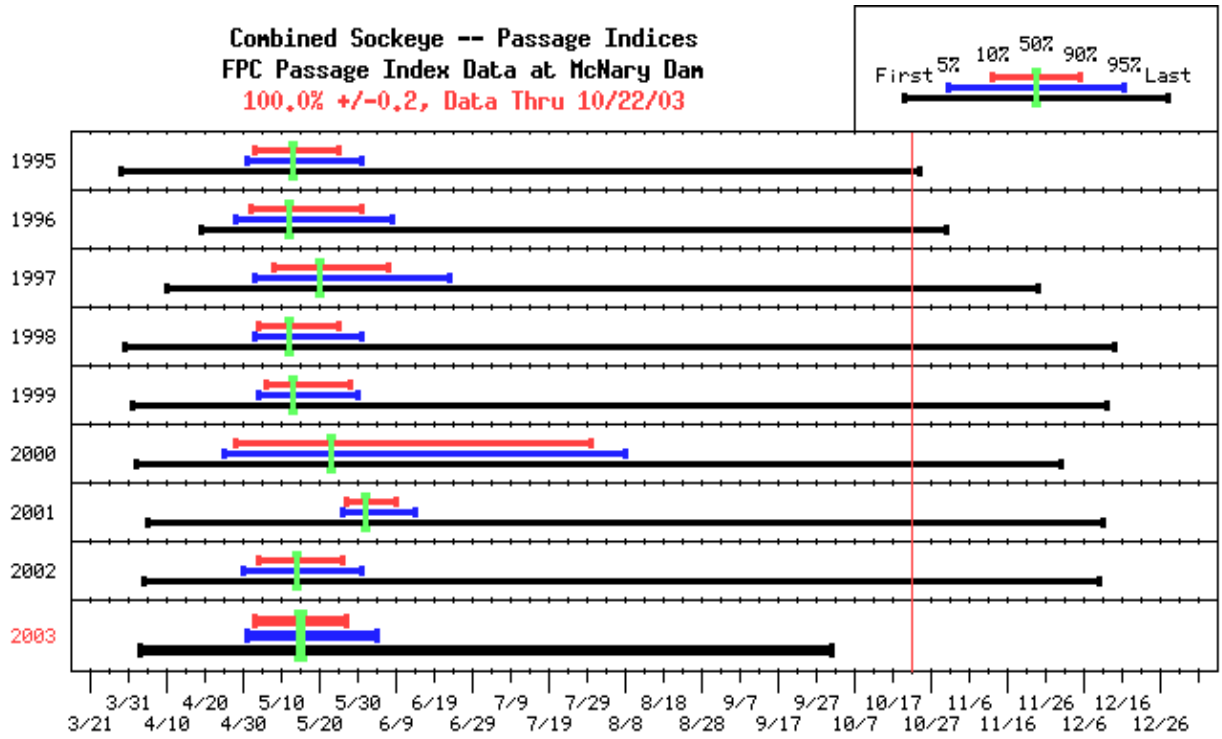


Table B46: Historical Combined Wild and Hatchery Sockeye Salmon outmigration timing characteristics at John Day Dam.

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
2003	04/03	05/08	05/10	05/19	06/02	06/06	08/24	24	725830

Figure B47: Historical outmigration run-timing at McNary Dam of the Run-at-Large of Combined Wild and Hatchery Sockeye Salmon.



Passage date at McNary Dam, based on passage indices

Table B47: 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
2003	04/03	05/01	05/03	05/15	05/27	06/04	10/01	25	841734

Figure B48: Historical outmigration run-timing at Rock Island Dam of the Run-at-Large of Combined Wild and Hatchery Sockeye Salmon.

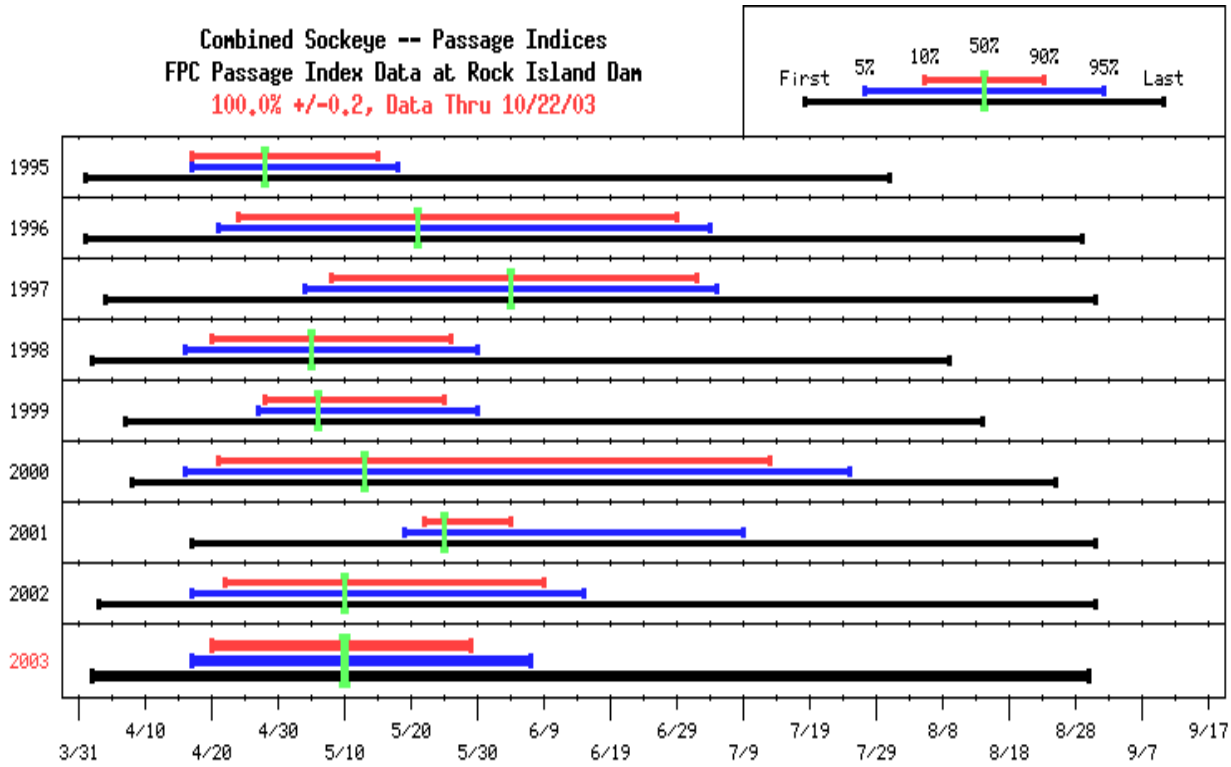


Table B48: Historical Combined Wild and Hatchery Sockeye Salmon outmigration timing characteristics at Rock Island Dam.

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
2003	04/02	04/17	04/20	05/10	05/29	06/07	08/30	40	10312

Figure B49: Historical outmigration run-timing at John Day Dam of the Run-at-Large of Combined Wild and Hatchery Steelhead Trout.

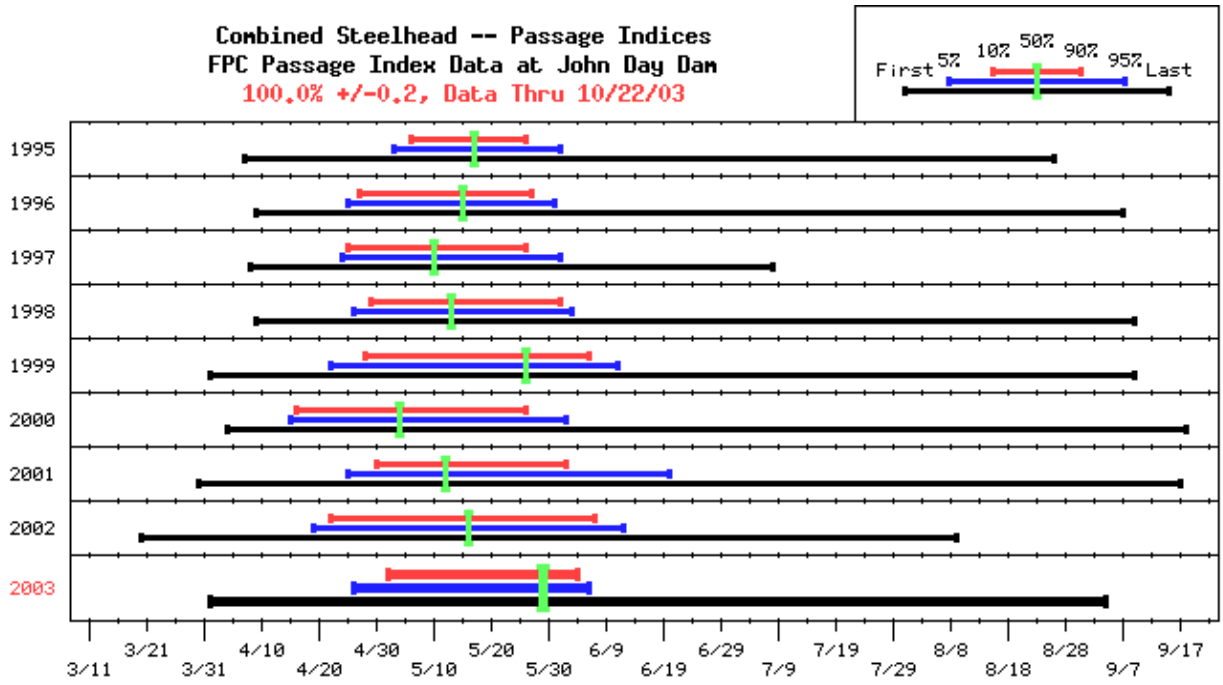


Table B49: Historical Combined Wild and Hatchery Steelhead Trout outmigration timing characteristics at John Day Dam.

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
2003	04/01	04/26	05/02	05/29	06/04	06/06	09/04	34	553495

Figure B50: Historical outmigration run-timing at McNary Dam of the Run-at-Large of Combined Wild and Hatchery Steelhead Trout.

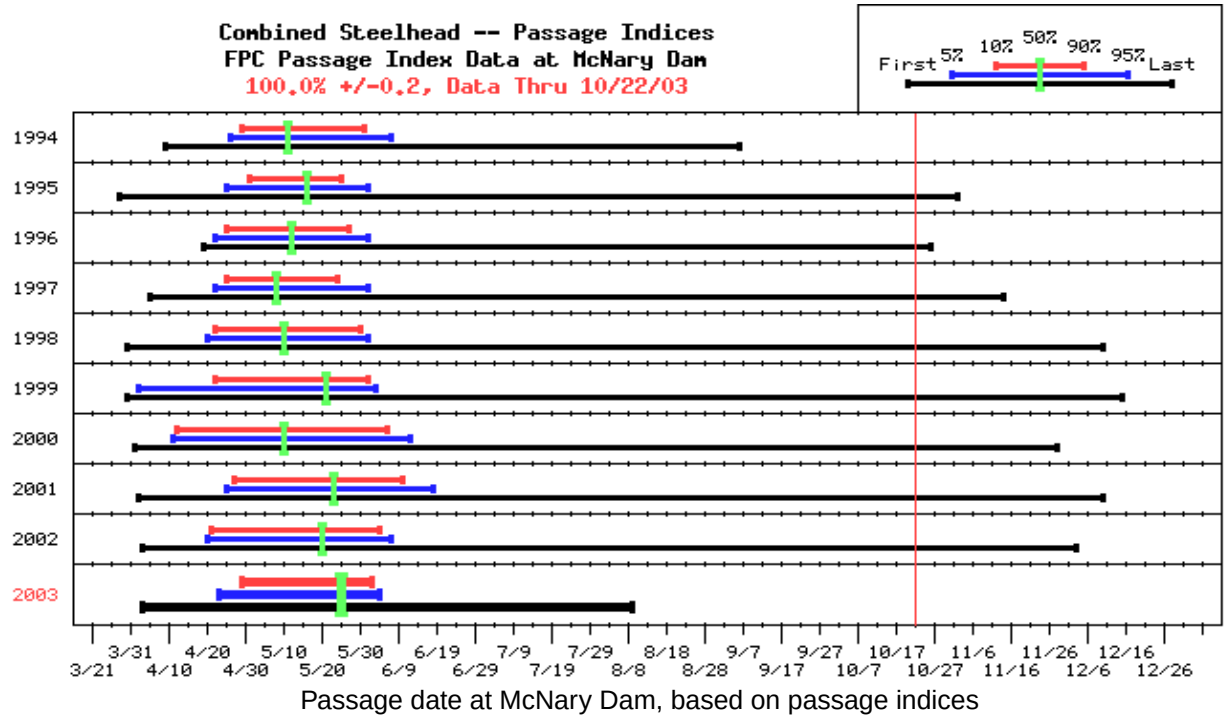


Table B50: Historical Combined Wild and Hatchery Steelhead Trout outmigration timing characteristics at McNary Dam.

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
2003	04/03	04/23	04/29	05/25	06/02	06/04	08/09	35	245583

Figure B51: Historical outmigration run-timing at Rock Island Dam of the Run-at-Large of Combined Wild and Hatchery Steelhead Trout.

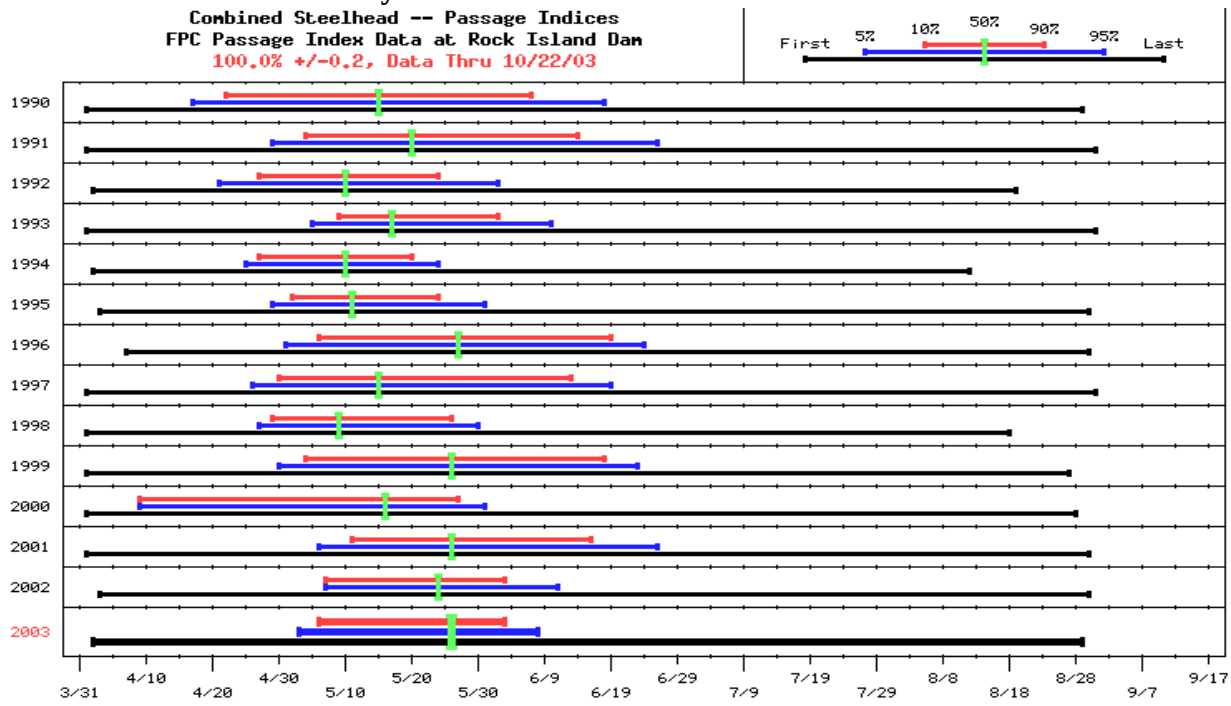


Table B51: Historical Combined Wild and Hatchery Steelhead Trout outmigration timing characteristics at Rock Island Dam.

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
2003	04/02	05/03	05/06	05/26	06/03	06/08	08/29	29	15507

Appendix C

Daily Expansion Factors for Spill-Adjusted PIT-Tagged Stocks Forecasted by Project RealTime in Migration Year 2003, including Chinook Salmon and Steelhead Trout at Lower Granite Dam and salmonids tracked to McNary Dam

Table C1: Migration year 2003 outflow and spill at Lower Granite Dam and McNary Dam and expansion factors used to upwardly adjust 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	76.3	10.2	1.41	1.37	172.9	0	1
04/04	70.8	20.4	2.06	1.81	174.4	0	1
04/05	68.7	20.1	2.08	1.82	173.4	0	1
04/06	66.8	19.4	2.07	1.81	173.5	0	1
04/07	62.5	20	2.21	1.9	175.2	0	1
04/08	61.3	20.7	2.3	1.95	173.7	0	1
04/09	61.3	20.7	2.3	1.95	173.1	0	1
04/10	60	26.3	2.84	2.28	161.4	0	1
04/11	64.6	19.8	2.15	1.86	174.7	0	1
04/12	68.5	20.2	2.09	1.82	174.3	0	1
04/13	73.9	20.2	1.99	1.76	174.1	0	1
04/14	82.3	25.5	2.16	1.87	177.7	33.9	1.24
04/15	82.2	20.5	1.88	1.69	189.1	68.1	1.56
04/16	75.4	15	1.66	1.55	193.3	68.5	1.55
04/17	73.8	20.3	2	1.77	222.3	83.1	1.6
04/18	70.4	20.3	2.06	1.81	216	75.9	1.54
04/19	65	20	2.15	1.86	201.9	80.3	1.66
04/20	63.6	25.4	2.63	2.14	188.4	73.8	1.64
04/21	65.2	20.5	2.19	1.88	173.5	59.9	1.53
04/22	67.6	15.3	1.78	1.63	228.1	102.7	1.82
04/23	74.3	20.4	1.99	1.77	231.9	101.1	1.77
04/24	80.7	25.5	2.19	1.89	220.1	98.3	1.81
04/25	81	20.5	1.9	1.7	201.8	77.3	1.62
04/26	82.1	15.4	1.62	1.52	238.8	90.9	1.61

Table C1: Migration year 2003 outflow and spill at Lower Granite Dam and McNary Dam and expansion factors used to upwardly adjust 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	81.3	20.8	1.91	1.71	205.6	72.3	1.54
04/28	79.3	26.1	2.26	1.93	207.9	70.5	1.51
04/29	72.6	20.5	2.03	1.79	217.5	69.5	1.47
04/30	73.1	20.5	2.02	1.78	225.6	69.5	1.45
05/01	70.8	20.5	2.07	1.81	222.6	70.7	1.47
05/02	67.5	15.8	1.81	1.65	192.8	69.6	1.56
05/03	65.8	20.7	2.19	1.88	201.2	68.8	1.52
05/04	63.4	25.5	2.64	2.15	203	67.7	1.5
05/05	65.7	20.5	2.17	1.88	220.9	68.8	1.45
05/06	73.3	15.2	1.7	1.58	218.3	76.6	1.54
05/07	69.7	20.3	2.07	1.81	230.8	76.1	1.49
05/08	70.4	20.4	2.07	1.81	224.6	84.2	1.6
05/09	68	20.5	2.12	1.84	224.1	73.9	1.49
05/10	66.1	25.6	2.56	2.11	201	68.2	1.51
05/11	64	20.5	2.22	1.9	180.2	65.1	1.57
05/12	65.2	15.7	1.84	1.67	189.8	69.1	1.57
05/13	72.4	20.8	2.05	1.8	218	79.9	1.58
05/14	78.2	25.5	2.24	1.92	256.5	102.7	1.67
05/15	79.2	20.5	1.92	1.72	226.4	73.3	1.48
05/16	87	15.3	1.57	1.49	242.7	72.7	1.43
05/17	89.7	20.4	1.78	1.63	241.3	71.4	1.42
05/18	83.8	25.6	2.14	1.86	224.9	71.2	1.46
05/19	83.8	20.5	1.86	1.68	217.8	71.8	1.49
05/20	72.1	15.4	1.72	1.59	215.6	72.6	1.51
05/21	74.4	20.4	1.99	1.77	217	71.7	1.49

Table C1: Migration year 2003 outflow and spill at Lower Granite Dam and McNary Dam and expansion factors used to upwardly adjust 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	72	25.6	2.4	2.01	245.2	82.4	1.51
05/23	79.7	20.5	1.91	1.72	249.2	85.8	1.53
05/24	95.7	20.5	1.73	1.59	259.7	90.1	1.53
05/25	122.7	30.6	1.88	1.69	221.2	65.8	1.42
05/26	146.7	53.8	2.45	2.04	248.3	76.8	1.45
05/27	155.2	61.4	2.61	2.13	291.9	117.8	1.68
05/28	156.8	63	2.64	2.15	298.8	124.9	1.72
05/29	172.1	77.9	2.92	2.33	329	153	1.87
05/30	186.2	91.9	3.16	2.48	352.5	176.3	2
05/31	208.2	114.3	3.5	2.7	352.4	176.8	2.01
06/01	190.8	96.5	3.23	2.52	320.2	144.9	1.83
06/02	165.9	72.2	2.82	2.26	289.6	115.4	1.66
06/03	149.1	55.6	2.49	2.06	294.5	121.4	1.7
06/04	133	43.2	2.24	1.91	296.7	125.9	1.74
06/05	118.1	30.1	1.9	1.71	273.8	98.8	1.56
06/06	114.7	27	1.82	1.65	262.8	92.5	1.54
06/07	108.7	24.5	1.77	1.63	285.9	115.1	1.67
06/08	111	26	1.81	1.65	283.9	108.1	1.61
06/09	109	31.3	2.05	1.8	265	90.4	1.52
06/10	110.5	31	2.02	1.78	278.5	108.1	1.63
06/11	109.7	25.8	1.82	1.65	305.2	130.1	1.74
06/12	101.8	20.8	1.68	1.57	304.8	129.1	1.73
06/13	97.3	20.1	1.69	1.57	260.9	87.9	1.51
06/14	86	20.3	1.82	1.66	284.4	109.4	1.63
06/15	80.9	20.8	1.91	1.72	239.1	65.1	1.37

Table C1: Migration year 2003 outflow and spill at Lower Granite Dam and McNary Dam and expansion factors used to upwardly adjust 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	82.2	20.8	1.9	1.7	247	87	1.54
06/17	83	20.4	1.86	1.68	255	80.5	1.46
06/18	80.2	20.3	1.9	1.7	266	95.2	1.56
06/19	73.3	20.4	2.01	1.78	235.5	79	1.5
06/20	74.2	10.1	1.42	1.37	174.1	32	1.23
06/21	70.1	0	1	1	194.1	19.5	1.11
06/22	55.7	0	1	1	180.7	5	1.03
06/23	59.6	0	1	1	161.8	0	1
06/24	58.9	0	1	1	188.3	15.6	1.09
06/25	50.8	0	1	1	219.4	43.9	1.25
06/26	47.4	0	1	1	217.6	43.6	1.25
06/27	41.6	0	1	1	218.8	44.9	1.26
06/28	42.1	0	1	1	176.9	2.9	1.02
06/29	38.2	0	1	1	178.6	5.1	1.03
06/30	39.3	0	1	1	172.9	0	1
07/01	39.1	0	1	1	170.3	0.1	1
07/02	36.2	0	1	1	170.2	0	1
07/03	36.5	0	1	1	113.3	0	1
07/04	35.1	0	1	1	144.9	0	1
07/05	34.8	0	1	1	145.7	0	1
07/06	28.7	0	1	1	100.4	0	1
07/07	33.1	0	1	1	131.8	0	1
07/08	36.5	0	1	1	138.4	0	1
07/09	35.5	0	1	1	167.7	0	1
07/10	35.8	0	1	1	159	0	1

Table C1: Migration year 2003 outflow and spill at Lower Granite Dam and McNary Dam and expansion factors used to upwardly adjust 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	36	0	1	1	170.1	0	1
07/12	37.7	0	1	1	163.4	0	1
07/13	35.1	0	1	1	144	0	1
07/14	33.5	0	1	1	155.9	0	1
07/15	24.3	4.5	1.61	1.51	151.5	0	1
07/16	40.2	0	1	1	156.9	0	1
07/17	31.7	0	1	1	150.8	0	1
07/18	33	0	1	1	125.8	0	1
07/19	31.5	0	1	1	125.6	0	1
07/20	30.3	0	1	1	138.9	0	1
07/21	31.8	0	1	1	134.9	0	1
07/22	34.6	0	1	1	149.1	0.2	1
07/23	32.7	0	1	1	160.5	0.2	1
07/24	32	0	1	1	155.2	0	1
07/25	28.8	0	1	1	132.9	0.1	1
07/26	27.8	0	1	1	144.2	0.1	1
07/27	28.7	0	1	1	103.6	0	1
07/28	28.8	0	1	1	144.2	0	1
07/29	27.8	0	1	1	140.8	0	1
07/30	28.9	1.9	1.19	1.16	138.3	0	1
07/31	30.7	0	1	1	135.6	0	1
08/01	29.5	0	1	1	146.2	0	1

Appendix D

Historical MADs for RealTime 2003 Stocks With at Least Three Years Inclusion in the RealTime Run-Timing Prediction Project.

Table D.1: Historical MADS for all wild PIT-tagged Realtime Stocks forecasted more than two years to Lower Granite Dam (LWG) and McNary Dam (MCN) by 2003.

Stock Name	Dam	Year									
		1995	1996	1997	1998	1999	2000	2001	2002	**Hist. Avg.**	**2003**
Bear Valley Creek		4.5	---	---	8.0	8.1	3.3	9.1	4.3	**6.2**	**6.4**
Catherine Creek.		5.6	5.4	7.4	8.4	6.2	5.2	6.5	3.9	**6.1**	**4.1**
Elk Creek		---	---	---	12.5	3.6	4.3	---	13.9	**8.6**	**14.1**
Herd Creek						5.1	5.8	7.7	---	**6.2**	**6.1**
Imnaha River		10.0	6.8	3.2	10.6	3.4	2.6	5.6	30.5	**9.1**	**2.9**
Johnson Creek		---	---	---	---	---	4.8	8.7	6.4	**6.6**	**2.9**
Lake Creek		---	---	10.2	8.7	3.2	3.2	---	8.4	**6.7**	**14.2**
Lostine River	LWG	3.5	9.5	4.4	---	5.8	2.1	3.0	3.0	**4.5**	**4.5**
Marsh Creek		---	---	---	---	4.0	2.8	---	8.4	**5.1**	**7.8**
Minam River		---	2.8	8.3	7.8	5.8	2.2	1.6	4.1	**4.7**	**5.1**
Salmon River, SF		8.7	6.2	6.5	4.3	5.9	2.9	5.2	9.3	**6.1**	**27.7**
Secesh River		2.8	---	7.3	6.5	3.9	3.5	12.1	3.2	**5.6**	**16.9**
Valley Creek		7.3	---	---	---	7.4	5.5	10.3	3.7	**6.8**	**6.5**
Select Composite		2.2	2.4	1.8	2.6	2.5	1.1	4.3	5.4	**2.8**	**4.4**
Snake River Subyearling Chinook (SNAKER)		---	---	---	---	4.7	4.9	4.8	5.2	**4.9**	**8.6**

Table D.1: Historical MADS for all wild PIT-tagged Realtime Stocks forecasted more than two years to Lower Granite Dam (LWG) and McNary Dam (MCN) by 2003.

Stock Name	Dam	Year									
		1995	1996	1997	1998	1999	2000	2001	2002	**Hist. Avg.**	**2003**
Snake R. Yearling Chinook salmon	LWG	---	---	---	---	---	1.7	3.6	5.2	**3.5**	**11.1**
Snake R. steelhead trout		---	---	---	---	---	4.8	1.8	6.8	**4.5**	**16.2**
Upper Columbia River Subyearling Chinook		---	---	---	---	---	---	7.9	3.4	**5.7**	**3.3**
Snake. River Subyearling Chinook		---	---	---	---	---	---	4.7	7.2	**6.0**	**2.9**
Snake River Yearling Chinook	MCN	---	---	---	---	---	---	3.3	0.80	**2.1**	**2.5**
Snake River Sockeye		---	---	---	---	---	---	6.0	5.6	**5.8**	**9.6**
Upper Columbia River Steelhead		---	---	---	---	---	---	4.9	10.6	**7.8**	**5.5**
Snake River Steelhead		---	---	---	---	---	---	1.4	4.6	**3.0**	**14.0**
Upper Columbia and Snake River Steelhead		---	---	---	---	---	---	2.3	4.3	**3.3**	**11.9**

Table D.2: Historical MADS for all FPC passage-indexed Realtime Stocks forecasted more than two years to Rock Island Dam (RIS), McNary Dam (MCN), or John Day Dam (JDA) by 2003.

Stock Name	Dam	2000	2001	2002	**Hist. Avg.**	**2003**
Subyearling Chinook	RIS	2.90	9.1	5.71	**5.9**	**7.1**
Yearling Chinook		5.04	7.7	1.30	**4.7**	**2.5**
Coho		1.04	3.7	2.13	**2.3**	**1.2**
Sockeye		16.96	12.8	4.99	**11.6**	**2.9**
Steelhead		4.47	4.1	2.76	**3.8**	**2.0**
Subyearling Chinook	MCN	1.57	6.3	1.66	**3.2**	**1.9**
Yearling Chinook		0.59	5.70	1.8	**2.7**	**1.5**
Coho		0.72	2.55	1.40	**1.6**	**3.4**
Sockeye		9.47	8.52	1.31	**6.4**	**1.4**
Steelhead		2.85	9.36	2.83	**5.0**	**6.9**
Subyearling Chinook	JDA	---	10.0	6.47	**8.3**	**3.9**