Evaluation of the 1995 Predictions 0f the Run-Timing of Wild Migrant Yearling Chinook in the Snake River Basin using Program RealTime

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PREFACE

This project was initiated in 1993 in response to Endangered Species Act listings and the need for synthesis of biological information and development of new methodologies for inriver management to improve the protection of threatened and endangered stocks. Using the data provided from smolt monitoring and research projects, the Fish Passage Center and the Pacific States Marine Fisheries Commission PIT-Tag Information System (PTAGIS) primary database centers, and the second-tier University of Washington database support center DART (project 9601900), the focus was to develop statistical methods and software tools for the systematic inseason prediction of salmonid smolt outmigrations status and trends, as well as forecasting of the cumulative passage.

The initial version of the program RealTime (Skalski et al. 1994) used 1994 real-time PIT-tag detections at Lower Granite Dam to make daily predictions of the “percent run to date" and “date to specified percentiles” for a number of individual streams included in the NMFS ESU for wild Snake River spring/summer yearling chinook. In this first year, two experimental approaches, a synchronized historical run pattern matching algorithm and a least-squares algorithm, were compared to two algorithms in use by the Fish Passage Center (Townsend, et. al. 1995). Following the 1994 season, discussions with the technical staff of the Fish Passage Center and other parties resulted in combining the best aspects of all of the algorithms and an improved version of program RealTime was readied for the 1995 season (this report). The expansion of the RealTime program to include predictions for wild subyearling fall chinook salmonid smolt, based on the use of fish passage indices, was also developed and tested for the 1995 season (results not included in this report). For the1996 migration season, RealTiie is being integrated with the CRiSP project, to allow the prediction of smolt passage at other Snake and Columbia River dams from Little Goose to McNary Dams.

The predictions from these tools are provided interactively inseason, realtime to the fisheries community, including the National Marine Fisheries Service Technical Management Team committee via the World Wide Web to assist management of flow and spill augmentation to maximize benefits to smolt outmigration. Program RealTiie is available to all parties wishing to enhance monitoring and evaluation capabilities of their agency and of the fisheries community.

ACKNOWLEDGEMENTS

We wish to express thanks to the many fisheries agencies and Tribes who have expended considerable resources in the generation, assembly, analysis and sharing of Columbia River PIT-tag information. Deserving particular thanks are the National Marine Fisheries Service, the non-federal Smolt Monitoring Program agencies and Tribes, the Fish Passage Center and the Pacific States Marine Fisheries Commission PIT-Tag Information System (PTAGIS) primary database centers, and the second-tier University of Washington database support center DART (project 9601900).

Executive Summary

Since 1988, wild salmon have been PIT-tagged through monitoring and research programs conducted by the Columbia River fisheries agencies and Tribes. Information from these studies is presented in reports by the Fish Passage Center (1994, 1995, 1996~in press), National Marine Fisheries Service (Accord et al. 1992, 1994, 1995a, 1995b, 1996), Idaho Department of Fish and Game (Kiefer et al. 1993, 1994), Oregon Department of Fish and Game (Walters et al. 1993, 1994a, Keefe et al. 1994b) and the Nez Perce Tribe (Ashe et al. 1995). The detection of tagged individuals at Lower Granite Dam provides a measure of the temporal and spatial distribution of the wild populations. PIT Forecaster was developed to take advantage of this historical data to predict the proportion of a particular population which had arrived at the index site in real-time and to forecast elapsed time to some future percentile in a migration.

The 1995 RealTime PIT Forecaster used an improvement in the 1994 Least Squares (IS) algorithm (Skalski et al. 1994, Townsend et al. 1995). denoted as the New Least Squares (NLS) prediction method. This report compares the new algorithm's performance with the 1994 PIT Forecaster predictions, and evaluates the 1995 overall run prediction effectiveness for individual streams and river composite.

The NLS method was applied to the 1994 outmigration for a direct comparison of the LS and NLS methods. For the 1994 spring/summer outmigration, the LS method gave an average error (mean average deviance (MAD)) of 11% over the entire run of the selected individual streams, with mean MADs of 13% and 11% for the first and last halves of the run. The NLS method gave a mean MAD for the selected individual streams of 4.3% for the entire 1994 run, with mean MADs of 5.7% and 3.9% for the first and last halves of the run. The new algorithm for 1995 thus improved performance by reducing the average error by over 50%.

For the 1995 spring/summer outmigration, the NL,S method had a mean MAD of 6.4% for individual streams over the entire run, with average MADs of 7.1% and 6.1% for the first and last halves of the run respectively. The new river composite had a MAD of 2.2% over the entire run, with MADs 2.7% and 2.0% for the first and last halves of the run, indicating that though individual streams vary widely from each other and from year to year, there is a consistent pattern to the overall spring/summer smolt outmigration which the Realtime PIT-tag program is able to detect and use effectively in day-to-day predictions.

Introduction

Three Ecologically Significant Units (ESU) of Pacific salmon (spring/summer Chinook fall chinook and sockeye salmon) have been designated as either threatened or endangered (T&E) under the Endangered Species Act (ESA) in the Snake River Basin. The tributary populations of spring/summer chinook reside primarily in the Salmon and Grande Ronde drainages and Imnaha River, all of which are situated upstream of Lower Granite Dam. Additionally, a small population resides in the Tucannon River, which enters the Snake River between Lower Monumental and Little Goose dams. The sockeye reside in the uppermost portion of the main Salmon River in the Stanley Basin. Except for the Tucannon River population, all others reside upstream from Lower Granite Dam on the Snake River.

Regulating the timing and volume of water released from storage reservoirs (flow augmentation) has become a central mitigation strategy for improving downstream migration conditions for juvenile salmonids in the Snake River. Threatened and endangered salmon stocks have received increased priority with regard to the timing of this flow augmentation. The optimum is to release water from the storage reservoirs at times when the listed stocks are in geographic locations where they encounter the augmented flow.

In the Snake River Basin, regulated water enters the system at two locations, below Hell's Canyon Dam on the Snake River and below Dworshak Dam on the Clear-water River. The preponderance of regulated water available for fish passage is provided by Dworshak Reservoir. None of the listed stocks are located in the Clearwater drainage, and thus listed stocks must migrate to below the confluence of the Clearwater and Snake Rivers before they are fully exposed to augmented flows. The confluence forms the approximate upper boundary of the Lower Granite Reservoir Determining when stocks are in the vicinity of Lower Granite Dam and reservoir is a chief consideration in requesting flow augmentation.

Since 1988, wild salmon have been PIT-tagged through monitoring and research programs conducted by the Columbia River fisheries agencies and Tribes. Information from these studies is presented in reports by the Fish Passage Center (1994. 1995, 1996in press), National Marine Fisheries Service (Accord et al. 1992, 1994, 1995a. 1995b. 1996) Idaho Department of Fish and Game (Kiefer et al. 1993, 1994), Oregon Department of Fish and Game (Walters et al. 1993, 1994a, Keefe et al. 1994b) and the Nez Perce Tribe (Ashe et al. 1995). The detection of tagged individuals at Lower Granite Dam provides a measure of the temporal and spatial distribution of the wild populations. PIT Forecaster was developed to take advantage of this historical data to predict the proportion of a particular population which had arrived at the index site in real-time and to forecast elapsed time to some future percentile in a migration.

This report is a post-season analysis of the accuracy of the 1995 predictions from the program RealTime. Observed 1995 data were compared to the predictions made by RealTime for the spring outmigration of wild spring chinook observed at Lower Granite Dam through-out the season. Appendix C displays the graphical report capabilities of the RealTime program which were interactively accessible via the World Wide Web during the 1995 migration season. Final reports are still available at address http://www.cqs.washington.edu/rt/chinl-out.html.

Methods

Description of Data

The spring outmigration of wild spring chinook from thirteen individual streams were used in evaluating the 1995 performance of the New Least Squares (NLS) algorithms. These streams were chosen for their consistent recovery numbers, each having at least three years of data with a minimum of 30 detections per year. This was the minimum amount of historical data considered necessary in the formulation of the PIT Forecaster. A new inclusion for the 1995 season was the Grande Ronde, which did not have sufficient historical data for predictions prior to the 1995 season. River composites (Skalski, et al. 1994) were dropped from the program in favor of one overall river composite to better meet the requirements of river management.

Table 1: The thirteen individual rivers used in evaluating the predictive performance of the PIT-Forecaster program.

StreamName	epa-reach
Bear Valley Creek	17060205
BigCreek	17060206
Catherine Creek	17060104
ElkGeek	17060205
Grande Ronde River[a]	17060106
lmnaha River	17060102
Lostine River	17060105
Marsh Creek	17060205
Salmon River	17060209
Salmon River. East Fork	17060202
Salmon River, south Fork	17060208
Secesh River	17060208
Valley Creek	17060201

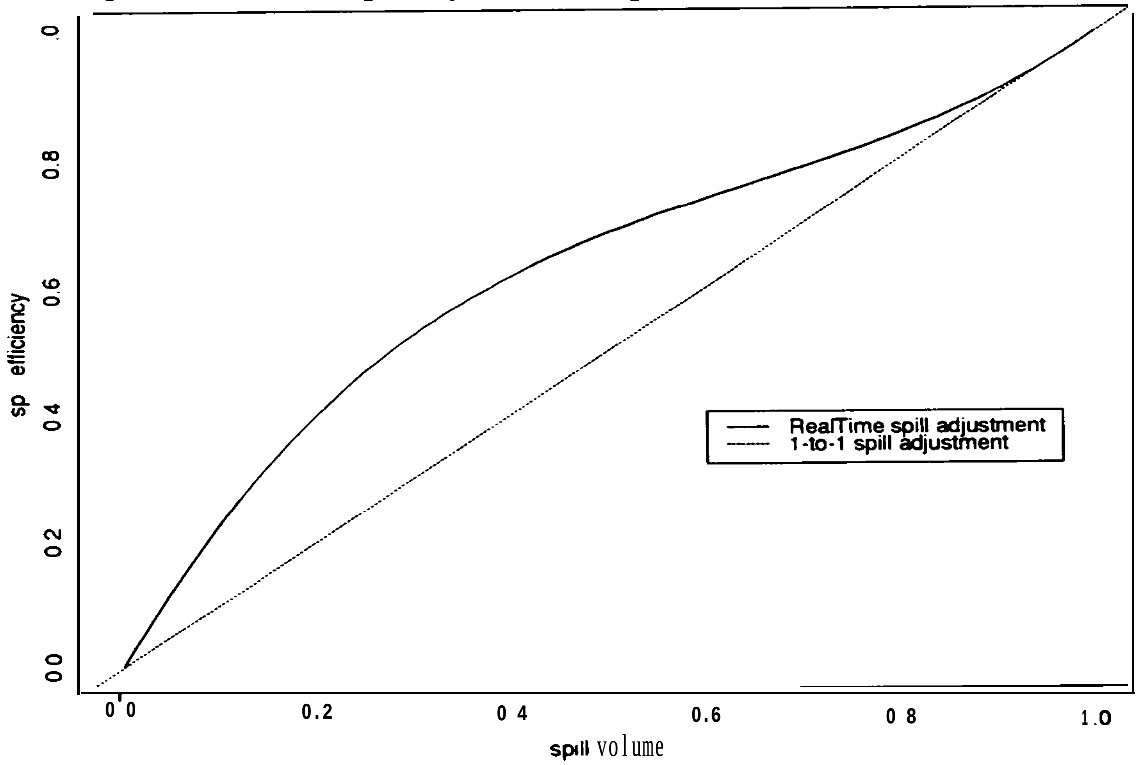
a. Grande Ronde available for 1995 predictions only.

The daily number of fish observed are adjusted for spill using a variant on a method suggested by Giorgi (1985) and Stuehrenberg (1986). For 20 and 40% of the total water volume going through the spillway at Lower Granite Dam, the suggested spill effectiveness was 41 and 61%, respectively. A quadratic equation (1) approximates these two points of adjustment, as well as the points (0,O) and (1,l). This interpolation is compared to a one-to-one conversion in Fig. 1.

$$spilleff = spillvol \times (2.583 + spillvol \times (spillvol \times 1.667 - 3.25)) \quad (1)$$

where: *spilleff* = spill efficiency, and
spillvol = total water volume going through the spillway.

Figure 1: RealTime spill adjustment compared to a one-to-one conversion.



Prediction Models

In the 1994 post-season analysis of Realtime (Townsend et al. 1995), two alternative methods were suggested as bench-mark comparisons to the 1994 Least Squares prediction method. Alternative #l to the LS method made a prediction of run timing by using the total recapture proportion observed in a previous season and then assuming that proportion to be consistent for the present year. For Alternative #2, the prediction was the historical proportion observed on a given day of outmigration for a specified historical year. The New Least Squares (NLS) method is a variation of the Least Squares (LS) prediction method used for the 1994 season, incorporating release-recapture information (or other external pre-run estimates) and an improved measure of the age of the run (using the mean fish-run-age vice the raw age of the run) into its prediction analysis. This effectively binds versions of Alternative methods #l and #2 and the 1994 Least Squares method together into a single, more accurate and robust predictor.

New Least-Squares (NLS) Algotithm

For a given day in the run, the NLS algorithm computes the predicted percentage ($\hat{p}$) of the outmigration by finding the value of fi **that** minimizes the estimated error according to historical run data. The $\hat{p}$ error is a weighted combination of the least-squares (LS) error, the release-recapture (RR) error, and the age-of-run (AR) error. Weighting depends on the age of the run and the quality of the historic data for the given stream. In the 1994 post-season analysis, the release-recapture method was shown to be a better predictor at the beginning of a run, deteriorating as time progressed. On the other hand, the least-squares method started poorly, but became a better predictor as the run progressed. To combine these two methods, the release-recapture algorithm prediction is heavily weighted initially, with weight shifted to the **LS** method over time. The initial weighting of the RR error also depends on the consistency of release-recapture history for the selected stream or river composite.

Least-Squares (LS) Error

The least squared error (LSE) for each $\hat{p}$ is summed over the historical years for which data are available. Each outmigration pattern is divided into 100 equal portions and the slopes at each corresponding point are computed. The sum of squares for a prediction compares the slopes for the current year (s_{oj}) versus the respective slopes for the historical years (s_{ij}). The total squared error for each predicted percentage of outmigration $\hat{p}$ is calculated according to the formula

$$LSE(\hat{p}) = \sum_{i=1}^{n} \sum_{j=0}^{\hat{p}} (s_{oj} - s_{ij})^2 w_i \qquad (2)$$

where s_{oj} = observed slope at the jth percentile ($j = 0, \ldots, p$) for the current year of prediction,
s_{ij} = slope at the jth percentile ($j = 0, \ldots$, p) for the ith historical year ($i = 1, \ldots, n$), and
w_{ij} = weight for the jth percentile for the ith historical year.

For example, letting $\hat{p}$ = 30%. the present run will be compared to the first 30% of the outmigration for each historical year. Similar calculations are performed for each percentage from 0 to 100 percent. The percentage that minimizes the sum of squares (Eq. 2) is the best prediction for the current outmigration timing according to the LS algorithm. The weighting factor is included to more evenly distribute the squared error contribution throughout the outmigration distribution. The weights are

$$w_{ij} = \frac{D_{oj} + D_{ij}}{R_o + R_i}$$

where D_{oj} = estimated number of days between the (j-1) and jth percentile for the present year,
D_{ij} = number of days between the (j-1) and jth percentile for the ith historical year (i = 1, ..., n),
R, = range in days of the current observed outmigration, and
R_i = range in days of the ith historical year outmigration ($i = 1, \ldots, n$).

The effect of w_{ij} is to give more weight to the errors generated from the tails of the distribution, where the slopes tend to be flat and the number of days between each percentile point are high. Less weight is given to the mid-season, where large slopes are more likely. The total sum of the weights adds to one.

Release-Recapture (RR) Error

Alternative #l made predictions of run timing by using the total recapture proportion observed in a previous season and then assuming that proportion to be consistent for the present year. Further analysis of the recapture-recovery proportions show that this number is not homogeneous through the years for all streams (Appendix B), so the average proportion ($\bar{p}$) for an individual stream is used. The predicted percent of the run is calculated according to the formula

$$p_{RR} = \frac{x_d}{\bar{p} \times N} \qquad (3)$$

where

p_{RR} = estimated proportion of the outmigration passed on day d,
x_d = total observed smolt to day d,
p = mean total proportion of outmigration recovered, and
N = total number of smolt tagged for the present year.

The number of fish tagged for the present year for a given stream or stream aggregate is multiplied by the mean recapture ratio ($\bar{p}$) of previous years (Table 2) to determine the total number of fish expected. The proportion passed is then estimated. For example, Valley Creek observed an mean recapture ratio of 3.83% at Lower Granite Dam over the years 1989 to 1994. For the 1995 run, 1552 smolt were released in Valley Creek. The expected total number of smolt for 1995 based on historical data would be 59.44 smolt (1552 * 0.0383).

RealTime then evaluates each possible percentage $\hat{p}$ (0 to 100) by calculating an associated Release-Recapture error (RRE). The RRE is the ratio of alternative #l's prediction p_{RR} and each percentage $\hat{p}$:

$$RRE(\hat{p}) = \begin{cases} \dfrac{\hat{p}}{p_{RR}} & if \quad \hat{p} > p_{RR} \\ \dfrac{p_{RR}}{\hat{p}} & if \quad \hat{p} < p_{RR} \\ 1 & if \quad \hat{p} = p_{RR} \end{cases} \qquad (4)$$

The prediction $\hat{p}$ is assigned the least amount of error ($RRE(\hat{p})$ = 1) when it is equal to the alternative #l prediction p_{RR} and more error ($RRE(\hat{p})$ > 1) the further $\hat{p}$ is from p_{RR} .

Table 2: Summary for the thirteen streams used in the 1995 evaluation of the PIT-Forecaster program showing (1) wild chinook salmon parr released in 1994, (2) detected number of smolts at Lower Granite Dam in 1995, (3) number of years of historical data, (4) average historical recapture percentage ($\bar{p}$) and (5) the observed recapture percentage for 1995.

Tagging Location	(1) Parr Tagged 1994	(2) Smolt PIT detections Lower Granite Dam 1995	(3) Number of years historical data	(4) Average historical recapture $\bar{p}$ vi)	(5) 1995 recapture p^a (%)
Bear Valley Creek	1460	74	5	8.28	5.07
Big Creek	1484	164	5	7.73	11.05
Catherine Creek	2061	202	4	7.98	9.80
Elk Creek	1514	76	5	8.21	5.02
Grande Ronde	1898	169	3	7.97	8.90
Imnaha River	999	40	6	7.83	4.00
Lostine River	1008	112	5	9.66	11.11
Marsh Creek	1590	103	5	8.51	6.48
Salmon River	1217	19	5	7.61	1.56
Salmon River East Fork	986	69	5	5.15	7.00
Salmon River South Fork	1574	78	5	7.81	4.96
secesh River	1551	90	6	7.49	5.80
Valley Creek	1552	50	6	3.83	3.22

a. Data Sources PTAGIS Database and RealTime program output as of 6 December 1995.

Age-of-Run (AR) Error

For Alternative #2 in last year's analysis, the prediction $\hat{p}$ was the historical proportion observed on a given day of outmigration for a specified historical year.

$$\hat{p} = p_{yd} \tag{5}$$

where p_{yd} = proportion of outmigration passed on day d for historical year y.

For a given day of run, the proportion predicted is given by the proportion observed in the index year on that day of the run (e.g. for a run estimated to be in its 15th day. the percentage passed by day 15 in a historical run is the estimated present percentage observed). This method was very unstable as historical patterns did not support a day-for-day matching in smolt migration through the years. On the other hand, the mean age of the run, weighted by the cumulative number of fish observed per day, appeared to offer further information and be more robust year to year. The mean fish-run-age (MFRA) is calculated for each p of the last historical outmigration and the present run by

$$MFRA\ (p) = \frac{\sum_{d=1}^{n} [fish_d \times (n+1-d)]}{\sum_{d=1}^{n} fish_d} \tag{6}$$

where:

$fish_d$ = number of fish observed on day d,

n = total number of days until the cumulative proportion p of the total smolt outmigration has been observed.

The present year's MFRA is matched to each historical year's MFRA. The historical observed p corresponding to the matching MFRA is the predicted p_{AR} from that year.

The Age-of-Run error associated with this prediction (ARE) is the ratio of the present run mean fish-run-age ($MFRA_{AR}$) and the predicted percentage $\hat{p}$ mean fish-run-age ($MFRA_{\hat{p}}$):

$$ARE(\hat{p}) = \begin{cases} \dfrac{MFRA_{\hat{p}}}{MFRA_{AR}} & if\ MFRAj > MFRA_{AR} \\ \dfrac{MFRA_{AR}}{MFRA_{\hat{p}}} & if\ MFRA_{\hat{p}} < MFRA_{AR} \\ 1 & if\ MFRA_{\hat{p}} = MFRA_{AR} \end{cases} \tag{7}$$

This gives the prediction from the AR algorithm the least amount of error, with more error the further $\hat{p}$ is from p_{AR}.

Calculation of the Total Error

An error is computed for each $\hat{p}$ (0- 100) by combining the three algorithms by

$$Err(\hat{p}) = \left(1 + \frac{LSE}{LSE\ x\ MFRA + 200.0}\right) \times \left(1 + \left[\frac{100}{MFRA^2 + p_{RR} \times 16} \times RRE\right]^2\right) \times \left(1 + \frac{ARE}{50.0}\right) \tag{8}$$

where:

ARE = age-of-run error for $\hat{p}$ from Eq. 6,

LSE = least squares error for $\hat{p}$ from Eq. 1,

$MFRA$ = mean fish-run-age for the present run from Eq. 5,

p = predicted proportion of observed present smolt outmigration, and

RRE = release-recapture error for $\hat{p}$ from Eq. 3.

The MFRA in Eq. 6 also serves the purpose of shifting weighting of the errors from the release-recapture algorithm to the least-squares algorithm as the age of the run increases. The constants were found by heuristically adjusting the equation and observing program prediction performance for historical outmigration data. The program selects the $\hat{p}$ with the minimal calculated error.

Calculation of Comparison Scores

The results presented in Tables 3 through 5 contain the mean absolute deviance (MAD) of the NLS and LS predictions for each stream from the observed 1994 data and the NLS predictions of the observed 1995 data. The MAD is calculated by the formula

$$MAD = \frac{\sum_{i=1}^{n} \left| \hat{p}_i - p_i \right|}{n} \tag{9}$$

where $\hat{p}_i$ = predicted cumulative percentage of run completed for day i,
p_i = observed cumulative percentage of run completed for day i, and
n = total number of days in run for 1994 season.

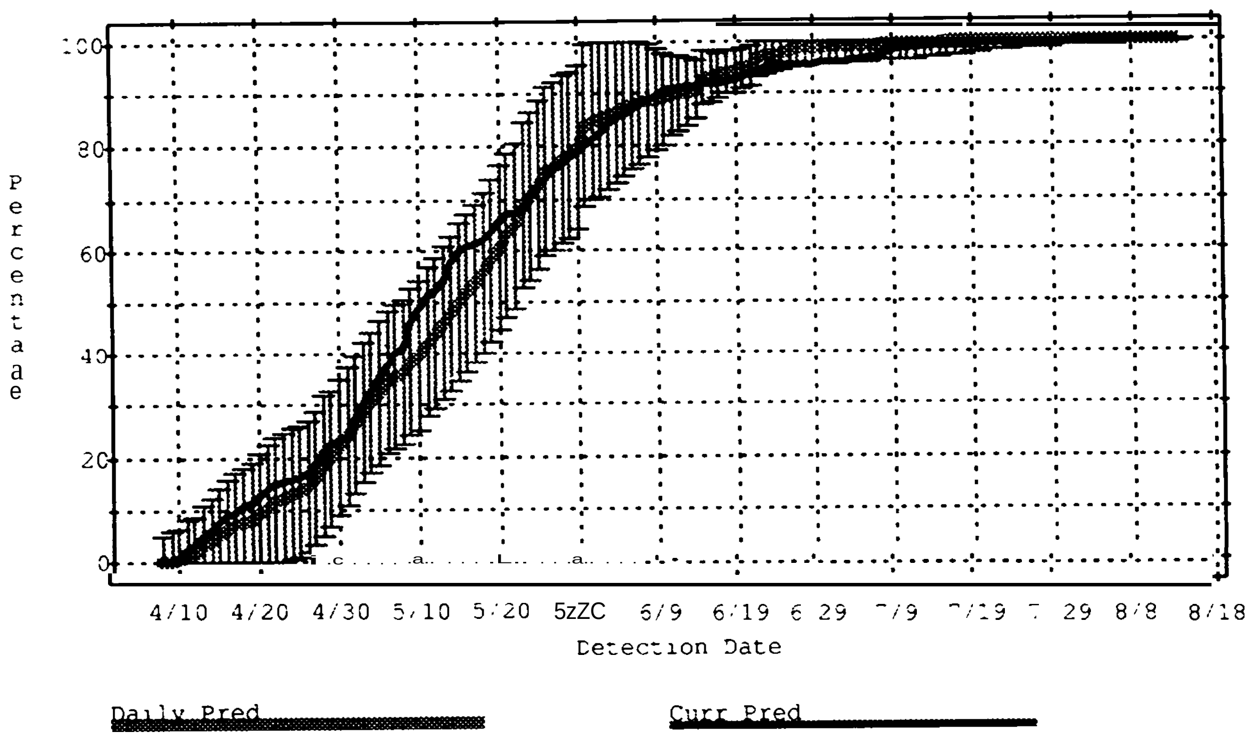
The methods are compared three ways: the MAD over the entire run, the MAD over the first half of the run (i.e. cumulative run to the 50%), and the MAD over the last half of the run.

Results

The 1994 and 1995 NLS method prediction results reveal that the modifications to the 1994 LS method dramatically improved the accuracy of the PIT Forecaster. In Table 3, we see that the 1994 NLS method prediction performance (mean MAD 4.3%) is much better than the performance of the 1994 LS method (mean MAD 11%). In 1995 the NLS method also performed well (6.4%). Tables 4 and 5 compare the performance of the predictors over the first and last halves of the run, respectively. Graphs of the daily RealTime predictions versus individual observed runs are in Appendix A.

In 1995, a composite run, an average of the daily predictions of our thirteen individual streams, was substituted in place of last year's aggregate predictions. The predictions for this composite proves to be extremely reliable and accurate throughout the run when compared to the observed run composite. Figure 2 compares the day-to-day composite predictions and confidence intervals with the observed composite run for the year. Figure 3 and Table 6 compare the ten, fifty and ninety percent-passage dates of the individual stocks/streams with the program RealTime composite dates. While the predictive performance of the composite works well to indicate status of the composite, some individual streams fall out of its predicted percentage passage dates. This is to be expected, as the composite does not weight the run estimate by stock, but by the total arrival pattern observed. Smaller runs will have less effect on this pattern, and may thus have part of their perspective run percentages outside of the indicated percentages. Using distances calculated from the release tables in the DART database via "DART PIT-tags observed by release site"[1], the two release sites furthest from Lower Granite Dam had an arrival distribution much later than the majority of releases (Figure 3), but the third farthest release site, East Fork Salmon River, arrived before the composite, so distance alone cannot account for the timing of arrival.

Figure 2: Day-to-day predictions and the daily confidence intervals compared to the observed run for 1995 season.



1. World Wide Web address: **http://www.cqs.washington.edu/dart/pit_rel_de.html.** Data courtesy of **Pacific** States Marine Fisheries Commission.

Table 3: Comparison of mean absolute deviances (MAD) for selected single streams for the entire observed 1994, 1995 outmigrations.

Tag Site	1994 LS	1994 NLS	1995 NLS
Bear Valley Creek	.08	.040	.045
Big Creek	.20	.052	.O29
Catherine Creek	.06	.036	.056
Elk Creek	.08	.040	.066
Grande Ronde River	---	---	.064
lmnaha River	.1l	.034	.100
Lostine River	.06	.029	.035
Marshcreek	.07	.030	.049
Salmon River	.30	.059	.155
Salmon River East Fork	.10	.067	.046
Salmon River South Fork	.05	.013	.087
Secesh River	.17	.087	.028
Valley Creek	.06	.035	.073
composite run	-----	.001	.022
mean MAD	.1l	.043	0.064
median MAD	.08	.038	0.049
range	.05-.30	.013-.087	.O28-.155

Table 4: Comparison of mean absolute deviances (MAD)for selected single streams for the first half of the observed 1994, 1995 outmigrations.

Tag Site	1994 LS	1994 NLS	1995 NLS
Bear Valley Creek	.15	.116	.056
Big Creek	.14	.050	.061
Catherine Creek	.09	.043	.027
Elk Creek	.15	.068	.082
Grande Ronde River	-----	-----	.050
lmnaha River	.18	.048	.155
Lostine River	.14	.024	.034
Marsh Creek	.1l	.093	.078
Salmon River	.21	.083	.131
Salmon River East Fork	.09	.035	.070
Salmon River South Fork	.04	.016	.086
Secesh River	.13	.046	.038
Valley Creek	.16	.065	.051
composite run	------	.012	.027
mean MAD	.13	.057	.071
median MAD	.14	.049	.061
range	.04-.21	.016-.116	.027-.155

Table 5: Comparison of mean absolute deviances (MAD) for selected single streams for the last half of the observed 1994, 1995 outmigrations.

Tagging Site	1994 LS	1994NL-S	1995NLS
Bear Valley Creek	.06	.015	.039
Big Creek	.21	.052	.015
Catherine Creek	.05	.034	.066
Elk Creek	.07	.034	.058
Grade Ronde River	----	- - -	.076
Imnaha River	.10	.031	.077
Lostine River	.04	.030	.036
Marsh Creek	.06	.020	.036
Salmon River	.31	.058	.161
Salmon River East Fork	.11	.074	.035
Salmon River South Fork	.05	.012	.087
Secesh River	.17	.088	.025
Valley Creek	.05	.024	.089
composite run	-----	.014	.020
meanMAD	-11	.039	.061
medianMAD	.06	.032	.058
range	.04-.31	.012-.088	.025--161

Figure 3: 1995 passage dates (10%, 50%. 90% and range) at Lower Granite Dam for PIT-tagged wild Snake River spring/summer chinook salmon smolts for the 13 individual streams used in the composite and the composite run of program RealTime. based on the PIT-tagging of parr in 1994. The dashed lines shows the 95% coverage by RealTime's composite of the individual streams. Distances calculated from the release tables in the DART database via "DART PIT-tags observed by release site"

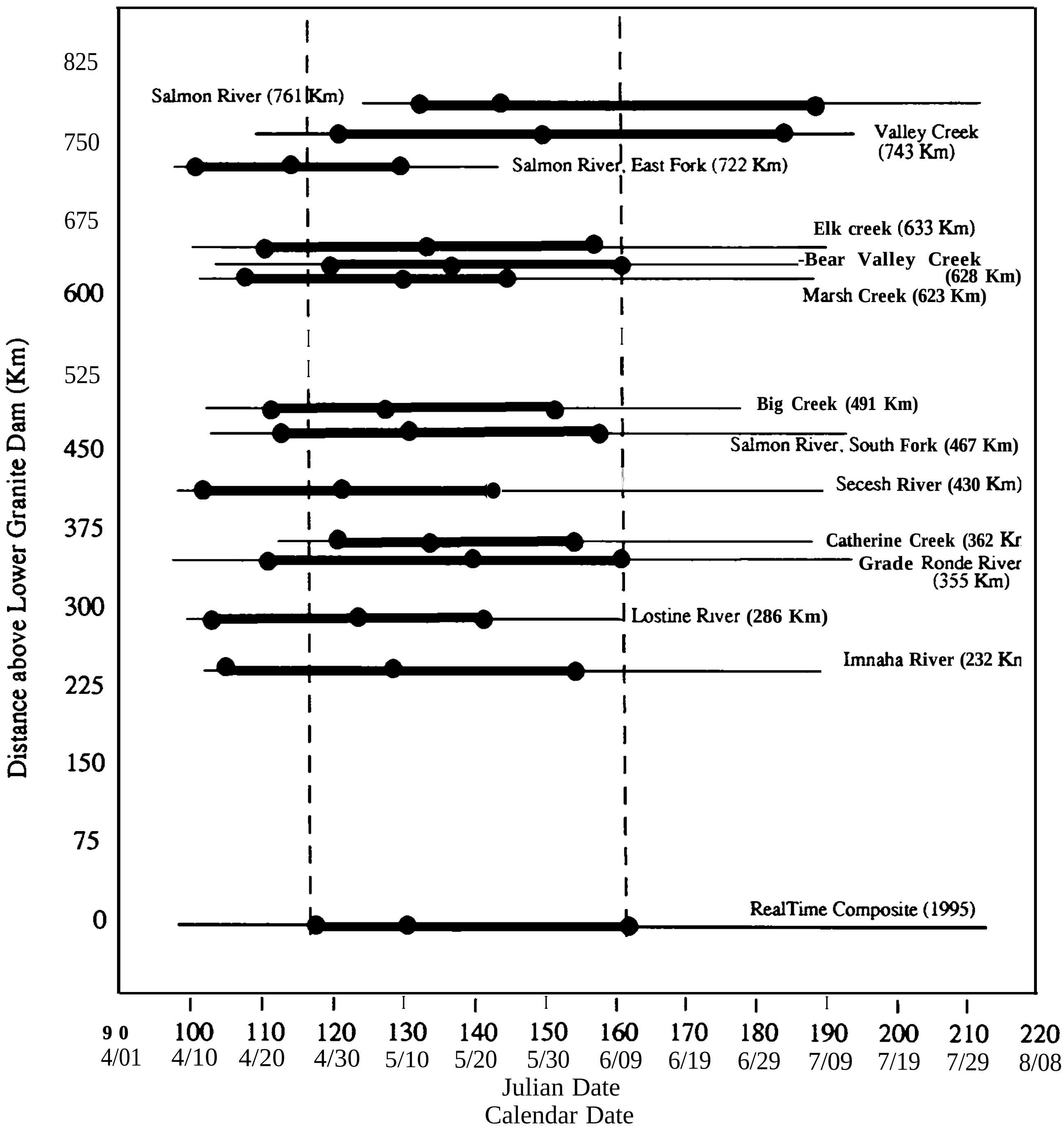


Table 6: 1995 passage dates (10% 50%, 90% and range) at Lower Granite Dam for PIT-tagged wild Snake River spring/summer chinook salmon smolts for the 13 individual streams used in the composite and the composite run on the program RealTime, based on the PIT-tagging of parr in 1994.

	Passage Dates at Lower Granite Dam			
population or stock	10%	50%	90%	Range
Bear Valley Creek	3OApril	18 May	10 June	13 April - 20 July
Big Creek	21 April	07May	30May	11 April-08 July
Catherine Creek	01 May	13 May	05 June	22 April - 08 July
Elk Creek	20 April	13 May	06 June	lOApril-09July
Grande Ronde River	2OApriJ	19 May	09 June	12 April - 01 July
Imnaha River	13Apri.l	08 May	02 June	10 April - 07 July
Lostine River	12 April	03 May	20 May	08 April-09 June
Marsh Creek	17 April	10 May	24May	11 April - 08 July
Salmon River	13 May	25 May	09 July	06 May - 01 August
Salmon River, East Fork	12 April	28 April	1 May	11 April - 27 May
Salmon River, South Fork	24 April	11 May	09 June	13 April - 13 July
Secesh River	12 April	03 May	26 May	10 April - 10 July
Valley Creek	04 May	02 June	07 July	22 April - 18 July
Program Real Time Composite	18 April	10 May	07 June	08 April - 01 August

Discussion

The results from the 1995 season show that the modifications proposed in the 1994 post-season analysis dramatically improved the Realtime prediction performance. The composite gives the additional tool of predicting run-status of the selected streams foral run at Lower Granite Dam. Unfortunately, this composite is not a catch-all single number which can be used to quantify the individual stock run-status. Stocks must be looked at separately to gain a complete picture (Appendix C displays the graphical report capabilities of the RealTime program). A graphical daily comparison of each individual stream and river with RealTime predictions (Appendix A) re-enforces the program's accuracy in per stock run predictions. Low spring/summer chinook spawner abundance and production in many streams and drainages of the Snake River system in 1995 reduced the number of streams where adequate numbers of par-r could be marked with PIT tags, likely decreasing the effectiveness of the composite run of the RealTime Forecaster program in outmigration year 1996. Future development of the RealTime program will include integration capabilities with the CRISP project to allow forecasts to be projected down-river of the Lower Granite Dam.

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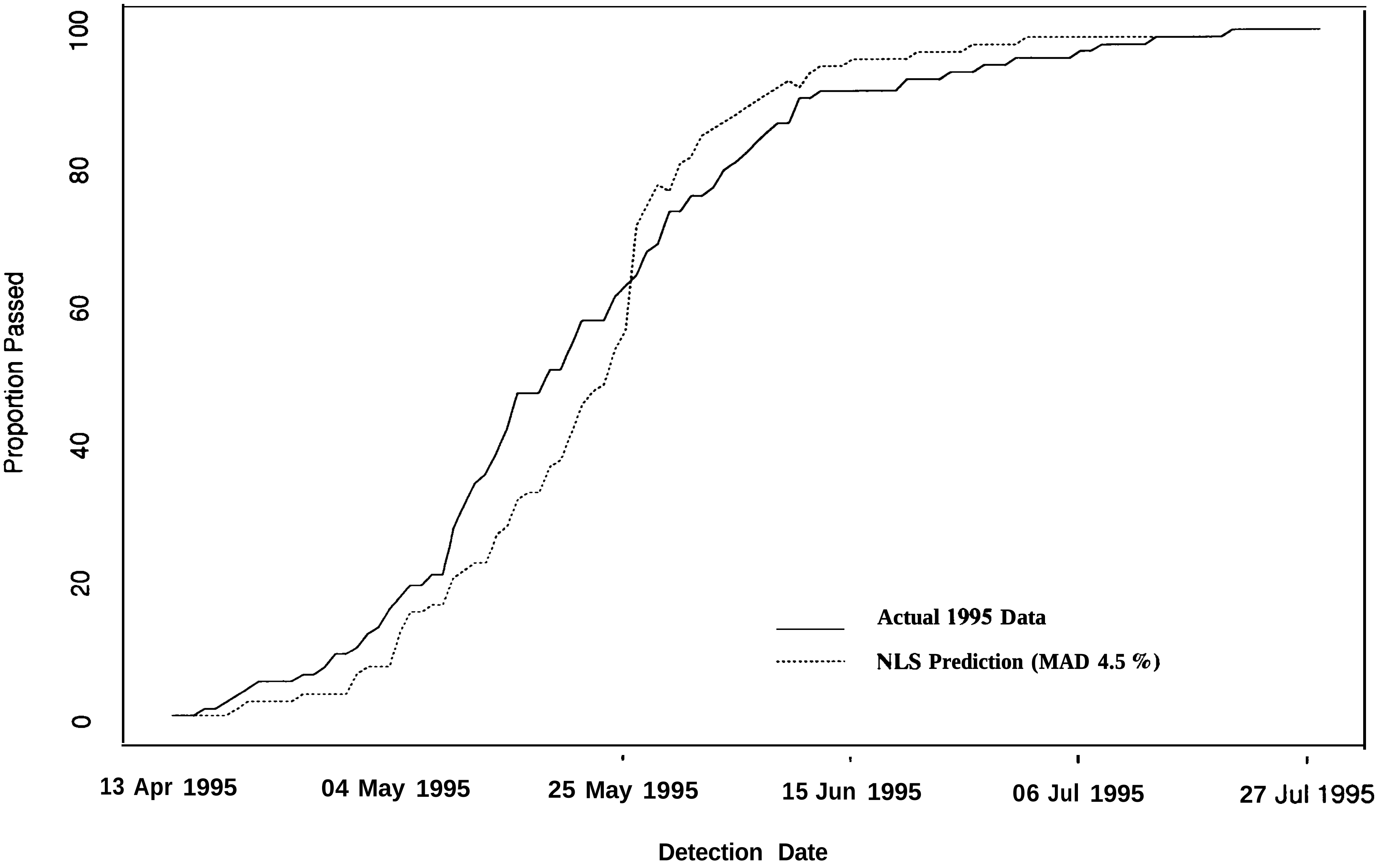
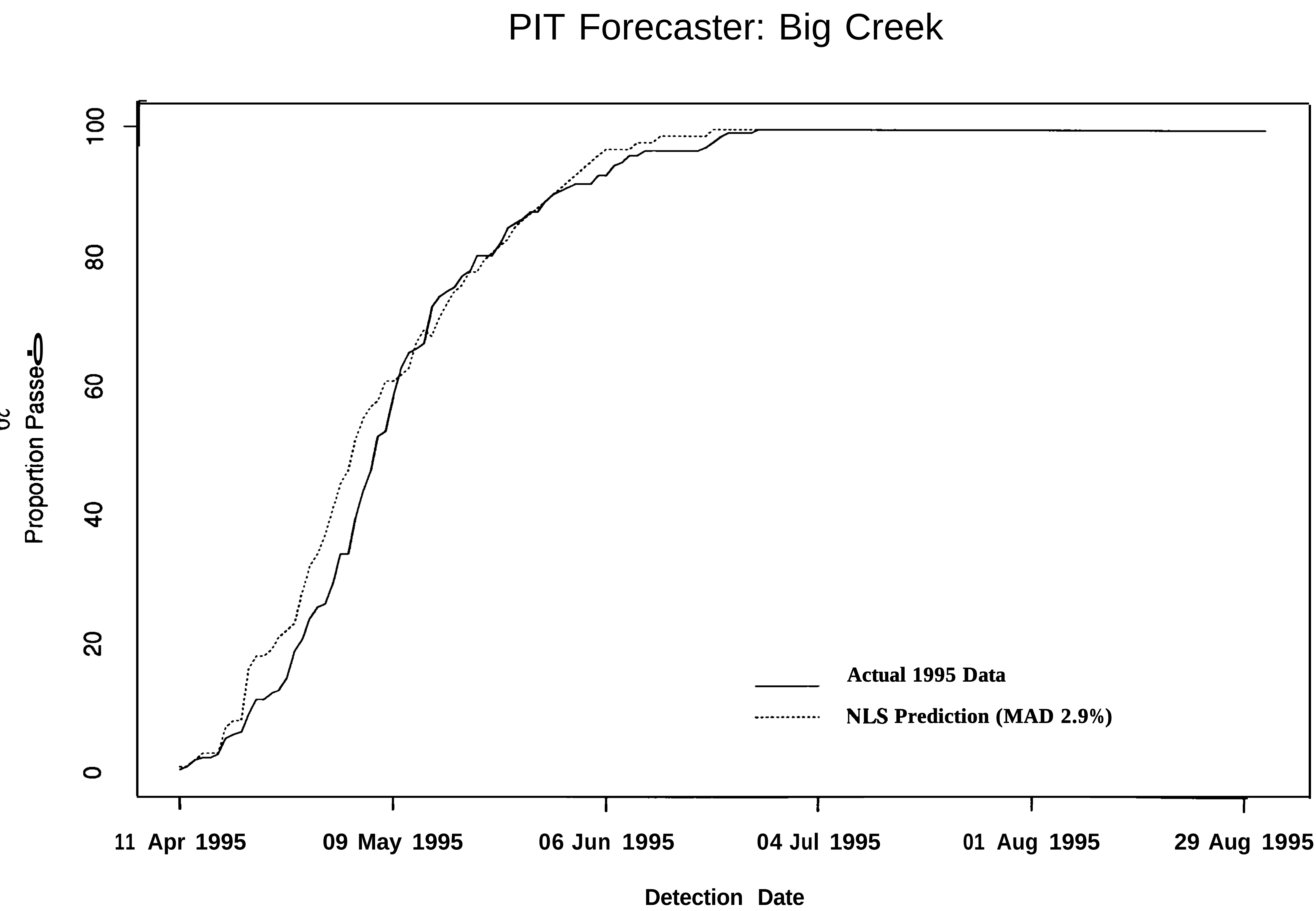
Appendix A

Performance Plots for the 1995 Outmigration Season

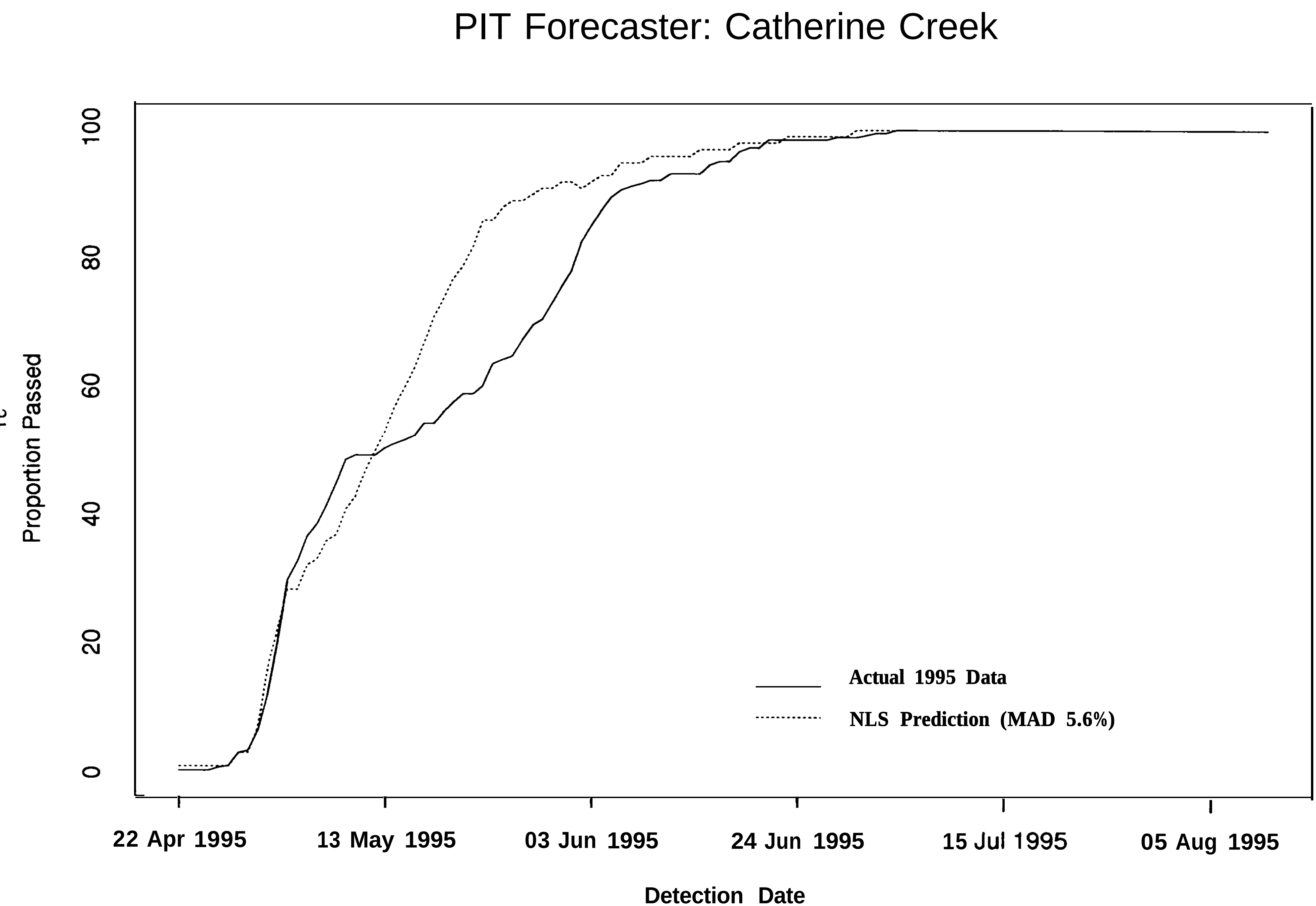
RealTime Plots

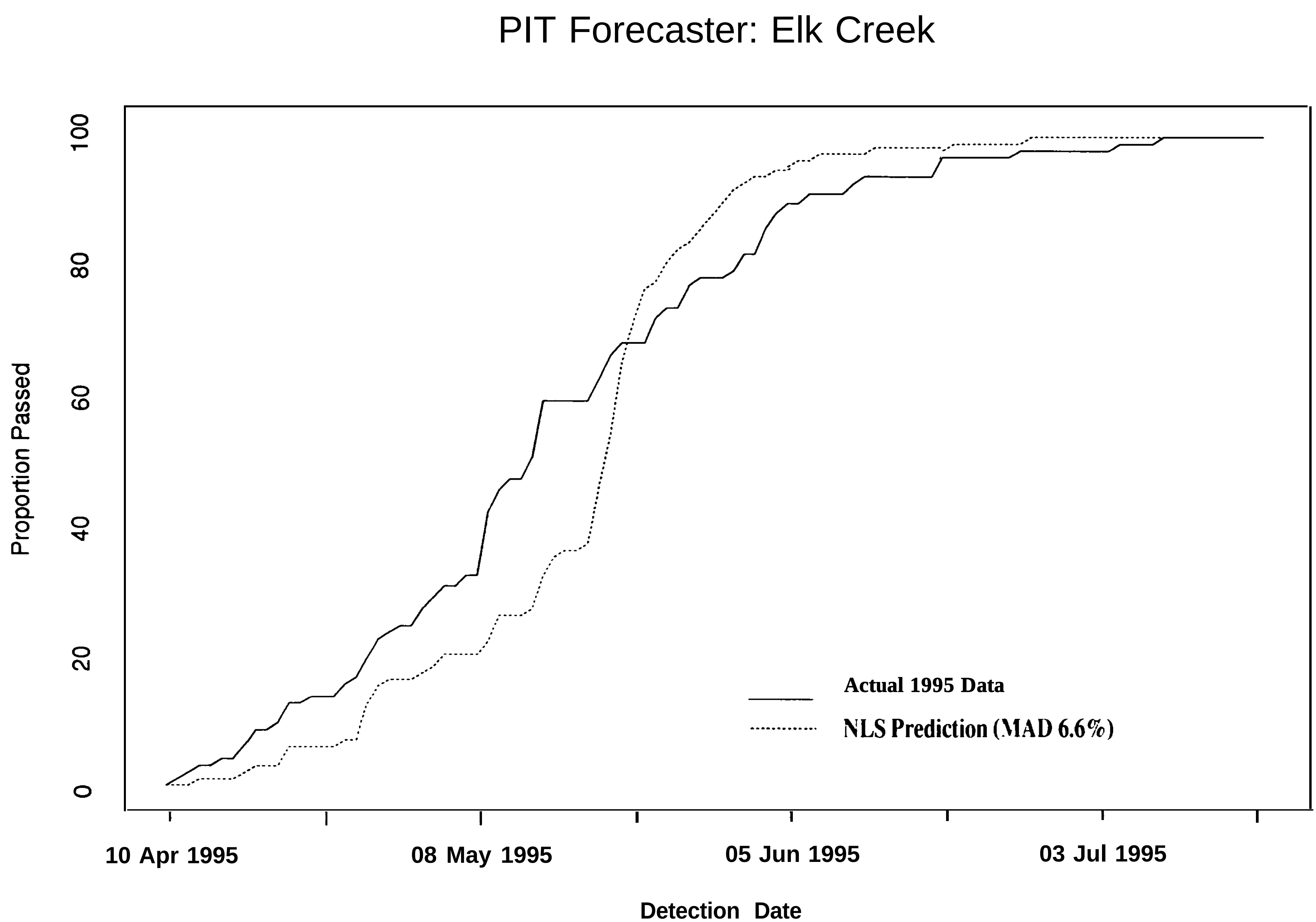
PIT Forecaster: Bear Valley Creek





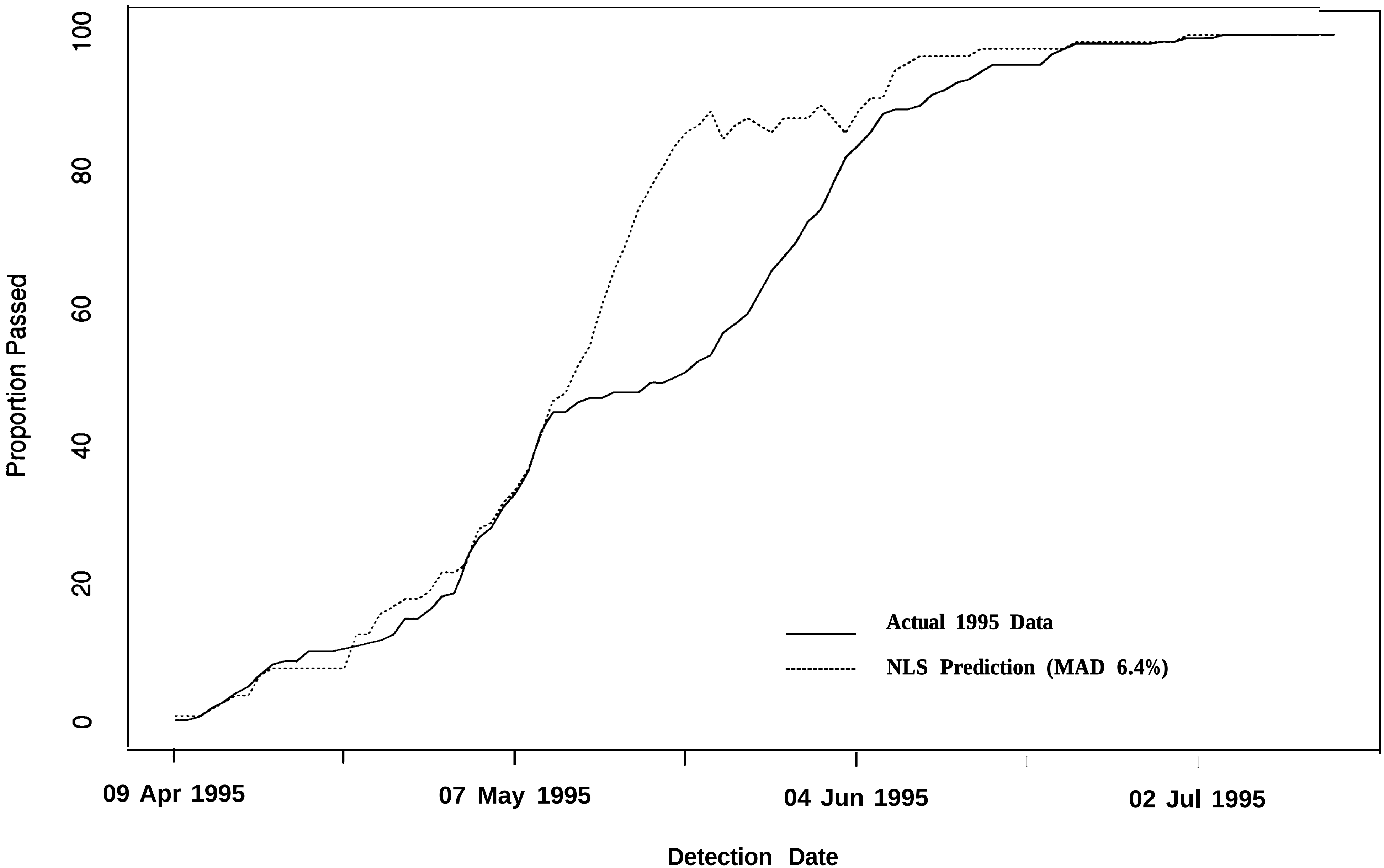
PIT Forecaster: Big Creek
Proportion Passed
0
20
40
60
80
100
11 Apr 1995
09 May 1995
06 Jun 1995
04 Jul 1995
01 Aug 1995
29 Aug 1995
Detection Date
Actual 1995 Data
NLS Prediction (MAD 2.9%)


PIT Forecaster: Catherine Creek
Proportion Passed
0
20
40
60
80
100
22 Apr 1995
13 May 1995
03 Jun 1995
24 Jun 1995
15 Jul 1995
05 Aug 1995
Detection Date
Actual 1995 Data
NLS Prediction (MAD 5.6%)

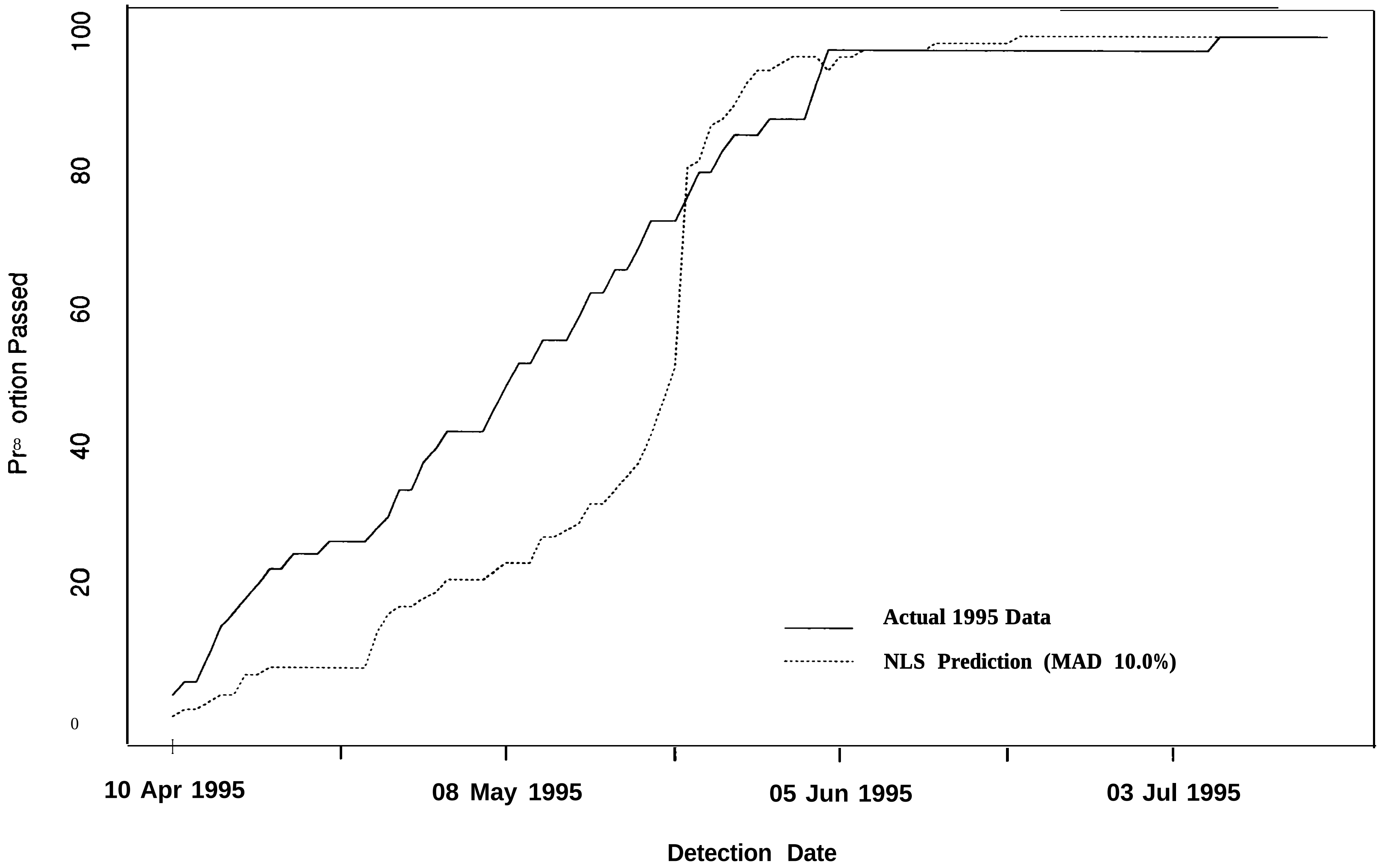


PIT Forecaster: Elk Creek
Proportion Passed
0
20
40
60
80
100
10 Apr 1995
08 May 1995
05 Jun 1995
03 Jul 1995
Detection Date
Actual 1995 Data
NLS Prediction (MAD 6.6%)

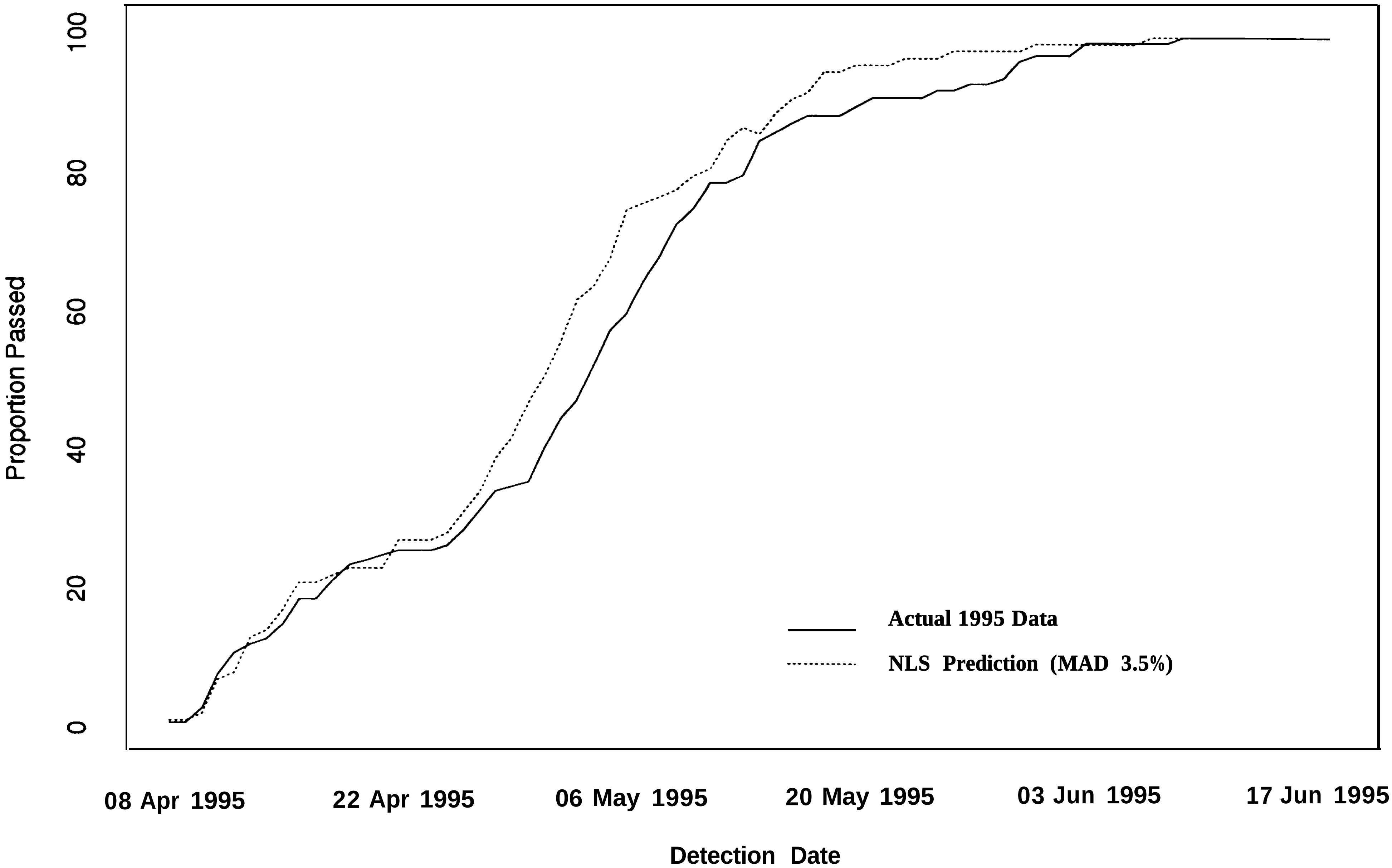
PIT Forecaster: Grand Ronde River

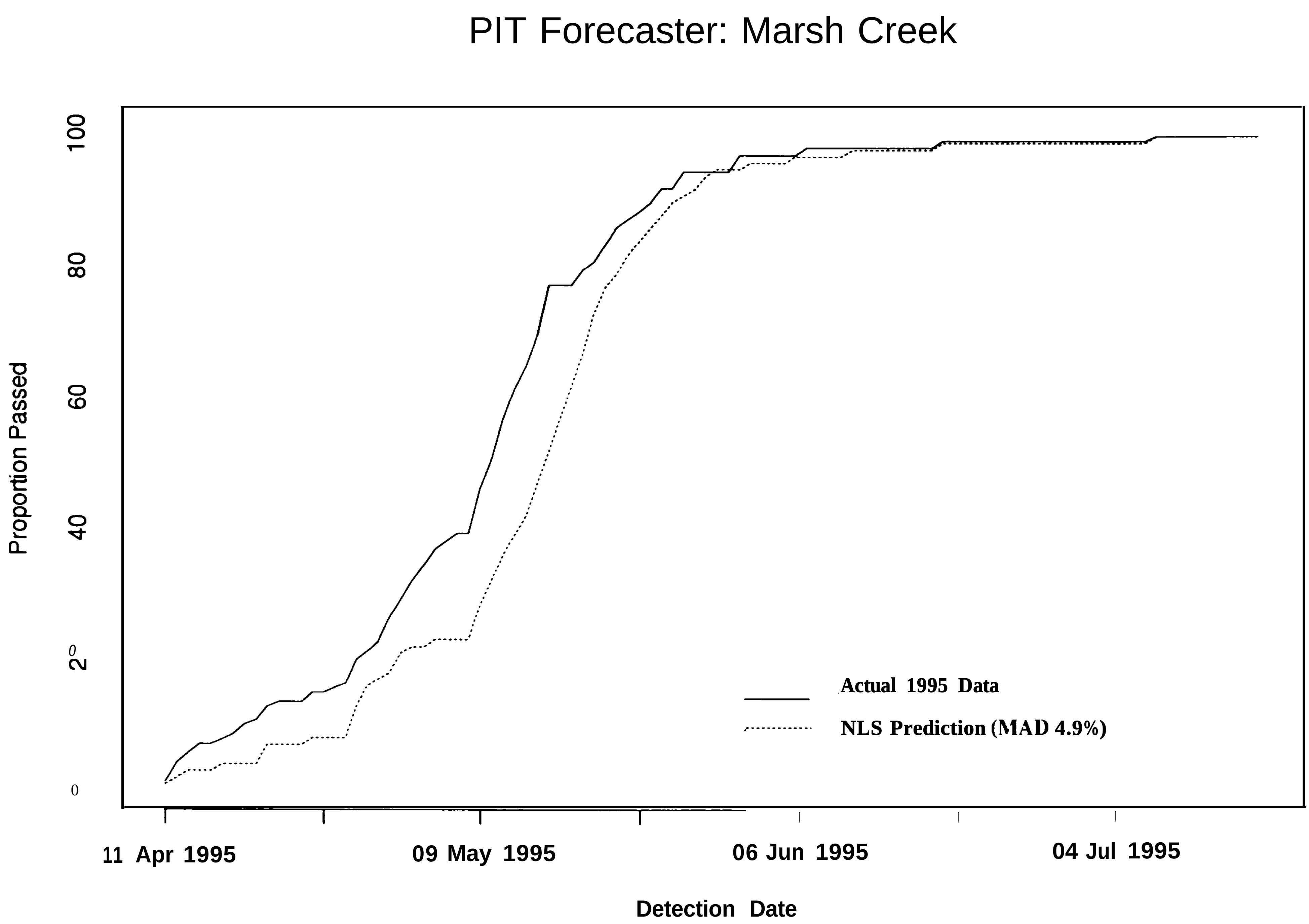


PIT Forecaster: lmnaha River

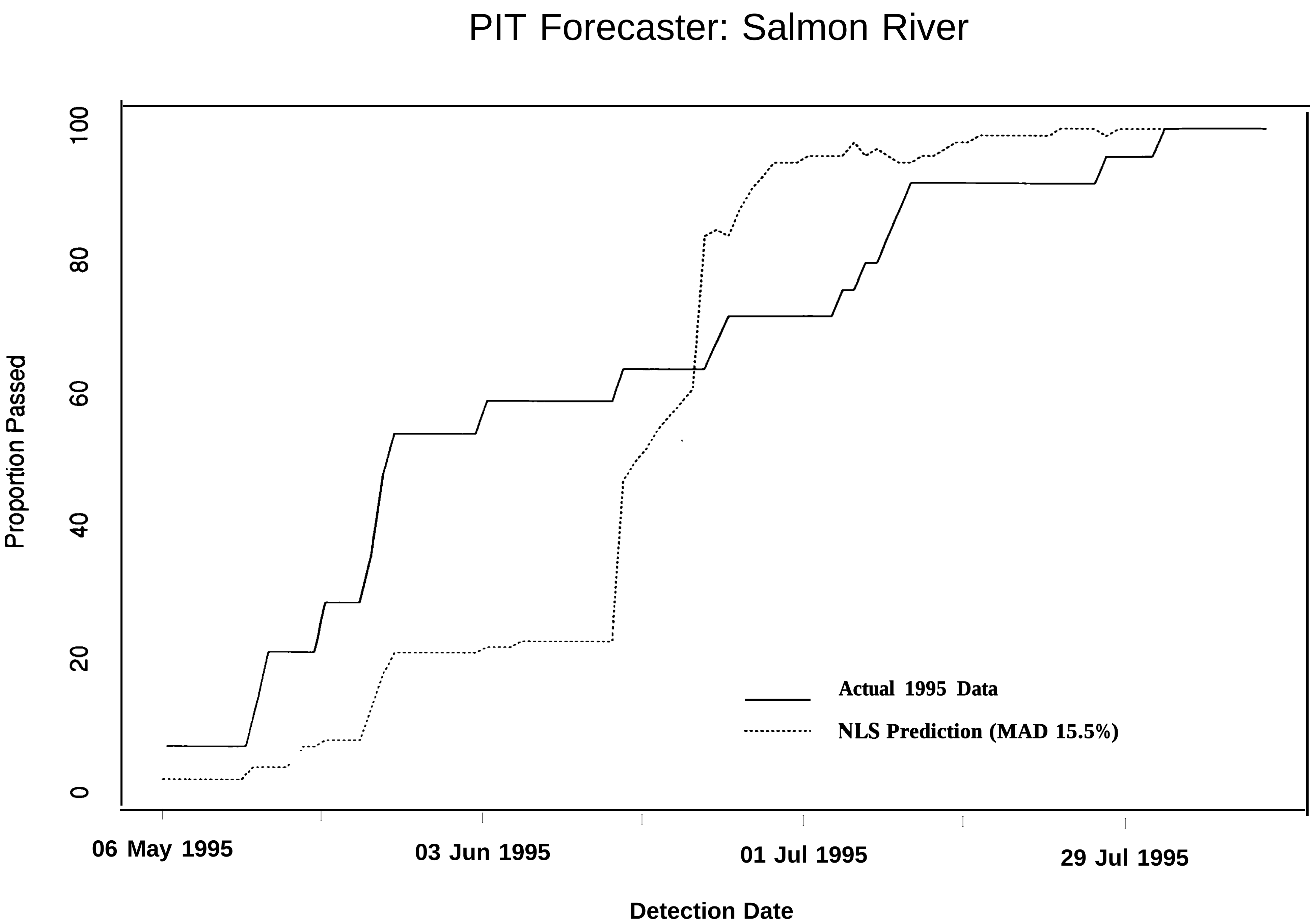


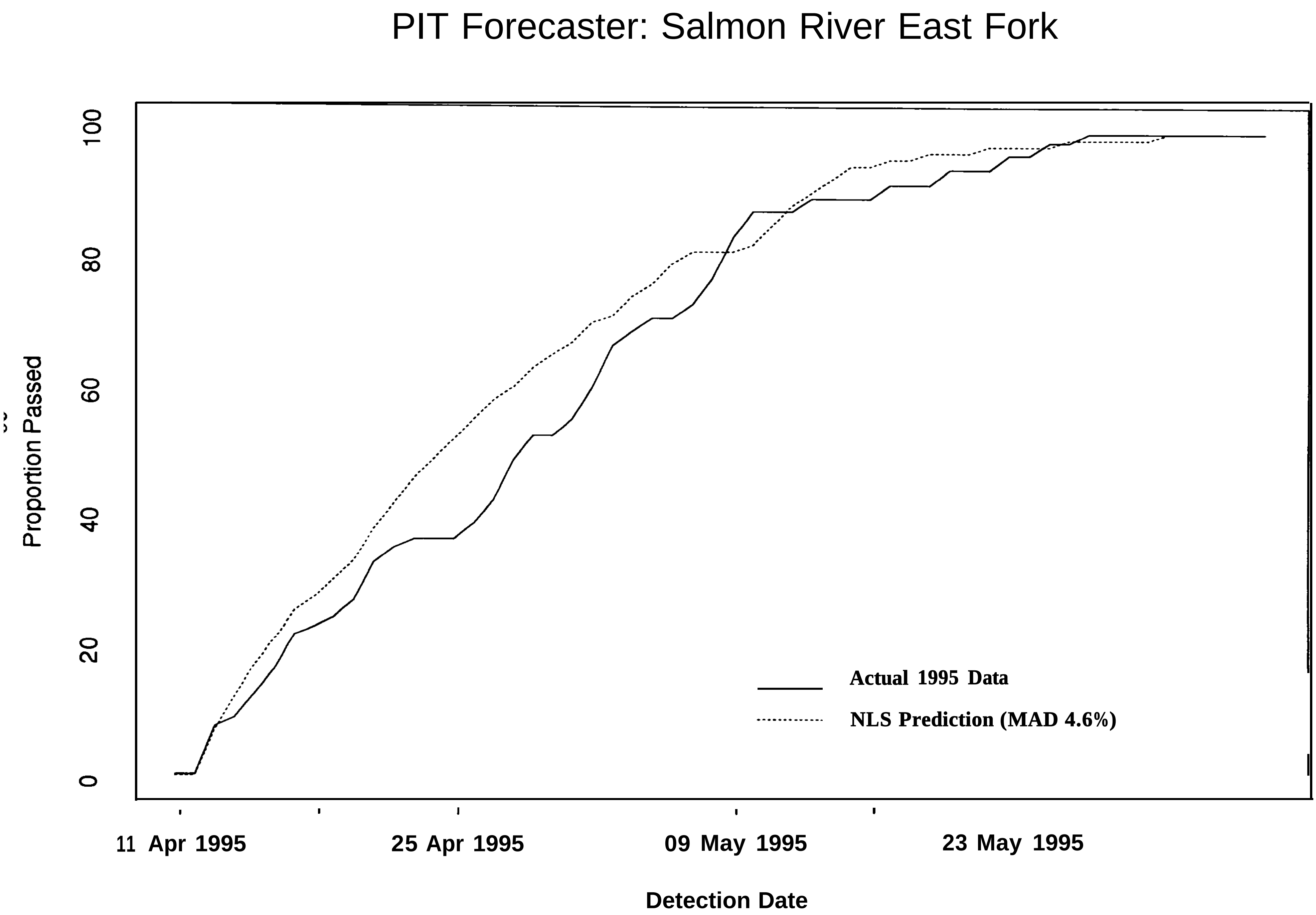
PIT Forecaster: Lostine River



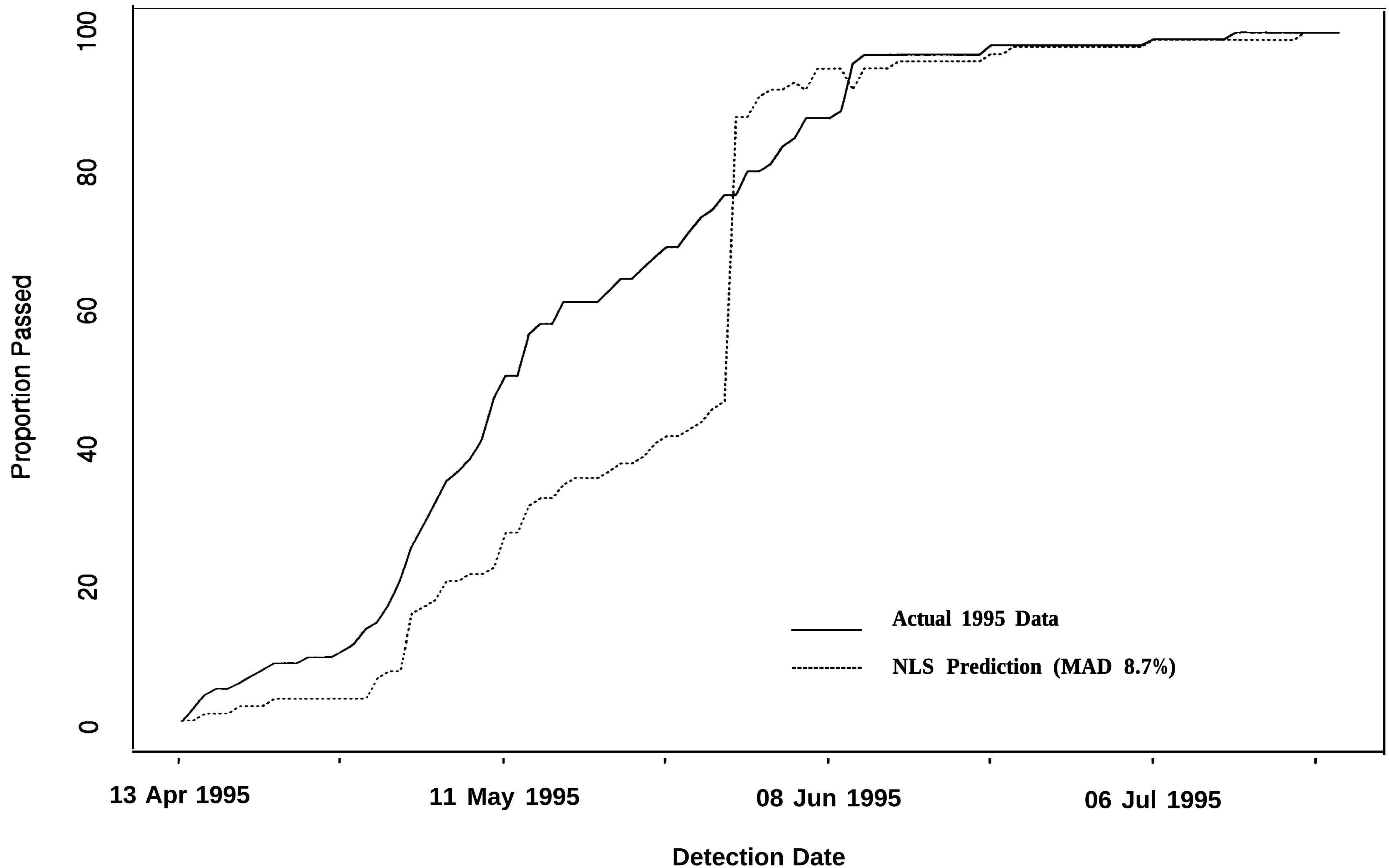


PIT Forecaster: Marsh Creek
Proportion Passed
100
80
60
40
20
0
Actual 1995 Data
NLS Prediction (MAD 4.9%)
11 Apr 1995
09 May 1995
06 Jun 1995
04 Jul 1995
Detection Date

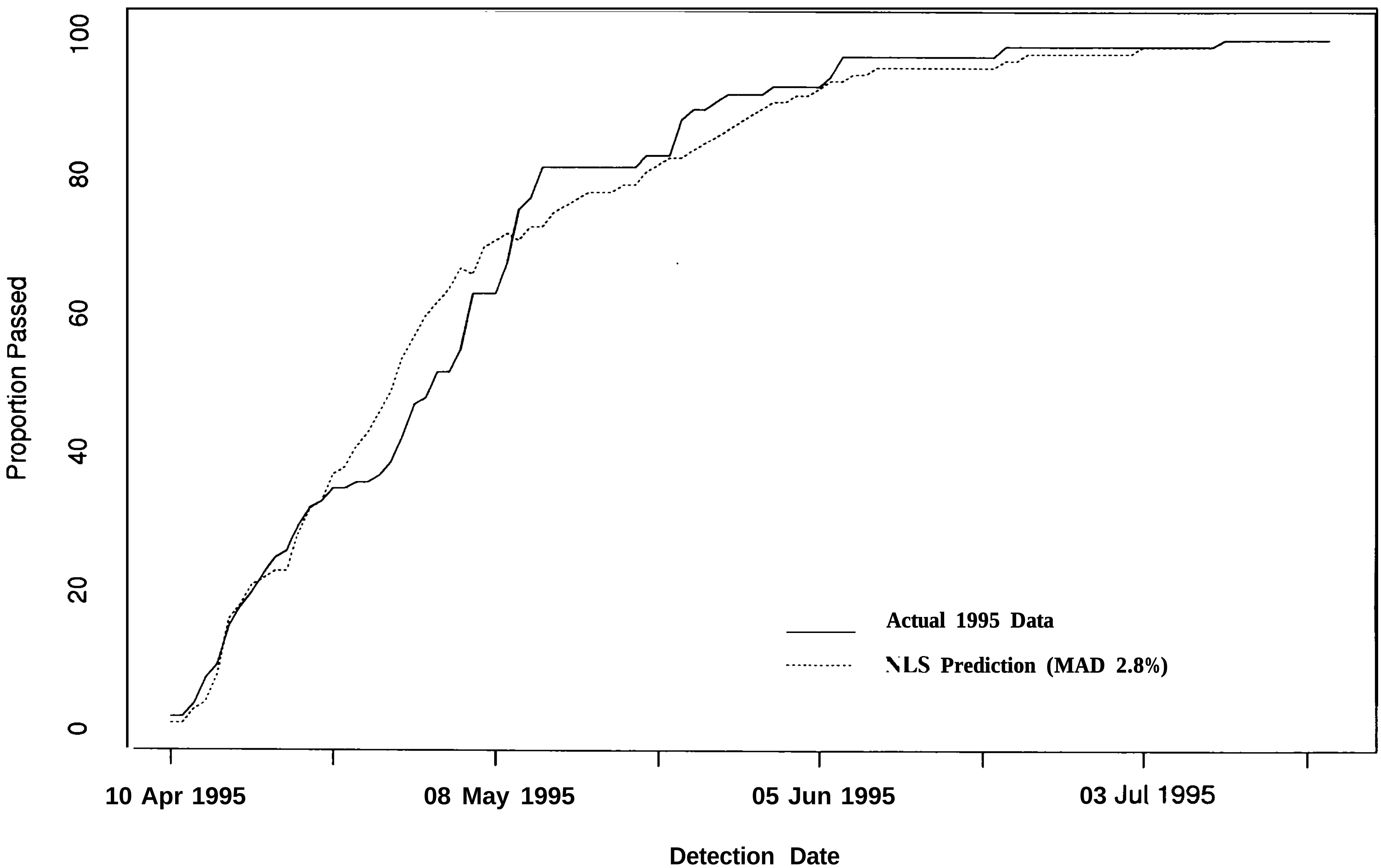

PIT Forecaster: Salmon River
Proportion Passed
0
20
40
60
80
100
Actual 1995 Data
NLS Prediction (MAD 15.5%)
06 May 1995
03 Jun 1995
01 Jul 1995
29 Jul 1995
Detection Date

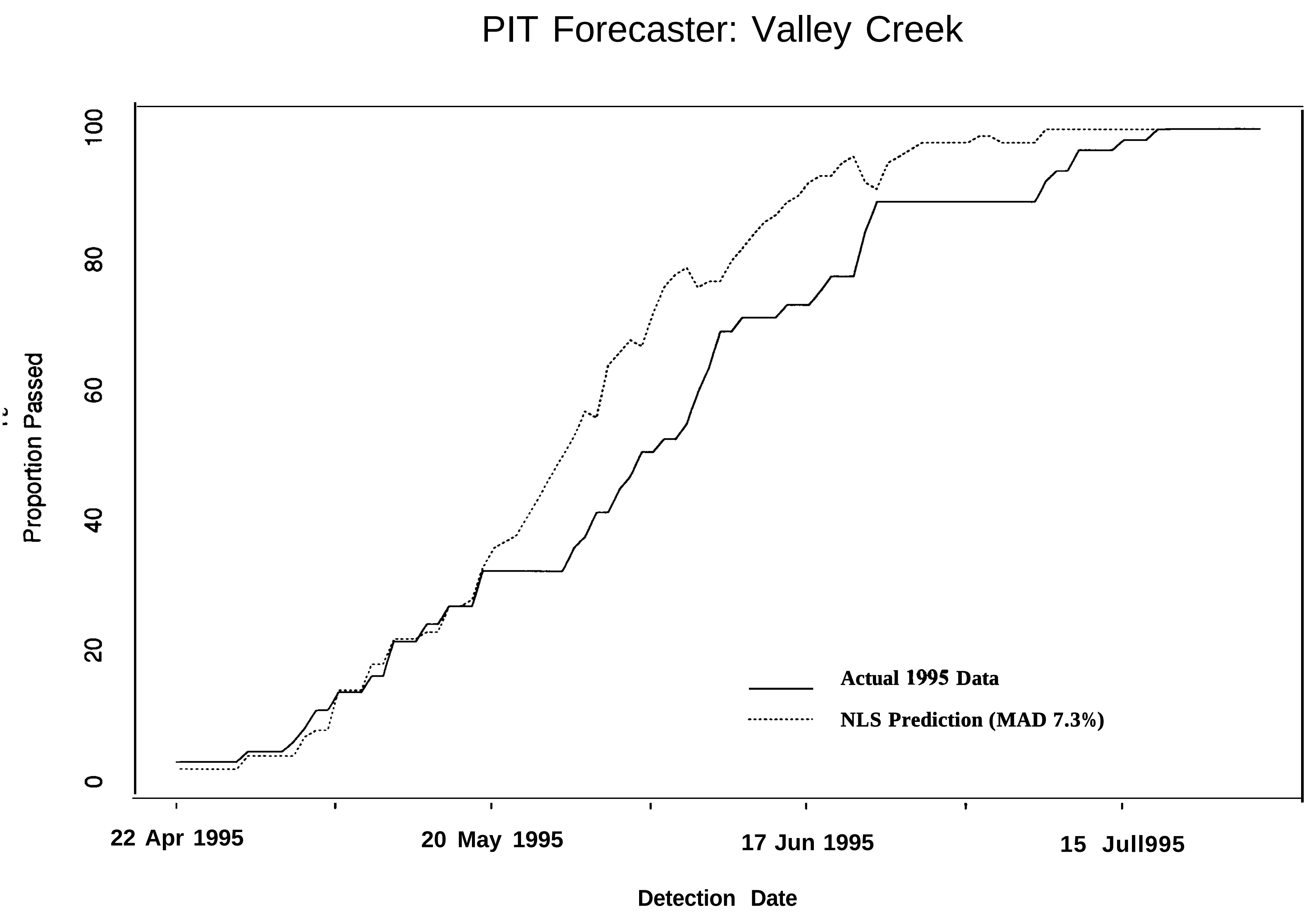

PIT Forecaster: Salmon River East Fork
Proportion Passed
0
20
40
60
80
100
11 Apr 1995
25 Apr 1995
09 May 1995
23 May 1995
Detection Date
Actual 1995 Data
NLS Prediction (MAD 4.6%)

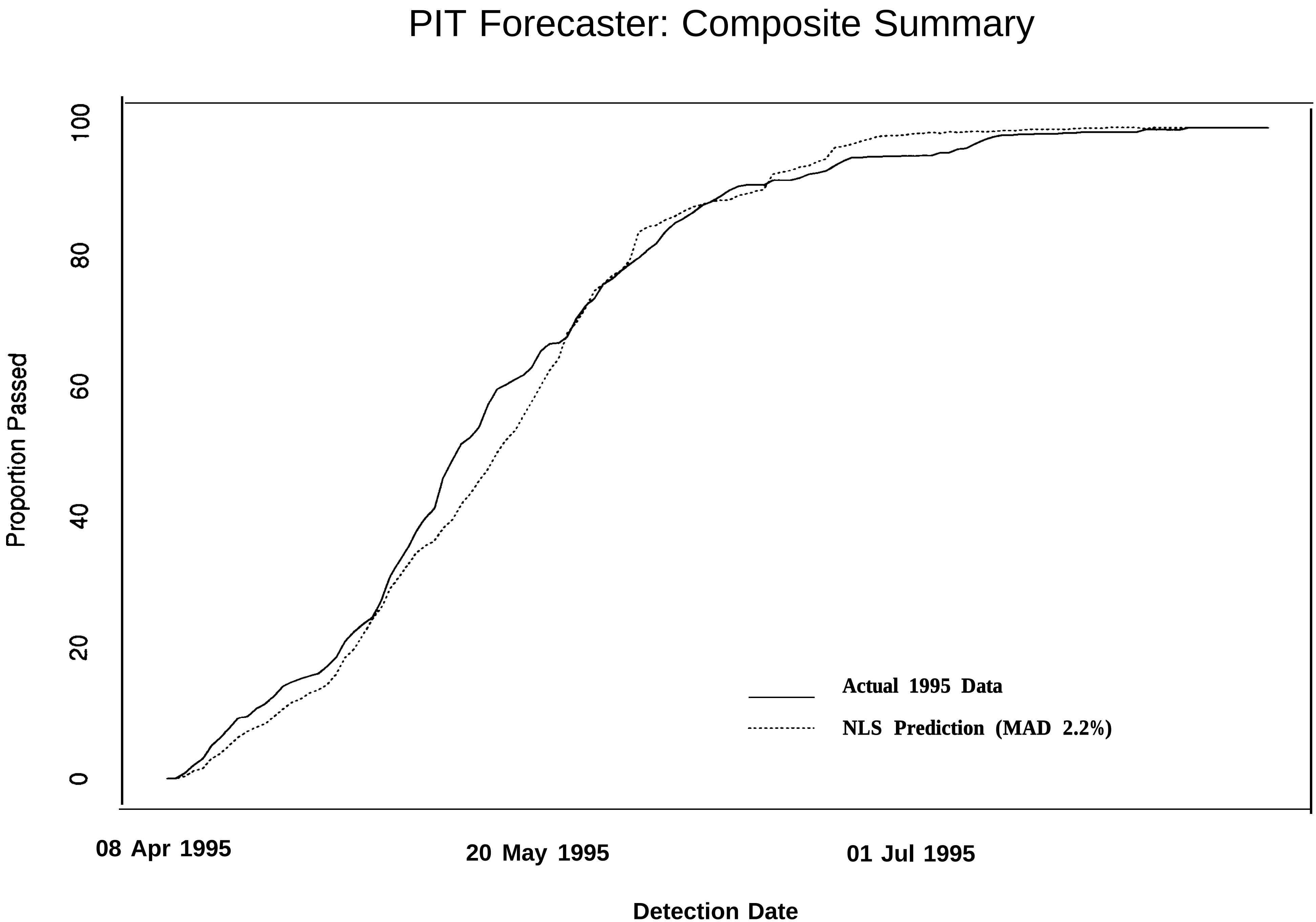
PIT Forecaster: Salmon River South Fork



PIT Forecaster: Secesh River




PIT Forecaster: Valley Creek
Proportion Passed
0
20
40
60
80
100
22 Apr 1995
20 May 1995
17 Jun 1995
15 Jull995
Detection Date
Actual 1995 Data
NLS Prediction (MAD 7.3%)


PIT Forecaster: Composite Summary
Proportion Passed
0
20
40
60
80
100
Actual 1995 Data
NLS Prediction (MAD 2.2%)
08 Apr 1995
20 May 1995
01 Jul 1995
Detection Date

Appendix B

Comparison of Historical Recovery Rates

The historical release and recovery rates of PIT-tagged spring/summer chinook smolt in the Snake River Basin were investigated as result of findings from the 1994 post-season performance report of the Realtime PIT-Forecaster program. This simple assumption that recovery rates from streams are consistent was explored, and the analysis determined that a useful prediction algorithm may be derived for the first half of the migration run. The release count for each year was categorized into "detec\d" and "not detected" recoveries and then tested for homogeneity between years with a x test of homogeneity. If the test had a p value of 0.10 or less, the years were significantly heterogeneous and an average recovery rate ($\bar{p}$) was calculated. A pooled recovery rate (p_p) was determined for the streams found to be homogeneous. Twenty-one of the 59 sites were homogenious, suggesting that this prediction method would work for only a few areas. $\bar{p}$ and p_p were calculated using the formulas

$$\bar{p} = \frac{\sum_{i=1989}^{1994} p_i}{n} \qquad (1)$$

where p_i = proportion of released smolt detected for year i (i = 1989, ... 1994) , pi = NA (missing value) if no data available,

n = number of years with available data, and

$$p_p = \frac{\sum_{i=1989}^{1994} d_i}{\sum_{j=1989}^{1994} R_j} \qquad (2)$$

where d_i = number of detected smolt for year i, and

Rj = number of smolt released for yearj.

These p and p_p were then used in the Realtime algorithms for the 1995 season forecasts. The following tables show the data used to calculate the individual stream recapture rates, the test of homogeneity of the available data for 1989-1994, and the predicted p based on historical data for 1995.

Release sites used by the RealTime program

Release Site: Bear Valley Creek (BEARVC) (spring chinook)

Observation Site: Lower Granite Juvenile (GRJ)

Migration Year:	89	90	91	92	93	94	95
Detected:		91	44	69	67	85	74
Not detected:		1429	309	1284	950	775	1386
Released:	None	1557	353	1044	1017	860	1460
Probability of Detection:		0.0584	0.1246	0.0661	0.0659	0.0988	0.0507

χ^2 p value < 0.0001, $\bar{p}$ = 0.0828

Observation Site: Snake River Trap Juvenile (SNJ)

Migration Year:	89	90	91	92	93	94	95
Detected:		0	1	1	3	1	0
Not detected:		1557	352	1043	1014	859	1460
Released:	None	1557	353	1044	1017	860	1460
Probability of Detection:		0	0.0028	0.0010	0.0029	0.0012	0

χ^2 p value = 0.2752, p_p = 0.0012

Release Site: Big Creek (BIGC) (spring chinook)

Observation Site:Lower Granite Juvenile (GRJ)

Migration Year:	89	90	91	92	93	94	95
Detected:		148	67	57	65	55	164
Not detected:		1887	660	951	668	667	1320
Released:	None	2035	727	1008	733	722	1484
Probability of Detection:		0.0727	0.0922	0.0565	0.0887	0.0762	0.1105

χ^2 p value = 0.0376, $\bar{p}$ = 0.0773

Observation Site: Snake River Trap Juvenile (SN J)

Migration Year:	89	90	91	92	93	94	95
Detected:		0	1	0	2	0	1
Not detected:		2035	726	1008	731	722	1483
Released:	None	2035	727	1008	733	722	1484
Probability of Detection:		0	0.0014	0	0.0027	0	0.0007

χ^2 p value = 0.0635, $\bar{p}$ = 0.0008

Release Site: Catherine Creek (CATHEC) (sprine chinook)

Observation Site: Lower Granite Juvenile (GR J)

Migration Year:	89	90	91	92	93	94	95
Detected:			79	67	102	76	202
Not detected:			935	873	1006	924	1859
Released:	None	None	1014	940	1108	1000	2061
Probability of Detection:			0.0779	0.0713	0.0921	0.0760	0.0980

χ^2 p value = 0.3280, p_p = *0.0798*

Observation Site: Snake River Trap Juvenile (SN J)

Migration Year:	89	90	91	92	93	94	95
Detected:			0	0	1	0	1
Not detected:			1014	940	1107	1000	2060
Released:	None	None	1014	940	1108	1000	2061
Probability of Detection:			0	0	o.ooo9	0	0.0005

χ^2 p value = 0.4459, p_p = o.OOQ2

Release Site: Elk Creek (ELKC) (spring chinook)

Observation Site: Lower Granite Juvenile (GRJ)

Migration Year:	89	90	91	92	93	94	95
Detected:		1	32	36	42	74	76
Not detected:		15	216	426	586	925	1438
Released:	None	16	248	462	628	999	1514
Probability of Detection:		0.0625	0.1290	0.0779	0.0669	0.0741	0.0502

χ^2 p value = 0.0366, $\bar{p}$ = 0.082 1

Observation Site: Snake River Trap Juvenile (SNJ)

Migration Year:	89	90	91	92	93	94	95
Detected:		0	0	0	1	0	0
Not detected:		16	248	462	627	999	1514
Released:	None	16	248	462	628	999	1514
Probability of Detection:		0	0	0	0.0016	0	0

χ^2 p value = 0.6008, p_p = 0.0004

Release Site: Grande Ronde River (GRANDR) (spring chinook)

Observation Site: Lower Granite Juvenile (GR J)

Migration Year:	89	90	91	92	93	94	95
Detected:	244				89	136	169
Not detected:	2750				875	1791	1729
Released:	2994	None	None	None	964	1927	1898
Probability of Detection:	0.08 15				0.0923	0.0706	0.0890

χ^2 p value = 0.1101, p_p = 0.0797

Release Site: Imnaha River (IMNAHR) (summer chinook)

Observation Site: Lower Granite Juvenile (GR J)

Migration Year:	89	90	91	92	93	94	95
Detected:	73	161	18	73	63	204	40
Not detected:	1140	1844	316	686	940	1549	954
Released:	1213	2005	334	759	1003	1753	999
Probability of Detection:	0.0602	0.0803	0.0539	0.0962	0.0628	0.1164	0.0400

χ^2 p value < 0.0001, $\bar{p}$ = 0.0783

Observation Site: Snake River Trap Juvenile (SNJ)

Migration Year:	89	90	91	92	93	94	95
Detected:	1	0	0	0	0	0	0
Not detected:	1212	2005	334	759	1003	1753	999
Released:	1213	2005	334	759	1003	1753	999
Probability of Detection:	0.0008	0	0	0	0	0	0

χ^2 p value = 0.4374, p_p = 0.0001

Release Site: Lostine River (LOSTIR) (spring chinook)

Observation Site: Lower Granite Juvenile (GR J)

Migration Year:	89	90	91	92	93	94	95
Detected:		8	90	93	123	69	112
Not detected:		76	927	1014	893	664	896
Released:	None	84	1017	1107	1016	733	1008
Probability of Detection:		0.0952	0.0885	0.0840	0.1211	0.0941	0.1111

χ^2 p value = 0.0444, $\bar{p}$ = 0.0966

Observation Site:Snake River Trap Juvenile (SNJ)

Migration Year:	89	90	91	92	93	94	95
Detected:		0	0	0	0	0	0
Not detected:		84	1017	1107	1016	733	1008
Released:	None	84	1017	1107	1016	733	1008
Probability of Detection:		0	0	0	0	0	0

χ^2 p value = **NA**, $\bar{p}$ = 0.00

Release Site: Marsh Creek (MARSHC) (spring chinook1

Observation Site:Lower Granite Juvenile (GRJ)

Migration Year:	89	90	91	92	93	94	95
Detected:		179	59	67	82	500	103
Not detected:		2338	802	914	918	3190	1487
Released:	None	2517	861	981	1000	3690	1590
Probability of Detection:		0.07 11	0.0685	0.0683	0.0820	0.1355	0.0648

χ^2 p value < 0.0001, $\bar{p}$ = 0.0851

Observation Site: Snake River Trap Juvenile (SN J)

Migration Year:	89	90	91	92	93	94	95
Detected:		0	0	0	1	8	0
Not detected:		2517	861	981	999	3682	1590
Released:	None	2517	861	981	1000	3690	1590
Probability of Detection:		0	0	0	0.0010	0.0022	0

χ^2 p value = 0.0507, $\bar{p}$ = 0.0006

Release Site: Salmon River (SALR) (spring chinook)

Observation Site: Lower Granite Juvenile (GR J)

Migration Year:	89	**90**	91	92	93	94	95
Detected:	103		3	61	38	46	19
Not detected:	555		24	2238	1543	693	1198
Released:	658	none	27	2299	1581	739	1217
Probability of Detection:	0.1565		0.1111	0.0265	0.0240	0.0622	0.0156

χ^2 **p** value c 0.0001, $\bar{p}$ = 0.0761

Observation Site: Snake River Trap Juvenile (SN J)

Migration Year:	89	**90**	91	92	93	94	95
Detected:	0		0	0	1	0	0
Not detected:	658		27	2299	1580	739	1217
Released:	658	none	27	2299	1581	739	1217
Probability of Detection:	0		0	0	0.0006	0	0

χ^2 p value = 0.6707, p_p = 0.0002

Release Site: Salmon River East Fork (SALREF) (spring chinook)

Observation Site: Lower Granite Juvenile (GR J)

Migration Year:	89	**90**	91	92	93	94	95
Detected:	57		18	33	40	45	69
Not detected:	688		515	636	805	840	917
Released:	745	None	533	669	845	885	986
Probability of Detection:	0.0765		0.0338	0.0493	0.0473	0.0508	0.0700

χ^2 **p-value** = 0.0111, $\bar{p}$ =0.0515

Observation Site: Snake River Trap Juvenile (SNJ)

Migration Year:	89	90	91	92	93	94	95
Detected:	0		0	0	0	0	0
Not detected:	745		533	669	845	0	986
Released:	745	None	533	669	845	885	986
Probability of Detection:	0		0	0	0	0	0

χ^2 p value = NA, $\bar{p}$ = 0.00

Release Site: Salmon River South Fork (SALRSF) (summer chinook)

Observation Site: Lower Granite Juvenile (GR J)

Migration Year:	89	90	91	92	93	94	95
Detected:	84		98	81	173	446	78
Not detected:	2142		894	950	1545	5505	1496
Released:	2226	None	992	1031	1718	595 1	1574
Probability of Detection:	0.0377		0.0988	0.0786	0.1007	0.0749	0.0496

χ^2 p value < 0.0001, $\bar{p}$ = 0.0781

Observation Site: Snake River Trap Juvenile (SN J)

Migration Year:	89	90	91	92	93	94	95
Detected:	2		0	1	2	5	1
Not detected:	2224		992	1030	1716	5946	1573
Released:	2226	None	992	1031	1718	595 1	1574
Probability of Detection:	0.0009		0	0.0010	0.0012	0.0008	0.0006

χ^2 p value = 0.8974, p_p = 0.0008

Release Site: Secesh River (SECESR) (summer chinook)

Observation Site: Lower Granite Juvenile

Migration Year:	89	90	91	92	93	94	95
Detected:	190	157	71	40	30	33	90
Not detected:	1750	2019	947	973	297	389	1461
Released:	1940	2176	1018	1013	327	422	1551
Probability of Detection:	0.0979	0.0722	0.0697	0.0395	0.0917	0.0782	0.0580

χ^2 p value < 0.0001, $\bar{p}$ = 0.0749

Observation Site:Snake River Trap Juvenile (SN J)

Migration Year:	89	90	91	92	93	94	95
Detected:	3	0	0	0	0	0	3
Not detected:	1937	2176	1018	1013	327	422	1548
Released:	1940	2176	1018	1013	327	422	1551
Probability of Detection:	0.0015	0	0	0	0	0	0.0019

χ^2 p value = 0.1756, p_p = o.ooo4

Release Site: Vallev Creek (VALEYC) (spring chinook)

Observation Site: Lower Granite Juvenile (GR J)

Migration Year:	89	90	91	92	93	94	95
Detected:	74	76	41	34	33	46	50
Not detected:	1868	2436	990	935	995	804	1502
Released:	1942	2512	1031	969	1028	850	1552
Probability of Detection:	0.0381	0.0303	0.0398	0.035 1	0.0321	0.0541	0.0322

χ^2 p value = 0.0446, $\bar{p}$ = 0.0383

Observation Site: Snake River Trap Juvenile (SNJ)

Migration Year:	89	90	91	92	93	94	95
Detected:	0	2	0	0	0	1	0
Not detected:	1942	2510	1013	969	1028	849	1552
Released:	1942	2512	1013	969	1028	850	1552
Probability of Detection:	0	0.0008	**0**	**0**	0	0.0012	0

χ^2 p value = 0.4568, p_p = 0.0004

Other Release Sites Investigated

Release Site: Alturas Lake Creek (ALTULC) (spring chinook)

Observation Site: Lower Granite Juvenile (GRJ)

Migration Year:	89	90	91	92	93	94	95
Detected:		4	11	2	18		8
Not detected:		1039	426	155	367		412
Released:	None	1043	437	157	385	None	420
Probability of Detection:		0.0038	0.0252	0.0127	**0.0468**		0.0190

χ^2 p value < 0.0001, $\bar{p}$ = 0.022 1

Observation Site: Snake River Trap Juvenile (SNJ)

Migration Year:	89	**90**	91	92	93	94	95
Detected:		0	0	2	**0**		0
Not detected:		1043	437	155	385		420
Released:	None	1043	437	157	385	None	420
Probability of Detection:		0	0	0.0127	0		0

χ^2 p value < 0.0001, $\bar{p}$ = 0.0032

Release Site: CaDe Horn Creek (CAPEHC) (spring chinook)

Observation Site: Lower Granite Juvenile (GR J)

Migration Year:	89	90	91	92	93	94	95
Detected:			25	19	22	0	84
Not detected:			139	190	184	460	1361
Released	None	None	164	209	206	460	1445
Probability of Detection:			0.1524	0.0909	0.1068	0	0.0581

x2p value < 0.0001, fi = 0.0875

Observation Site: Snake River Trap Juvenile (SNJ)

Migration Year:	89	90	91	92	93	94	95
Detected:			0	0	0	0	1
Not detected:			164	209	206	460	1444
Released:	None	None	164	209	206	460	1445
Probability of Detection:			0	0	0	0	0.0007

χ^2 p value = NA, $\bar{p}$ =0.00

Release Site: Chamberlain Creek (CHAMBC) (spring chinook1

Observation Site: Lower Granite Juvenile (GR J)

Migration Year:	89	90	91	92	93	94	95
Detected:				13		1	15
Not detected:				325		75	226
Released:	None	None	None	338	None	76	241
Probability of Detection:				0.0385		0.0 132	0.0622

χ^2 p value = 0.4523, p_p = 0.0258

Observation Site: Snake River Trap Juvenile (SNJ)

Migration Year:	89	90	91	92	93	94	95
Detected:				0		0	0
Not detected:				338		76	241
Released:	None	None	None	338	None	76	241
Probability of Detection:				0		0	0

χ^2 p value = NA, $\bar{p}$ = 0.00

Release Site: Chamberlain Creek. West Fork (CHAMWF) (spring chinook)

Observation Site: Lower Granite Juvenile (GRJ)

Migration Year:	89	90	91	92	93	94	95
Detected:				48	49	32	45
Not detected:				1017	451	468	872
Released:	None	None	None	1065	500	500	917
Probability of Detection:				0.045 1	0.0980	0.0640	0.0491

χ^2 p value = 0.0003, $\bar{p}$ = 0.0690

Observation Site: Snake River Juvenile (SNJ)

Migration Year:	89	90	91	92	93	94	95
Detected:				0	1	0	0
Not detected:				1065	499	500	917
Released:	None	None	None	1065	500	500	917
Probability of Detection:				0	0.0020	0	0

χ^2 p value = 0.2089, p_p = 0.0007

Release Site: Fourth of Julv Creek (4JULYC) (spring chinook)

Observation Site: Lower Granite Juvenile (GR J)

Migration Year:	89	90	91	92	93	94	95
Detected:					9		
Not detected:					264		
Released:	None	None	None	None	273	None	None
Probability of Detection:					0.0330		

one years data only, so no average, p = 0.0330

Observation Site: Snake River Trap Juvenile (SN J)

Migration Year:	89	90	91	92	93	94	95
Detected:					0		
Not detected:					273		
Released:	None	None	None	None	273	None	None
Probability of Detection:					0		

one years data only, so no average, p = 0.00

Release Site: Frenchman Creek (FRENCC) (sorinp chinook)

Observation Site: Lower Granite Juvenile (GR J)

Migration Year:	89	90	91	92	93	94	95
Detected:			5	14	53	0	21
Not detected:			191	561	508	387	574
Released:	None	None	196	575	561	387	595
Probability of Detection:			0.0255	0.0243	0.0945	0	0.0353

χ^2 p value < 0.0001, $\bar{p}$ = 0.0361

Observation Site:Snake River Trap Juvenile (SN J)

Migration Year:	89	90	91	92	93	94	95
Detected:			0	0	1	0	0
Not detected:			196	575	560	387	595
Released:	None	None	196	575	561	387	595
Probability of Detection:			0	0	0.0018	0	0

χ^2 p value = 0.5589, p_p = *0.0005*

Release Site: Herd Creek (HERDC) (spring chinook)

Observation Site: Lower Granite Juvenile (GR J)

Migration Year:	89	90	91	92	93	94	95
Detected:				18	16	4	36
Not detected:				294	208	115	498
Released:	None	None	None	312	224	119	534
Probability of Detection:				0.0577	0.07 14	0.0336	0.0674

χ^2 p value = 0.3616, p_p = 0.0580

Release Site: Huckleberrv Creek (HUCKLC) (spring chinook)

Observation Site: Lower Granite Juvenile (GR J)

Migration Year:	89	90	91	92	93	94	95
Detected:				6			15
Not detected:				170			249
Released:	None	None	None	176	None	None	264
Probability of Detection:				0.0341			0.0568

one years data only, so no average, p = 0.0341

Observation Site: Snake River Trap Juvenile (SN J)

Migration Year:	89	90	91	92	93	94	95
Detected:				0			0
Not detected:				176			264
Released:	None	None	None	176	None	None	264
Probability of Detection:				0			0

one years data only, so no average, p = 0.00

Release Site: Lemhi Weir (LEMHIW) (spring chinook)

Observation Site: Lower Granite Juvenile (GR J)

Migration Year:	89	90	91	92	93	94	95
Detected:					**82**	**85**	334
Not detected:					**553**	**665**	1452
Released:	None	None	None	None	**635**	**750**	1786
Probability of Detection:					0.1291	0.1133	0.1870

χ^2 p value = 0.4139, p_p = 0.1371

Observation Site:Snake River Juvenile **(SNJ)**

Migration Year:	89	90	91	92	**93**	**94**	95
Detected:					**0**	1	1
Not detected:					**635**	**749**	1785
Released:	None	None	None	None	**635**	**750**	1786
Probability of Detection:					0	0.0013	0.0006

χ^2 p value = 0.9336, p_p = 0.0007

Release Site: Looking Glass Creek (LOOKGC) (spring chinook)

Observation Site: Lower Granite Juvenile (GRJ)

Migration Year:	89	90	91	92	93	94	95
Detected:						241	285
Not detected:						1762	3329
Released:	None	None	None	None	None	2003	3614
Probability of Detection:						0.1203	0.0789

one years data only, so no average, p = 0.1203

Observation Site: Snake River Trap Juvenile (SNJ)

Migration Year:	89	90	91	92	93	94	95
Detected:						1	2
Not detected:						2002	3612
Released:	None	None	None	None	None	2003	3614
Probability of Detection:						0.0005	o.ooo6

one years data only, so no average, p = 0.0005

Release Site: Pole Creek (POLEC) (spring chinook)

Observation Site: Lower Granite Juvenile (GRJ)

Migration Year:	89	90	91	92	93	94	95
Detected:			8				
Not detected:			188				
Released:	None	None	196	None	None	None	None
Probability of Detection:			0.0408				

one year's data only, so no average, p = 0.0408

Observation Site: Snake River Trap Juvenile (SN J)

Migration Year:	89	**90**	91	92	93	94	95
Detected:			0				
Not detected:			196				
Released:	None	None	196	None	None	None	None
Probability of Detection:			0				

one year's data only, so no average, p = 0.00

Release Site: Salmon River North Fork (SALRNF) (Spring chinook)

Observation Site: Lower Granite Juvenile (GR J)

Migration Year:	89	**90**	91	92	93	94	95
Detected:					27	19	36
Not detected:					486	214	484
Released:	None	None	None	None	513	233	520
Probability of Detection:					0.0526	0.0815	0.0692

χ^2 **p value =** 0.1747, p_p **=** 0.0617

Observation Site: Snake River Trap Juvenile (SN J)

Migration Year:	89	**90**	91	92	93	94	95
Detected:					0	0	1
Not detected:					513	233	519
Released:	None	None	None	None	513	233	520
Probability of Detection:					**0**	**0**	0.0019

χ^2 p value = NA, $\bar{p}$ = 0.0000

Release Site: Smiley Creek (SMILEC) (spring chinook)

Observation Site: Lower Granite Juvenile (GRJ)

Migration Year:	89	90	91	92	93	94	95
Detected:						16	16
Not detected:						543	514
Released:	None	None	None	None	None	559	530
Probability of Detection:						0.0286	0.0302

One year's data only, so no average, p = 0.0286

Observation Site: Snake River Trap Juvenile (SNJ)

Migration Year:	89	90	91	92	93	94	95
Detected:						0	0
Not detected:						559	530
Released:	None	None	None	None	None	559	530
Probability of Detection:						0	0

One year's data only, so no average, p = 0.00

Release Site:Snake River (SNAKER) (spring chinook)

Observation Site:Lower Granite Juvenile (GR J)

Migration Year:	89	90	91	92	93	94	95
Detected:						165	
Not detected:						417	
Released:	None	None	None	None	None	582	None
Probability of Detection:						0.2835	

One year's data only, so no average, p = 0.2835

Release Site: Sulfur Creek (SULFUC) (spring chinook)

Observation Site: Lower Granite Juvenile (GRJ)

Migration Year:	89	90	91	92	93	94	95
Detected:		168		24	28		56
Not detected:		2348		186	686		672
Released:	None	2516	None	210	714	None	728
Probability of Detection:		0.0668		0.1143	0.0392	.	0.0769

χ^2 p value = 0.0003, $\bar{p}$ = 0.0734

Observation Site: Snake River Trap Juvenile (SN J)

Migration Year:	89	90	91	92	93	94	95
Detected:		0		0	0		0
Not detected:		2516		210	714		728
Released:	None	2516	None	210	714	None	728
Probability of Detection:		0		0	0		0

χ^2 p value = NA, $\bar{p}$ = 0.00

Release Site: Wenaha River (WENR) (Spring chinook)

Observation Site: Lower Granite Juvenile

Migration Year:	89	90	91	92	93	94	95
Detected:					23	21	21
Not detected:					173	191	238
Released:	None	None	None	None	196	212	259
Probability of Detection:					0.1173	0.0991	0.0811

χ^2 p value = 0.6633, p_p = 0.1078

Observation Site:Snake River Trap Juvenile (SNJ)

Migration Year:	89	90	91	92	93	94	95
Detected:					1	0	0
Not detected:					195	212	259
Released:	None	None	None	None	196	212	259
Probability of Detection:					0.005 1	0	0

x2 p value = 0.9687, p_p = 0.0025

Release Site:Wenaha River, South Fork (WENRSF) <u>(spring chinook)</u>

Observation Site:Lower Granite Juvenile (GRJ)

Migration Year:	89	90	91	92	93	94	95
Detected:					60	68	54
Not detected:					509	720	692
Released:	None	None	None	None	569	788	746
Probability of Detection:					0.1054	0.0863	0.0724

χ^2 p value = 0.2726, p_p = *0.0943*

Observation Site:Snake River Trap Juvenile (SNJ)

Migration Year:	89	90	91	92	93	94	95
Detected:					0	0	0
Not detected:					569	788	746
Released:	None	None	None	None	569	788	746
Probability of Detection:					**0**	**0**	**0**

χ^2 p value = NA, $\bar{p}$ = 0.00

Release Site:Sawtooth Trap (SAWTRP) (spring chinook)

Observation Site:Lower Granite Juvenile (GRJ)

Migration Year:	89	90	91	92	93	94	95
Detected:			74	0	48	4	106
Not detected:			2629	403	1829	147	1237
Released:	None	None	2703	403	1877	151	1343
Probability of Detection:			0.0274	0	0.0256	0.0265	0.0789

χ^2 p value = 0109, $\bar{p}$ = 0.0199

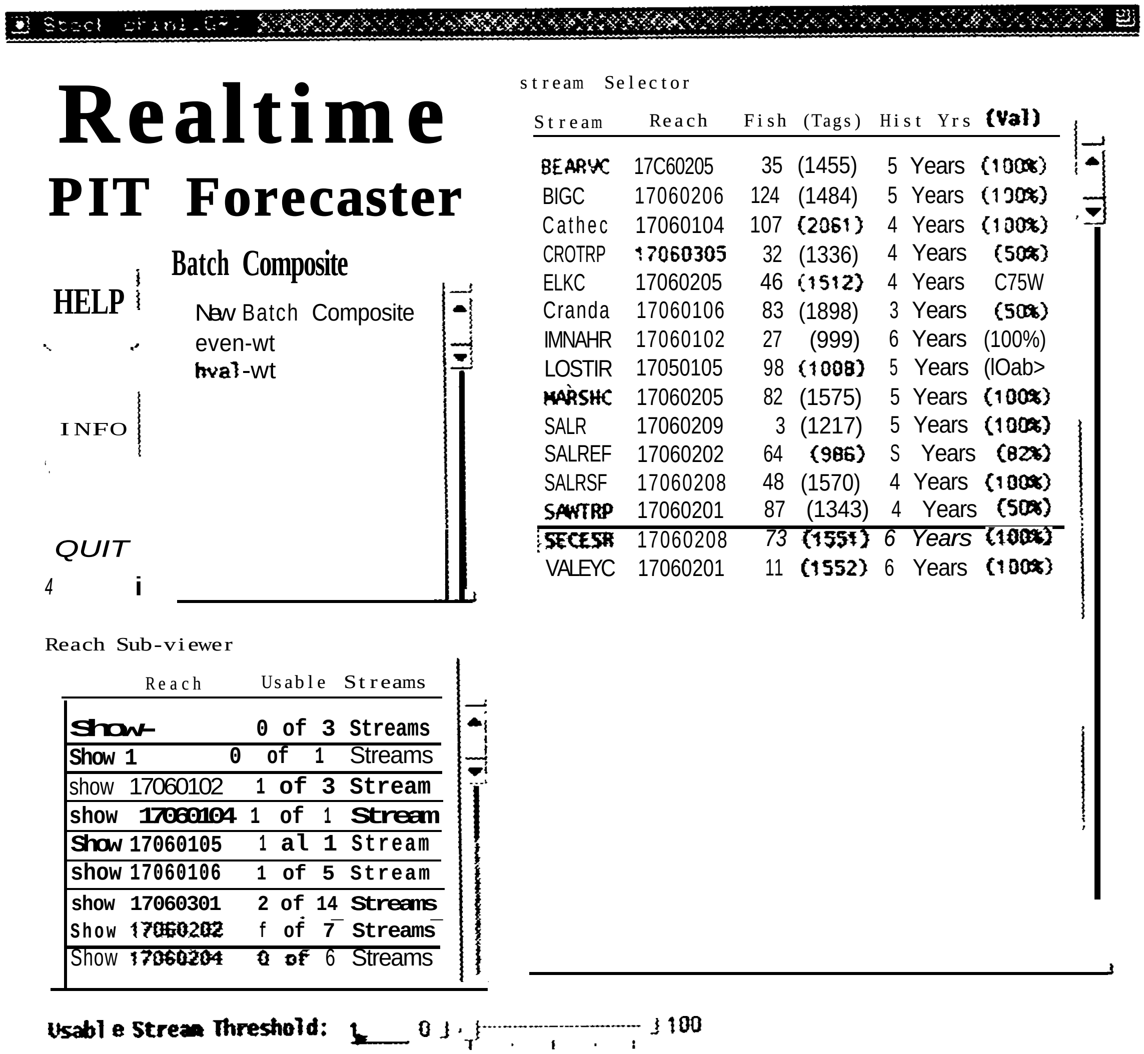
Observation Site:Snake River Trap Juvenile (SNJ)

Migration Year:	89	90	91	92	93	94	95
Detected:			0	0	0	0	1
Not detected:			2703	403	1877	151	1342
Released:	None	None	2703	403	1877	151	1343
Probability of Detection:			0	0	0	0	0.0007
Release Site:							

χ^2 p value = **NA,** $p_p = 0.00$

Appendix C

Graphical Capabilities of the RealTime Program

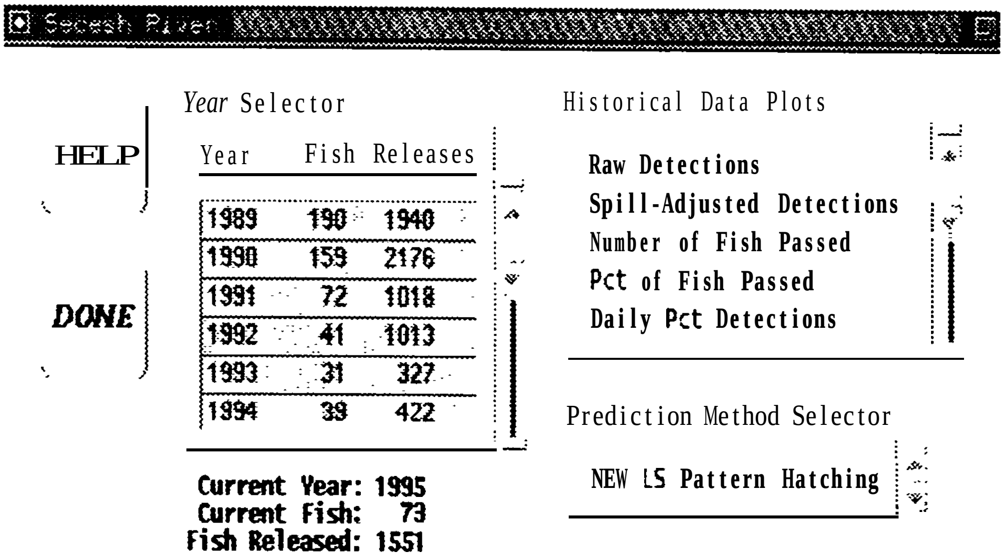


The *RedTime* base *window* allows a user to view and analyze one or more streams or composite runs. A stream can be chosen by clicking the left mouse button on a selection in the stream selector. To choose a composite, click on a selection in the batch composite selector. When a choice is made, a stream or composite window pertaining to your choice will appear.

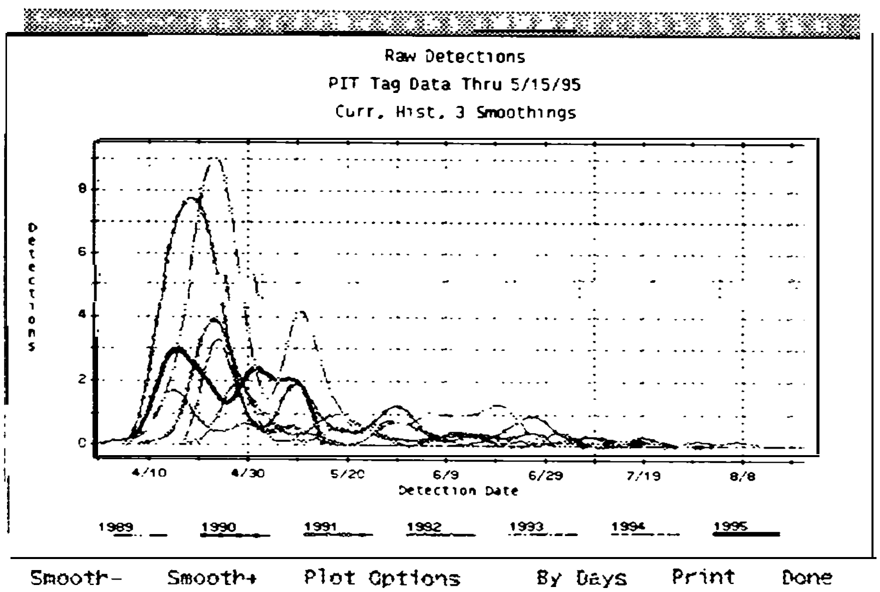
Clicking a second time on a selection will bring the corresponding stream or composite window to the front. Stream and composite windows can be deselected by clicking on the *done* button in the appropriate window.

The *stream threshold slider* and react1 *subviewer* allow a user to control which of the available streams in the database are listed in the stream selector.

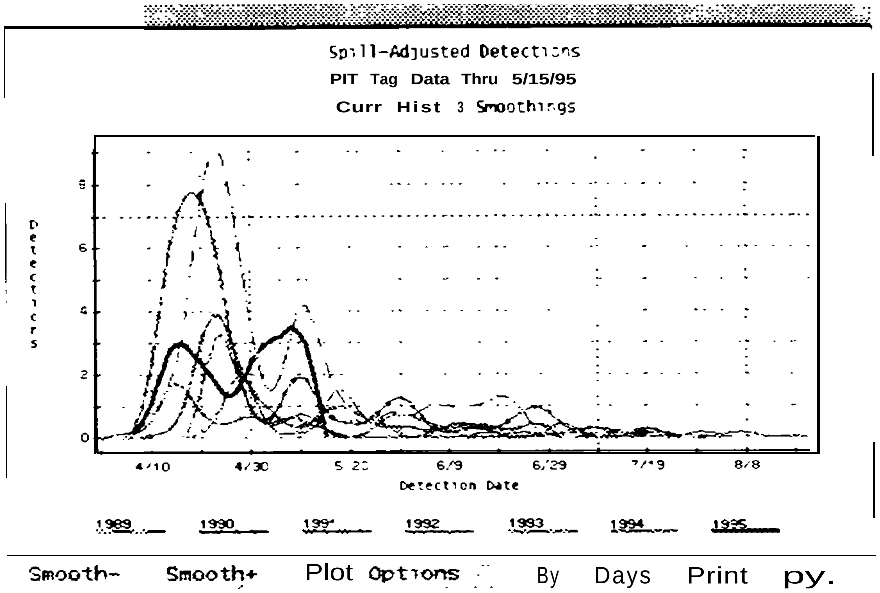
The *info* and *help* buttons contain additional information about the RealTimeRealTime.



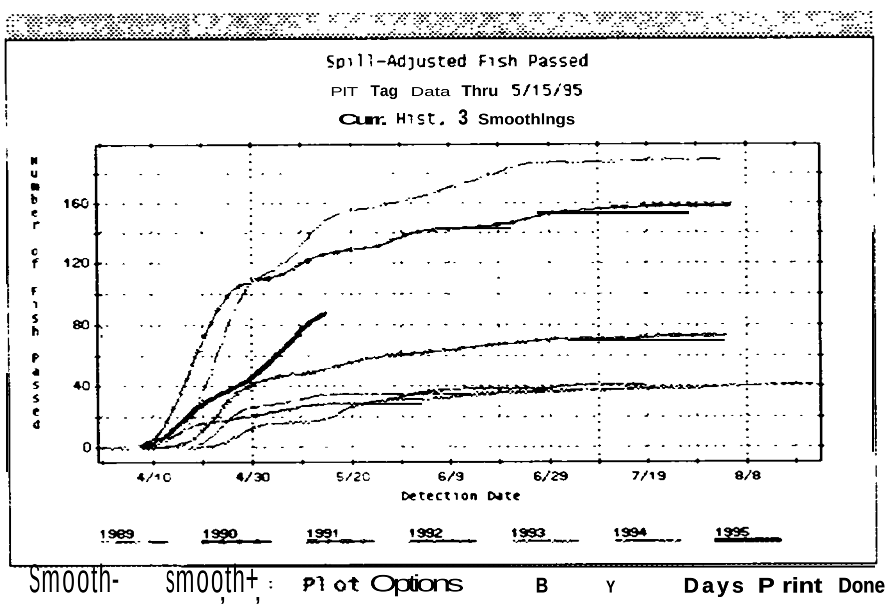
After selecting the appropriate streams or composite to be *analyzed, the stream* or *composite* (depending on choice) ***window*** allows a user to view river data from historical and / or the current run for a selected tag site. We will use Secesh River as our example throughout. Select a prediction method to bring up a Results Frame and begin a prediction.



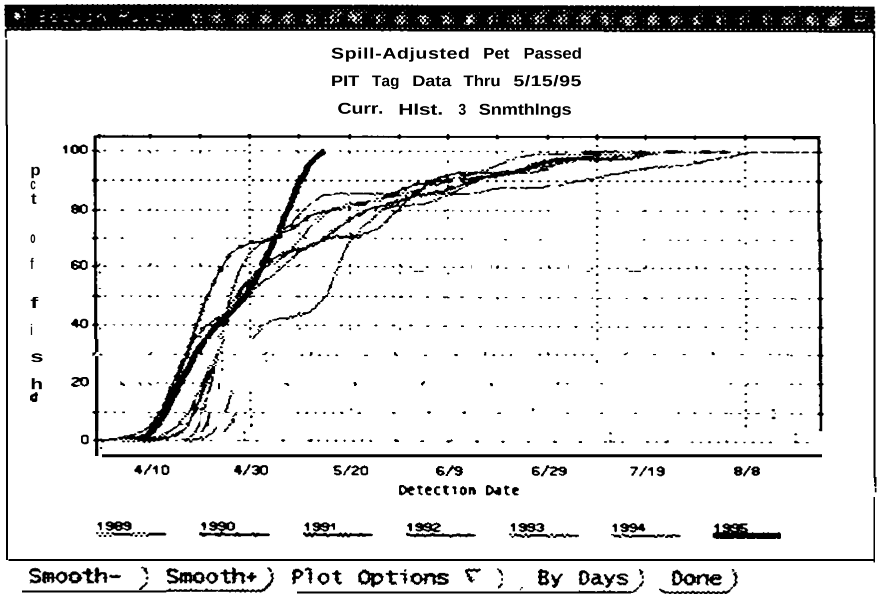
The *raw detections window* displays the number of raw detections for the selected tag site. Buttons below the draw window allow a user to specify the look of the graph. The graph data above is triple-smoothed for better visual clarity.



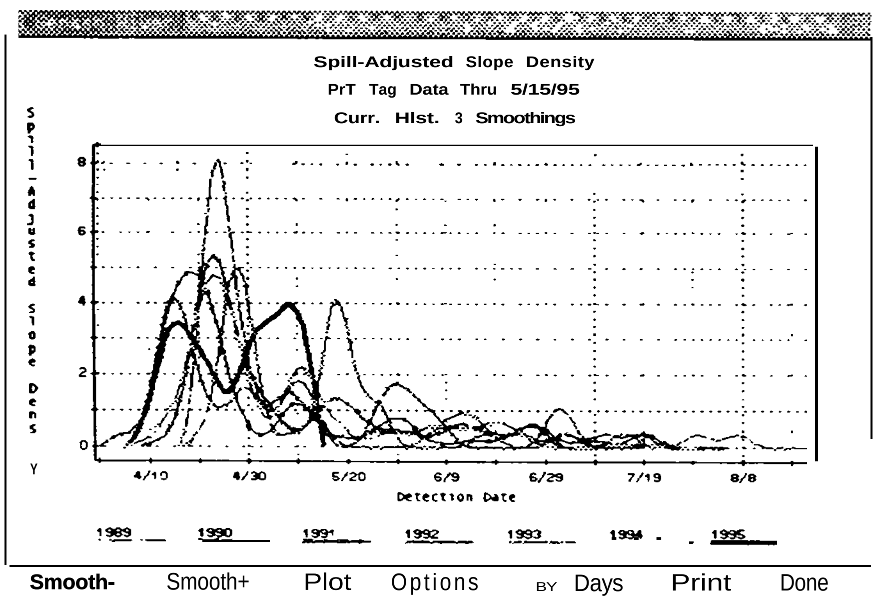
The *spill-adjusted detections window* displays fish counts adjusted by the spill percentage for the selected tag site.



The *cumulative detections window* displays cumulative, spill-adjusted fish counts for the selected tag site. The prediction shown here is for May 15, 1995.



The percentage passed witldonp is a normalization of the cumulative detections window for the selected tag site for comparing historical run timings.



The *slope density window* displays the slope of the percentage passed window for the selected tag site for visual comparisons of historical run trends. Equivalently, it is a lOO%-area-normalization of the spill-adjusted detection window.

Plots

Best Prediction and Forecast
Best Prediction Slope Density
Daily Prediction Record
Bootstrap Prediction Summary

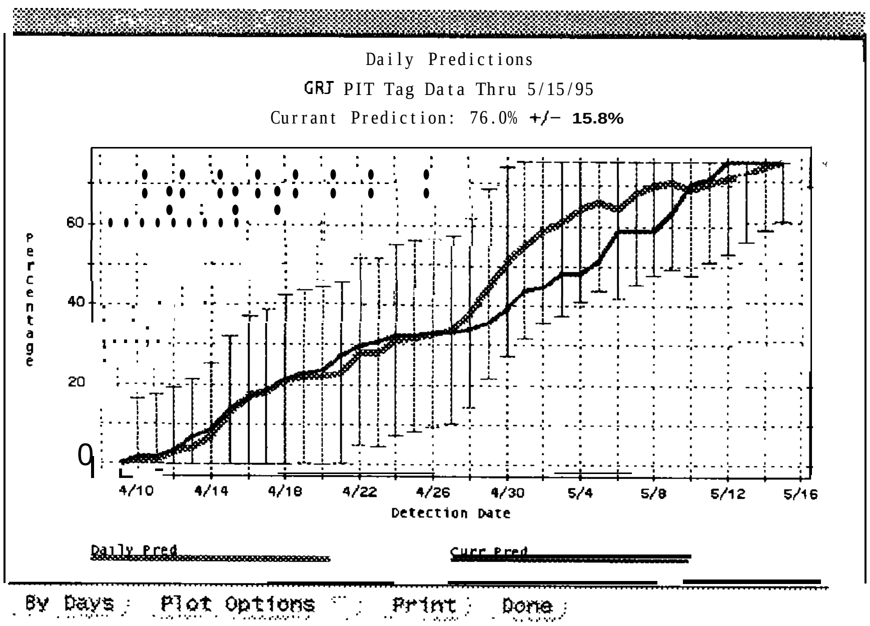
HELP **DONE**

Prediction Completed

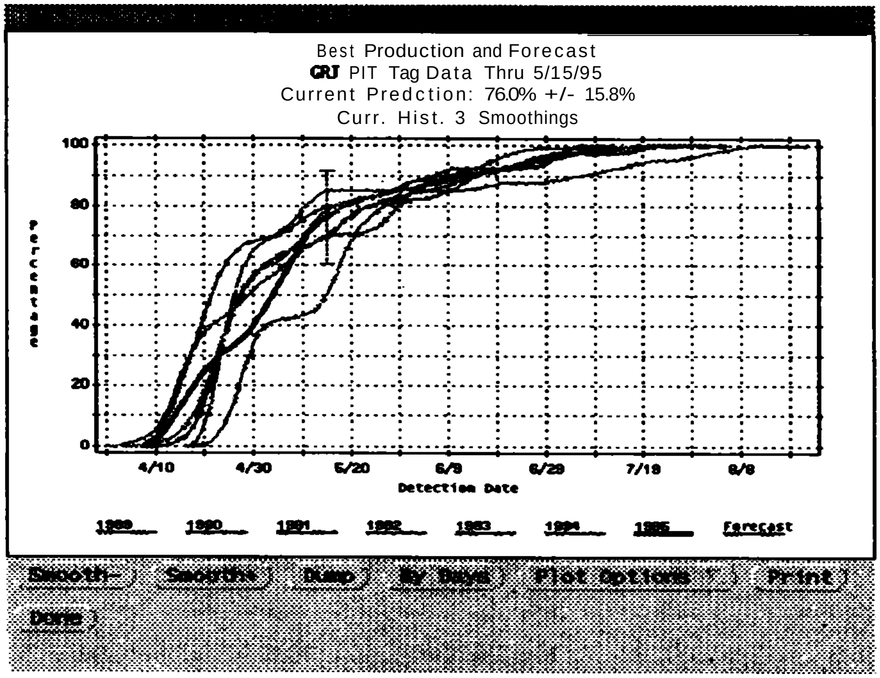
0 100

Date	Daily Pred (Err)	Today's Pred (Err)	Historical on This Date Min	Mean	Max
4/26/95	33.0 (23.6)	33.4 (6.9)	7.8	44.8	66.0
4/27/95	34.0 (23.6)	33.4 (6.9)	18.2	48.7	66.7
4/28/95	38.0 (23.6)	34.2 (7.1)	31.2	52.1	67.3
4/29/95	45.0 (23.5)	36.0 (7.5)	33.8	53.8	67.9
4/30/95	51.0 (23.4)	39.5 (8.2)	36.4	56.8	69.0
5/1/95	55.0 (23.0)	43.9 (9.1)	41.6	58.1	69.2
5/2/95	59.0 (22.9)	44.7 (9.3)	41.6	59.4	69.2
5/3/95	61.0 (23.3)	48.2 (10.0)	41.6	59.6	69.2
5/4/95	64.0 (22.8)	48.2 (10.0)	41.6	59.9	69.2
5/5/95	66.0 (22.1)	51.3 (10.6)	41.6	60.2	69.2
5/6/95	64.0 (22.1)	58.9 (12.2)	41.6	60.8	71.4
5/7/95	68.0 (22.5)	58.9 (12.2)	41.6	62.2	73.9
5/8/95	70.0 (22.0)	58.9 (12.2)	41.6	63.1	73.9
5/9/95	71.0 (21.8)	63.2 (13.1)	44.2	65.5	76.4
5/10/95	69.0 (20.9)	70.3 (14.6)	44.2	66.5	76.4
5/11/95	71.0 (19.9)	71.8 (14.9)	44.2	67.9	80.3
5/12/95	72.0 (18.9)	76.0 (15.8)	44.2	69.2	85.2
5/13/95	73.0 (17.8)	76.0 (15.8)	44.2	70.0	85.2
5/14/95	75.0 (16.7)	76.0 (15.8)	44.2	70.7	85.2
5/15/95	76.0 (15.8)	76.0 (15.8)	44.2	71.4	85.2

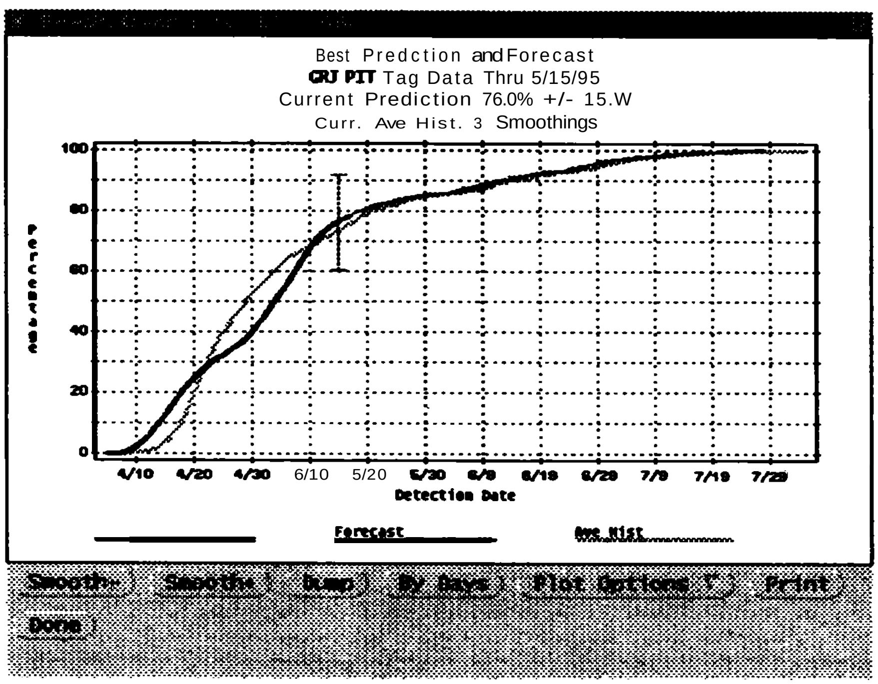
The *results window* displays a summary of daily predictions and historical data in the text window for the selected tag site. *Daily predictions* are a daily record of previous predictions, while *today's predictions* are the recalibrated daily predictions based on the present day's forecast. The *plots* selector allows a user to view one or more graphical results plots



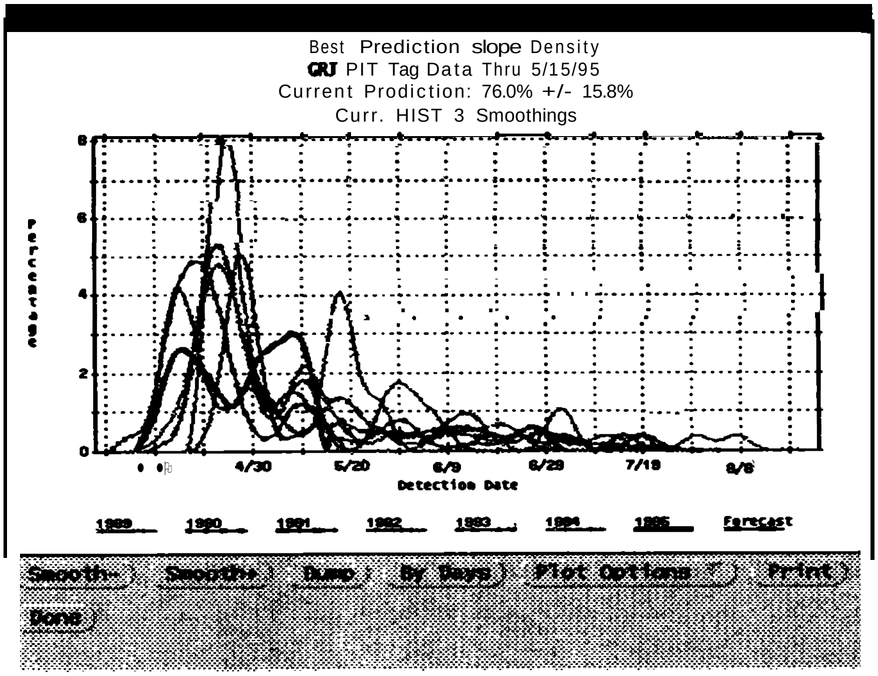
The *daily predictions window* displays the daily predictions made that were made on each day of the run for the selected tag site. The current prediction line shows the recalibrated prediction pattern up to most recent prediction of the current run.



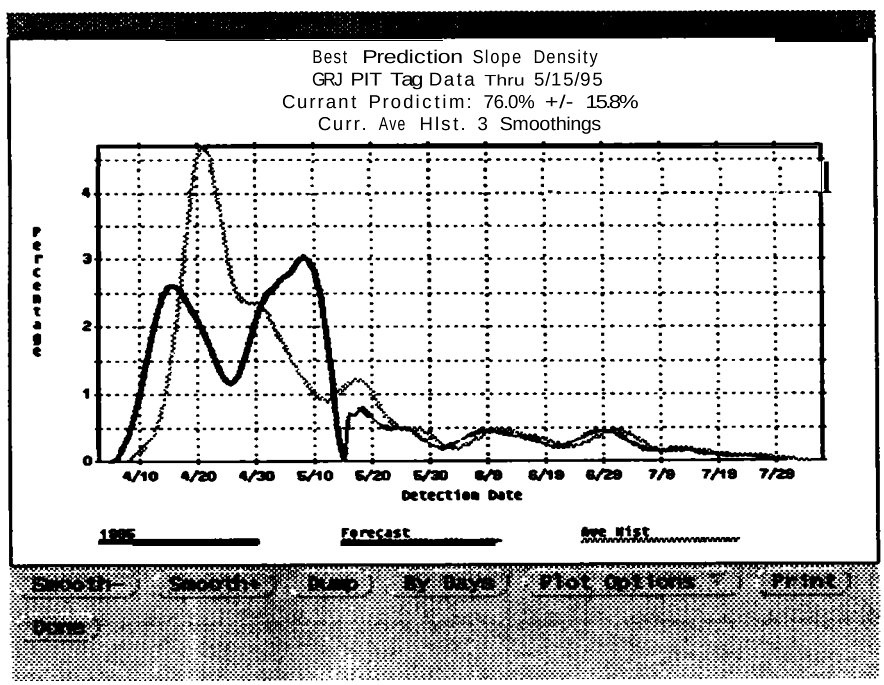
The best prediction and forecast window displays the **current best prediction and forecast line with the historical runs in the prediction for the selected tag site. This graph is similar to the Percentage Passed graph, with the current run scaled to the current best prediction**



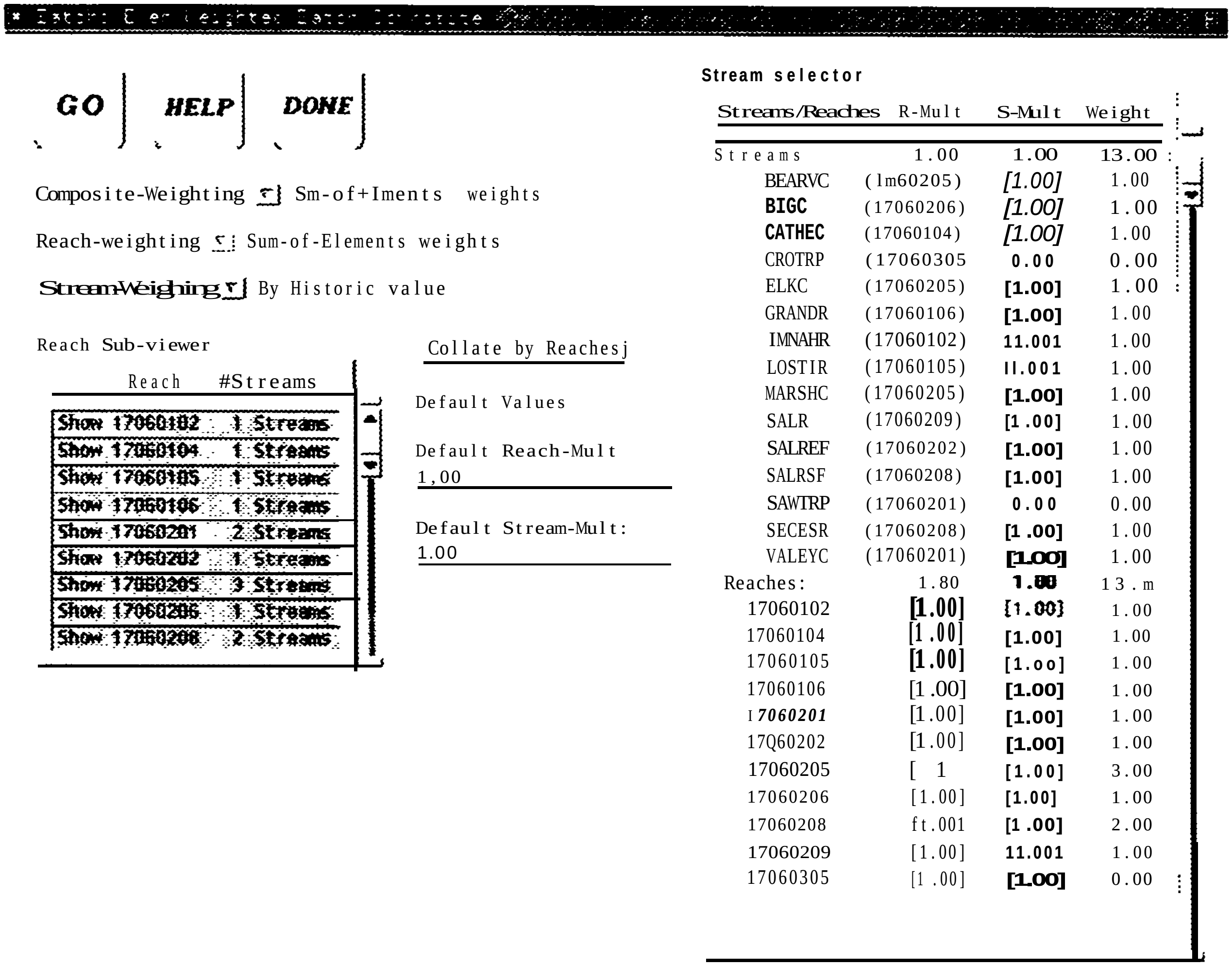
Another option in the prediction and forecast window displays the current best prediction line versus the average historical line, which represents the average historical date for each passage percentage.



The prediction slope density window displays the slopes **of the lines of the best prediction aad forecast window for the selected tag site. This is similar to the slape density graph, with the current run scaled to the current best prediction.**



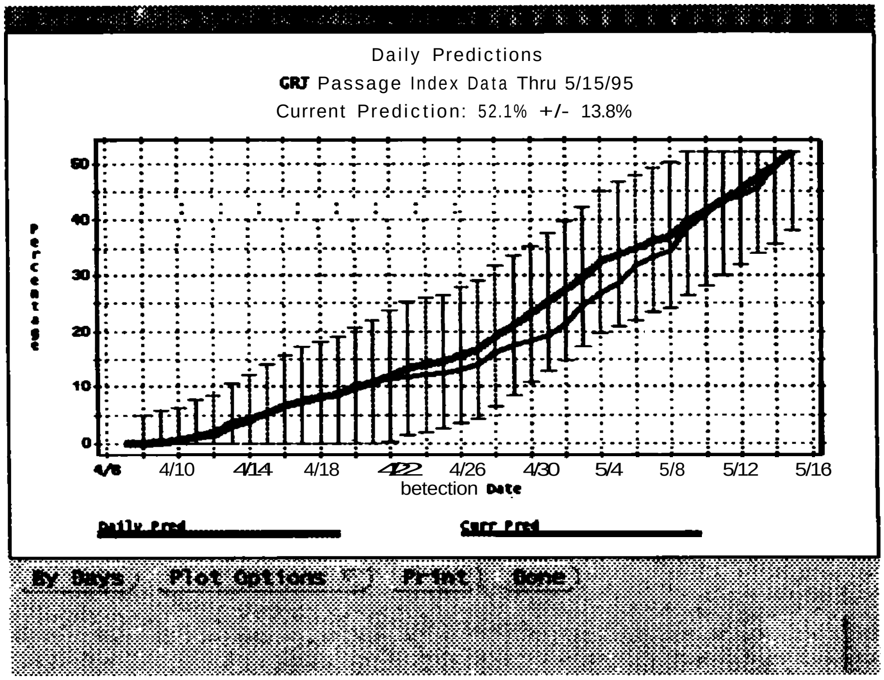
This window also has the option of comparing the current slope density line versus the avenge historical line.



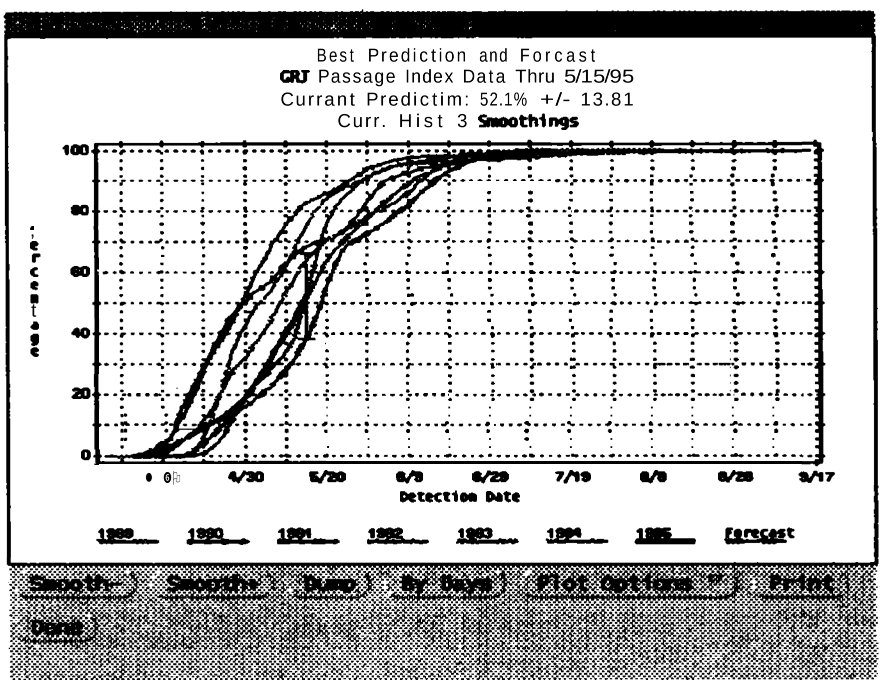
The *composire window* allows a user to modify a selected stream composite. Click on the *Stream Selector* to change the weighting of the selected stream. The weighting methods affect how these multipliers determine the stream's weight in the composite. The current weight of each stream is shown in the right-most column of the Stream Selector. The default weighting is 1 for each stream (evenly weighted). The *sun-of-elements* weighting method defines each stream within the composite as an element, then weights it according to its fraction of the total sum of weights. *Normalized* weights sets each reach's weight to 1, then normalizes the weighting of each stream within that reach. Stream weighting by *historical value* gives each stream a weight calculated by the quality and consistancy of historical information available.

The *reach sub-viewer* and *collation buttons* allow the user to modify the display of the Stream Selector. These controls are included for user convenience.

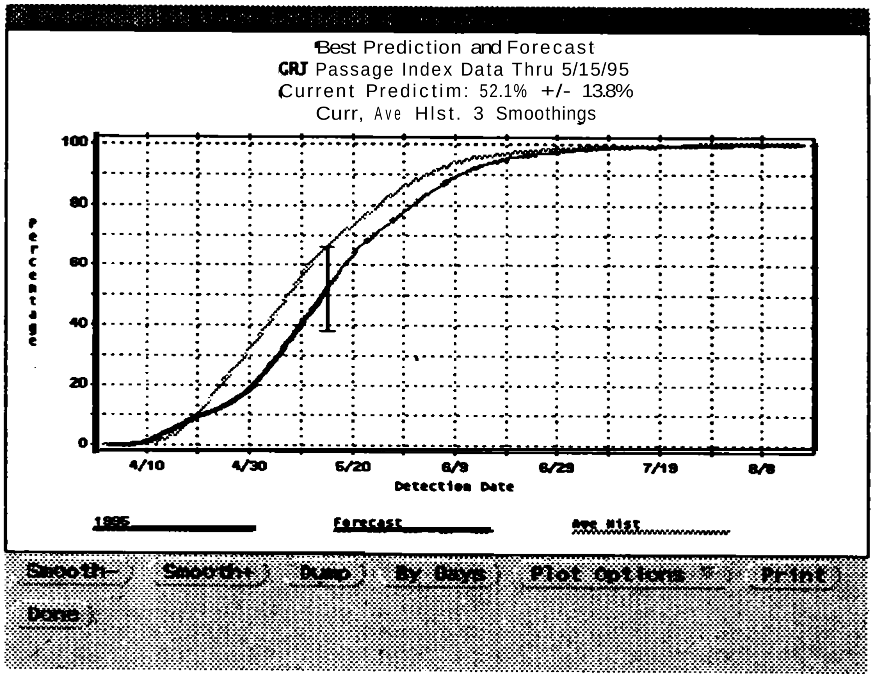
To begin the composite run, click on the Go button



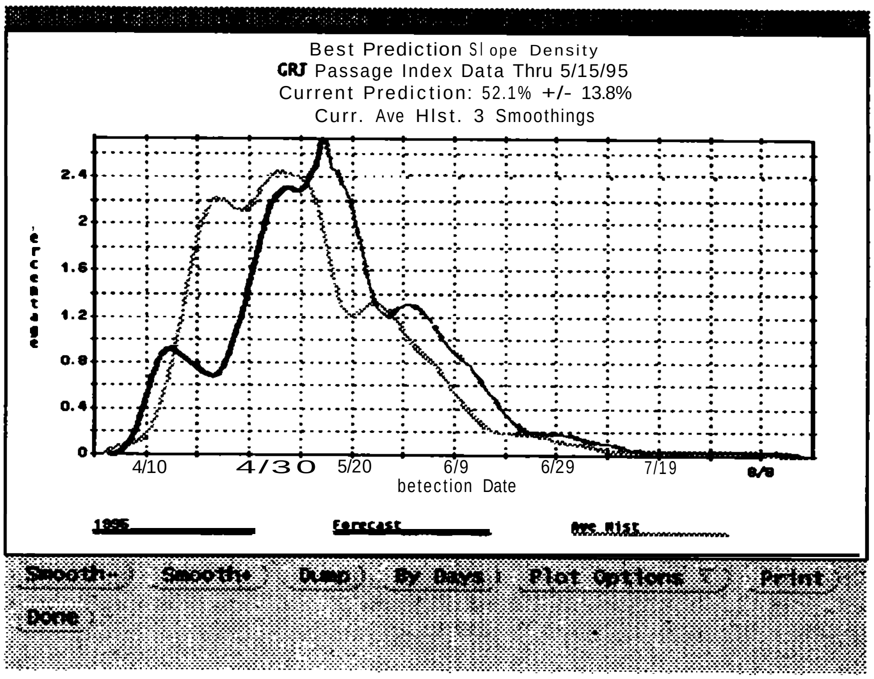
An example of the daily predictions window for the ***even-weighted composite run and the***



prediction and forecast window. These are similar to the displays **far a single stream or rive-r on pages 6 &7.**



The prediction and forecast window **for the composite run displays the current best prediction line versus the average historical line. The standard error is displayed by the bracket on the predicted day.**



The prediction slope density window **for the composite run displays the current slope density line versus tbe average historical line.**