MONITORING AND EVALUATION OF SMOLT MIGRATION IN THE COLUMBIA BASIN

VOLUME XXI

Evaluation of the 2011 Predictions of the Run-Timing of Wild and Hatchery-Reared Salmon and Steelhead Smolts to Rock Island, Lower Granite, McNary, John Day, and Bonneville Dams using Program RealTime

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Volume I: Townsend, R. L., J. R. Skalski, and D. Yasuda. 1997. Evaluation of the 1995 predictions of run-timing of wild migrant subyearling Chinook in the Snake River Basin using program RealTime. Technical Report (DOE/BP-35885-11) to BPA, Project 91-051-00, Contract 91-BI-91572.

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Volume III: Townsend, R. L., J. R. Skalski, and D. Yasuda. 2000. Evaluation of the 1997 predictions of run-timing of wild migrant yearling and subyearling Chinook and sockeye in the Snake River Basin using program RealTime. Technical Report to BPA, Project 91-051-00, Contract 91-BI-91572.

Volume IV: Burgess, C., R. L. Townsend, J. R. Skalski, and D. Yasuda. 2000. Evaluation of the 1998 predictions of the run-timing of wild migrant yearling and subyearling Chinook and steelhead, and hatchery sockeye in the Snake River Basin using program RealTime. Technical Report to BPA, Project 91-051-00, Contract 96BI-91572.

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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., and 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., and 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.

Volume XI: Burgess, C., and J. R. Skalski. 2004. Evaluation of the 2003 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 00004134.

Volume XII: Townsend, Richard L., C. Burgess, and J. R. Skalski. 2005. Evaluation of the 2004 Predictions of the Run-Timing of Wild and Hatchery-Reared Salmon and Steelhead Smolt to Rock Island, Lower Granite, McNary, John Day and Bonneville Dams using Program Real-Time. Technical Report to BPA, Project 91-051-00, Contract 00004134.

Volume XIII: Griswold, James D., R. L. Townsend, and J. R. Skalski. 2006. Evaluation of the 2005 Predictions of the Run-Timing of Wild and Hatchery-Reared Salmon and Steelhead Smolt to Rock Island, Lower Granite, McNary, John Day and Bonneville Dams using Program Real-Time. Technical Report to BPA, Project 91-051-00, Contract 00004134.

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Volume XV: Griswold, James D., Richard L. Townsend, and J. R. Skalski. 2007. Evaluation of the 2007 Predictions of the Run-Timing of Wild and Hatchery-Reared Salmon and Steelhead Smolt to Rock Island, Lower Granite, McNary, John Day and Bonneville Dams using Program Real-Time. Technical Report to BPA, Project 91-051-00, Contract 00004134.

Volume XVI: Buchanan, R. A., J. R. Skalski, J. L. Lady, P. Westhagen, and J. Griswold. 2007. Survival and Transportation Effects for Migrating Snake River Hatchery Chinook Salmon and Steelhead: Historical Estimates from 1996-2003. Technical report to BPA, Project 1991-051-00, Contract 00025093.

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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.

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Preface

Project 1991-051-00 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 non-listed 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 seventeenth in a series of technical reports presenting results of applications of statistical program RealTime to present inseason predictions of the status of smolt migrations in the Columbia River Basin. Results and evaluation of program RealTime 2011 predictions of the run-timing of wild and hatchery-reared salmon and steelhead to Lower Granite, Rock Island, McNary, John Day, and Bonneville 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 inseason population monitoring and assist inseason 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 2011 inseason outmigrations via the internet for selected PIT-tagged stocks of wild ESU Chinook salmon and steelhead to Lower Granite and/or McNary dams, one PIT-tagged wild stock of sockeye salmon to McNary Dam, and 25 passage-indexed runs-at-large, five each to Rock Island, Lower Granite, McNary, John Day, and Bonneville dams. Sixteen stocks are of wild yearling Chinook salmon captured, PIT-tagged, and released at sites above Lower Granite Dam, and have at least three years' historical migration data previous to the 2011 migration. These stocks originate in tributaries of the Salmon, Grande Ronde and Clearwater Rivers, all tributaries to the Snake River, and are subsequently detected through tag identification and monitored at Lower Granite Dam.

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, consisting of the Snake River yearling Chinook salmon and the steelhead runs. The hatchery-reared PIT-tagged sockeye salmon stock from Redfish Lake was not monitored at Lower Granite Dam this year due to no available releases. 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 forecasted to Rock Island, Lower Granite, McNary, John Day, and Bonneville dams.

Executive Summary

2011 Objectives

1. Apply Program RealTime to provide inseason 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, and coho salmon and steelhead to Rock Island, Lower Granite, McNary, John Day, and Bonneville dams (25 stocks total) and to provide inseason predictions of the run-timing of PIT-tagged stocks to Lower Granite and McNary dams (26 runs total). The PIT-tagged stocks include 17 wild runs-at-large of yearling and subyearling Chinook salmon. 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.

2. Post online predictions on outmigration status and trends in order to improve inseason 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 2011 to Rock Island, Lower Granite, McNary, John Day, and Bonneville dams. Runs-at-large of wild PIT-tagged salmon and steelhead were monitored and forecasted by Program RealTime to Lower Granite and McNary dams. These runs included Snake River steelhead, Upper Columbia steelhead, 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 Big Creek, Catherine Creek, Imnaha River, Imnaha Trap, Johnson Creek Trap, Lake Creek, Lemhi River, Lemhi River Weir, Lolo Creek, Lookingglass Creek, Lostine River, Minam River, Newsome Creek, Secesh River, Secesh River Trap, and Valley Creek (16 total). One release/recovery stock of wild PIT-tagged subyearling Chinook salmon released into the mainstem Snake River and tracked to Lower Granite Dam was monitored.

Since 1999, unmarked hatchery salmon have been released into the Snake River. To provide run-timing information on wild runs-at-large since then, the RealTime forecasting project has monitored and forecasted wild, PIT-tagged subpopulations of salmon and steelhead to Lower Granite Dam, and beginning in 2001, to McNary Dam.

Online run-timing predictions were provided via the Internet at *www.cbr.washington.edu/realtime* to the fisheries community throughout each smolt outmigration. The types of graphical displays available for each stock in the RealTime project are included throughout this report. Also available online are detailed tabular displays of historical run-timing information and expected rates of detection for each stock.

Findings

Program RealTime performance is evaluated using MADs (*mean absolute differences*, the average of the absolute difference between predicted and true passage percentiles), calculated for the first and last halves of the outmigration, and for the season-wide outmigration.

The run-at-large of wild PIT-tagged Snake River yearling Chinook salmon smolts monitored at McNary Dam was predicted well in 2011, with a season-wide MAD of 4.4%, and to Lower Granite Dam with a MAD = 3.2%. Though the first 50% of this outmigration had a MAD of 11.52% at Lower Granite, the forecast recovered to a 1.8% MAD during the last 50%. All sixteen individual stocks tracked had a season-wide MAD less than 10%.

RealTime predictions of the run-timing of wild PIT-tagged Snake River steelhead to Lower Granite and McNary Dams were again equivalent to last year (season-wide MADs of 4.5% and 7.0%, respectively, compared to 5.3% and 4.7% last year). Upper Columbia River steelhead outmigrating to McNary Dam were improved to a season-wide 3.5% MAD this year (9.3% last year), as were the combined Snake River and Upper Columbia River run (7.0% vs. 18.5% last year).

The monitoring and forecasting at McNary Dam of the run of wild PIT-tagged Snake River sockeye salmon was similar to 2010, with a season-wide MAD of 3.4% versus 3.1% last year.

Wild PIT-tagged Snake River subyearling Chinook had much worse MADs at both Lower Granite Dam (season-wide MAD = 11.7% versus last year's 5.5%), and McNary (19.5% this year vs. 4.9% last year). The run of wild PIT-tagged Upper Columbia subyearling Chinook salmon monitored at McNary Dam had season-wide MAD of 17.6%. High flows appear to have distorted the historical outmigration pattern of subyearling Chinook by elongating the tail end.

The results of Program RealTime in forecasting run-timing and passage percentiles of FPC passage-indexed runs-at-large to Rock Island, Lower Granite, McNary, John Day, and Bonneville Dams were excellent this year, with the exception of the sockeye forecast at Lower Granite Dam (12.3%) and steelhead forecasts at John Day Dam (13.5%). In particular, 6 of 25 stocks had season-wide MADs above 5%; 4 were between 3-5%, 7 had MADs 2-3%; and 8 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 inseason predictions of smolt outmigration timing for individual 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 publicly available to the fisheries community to assist inseason river management in real time throughout the course of the smolt outmigration.

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Acknowledgments

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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. Program RealTime was developed as 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 inseason 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 overwinter 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.

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. *Release-recovery* data was used for the first migration forecasts by RealTime, and beginning with 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 important for understanding how RealTime makes initial predictions early in the season, and 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 as part of a specific release group, 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. 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 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 providing run-timing information on wild Snake River runs-at-large of yearling and subyearling Chinook salmon and steelhead, 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 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 fish stocks. 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, and added Bonneville Dam in 2004.

This report presents a post-season analysis of Program RealTime performance for 2011. RealTime predictions are compared with end-of-season observed distributions of passage indices or PIT-tag detections at Lower Granite, Rock Island, McNary, John Day, and Bonneville dams. During the outmigration season, predictions were accessible daily, via the internet at address http://www.cbr.washington.edu/realtime. The website's end-of-season graphical and tabular displays of all Program RealTime results are now archived for all years since 1995 on the website. The archives contain the daily record of RealTime predictions compared with the end-of-season observed distributions for all runs monitored by Program RealTime, the 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. Historical daily flow, spill, and spill-adjustment parameters (Section 2.4) are available as well.

2.0 Methods

2.1 Description of Data

2.1.1 *PIT-Tagged Stocks*

Release-recapture Stocks

PIT-tag data are made available by the Pacific States Marine Fisheries Commission's PIT Tag Information System (PTAGIS) project. Initially, specific PIT-tagged releases were selected by potential interest to the community, large release size, and having a consistent number of annual releases. PIT-tagging has become more wide-spread, and used in smaller, infrequent release studies since then. Further exploration and analysis of the RealTime model applied to these studies has resulted in changes to selection of specific release groups. The outmigration status is now monitored and forecasted at Lower Granite for release sites of PIT-tag release sites that have at least 3 historical years of data, and an expected detection at Lower Granite of 100 fish. In 2011, PIT-tag releases of 16 yearling Chinook salmon, and one release of subyearling Chinook. There was not a hatchery release of Redfish Lake sockeye this year. These are grouped together under **Release-Recover PIT-Tagged Data** in this report (Table 2.1) and on the website.

Index-Count PIT-tagged Stocks

Composite stocks of run-at-large groups pose a challenge in estimating the outmigration status at a dam. While analyses of individual releases could provide a historical percentage of the release size observed at a dam, these individual releases are usually quite small and variable. In addition, release sizes change annually, further muddling the contribution each group adds to the expected number of total fish to be observed at a dam. Instead of focusing on the total number of fish released, index-count stocks estimate the status of the outmigration upon the number of fish observed at a dam compared to the total expected to be observed, based on historical counts. For example, a release-recapture stock may have 10% of the total released historically appear at Lower Granite Dam; so of 1000 fish released this year, we would expect that 100 fish total will show up. For an index-count stock, we don't know what percent of the fish released has been observed historically, but do know that on average, 100 total fish have been counted, and so expect the same again this year.

Run-at-large composites were created for a number of species. Each composite consists of PIT-tagged wild fish released in either the Snake River drainage or the Upper Columbia River. PIT-tagged wild fall subyearling Chinook salmon were monitored at Lower Granite and McNary dams to provide run-timing information about the wild run-at-large of Snake River fall subyearling Chinook salmon, as FPC passage indices for the wild run were unavailable after June 6, 1999 (Burgess et al., 1999). 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 catch counts near zero. They begin to appear in the detection facility at Lower Granite Dam around June 1 and continue through September or October. This subpopulation mimics passage of the run-at-large well during the first and middle portions of the run.

Table 2.2 lists the species run-at-large composites that were monitored at Lower Granite and McNary Dams, and are grouped together under **Run-of-River PIT-Tagged Data** on the website in 2011.

Table 2.1: The GIS hydro-units of the 16 PIT-tag/release sites for spring/summer yearling Chinook, 1 release of trapped subyearling Chinook salmon sampled, PIT-tagged, and released into the Snake River between river kilometers 224 and 268. These are all the individual release sites included in the 2011 Program RealTime forecasting project, monitored at Lower Granite Dam.

Release Site					GIS
Abbreviation	Long Name	Rearing	Run	Species	Hydrounit[1]
BIG2C	Big Creek	W	Sp	Chinook	17060206
CATHEC	Catherine Creek	W	Sp	Chinook	17060104
IMNAHR	Imnaha River	W	Sp	Chinook	17060102
IMNTRP	Imnaha Trap	W	Su	Chinook	17060102
JOHTRP	Johnson Creek Trap	W	Su	Chinook	17060208
LAKEC	Lake Creek	W	Su	Chinook	17060208
LEMHIR	Lemhi River	W	Sp	Chinook	17060204
LEMHIW	Lemhi River Weir	W	Sp	Chinook	17060204
LOLOC	Lolo Creek	W	Sp	Chinook	17060306
LOOKGC	Lookingglass Creek	W	Sp	Chinook	17060104
LOSTIR	Lostine River	W	Sp	Chinook	17060105
MINAMR	Minam River	W	Sp	Chinook	17060106
NEWSOC	Newsome Creek	W	Sp	Chinook	17060305
SECESR	Secesh River	W	Su	Chinook	17060208
SECTRP	Secesh River Trap	W	Su	Chinook	17060208
VALEYC	Valley Creek	W	Sp	Chinook	17060201
	Trapped Snake River	W	Fall	Chinook	

[1] Geographical Information System (GIS) designations established by the U.S. Geological Survey.

Table 2.2: Migration status at Lower Granite and McNary dams was monitored and forecasted for the indicated PIT-tagged, wild species released in the Snake River drainage, Upper Columbia River, or combination of the two. An "X" indicates that that group was included in 2011.

		Detection Site	
Species	Composite Run-at-Large	Lower Granite Dam	McNary Dam
Yearling Chinook salmon	Snake River	X	X
Steelhead	Snake River	X	X
	Upper Columbia River		X
	Combined		X
Sockeye salmon	Snake River		X
Subyearling Chinook salmon	Snake River[2]		X
	Upper Columbia River		X

2.1.2 *Fish Passage Center (FPC) Passage-Indexed Stocks*

Passage index data were made available by the Northwest Power and Conservation Council's (NWPCC) 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. Timing characteristics of these runs of mid-Columbia and mainstem Columbia River yearling and subyearling Chinook salmon, coho, and sockeye salmon and steelhead runs were monitored and forecasted to Rock Island, Lower Granite, McNary, John Day and Bonneville dams. The migration status 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). These runs are grouped under **FPC Index Data** on the website.

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] The subyearling Chinook run-at-large composite migration forecasts at Lower Granite Dam also used fish PIT-tagged and released into the Snake River between river kilometers 224 and 268, and which was not an *index-count* stock.

2.3 Adjustment of Raw Smolt Counts for Spill or Flow.

2.3.1 *PIT-Tagged Stocks*

PIT-tagged stocks are detected at a dam by passing through a PIT-tag interrogation system, usually set up in bypass routes. However, this is not the only route past a dam—fish that pass through the spillway are not detected, so formulas are devised to upwardly adjust the raw counts of PIT-detections. To get an estimate of the total fish passing through a dam on a particular day. 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 dam 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

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

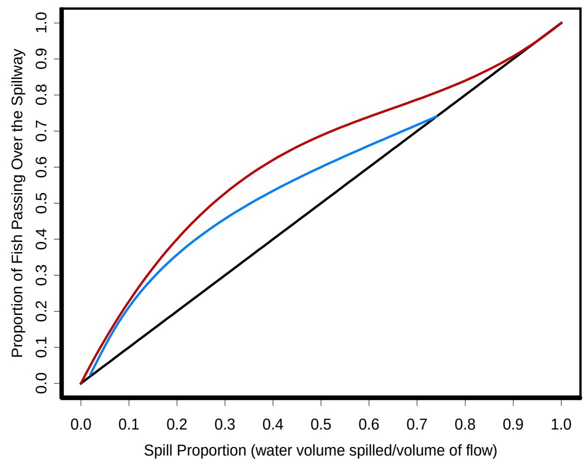
(Figure 2.1, red), and the formula for steelhead is given by Skalski and Perez-Comas (1998) as

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

In the figure, *S* is the daily volume of water spilled and *F* is daily outflow volume. For 2000, the 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 (i.e., the volume of water spilled divided by volume of outflow) (Figure 2.1, black),

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

Figure 2.1: Spill effectiveness (SE) functions (Equations 2.2a, b, c) used by Program RealTime to upwardly adjust raw PIT-tag detections. Shown are the 2006 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*

Raw passage index data are adjusted for the spill fraction by the Fish Passage Center.

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,…, 100, using the measure

$$\sum_j \left(s_j - s_{ijp}\right)^2, \qquad (2.3)$$

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 p of that minimizes (2.3), i.e.,

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

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

$$p_{RP} = \frac{x_d}{\widehat{E(S)}}, \tag{2.5}$$

where x_d = total number of fish observed by day d of the outmigration, and

$\widehat{E(S)}$ = the total expected outmigration through the detection facility.

How the expected total migration is estimated depends on the type of data. For tagged stocks that have reliable annual release/recapture data (i.e., the 19 release-recovery stocks monitored at Lower Granite Dam, Section 2.1.1), $\widehat{E(S)} = \overline{r} \times N$, where $\overline{r}$ is the average annual historical recapture percentage[3] at the detection facility, and N is total number of fish released from a release site the previous year (for yearling Chinook salmon) or earlier in the year (for subyearling Chinook and sockeye salmon). Table 2.3 displays $N, \overline{r}$, and $\widehat{E(S)}$ for each release-recovery stock. For index-count data such as FPC passage indices and PIT-tagged aggregates (Section 2.1.1), $\widehat{E(S)}$ is the average number of historical 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 model as the season progresses (Townsend et al. 1995, 1996, 1997).

The switching model is an age-of-run (AR) model based on mean fish-run-age (MFRA). This switching model weights the predictions from the LS and RP models differentially as the outmigration season progresses. Thus, each model provides its unique estimate for the true passage percentile for the day, and the algorithm minimizes a complex formula weighting estimates from each model and their respective error calculations (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.

[3] Annual recapture percentage is the number of unique fish detected divided by the total number released.

Table 2.3: Data used by Program RealTime in 2011 to compute initial predictions (Equation 2.5), for PIT-tagged, release-recovery stocks[4]. Only years that had ≥ 100 counts were used by the program. The number of PIT-tagged parr released by site (*N*), the historical average of annual recapture percentage for each site ($\bar{r}$), and the expected number of detections for the 2011 migration year.

Tagging Location	# parr released (N)	Avg. Historical % ($\bar{r}$)	# Historical Years with > 100 detections	$\hat{E}(S)$
Big Creek Yearling Chinook	7,822	8.8	11	689
Catherine Creek Yearling Chinook	1,978	8.3	8	164
Imnaha River Yearling Chinook	997	12.9	4	128
Imnaha Trap Yearling Chinook	4,348	13.9	15	604
Johnson Creek Trap Yearling Chinook	7,846	11	12	863
Lake Creek Yearling Chinook	3,991	9.7	8	389
Lemhi River Yearling Chinook	3,756	11	4	413
Lemhi River Weir Yearling Chinook	4,292	16.7	11	717
Lolo Creek Yearling Chinook	2,281	13.4	9	305
Lookingglass Creek Yearling Chinook	1,767	8.5	9	150
Lostine River Yearling Chinook	2,585	11.7	11	303
Minam River Yearling Chinook	1,936	12.1	8	235
Newsome Creek Yearling Chinook	2,345	9.1	5	213
Secesh River Yearling Chinook	5,873	8.8	15	517
Secesh River Trap Yearling Chinook	7,193	10.3	5	739
Valley Creek Yearling Chinook	2,513	6.8	4	171
Wild Trapped Snake River Subyrg Chinook	7,031	18.4	18	1,296

[4] Data Sources: PTAGIS and FPC Smolt Index Databases and RealTime program output as of December 2010

Table 2.4: Data used by Program RealTime in 2011 to compute predictions (Equation 2.5) for index-count stocks at the beginning of the migration. Average historical observed counts[5] of index-count stocks (runs-at-large) monitored are used to predict current year expected numbers of counts, $\widehat{E(S)}$, (Section 2.4.1) using the run percentage (RP) model.

Rearing	Type of Data	Predicted Passage at	Stock	$\widehat{E(S)}$
Wild	PIT-tag	Lower Granite Dam	Snake River Spring/Summer Yearling Chinook	7,852
			Snake River Steelhead Salmon	5,515
		McNary Dam	Snake River Yearling Chinook Salmon	7,500
			Snake River Steelhead Salmon	2,442
			Upper Columbia River Steelhead	318
			Snake & Upper Columbia River Steelhead	2,713
			Snake River Sockeye Salmon	515
			Snake River Subyearling Chinook Salmon	356
			Upper Columbia River Subyearling Chinook Salmon	1,604
Combined Wild & Hatchery	FPC Passage Indices	Rock Island Dam	Yearling Chinook Salmon	26,129
			Steelhead	24,539
			Coho Salmon	39,900
			Sockeye Salmon	18,393
			Subyearling Chinook Salmon	23,181
		Lower Granite Dam	Yearling Chinook Salmon	2,755,935
			Steelhead	4,872,461
			Coho Salmon	120,019
			Sockeye Salmon	21,094
			Subyearling Chinook Salmon	442,763
		McNary Dam	Yearling Chinook Salmon	2,291,953
			Steelhead	675,872
			Coho Salmon	198,986
			Sockeye Salmon	607,722
			Subyearling Chinook Salmon	6,639,883
		John Day Dam	Yearling Chinook Salmon	1,190,486
			Steelhead	651,549
			Coho Salmon	224,753
			Sockeye Salmon	279,254
			Subyearling Chinook Salmon	1,696,992
		Bonneville Dam	Yearling Chinook Salmon	1,334,436
			Steelhead	460,384
			Coho Salmon	859,462
			Sockeye Salmon	232,241
			Subyearling Chinook Salmon	1,650,114

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

[5] Data Sources: PTAGIS and FPC Smolt Index Databases and RealTime program output as of December 2011

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, P_d, can only be observed after the run is finished and all the fish that will be detected have passed (i.e., $P_{last} = 100\%$). When the run is over, we evaluate program 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*, until both predicted and observed runs are at 100%:

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

where *n* is the total number of days from the appearance of the first fish to the day where both the observed and predicted run has reached 100%. This is a slight change from previous years, but more accurately reflects those occasions where Program RealTime has continued to forecast less than 100% passage at a dam after the last fish has, in fact, been observed for the current migration season. Historical MADs presented in this report have been updated to reflect this change, and to give legitimate comparisons to past performance.

3.0 Results

3.1 Wild ESUs

3.1.1 *PIT-Tagged Yearling Chinook Salmon*

Release-Recovery Stocks Monitored at Lower Granite Dam

Table 3.1 displays MADs for the yearling Chinook salmon release/recovery stocks tracked at Lower Granite Dam, the average MADs of all these stocks. Only three of sixteen stocks (Catherine Creek, Lemhi River and Newsome Creek) had larger MADs than last year. The mean first-half MAD over all 16 spring/summer Chinook salmon release/recovery stocks was 4.31%, the mean last-half MAD was 5.07%, and the mean season-wide MAD was 4.75%. The observed detection counts were consistent with the historical average (Table 3.2), helping to improve the RealTime forecasts.

Table 3.1: Mean absolute differences (MADs, Section 2.4.3) for the 2010 and 2011 outmigrations to Lower Granite Dam of 16 wild PIT-tagged Snake River spring/summer, spring, and summer yearling Chinook salmon ESUs. 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.

Stock	2010			2011		
	Entire Run	First 50%	Last 50%	Entire Run	First 50%	Last 50%
Big Creek Yearling Chinook	5.78	2.35	6.69	4.72	3.34	5.64
Catherine Creek Yearling Chinook	4.40	4.94	4.01	8.12	3.58	11.34
Imnaha River Yearling Chinook	10.37	11.24	10.02	7.40	3.87	9.68
Imnaha Trap Yearling Chinook	28.64	3.27	49.78	5.58	1.65	7.25
Johnson Creek Trap Yearling Chinook	3.35	5.44	2.68	2.05	3.21	1.38
Lake Creek Yearling Chinook	6.78	6.61	6.81	2.71	5.01	1.62
Lemhi River Weir Yearling Chinook	14.13	13.10	14.31	6.17	9.83	4.24
Lemhi River Yearling Chinook	5.20	3.01	5.41	9.55	10.88	8.60
Lolo Creek Yearling Chinook	3.03	3.75	2.73	1.67	1.19	1.95
Lookingglass Creek Yearling Chinook	8.94	5.55	10.33	4.25	3.33	4.99
Lostine River Yearling Chinook	7.49	8.82	7.03	1.62	0.60	2.15
Minam River Yearling Chinook	7.75	8.60	7.52	3.62	4.08	3.28
Newsome Creek Yearling Chinook	3.30	5.97	2.46	3.39	4.76	2.69
Secesh River Trap Yearling Chinook	12.16	11.67	12.22	4.01	3.00	4.64
Secesh River Yearling Chinook	3.91	8.62	2.97	1.51	1.81	1.37
Valley Creek Yearling Chinook	17.71	12.16	19.31	9.65	8.88	10.36
Mean MAD	8.93	7.19	10.27	4.75	4.31	5.07

Table 3.2: Comparison of observed versus expected total (spill-adjusted) fish detected (columns 1 and 2) at Lower Granite Dam for each release-recovery stock of yearling Chinook salmon stocks monitored by Program RealTime in 2011, and comparison of observed versus historical average recapture percentages (columns 3 and 4). Average recapture percentages are fundamental to making initial fish passage predictions (Section 2.4). Ten of the 16 stock showed lower-than-average recapture percentages (less than expected fish) in 2011.

Tagging Location	Observed # Detections in 2011	Expected # Detections $\widehat{E(S)}$	Observed Recapture %	Average Historical % $\overline{r}$
Big Creek	876	666	11.2	8.5
Catherine Creek	114	130	5.8	6.6
Imnaha River	68	75	6.8	7.5
Imnaha Trap	472	574	10.9	13.2
Johnson Creek Trap	775	863	9.9	11
Lake Creek	222	309	5.6	7.7
Lemhi River	665	648	15.5	15.1
Lemhi River Weir	527	336	14	8.9
Lolo Creek	187	227	8.2	10
Lookingglass Creek	163	139	9.2	7.9
Lostine River	221	255	8.5	9.9
Minam River	176	171	9.1	8.8
Newsome Creek	228	162	9.7	6.9
Secesh River	728	739	10.1	10.3
Secesh River Trap	405	489	6.9	8.3
Valley Creek	75	106	3	4.2

Index-Count Stocks Monitored at Lower Granite and McNary Dams

The Index-Count Stocks once again had higher rates of detection than the historical average. The individual release-recovery ESUs of wild Snake River yearling Chinook salmon had 1.8-2.1 times higher-than-average. The MADs increased from 2.31% to 4.42% this year for the run-at-large Lower Granite Dam, and from 2.40% to 3.20% at McNary.

Table 3.3: Mean absolute deviations (MADs) for the 2010 and 2011 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.

	2010			2011		
Detection Location	Entire Run	First 50%	Last 50%	Entire Run	First 50%	Last 50%
Lower Granite Dam	2.31	3.66	1.79	4.42	11.52	1.80
McNary Dam	2.40	4.24	1.99	3.20	2.91	3.28

3.1.2 *PIT-Tagged Steelhead*

The season-wide MADs of wild PIT-tagged Snake River steelhead were slightly smaller compared to last year at Lower Granite Dam, but higher at McNary (Table 3.4). Also, at McNary Dam, season-wide MADs of the PIT-tagged run-at-large of Upper Columbia wild steelhead decreased from 9.34% to 3.50%, and for the combined PIT-tagged steelhead from18.50% to 7.04%.

Table 3.4: Mean absolute deviations (MADs) for the 2010 and 2011 outmigrations of the PIT-tagged subpopulations of wild Snake and Upper Columbia Rivers steelhead detected at Lower Granite and McNary Dams. Columns show MADs for the entire run, the first 50% of the run, and the last 50% of the run.

	2010			2011		
Stock	Entire Run	First 50%	Last 50%	Entire Run	First 50%	Last 50%
Snake River steelhead detected at Lower Granite Dam	5.29	5.50	5.18	4.54	7.23	2.46
Snake River steelhead detected at McNary Dam	4.67	4.81	4.57	6.99	4.87	8.04
Upper Columbia River steelhead detected at McNary Dam	9.34	5.65	11.14	3.50	1.75	4.78
Combined Snake and Upper Columbia River wild steelhead detected at McNary Dam	18.50	9.55	23.57	7.04	5.27	7.97

3.1.3 *PIT-Tagged Sockeye Salmon*

The MAD for the wild PIT-tagged run-at-large of Snake River sockeye salmon smolts (an index stock) forecasted at McNary Dam was equivalent to last year. The season-wide MAD was 3.35% compared to 3.05% last year (Table 3.5). The expected count was lower than observed this year (515 vs. 2,771).

Table 3.5: Mean absolute deviations (MADs) for the 2010 and 2011 outmigrations to McNary Dam 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.

	2010			2011		
Detection Location	Entire Run	First 50%	Last 50%	Entire Run	First 50%	Last 50%
McNary Dam	3.05	11.99	1.72	3.35	7.22	2.51

3.1.4 *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. The MAD for this year were much higher across the season compared to last year (11.66% vs. 5.49 last year). There was a significant number of subyearling Chinook detected after October 1 (98 of the 751 total) that distorted the typical outmigration pattern.

Table 3.6: Mean absolute deviation (MAD) for the 2010 and 2011 outmigrations to Lower Granite Dam of PIT-tagged populations of wild Snake River fall subyearling Chinook salmon. Columns show MADs for the entire run, the first 50% of the run, and the last 50% of the run.

	2010			2011		
Stock	Entire Run	First 50%	Last 50%	Entire Run	First 50%	Last 50%
Snake River	5.49	2.80	6.34	11.66	12.31	11.45

Index-Count Stocks Monitored at McNary Dam

Prediction performances for both Snake River and Upper Columbia River subyearling Chinook salmon runs to McNary Dam were much worse than last year. The Snake River season-wide MAD (19.45% vs. 4.92% last year, Table 3.7), and Upper Columbia River MAD (17.61% vs 5.90% last year) were almost 4 times larger. The higher flows greatly affected the historical outmigration patterns.

Table 3.7: Mean absolute deviations (MADs) for the 2010 and 2011 outmigrations of PIT-tagged populations of wild Snake River fall subyearling Chinook salmon and wild Upper Columbia River subyearling Chinook salmon monitored at McNary Dam. Columns show MADs for the entire run, the first 50% of the run, and the last 50% of the run.

	2010			2011		
Stock	Entire Run	First 50%	Last 50%	Entire Run	First 50%	Last 50%
All Wild PIT-tagged Snake River Subyearling Chinook Salmon detected at McNary Dam	4.92	7.06	3.20	19.45	31.61	2.57
All Wild PIT-tagged Upper Columbia River Subyearling Chinook Salmon detected at McNary Dam	5.90	13.84	4.94	17.61	8.07	20.04

3.2 Hatchery-Reared ESUs

There were no releases of hatchery-reared PIT-tagged summer-run sockeye from Redfish Lake in 2011.

3.3 Combined Wild and Hatchery Runs-at-Large

In general, RealTime improved in 2011 from last year. While MADs were generally equivalent between the years, species that did better at one dam were slightly worse at others. There were 5 fewer MADs in the 3-5% range, and 5 more in the 2-3% range. Most notably, the MADs were much worse at Lower Granite Dam for sockeye and John Day Dam for steelhead, due to surges in migration of both species in late April and early May.

Table 3.8: Mean absolute deviations (MADs, Section 2.4.3) for the 2010 and 2011 outmigrations to Rock Island, Lower Granite Dam, McNary, John Day, and Bonneville 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.

Detection Site	Stock	2010 Entire Run	2010 First 50%	2010 Last 50%	2011 Entire Run	2011 First 50%	2011 Last 50%
Rock Island Dam	Yearling Chinook Salmon	4.53	5.16	4.21	1.72	1.30	1.92
	Steelhead	1.80	2.23	1.60	2.76	1.34	3.52
	Coho Salmon	1.05	0.42	1.45	1.25	1.76	0.86
	Sockeye Salmon	12.54	25.52	5.35	2.54	1.67	2.89
	Subyearling Chinook Salmon	18.14	20.18	13.63	6.68	11.08	3.61
Lower Granite Dam	Yearling Chinook Salmon	1.14	1.06	1.18	4.64	10.82	1.87
	Steelhead	3.56	6.35	2.35	7.09	15.72	3.00
	Coho Salmon	5.70	8.69	5.08	1.92	1.71	1.99
	Sockeye Salmon	6.28	4.42	7.19	12.27	42.61	0.87
	Subyearling Chinook Salmon	4.30	11.98	3.76	1.90	10.14	0.87
McNary Dam	Yearling Chinook Salmon	1.67	0.56	2.16	1.49	0.89	1.66
	Steelhead	2.09	2.20	2.05	1.79	0.91	1.99
	Coho Salmon	4.36	8.02	2.08	4.96	9.91	3.00
	Sockeye Salmon	6.51	16.27	1.97	2.43	4.55	1.86
	Subyearling Chinook Salmon	3.48	5.14	2.87	4.54	7.14	2.96
John Day Dam	Yearling Chinook Salmon	1.29	1.20	1.34	5.11	6.96	4.05
	Steelhead	3.54	1.14	4.73	13.53	32.38	1.30
	Coho Salmon	2.76	4.66	1.52	2.67	6.45	0.51
	Sockeye Salmon	3.58	3.81	3.45	1.91	3.14	1.30
	Subyearling Chinook Salmon	3.45	3.95	3.25	7.73	17.48	2.21
Bonneville Dam	Yearling Chinook Salmon	1.95	3.02	1.22	2.82	2.63	2.96
	Steelhead	1.69	2.35	1.17	2.09	3.32	1.42
	Coho Salmon	1.86	2.81	1.48	1.62	3.56	0.78
	Sockeye Salmon	5.08	8.16	2.00	2.20	2.47	2.09
	Subyearling Chinook Salmon	4.43	11.22	2.42	4.57	10.78	2.28

4.0 Discussion

The RealTime Program 2011 performance in predicting run-timing of FPC passage-indexed stocks and PIT-tagged stocks was similar to 2010. Season-wide MADs stayed close to last year's results, with a few exceptions, which appear to have been greatly influenced by unusually high flows. While the run-at-large and passage indexed forecasts were fairly consistent in performance, the source of fish making up the outmigration run has changed through time.

Table 4.1 displays the observed versus predicted counts of fish at each of the dams for all the index-count stocks used by RealTime in 2011. These expected counts are based on the historical average of counts at each site for each species, and it was rare that they were close to what actually was observed. In determining the status of outmigration for these stocks at each site, the simple method of using the historical average to gauge the present year's migration status is woefully inadequate. Program RealTime has shown that incorporating the additional information of a stock's historical outmigration characteristics (length of run, percentage of fish observed daily, etc.) dramatically improves the status predictions. This program has proven to be an excellent tool in the determination of migration status, and as the historical data accumulates, will continue to improve.

Table 4.1: Comparison of expected number of detections for passage indices and the observed numbers for all index-count stocks monitored by Program RealTime in 2011.

Rearing/ Data Type	Detection Site	Stock	Expected 2011 Counts	Observed 2011 Counts
Wild/PIT-tag	Lower Granite Dam	Spring/Summer Yearling Chinook	7,852	16,879
		Steelhead	5,515	6,827
	McNary Dam	Snake River Yearling Chinook Salmon	7,500	13,360
		Snake River Steelhead	2,442	3,451
		Upper Columbia River Steelhead Salmon	318	407
		Snake & Upper Columbia River Steelhead Salmon	2,713	3,858
		Snake River Sockeye Salmon	515	2,771
		Snake River Subyearling Chinook Salmon	356	427
		Upper Columbia River Subyearling Chinook Salmon	1,604	566
Combined Wild & Hatchery/FPC Passage Indices	Rock Island Dam	Yearling Chinook Salmon	26,129	26,407
		Steelhead	24,539	28,408
		Coho Salmon	39,900	46,291
		Sockeye Salmon	18,393	18,697
		Subyearling Chinook Salmon	23,181	27,397
	Lower Granite Dam	Yearling Chinook Salmon	2,755,935	3,831,119
		Steelhead	4,872,461	4,118,605
		Coho Salmon	120,019	83,949
		Sockeye Salmon	21,094	119,438
		Subyearling Chinook Salmon	442,763	834,436
	McNary Dam	Yearling Chinook Salmon	2,291,953	1,979,397
		Steelhead	675,872	608,017
		Coho Salmon	198,986	188,028
		Sockeye Salmon	607,722	325,860
		Subyearling Chinook Salmon	6,639,883	5,561,891
	John Day Dam	Yearling Chinook Salmon	1,190,486	2,936,420
		Steelhead	651,549	2,620,215
		Coho Salmon	224,753	477,004
		Sockeye Salmon	279,254	364,035
		Subyearling Chinook Salmon	1,696,992	3,200,424
	Bonneville Dam	Yearling Chinook Salmon	1,334,436	1,322,343
		Steelhead	460,384	246,514
		Coho Salmon	859,462	439,977
		Sockeye Salmon	232,241	114,210
		Subyearling Chinook Salmon	1,650,114	2,552,157

5.0 Recommendations

The RealTime webpage has been revamped to more easily allow a user to focus on a particular species, release group, or dam to determine the outmigration progress. In addition, the historical data available, the availability of PIT-tag releases and FPC index counts, and the new dynamic web page allows us to provide more historical documentation on migration patterns and predictor performance in an easily accessible site. We will continue to provide more detailed information online (MADs, passage dates, detection counts, daily record graphs, passage bar graphs) in proceeding years.

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7.0 Appendix

The following figures are snapshots of the RealTime website, giving examples of the new layout and information that can be obtained. The homepage for the RealTime results is http://www.cbr.washington.edu/realtime

Figure A.1. RealTime homepage. Forecasted runs can be called up by year, and then grouped by species, dam site, or data category (Release-Recapture PIT-tagged, FPC Index, Run of River PIT-tagged, and Chelan Index data).

Realtime Inseason Forecaster

◀ Inseason Forecaster Home | Stock Map & Information | Forecast Archive | Publications | Overview

Navigation

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Release Recapture

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Run-of-River

» Expected Values

Results

Filter

Grouping: Data Type Year: 2010

Release-Recapture PIT-Tagged Data

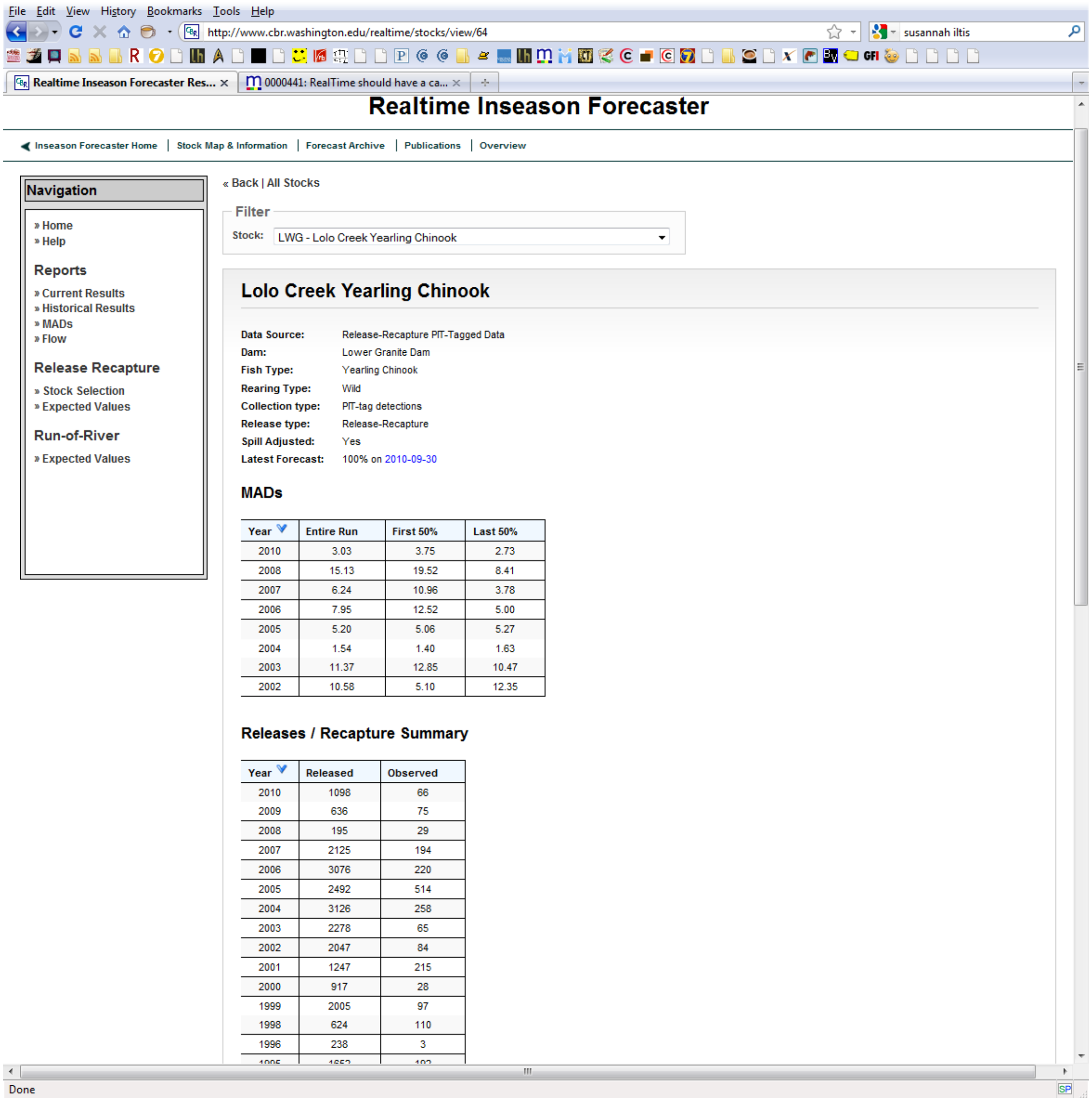
Dam	Rearing Type	Stock	Data Date	Prediction	Actions
Lower Granite Dam	Wild	Lolo Creek Yearling Chinook	2010-09-30	100	Plot
Lower Granite Dam	Wild	Lemhi River Weir Yearling Chinook	2010-09-30	100	Plot
Lower Granite Dam	Hatchery	Redfish Lake Hatchery Sockeye	2010-07-30	100	Plot
Lower Granite Dam	Wild	Secesh River Yearling Chinook	2010-09-30	100	Plot
Lower Granite Dam	Wild	Secesh River Trap Yearling Chinook	2010-09-30	100	Plot
Lower Granite Dam	Wild	Minam River Yearling Chinook	2010-09-30	100	Plot
Lower Granite Dam	Wild	Lostine River Yearling Chinook	2010-09-30	100	Plot
Lower Granite Dam	Wild	Lookingglass Creek Yearling Chinook	2010-09-30	100	Plot
Lower Granite Dam	Wild	Johnson Creek Trap Yearling Chinook	2010-09-30	100	Plot
Lower Granite Dam	Wild	Imnaha Trap Yearling Chinook	2010-09-30	100	Plot
Lower Granite Dam	Wild	Imnaha River Yearling Chinook	2010-09-30	100	Plot
Lower Granite Dam	Wild	Catherine Creek Yearling Chinook	2010-09-30	100	Plot
Lower Granite Dam	Wild	Big Creek Yearling Chinook	2010-09-30	100	Plot
Lower Granite Dam	Wild	Lake Creek Yearling Chinook	2010-09-30	100	Plot
Lower Granite Dam	Wild	Lemhi River Yearling Chinook	2010-09-30	100	Plot
Lower Granite Dam	Wild	Wild Trapped Snake River Sub-yearling Chinook	2010-12-16	100	Plot
Lower Granite Dam	Wild	Newsome Creek Yearling Chinook	2010-09-30	100	Plot
Lower Granite Dam	Wild	Valley Creek Yearling Chinook	2010-09-30	100	Plot

Total rows: 18

FPC Index Data

Dam	Rearing Type	Stock	Data Date	Prediction	Actions
McNary Dam	Combined Wild and Hatchery	Run of River Yearling Chinook	2010-09-30	100	Plot
Bonneville Dam	Combined Wild and Hatchery	Run of River Sub-yearling Chinook	2010-10-31	100	Plot
John Day Dam	Combined Wild and Hatchery	Run of River Steelhead	2010-09-30	100	Plot
McNary Dam	Combined Wild and Hatchery	Run of River Sub-yearling Chinook	2010-09-30	100	Plot

Figure A.2. Clicking on a run name brings up historical MADs, Release/Recapture Summary, and passage date tables (predicted and observed), for that particular release group.



File Edit View History Bookmarks Tools Help

http://www.cbr.washington.edu/realtime/stocks/view/64

Realtime Inseason Forecaster Res... | 0000441: RealTime should have a ca...

Realtime Inseason Forecaster

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Navigation

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» Expected Values

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Filter

Stock: LWG - Lolo Creek Yearling Chinook

Lolo Creek Yearling Chinook

Data Source: Release-Recapture PIT-Tagged Data
Dam: Lower Granite Dam
Fish Type: Yearling Chinook
Rearing Type: Wild
Collection type: PIT-tag detections
Release type: Release-Recapture
Spill Adjusted: Yes
Latest Forecast: 100% on 2010-09-30

MADs

Year	Entire Run	First 50%	Last 50%
2010	3.03	3.75	2.73
2008	15.13	19.52	8.41
2007	6.24	10.96	3.78
2006	7.95	12.52	5.00
2005	5.20	5.06	5.27
2004	1.54	1.40	1.63
2003	11.37	12.85	10.47
2002	10.58	5.10	12.35

Releases / Recapture Summary

Year	Released	Observed
2010	1098	66
2009	636	75
2008	195	29
2007	2125	194
2006	3076	220
2005	2492	514
2004	3126	258
2003	2278	65
2002	2047	84
2001	1247	215
2000	917	28
1999	2005	97
1998	624	110
1996	238	3

Done

Figure A.3. Clicking on "plot" on the release group name brings up the Daily Record Graph for that particular release group, with tabs for the observed Detection Graph, Passage Bar Graph, and a text file of the daily Results In Depth.

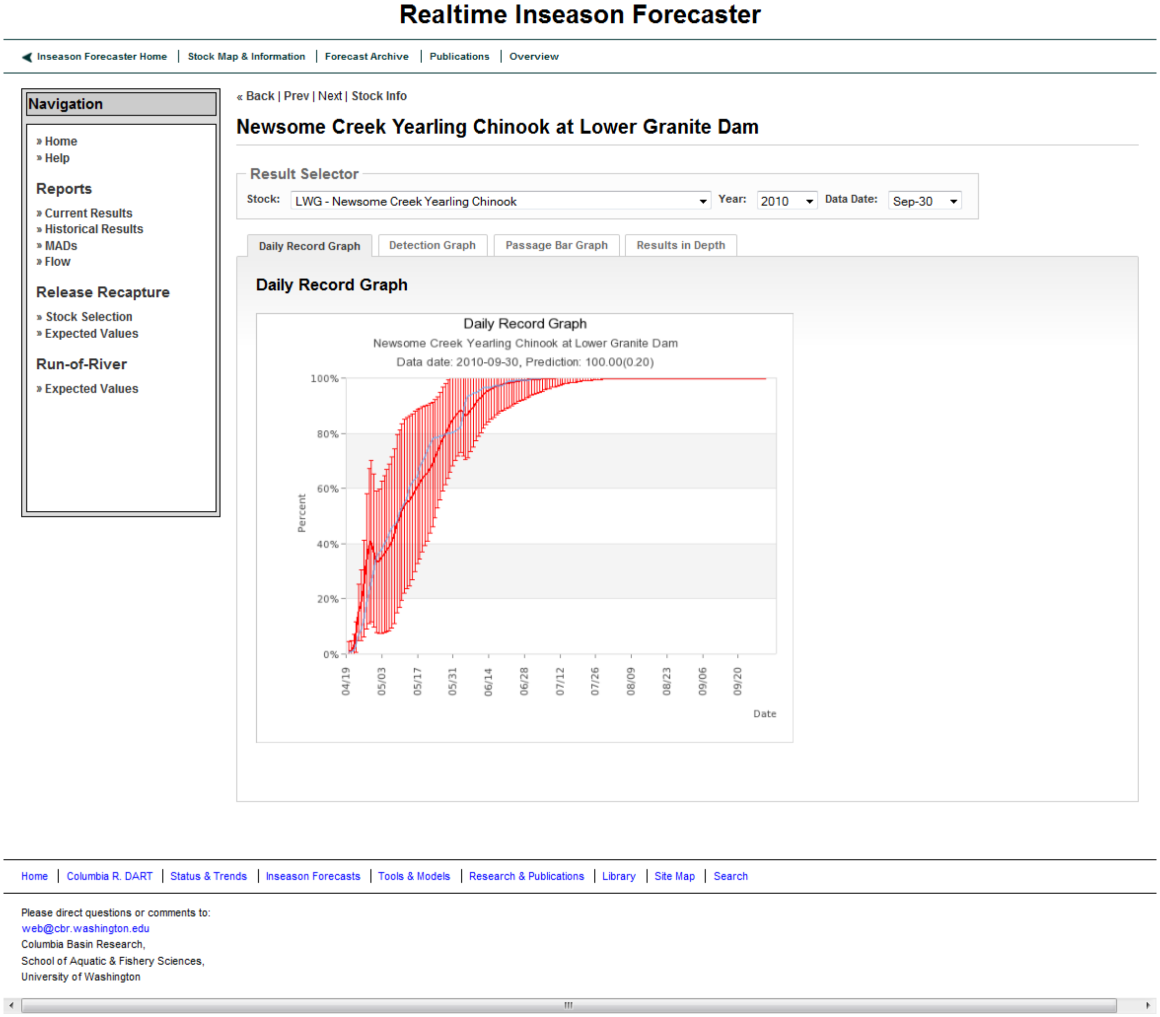
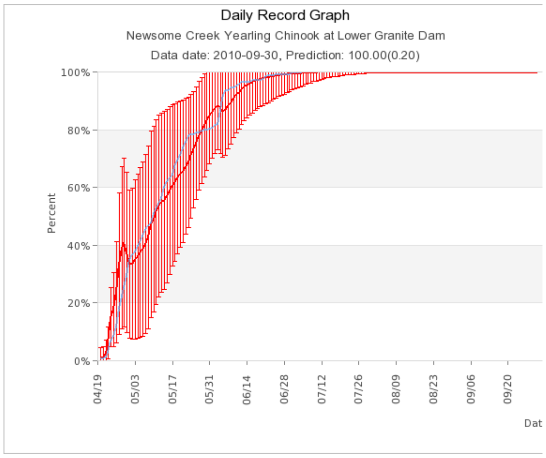
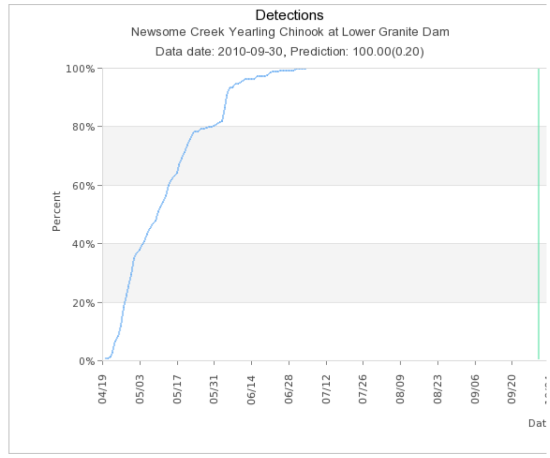


Figure A.4. Daily Record Graph, Detection Graph, Passage Bar Graph, and a text file of the daily Results In Depth.

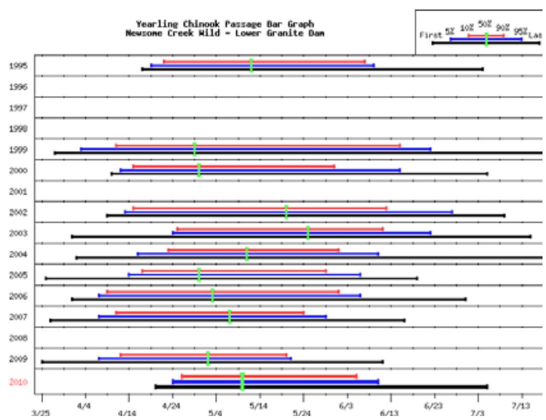
a. Daily Record Graph



b. Detection Graph



c. Passage Bar Graph



d. Results in Depth

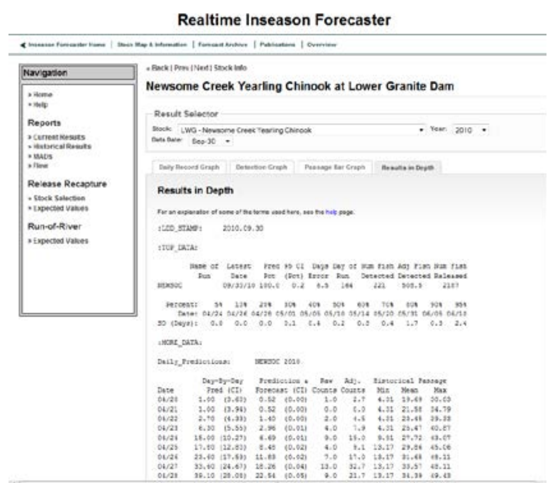
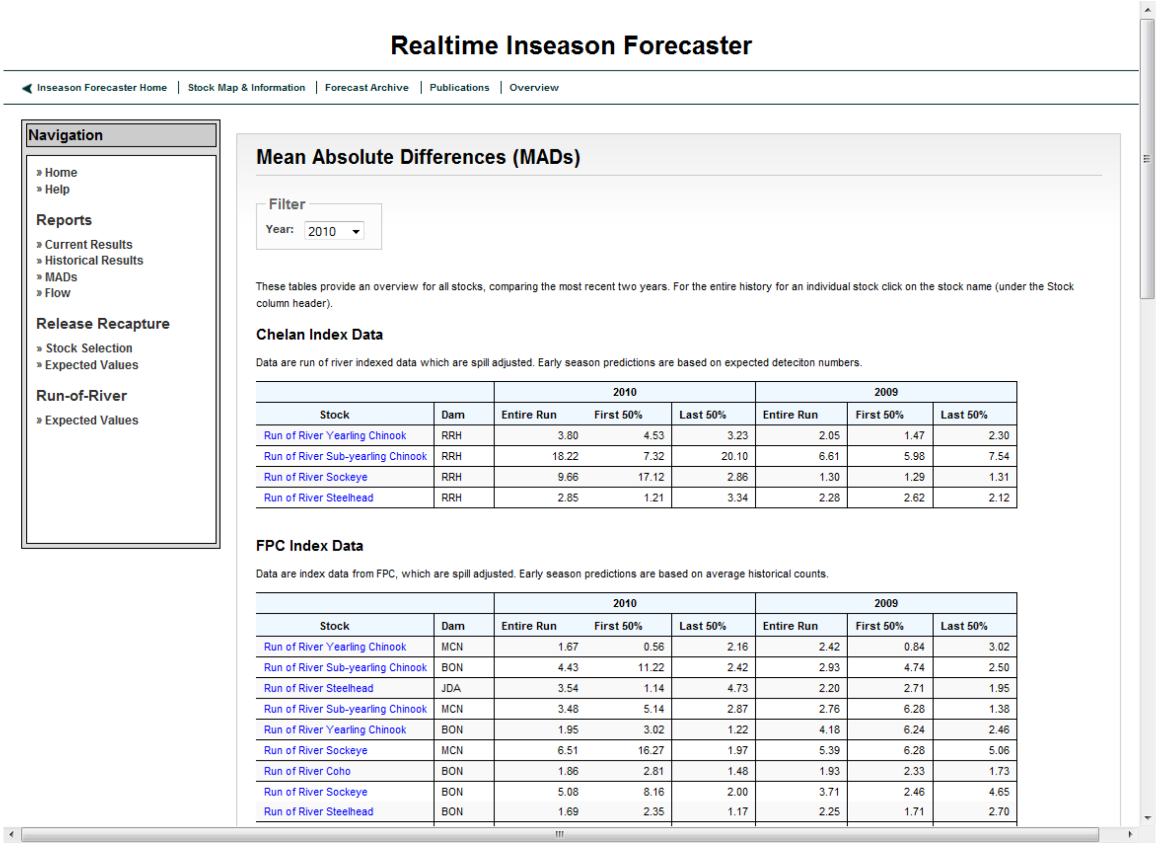


Figure A.5. MADs for all releases for a year are available on one page.



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Mean Absolute Differences (MADs)

Filter
Year: 2010

These tables provide an overview for all stocks, comparing the most recent two years. For the entire history for an individual stock click on the stock name (under the Stock column header).

Chelan Index Data

Data are run of river indexed data which are spill adjusted. Early season predictions are based on expected deteciton numbers.

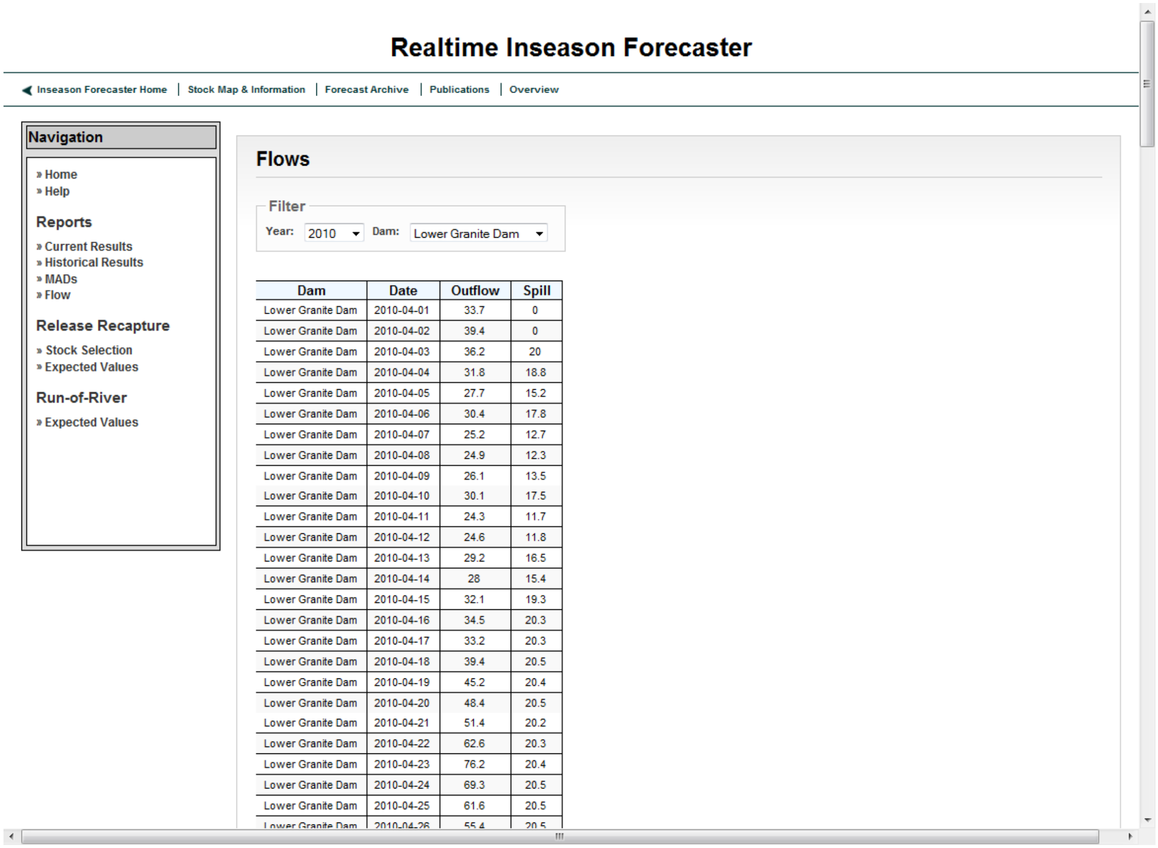
		2010			2009		
Stock	Dam	Entire Run	First 50%	Last 50%	Entire Run	First 50%	Last 50%
Run of River Yearling Chinook	RRH	3.80	4.53	3.23	2.05	1.47	2.30
Run of River Sub-yearling Chinook	RRH	18.22	7.32	20.10	6.61	5.98	7.54
Run of River Sockeye	RRH	9.66	17.12	2.86	1.30	1.29	1.31
Run of River Steelhead	RRH	2.85	1.21	3.34	2.28	2.62	2.12

FPC Index Data

Data are index data from FPC, which are spill adjusted. Early season predictions are based on average historical counts.

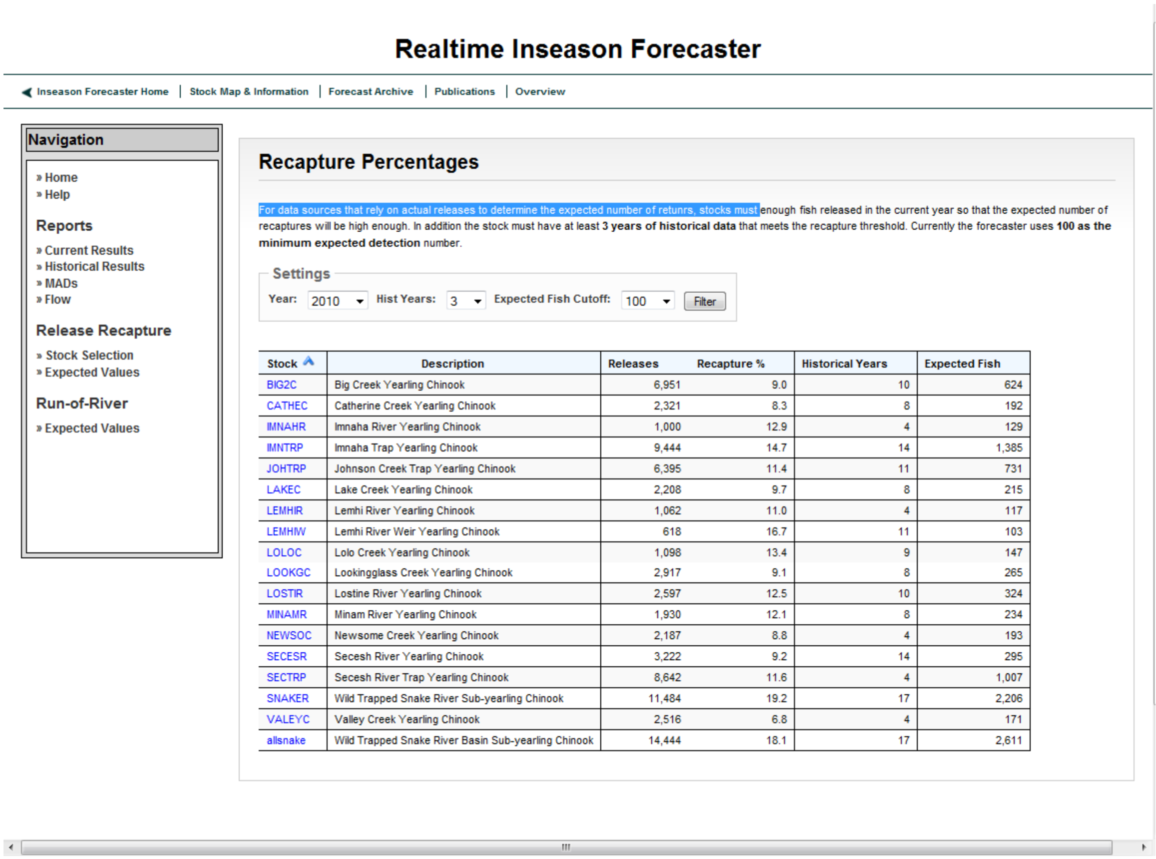
		2010			2009		
Stock	Dam	Entire Run	First 50%	Last 50%	Entire Run	First 50%	Last 50%
Run of River Yearling Chinook	MCN	1.67	0.56	2.16	2.42	0.84	3.02
Run of River Sub-yearling Chinook	BON	4.43	11.22	2.42	2.93	4.74	2.50
Run of River Steelhead	JDA	3.54	1.14	4.73	2.20	2.71	1.95
Run of River Sub-yearling Chinook	MCN	3.48	5.14	2.87	2.76	6.28	1.38
Run of River Yearling Chinook	BON	1.95	3.02	1.22	4.18	6.24	2.46
Run of River Sockeye	MCN	6.51	16.27	1.97	5.39	6.28	5.06
Run of River Coho	BON	1.86	2.81	1.48	1.93	2.33	1.73
Run of River Sockeye	BON	5.08	8.16	2.00	3.71	2.46	4.65
Run of River Steelhead	BON	1.69	2.35	1.17	2.25	1.71	2.70

Figure A.6. Annual daily flow and spill at Lower Granite Dam used by the RealTime program to spill-adjust detection counts is available on the Flow page.



Dam	Date	Outflow	Spill
Lower Granite Dam	2010-04-01	33.7	0
Lower Granite Dam	2010-04-02	39.4	0
Lower Granite Dam	2010-04-03	36.2	20
Lower Granite Dam	2010-04-04	31.8	18.8
Lower Granite Dam	2010-04-05	27.7	15.2
Lower Granite Dam	2010-04-06	30.4	17.8
Lower Granite Dam	2010-04-07	25.2	12.7
Lower Granite Dam	2010-04-08	24.9	12.3
Lower Granite Dam	2010-04-09	26.1	13.5
Lower Granite Dam	2010-04-10	30.1	17.5
Lower Granite Dam	2010-04-11	24.3	11.7
Lower Granite Dam	2010-04-12	24.6	11.8
Lower Granite Dam	2010-04-13	29.2	16.5
Lower Granite Dam	2010-04-14	28	15.4
Lower Granite Dam	2010-04-15	32.1	19.3
Lower Granite Dam	2010-04-16	34.5	20.3
Lower Granite Dam	2010-04-17	33.2	20.3
Lower Granite Dam	2010-04-18	39.4	20.5
Lower Granite Dam	2010-04-19	45.2	20.4
Lower Granite Dam	2010-04-20	48.4	20.5
Lower Granite Dam	2010-04-21	51.4	20.2
Lower Granite Dam	2010-04-22	62.6	20.3
Lower Granite Dam	2010-04-23	76.2	20.4
Lower Granite Dam	2010-04-24	69.3	20.5
Lower Granite Dam	2010-04-25	61.6	20.5
Lower Granite Dam	2010-04-26	55.4	20.5

Figure A.7. The Stock Selection webpage displays PIT-tag release groups for a particular year that have the necessary number of historical years and minimum expected fish detected. Program RealTime now uses a minimum of 3 historical years with at least 100 expected fish detected at Lower Granite Dam.



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Recapture Percentages

For data sources that rely on actual releases to determine the expected number of retunrs, stocks must enough fish released in the current year so that the expected number of recaptures will be high enough. In addition the stock must have at least **3 years of historical data** that meets the recapture threshold. Currently the forecaster uses **100 as the minimum expected detection** number.

Settings

Year: 2010 Hist Years: 3 Expected Fish Cutoff: 100 Filter

Stock	Description	Releases	Recapture %	Historical Years	Expected Fish
BIG2C	Big Creek Yearling Chinook	6,951	9.0	10	624
CATHEC	Catherine Creek Yearling Chinook	2,321	8.3	8	192
IMNAHR	Imnaha River Yearling Chinook	1,000	12.9	4	129
IMNTRP	Imnaha Trap Yearling Chinook	9,444	14.7	14	1,385
JOHTRP	Johnson Creek Trap Yearling Chinook	6,395	11.4	11	731
LAKEC	Lake Creek Yearling Chinook	2,208	9.7	8	215
LEMHIR	Lemhi River Yearling Chinook	1,062	11.0	4	117
LEMHIW	Lemhi River Weir Yearling Chinook	618	16.7	11	103
LOLOC	Lolo Creek Yearling Chinook	1,098	13.4	9	147
LOOKGC	Lookingglass Creek Yearling Chinook	2,917	9.1	8	265
LOSTIR	Lostine River Yearling Chinook	2,597	12.5	10	324
MINAMR	Minam River Yearling Chinook	1,930	12.1	8	234
NEWSOC	Newsome Creek Yearling Chinook	2,187	8.8	4	193
SECESR	Secesh River Yearling Chinook	3,222	9.2	14	295
SECTRP	Secesh River Trap Yearling Chinook	8,642	11.6	4	1,007
SNAKER	Wild Trapped Snake River Sub-yearling Chinook	11,484	19.2	17	2,206
VALEYC	Valley Creek Yearling Chinook	2,516	6.8	4	171
allsnake	Wild Trapped Snake River Basin Sub-yearling Chinook	14,444	18.1	17	2,611