FISH RESEARCH PROJECT
OREGON

SMOLT MIGRATION CHARACTERISTICS AND MAINSTEM SNAKE AND COLUMBIA RIVER DETECTION RATES OF PIT-TAGGED GRANDE RONDE AND IMNAHA RIVER NATURALLY PRODUCED SPRING CHINOOK SALMON

1993,1994 AND 1995 ANNUAL REPORTS

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Annual Progress Report
Project Period: 1 January 1993 to 31 December 1993

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EXECUTIVE SUMMARY

Objectives for 1993

1. Collect and tag with implantable passive integrated transponders (PITs) 1,000 naturally produced spring and summer chinook salmon parr on each of Catherine Creek, and the upper Grande Ronde, Lostine, Imnaha, Wenaha, and Minam Rivers.

2. Determine size frequency distribution .and mean length and weight for juvenile chinook salmon in six streams in the Grande Ronde and Imnaha River subbasins.

3. Submit PIT-tagging data files to the PIT Tag Information System database administered by the Pacific States Marine Fisheries Commission.

4. Determine the short term (24 hrs) effects of PIT tags on survival of juvenile chinook salmon.

5. Compare average length of juvenile chinook salmon in six streams in the Grande Ronde and Imnaha River subbasins. Correlate with relative abundance and habitat quality.

6. Determine and compare cumulative detection rate and downstream migration timing of juvenile chinook salmon from six streams in the Grande Ronde and Imnaha River subbassins.

Accomplishments in 1993

We achieved all our objectives in 1993 except: (1) We tagged only 726 juvenile chinook salmon on the Lostine; (2) We did not correlate average length with relative abundance and habitat quality. We have not yet been able to obtain the data necessary to complete the correlations.

Findings in 1993

We tagged and released a total of 5,720 chinook salmon parr on six study streams. Twenty-five fish were killed during the collection process. Tagging mortality occurred only on the Imnaha and Grande Ronde.Rivers, where a total of 3 tagged fish died 24 hrs after tag insertion. In addition, one tagged fish each from the Wenaha and Lostine Rivers was killed while collecting fish for a separate genetics study.

Fork length of collected fish ranged from 42 mm to 138 mm. Mean fork length for each stream ranged from 60.4 mm to 80.4 mm. Fork length of tagged fish ranged from 53 mm to 106 mm, with means for each stream ranging from 63.2 mm to 80.4 mm.

Wet weights of collected fish ranged from 0.6 g to 36.1 g. Average wet weight of collected fish for each stream ranged from 2.60 g to 6.35 g. Wet weights of tagged fish ranged from 1.6 g to 14.8 g, with means for each stream ranging from 2.94 g to 6.39 g.

Total tagging mortality (instantaneous plus 24 hour mortality) for the entire population of tagged fish never exceeded 0.2% on any stream, and was 0.05% overall. Collection mortality for the entire population of fish collected never exceeded 0.6% on any stream, and was 0.38% overall. Twenty-four hour mortality data indicated that tagging mortality was the same as mortality due to handling alone.

Median migration timing through Lower Granite Dam for all six streams combined was 08 May when data were expanded for spillway flow. Over 50% of the fish had passed Lower Granite Dam prior to peak flows. Early migrants were predominantly from the Wenaha and South Fork Wenaha, Lostine, and Minam Rivers, while late migrants were predominantly from Catherine Creek and the Grande Ronde River. Migration timing from the Imnaha River was intermediate and protracted.

Cumulative detection rates varied between streams. When unexpanded for spillway flow, cumulative detection rates ranged from 11.7% for the Imnaha River to 22.1% for the Grande Ronde River.

Mortality during the collection and tagging process was lower than that in 1992. This may reflect a change in collection and tagging schedule. We adjusted our tagging schedule so streams with the highest mortality rates in 1992 were sampled later in the field season when water temperatures were lower.

Management Implications

Migration timing of juvenile chinook from naturally-produced populations varied extensively both within the Grande Ronde River basin and between the Grande Ronde and Imnaha River basins. Median passage dates for each population at Lower Granite Dam ranged from 28 April to 18 May. In a separate study, migration timing of Rapid River and Imnaha stocks of chinook salmon released from Lookingglass fish hatchery in 1993 varied little, ranging from late April to the first week in May. Peak migration periods for several streams preceded peak flows in the Snake River, while peak migration periods for two streams coincided with peak flows in the Snake River. Peak migration periods for hatchery chinook salmon also preceded peak flows.

Recommendations

To facilitate wild fish passage through the Snake and Columbia River dams, we should continue to monitor migration timing of multiple populations. We need additional data to determine the best time to adjust spillway flows to improve passage of all populations. To minimize handling and tagging mortality, tagging schedules should be arranged so fish are tagged at temperatures of 15°C or less.

INTRODUCTION

This is the second year of a multi-year study to assess smolt migration characteristics and cumulative detection rates of naturally produced spring chinook salmon (Oncorhynchus tshawytscha) from Northeast Oregon streams. The goal of this project is to develop an understanding of interpopulational and interannual variation in several early life history parameters of naturally produced spring and summer chinook salmon in the Grande Ronde and Imnaha River subbasins. This project will provide information to assist chinook salmon population recovery efforts. Specific populations included in the study are: (1) Catherine Creek; (2) Upper Grande Ronde River; (3) Lostine River; (4) Imnaha River; (5) Wenaha River; and (6) Minam River. In this document, we present findings and activities from research completed in 1993.

Naturally produced chinook salmon populations in the Grande Ronde and Imnaha River subbasins have declined drastically in recent years (Carmichael 1991). Habitat alterations (ASET 1979; Carmichael 1989; Raymond 1988) and hydropower (Wedemeyer et al. 1985; Raymond 1988) have contributed to the decline of these populations. Mitigation efforts have included improving fish passage, artificial production, supplementation, and habitat modification (BPA Division of Fish and Wildlife 1990). Despite these extensive mitigation efforts, the National Marine Fisheries Service (NMFS) listed Snake River basin spring/summer chinook salmon as threatened under the Endangered Species Act (NMFS 1992).

The continued decline of naturally produced spring and summer chinook salmon populations in the Grande Ronde and Imnaha River subbasins indicates that mitigation efforts have failed to rebuild these depressed stocks. One potential problem with current water budget and fish transport mitigation efforts is that they were developed and implemented using data from hatchery populations or from pooled groups of in-river migrants. Water budget decisions have been tied to peak fish passage indices (FPI) which usually coincide with hatchery releases and hatchery fish migration timing (DeHart and Karr 1987). In addition, in the past, naturally produced and hatchery spring and summer chinook were indistinguishable when marked as in-river migrants (Matthews et al. 1990), and most studies evaluating smolt passage or transport effectiveness have relied on marked hatchery releases or marked groups of in-river migrants (Buettner and Nelson 1987, 1990; DeHart and Karr 1987; Fish Passaqe Center 1987). Consequently, there has been no thorough evaluation of the effect of these-mitigation efforts on naturally produced chinook salmon populations.

There is considerable evidence which suggests that migration timing differs between wild and hatchery fish (Matthews et al. 1990, 1992). Recent work by Matthews et al. (1990, 1992) also indicates that there is substantial variation in early life history parameters, such as migration timing and duration, among naturally-produced chinook salmon populations. Therefore, it is essential to increase our knowledge of the variation in early life history characteristics of chinook salmon in the wild. This study, along with a study conducted by Matthews et al (1990, 1992), and Achord et al. (1992), will provide data on migration timing of naturally-produced chinook salmon. This information can then be incorporated into the Smolt Monitoring Program under the Fish Passage Center (FPC), which provides recommendations to guide

modifications of flow, fish passage, and transport (Fish Passage Center 1987). Information on smolt passage timing allows the FPC to anticipate river discharge needs, improve fish passage and migration conditions, and plan collection and transport operations (bUETTNER and Nelson 1987, 1990).

In addition to fish passage and transport applications, this study has several other management applications. In accordance with the Oregon Department of Fish and Wildlife Wild Fish Management Policy, this study will provide information useful in assessing and identifying wild chinook salmon stocks in conjunction with ongoing genetic studies. Furthermore, information on individual populations will be useful in developing broodstock guidelines and supplementation strategies for future hatchery programs.

METHODS

We selected juvenile chinook salmon sampling sites using data collected during 1992 and data from previous unrelated studies. We then collected and PIT tagged naturally produced spring chinook salmon parr on Catherine Creek, and the upper Grande Ronde, Lostine, Imnaha, Wenaha, and Minam Rivers from 17 August through 22 October (Table 1). We collected all fish with seines, occasionally using snorkeling gear to locate concentrations of fish and herd them to seinable areas.

PIT tags were implanted using general methods described by Prentice et al. (1986, 1990b) and Matthews et al. (1990, 1992). In most streams, we proceeded with tagging and release operations at temperatures of 15°C or less, except on the Minam River, where the temperature at release reached 19°C on the final sampling day. Fish were anesthetized with 40-50 ppm MS-222 (Strange and Schreck 1978; Matthews et al. 1990, 1992), after which we manually injected PIT tags using a modified hypodermic syringe. The syringes were disinfected for 10 minutes in 70% ethanol prior to tagging. We determined fork length (in mm) of all chinook salmon tagged, and weight (in g) when conditions permitted. We attempted to tag only fish of minimum 55 mm fork length that appeared to be in good health. We did not tag precocious males. We also did not tag fish collected in excess of 1,000 per stream or fish collected simultaneously for a separate genetics study. Fish were allowed to recover equilibrium prior to release, and were then released as near the collection site as possible. We incorporated data into ASCII files according to criteria developed by the PIT Tag Steering Committee, and submitted files to the PIT Tag Information System database administered by the Pacific States Marine Fisheries Commission.

To determine the short term effects of PIT tags on survival of juvenile chinook salmon, we held tagged and untagged control groups of chinook salmon for 24 h and recorded all mortalities. Untagged controls were subject to the same handling conditions as PIT-tagged fish, except they were not injected with a PIT tag. In most streams, two groups of approximately 50 tagged fish and 2 groups of approximately 25 untagged fish were held in separate but similar live cages at equal densities. On the Wenaha River, sample size varied, with two groups of 50 tagged fish, and groups of 42 and 120 untagged fish. The variation in sample size on this stream resulted from a shortage of containers and the need to keep fish from different stream reaches separate. The covered live cages were placed within the stream and received constant

stream flow. Mortality rates of tagged and untagged fish during the 24 h test were compared using a binomial test of two independent groups. Instantaneous mortality (collection mortality and mortality observed immediately after tagging) were also recorded. The two types of mortality (instantaneous and 24 h) were combined for total tagging mortality.

After the 1993 migration year was completed, observation data from Lower Granite, Little Goose, Lower Monumental, and McNary dams for fish tagged in 1992 were downloaded from the PTAGIS database. We pooled run timing data for all six streams at Lower Granite dam, and then compiled run timing data for individual streams at all four dams. Run timing at Lower Granite Dam was compared using the Kruskal-Wallis test, followed by a multiple comparison test (Hollander and Wolfe 1973; SAS Institute 1988). Run timing data to all dams during this report period is from actual first-time observations of individual tagcodes expanded for spillway flow. This expansion factor was:

(Powerhouse Flow + Spillway Flow)/ Powerhouse Flow

This expansion factor (Appendix Table 7) accounts for undetected PIT tagged fish which passed over the spillway at each dam. Many PIT tagged fish were diverted into the river after passing through the bypass system, while most downstream migrants were barged downstream after going through the bypass system. As a result, first-time detections at downstream dams are more representative of the entire population. Therefore, data from fish detected multiple times at different dams is not included in run timing analysis. Median travel time between dams was estimated as the difference between median passage dates. Cumulative detection rate of chinook salmon from individual streams was determined by dividing the sum of unexpanded first-time tagcode observations at each dam by total number of fish tagged and released.

RESULTS AND DISCUSSION

We collected a total of 6,647 chinook salmon parr on six study streams, and tagged and released 5,720 chinook salmon. We tagged and released approximately 1,000 fish on all streams except the Lostine River, where we tagged and released 726 (Table 1). Overall collection and tagging mortality was 28 fish (0.42%). This is similar to overall collection and tagging mortality rates during other tagging studies in Northeast Oregon streams in 1988 and 1989 (Matthews et al. 1990, 1992; Walters et al. 1992). Collection operations resulted in twenty-five mortalities (0.38%), while tagging resulted in a total of three mortalities (0.05%) (Table 1). In addition, two tagged fish were later collected and killed as part of an unrelated genetics study.

Table 1. Collection and tagging information for chinook salmon PARR from six streams in the gRANDE rONDE and iMNAHA River subbasins, 1993. Data excludes recaptured PIT tagged fish. Catherine = Catherine Creek. gRANDE = Upper Grande Ronde. Number collected includes fish collected and incorporated in a separate genetics study.

Stream	Dates Collected	Number Collected	Collection Mortality	Number Tagged and Released	Overall[b] Tagging Mortality
Catherine	9/20-9/21	1,085	4 (0.36%)	1,000	0
Grande	9/13-9/16	1,410	8 (0.57%)	1,001	1[a]
Imnaha	9/01-9/03, 10/20-10/21	1,141	6 (0.53%)	998	2[a]
Lostine	8/17-8/19, 10/22	794	1 (0.13%)	726	0
Minam	9/07-9/09	1,093	1 (0.09%)	997	0
Wenaha	8/23-8125	1,124	5 (0.44%)	998	0
Total		6,647	25 (0.38%)	5,720	3 (0.05%)

[a] *Died during 24 mortality test*
[b] *In addition, two fish PREVIOUSLY* tagged were killed during *collection of genetics samples for an unrelated study (One on Lostine, one on Wenaha). These fish are included in the number tagged and released.*

There was some variability in length of juvenile chinook salmon. Fork lengths of fish collected ranged from 42 mm to 138 mm (Table 2). Mean fork length (+ SE) ranged from 60.4 mm (+ 0.20) on the upper Grande Ronde River to 80.4 mm (+ 0.21) on Catherine Creek (Table 2). We attempted to tag only fish $\geq$ *55 mm fork length, and did not tag precocious males or any fish collected* over the 1,000 needed for tagging. Therefore, lengths of tagged and released fish differed slightly from total fish collected. Fork lengths of tagged and released fish ranged from 53 mm to 106 mm, with average length ranging from 63.2 mm (+ 0.20) on the Upper Grande Ronde River to 80.4 mm (2 0.22) on Catherine Creek (Table 2).

Table 2. Length (mm) of chinook salmon parr collected for an early life history study on six streams in the Grand Ronde and Imnaha River subbasins, 1993. SE = std error, Min = minimum length, Max = maximum length. Number collected includes fish collected and incorporated in a separate genetics study.

	Collected				
Stream	N	Mean	SE	Min	Max
Catherine Cr.	1,080	80.4	0.21	53	106
Grande Ronde	1,360	60.4	0.20	42	89
Imnaha	1,078	73.2	0.29	46	103
Lostine	778	73.0	0.33	53	138
Minam	1,089	76.3	0.23	48	101
Wenaha	1,000	74.9	0.24	50	98

	Tagged and Released				
Stream	N	Mean	SE	Min	Max
Catherine Cr.	999	80.4	0.22	53	106
Grande Ronde	1,001	63.2	0.20	54	89
Imnaha	997	74.2	0.28	56	103
Lostine	723	72.3	0.31	53	103
Minam	995	76.5	0.23	57	101
Wenaha	996	74.9	0.24	55	98

Length of chinook salmon parr varied between years. Average fork lengths of tagged and released fish on all streams except Catherine Creek and the Imnaha River were less than those in 1992 (Walters et al. 1992). Average fork lengths of tagged and released fish on Catherine Creek, and the Grande Ronde, Imnaha, and Lostine Rivers were similar to those in 1988-1990 (Matthews et al. 1990, 1992; Achord et al. 1992). Differences may be attributed to interannual variability, sample timing, or collection technique. Sample timing and interannual variability in stream conditions could affect size at

capture and growth rate, while different collection techniques may sample different portions of the population.

PIT tagging chinook parr had little or no effect on mortality as indicated by only three tagged fish dying after tagging (Table 1). There were too few data to compare average lengths of tagging mortalities to the overall tagged population or mortalities from previous studies. Previous research has indicated there was no effect of PIT tags on growth or survival of salmonids $\geq$ 55 mm fork length while in a hatchery environment (Prentice et al. 1986, 1990a). Regardless, the incidence of instantaneous or 24 h tagging mortality seen in this study is low enough to be indistinguishable from handling mortality.

Wet weight of chinook salmon parr varied between streams. Average wet weight (+ SE) of collected chinook salmon ranged from a low of 2.60 g (+ 0.027) on the Grande Ronde River to a high of 6.35 g (+ 0.053) on Catherine Creek (Table 3). Average wet weight of tagged and released fish ranged from a low of 2.94 g (+ 0.030) on the Grande Ronde River to a high of 6.39 g (+ 0.055) on Catherine Creek (Table 3). Once again, the slight size discrepancy between the collected groups and the tagged and released groups may reflect our attempt to selectively tag fish > 55 mm fork length and reject precocious males, which tend to be larger than immature males. Minimum wet weight of collected fish was 0.6 g, while minimum wet weight of tagged and released fish was 1.6 g (Table 3). Maximum wet weight of collected fish'was 36.1 g, while maximum wet weight of tagged and released fish was 14.8 g (Table 3).

Wet weight of chinook parr varied between years. Fish on Catherine Creek and the Imnaha River were heavier or similar in weight to those in 1992, while wet weights on the Upper Grande Ronde, Lostine, Minam, and Wenaha were substantially less than those PIT-tagged in 1992 (Walters et al. 1992). Average wet weights of tagged and released fish on Catherine Creek and the Lostine River were similar to average weight in 1990 and 1989-1990 (Matthews et al. 1990, 1992; Achord et al. 1992). Average wet weight on the Imnaha River was substantially greater than that in 1988-1990; and average wet weight on the upper Grande Ronde River was substantially less than in 1988 (Matthews et al. 1990, 1992; Achord et al. 1992). Differences may be attributed to interannual variability, sample timing, or collection technique. Sample timing and interannual variability in stream conditions could affect size at capture and growth rate, while different collection techniques may sample different portions of the population.

We held two replicates of tagged and untagged fish in six study streams for 24 h to determine effects of PIT tags on short-term survival. Replicates were not significantly different, so the data were pooled. Mortality rates were not significantly different between tagged and control groups (P=0.267). One mortality was recorded for a total of 411 untagged fish (0-24%), and 3 of 611 (0.49%) tagged fish died (Table 4). Tagging mortality occurred on the Grande Ronde and Imnaha Rivers, where 1 (1.0%) and 2 (2.0%) of 100 tagged fish, respectively, died (Table 4). Control mortality occurred on the Wenaha River, where 1 (0.6%) of 162 fish died (Table 4).

Table 3. Weight (g) of chinook salmon parr collected for an early life history study on six streams in the Grande Ronde and Imnaha River subbasins, 1993. SE = std error, Min = minimum weight, Max = maximum weight. Number collected includes fish collected and incorporated in a separate genetics study.

	Collected				
Stream	N	Mean	SE	Min	Max
Catherine Cr.	1,079	6.35	0.053	1.6	14.8
Grande Ronde	1,357	2.60	0.027	0.6	7.4
Imnaha	1,061	4.59	0.058	1.1	12.3
Lostine	769	4.84	0.078	1.6	36.1
Minam	1,084	5.31	0.052	1.1	13.6
Wenaha	990	5.05	0.050	1.7	11.6

	Tagged and Released				
	N	Mean	SE	Min	Max
Catherine Cr.	998	6.39	0.055	1.6	14.8
Grande Ronde	999	2.94	0.030	1.6	7.4
Imnaha	995	4.69	0.058	1.7	12.3
Lostine	717	4.65	0.063	1.6	12.0
Minam	991	5.35	0.054	1.8	13.6
Wenaha	990	5.05	0.050	1.7	11.6

Table 4. Mortality of chinook salmon parr PIT tagged and held for 24 h during an early life history study on six streams in the Grande Ronde and Imnaha River subbasins, 1993. Catherine = Catherine Creek. Ronde = Upper Grande Ronde River.

	Replicate 1				Replicate 2			
	Tagged		Untagged		Tagged		Untagged	
	N	Number of Morts	N	Number of Morts	N	Number of Morts	N	Number of Morts
Catherine	50	(0)	25	(0)	50	(0)	25	(0)
Ronde	50	(1)	25	(0)	50	(0)	25	(0)
Imnaha	50	(2)	23	(0)	50	(0)	25	(0)
Lostine	50	(0)	25	(0)	50	(0)	26	(0)
Minam	50	(0)	25	(0)	50	(0)	25	(0)
Wenaha	55	(0)	42	(0)	56	(0)	120	(1)
Total	305	(3)	165	(0)	306	(0)	246	(1)

Data on short-term (24 h) tagging mortality in the wild is variable. Short-term (24 h) mortality rates for other PIT tagging studies of wild spring and summer chinook salmon on individual streams ranged from 0% to 6.7% (Matthews et al. 1990, 1992; Walters et al. 1992). Short-term mortality for individual streams in all studies was $\leq$ 2.4% in all instances except Catherine Creek in 1992, when water temperatures exceeded tagging criteria at release, and tagging mortality during a 24 h mortality test reached 6.7% (Walters et al. 1992).

Pooled migration timing for fish from all streams through Lower Granite Dam is presented in Figure 1. When data were expanded for spillway flow, median migration date was 8 May. Over 50% of the fish had passed Lower Granite dam prior to peak flows, with migration peaks occurring during the weeks ending 29 April and 06 May (Figure 1). However, an additional migration peak occurred at high flow. This peak in migration occurred during the seven day period ending 20 May, concomitant with flows averaging 170,000 cfs or greater (Figure 1).

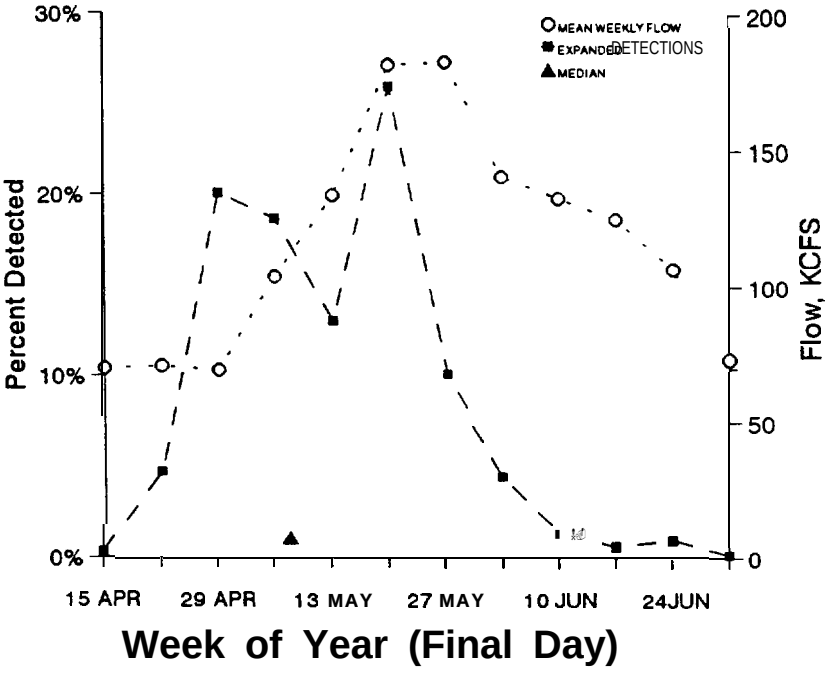

Figure 1. Overall migration timing and flow at Lower Granite Dam for spring chinook salmon from the Grande Ronde and Imnaha River subbasins, 1993 Migration Year. ▲ = median migration date. Data were expanded for spillway flow.

Migration timing for chinook from individual streams through Lower Granite, Little Goose, Lower Monumental, and McNary dams is presented in Figures 2-7 and Appendices 1-6. At Lower Granite dam, migration timing was significantly different between streams (Krugkal-Wallis test, P=0.0001). Multiple comparisons of median migration date at the P=0.05 level indicated that migrants from the Wenaha River were earliest, followed by migrants from the Lostine and Minam Rivers. Migration timing for chinook salmon from the Imnaha River was intermediate and protracted, while late migrants were predominantly from Catherine Creek and the Upper Grande Ronde River (Figures 2-7). Median migration timing at Lower Granite dam ranged from 28 April for the Wenaha and South Fork Wenaha Rivers (N=84) (Figure 7) to 18 May for Catherine Creek (N=125) (Figure 2).

Overall median migration timing of fish at Lower Granite Dam in the current study was prior to peak flows. However, peak migration timing of fish from both Catherine Creek and the Grande Ronde River occurred at times of high flow. These results are similar to those of Achord et al. (1992), who noted that peak migration periods of naturally-produced spring chinook tagged from 1988-1990 were generally associated with high flows.' However, these peaks

were primarily composed of fish from a few streams, even though they tagged spring chinook in 7 to 9 streams each year (Achord et al. 1992).

Median migration date for chinook salmon at Little Goose dam was 6.8 days later than median migration date at Lower Granite Dam (Figures 2-7). Fish from individual streams had estimated median travel times between Lower Granite and Little Goose Dams that ranged from as little as 3 days for Catherine Creek to as great as 13 days for the Lostine River. Median migration date through Little Goose dam ranged from 02 May for the Wenaha and South Fork Wenaha Rivers (N=40) to 22 May for the Grande Ronde River (N=103) (Figures 2-7).

Median migration date for chinook salmon at Lower Monumental Dam was 6.0 days later than median migration date at Lower Granite Dam (Figures 2-7). Fish from individual streams had estimated median travel times between Lower Granite and Lower Monumental Dams that ranged from as little as -1 day for Catherine Creek to as great as 15 days for the Imnaha River. Median migration timing ranged from as early as 07 May for the Wenaha and South Fork Wenaha Rivers (N=18) to as late as 19 May for the Grande Ronde, Imnaha, and Minam Rivers (N=30, 12, and 20, respectively, Figures 2-7).

Median migration date for chinook salmon at McNary dam was 11.7 days later than median migration date at Lower Granite Dam (Figures 2-7). Fish from individual streams had estimated median travel times between Lower Granite and McNary Dams that ranged from as little as 6 days for Catherine Creek to as great as 18 days for the Lostine and Minam Rivers. Median migration date ranged from as early as 07 May for the Wenaha and South Fork Wenaha Rivers (N=12) to as late as 28 May for the Grande Ronde River (N-37) (Figures 2-7).

The final parameter evaluated was cumulative detection rate of chinook salmon from each stream. Cumulative detection rate varied between streams. Detection rates ranged from 11.7% for the Imnaha River to 22.1% for the Grande Ronde River. Detection rate for all PIT tagged chinook salmon was 17.2% (Table 5). With the exception of the Imnaha River, detection rates in the current study were generally greater than those observed by Matthews et al. (1990, 1992) and Achord et al. (1992) in prior years.

Migration timing and cumulative detection rates of juvenile chinook salmon varied extensively both within the Grande Ronde River basin and between the Grande Ronde and Imnaha River basins. To facilitate wild fish passage through the Snake and Columbia River dams, and improve Parr-to-smolt survival, we should continue to monitor both detection rate and migration timing of wild chinook salmon populations. This will allow us to adjust spillway flows to improve passage of all populations, and also provide opportunities to determine and improve limiting factors in Parr-to-smolt survival.

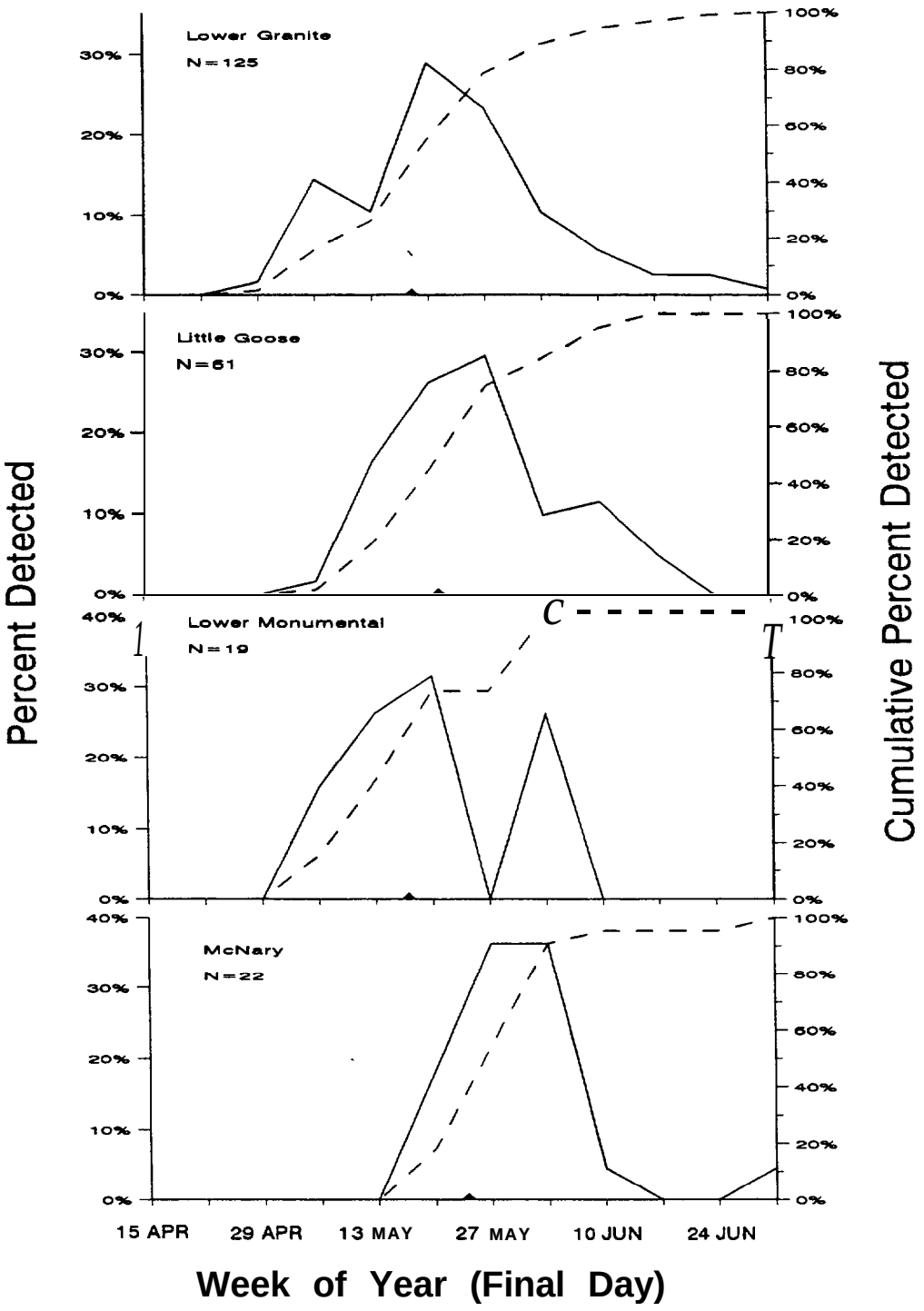

Figure 2. Migration timing at Lower Granite, Little Goose, Lower Monumental, and McNary Dams for naturally produced spring chinook salmon from Catherine Creek, 1993 Migration Year. A = Median migration date. Data were expanded for spillway flow.

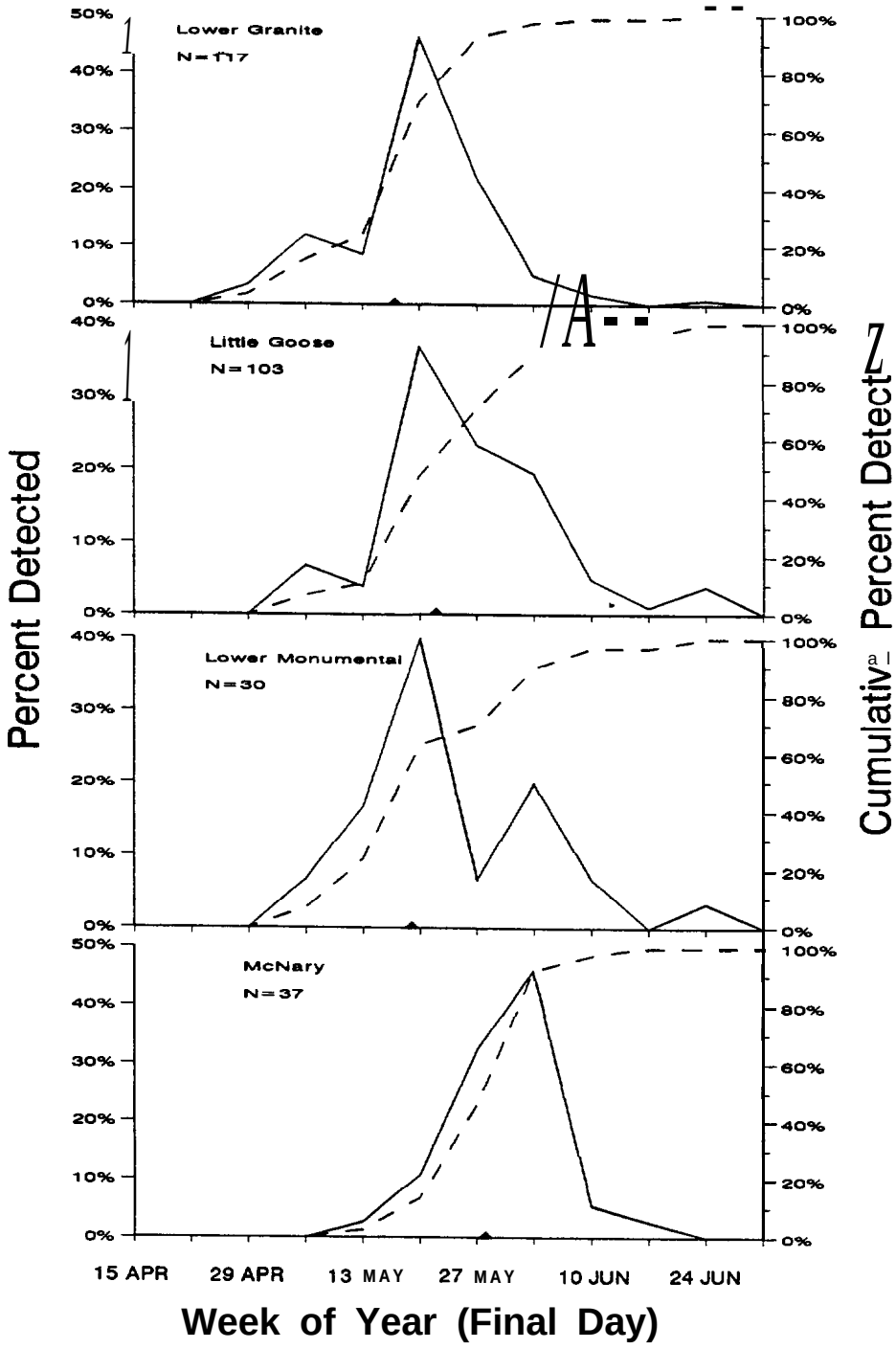

Figure 3. Migration timing at Lower Granite, Little Goose, Lower Monumental, and McNary Dams for naturally produced spring chinook salmon from the Grande Ronde River, 1993 Migration Year. A = Median migration date. Data were expanded for spillway flow.

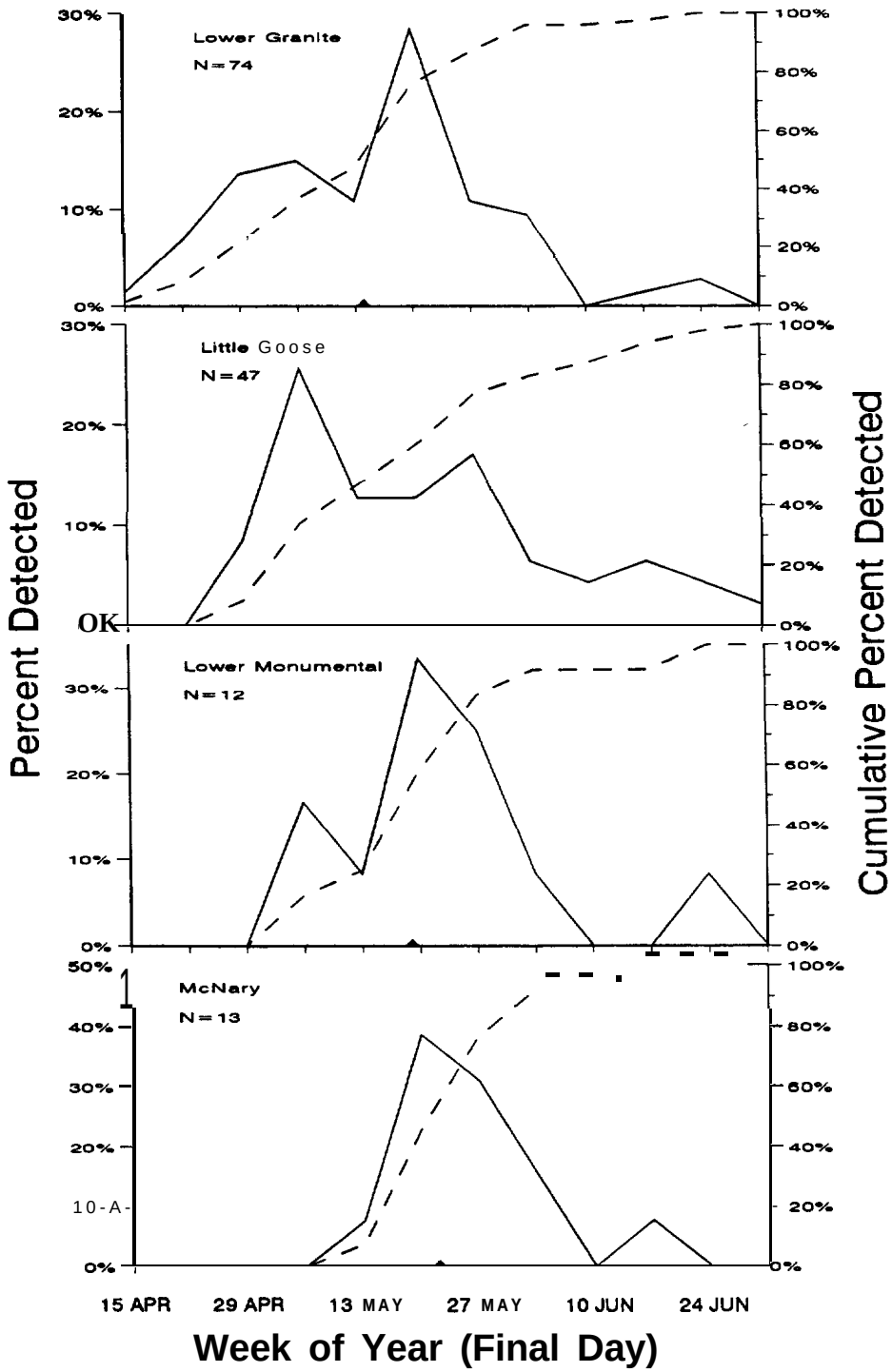

Figure 4. Migration timing at Lower Granite, Little Goose, Lower Monumental, and McNary Dams for naturally produced spring chinook salmon from the Imnaha River, 1993 Migration Year. A = Median migration date. Data were expanded for spillway flow.

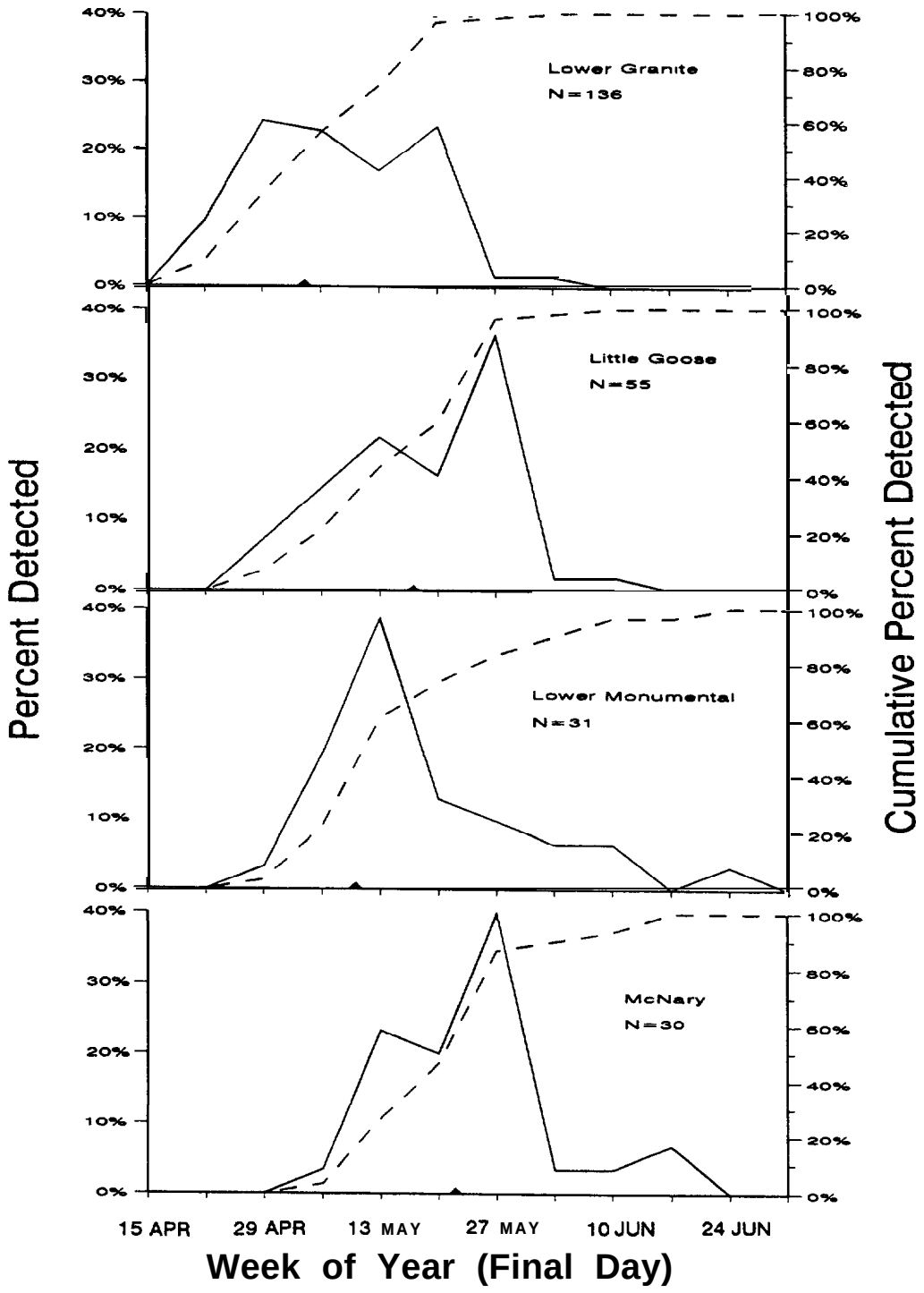

Figure 5. Migration timing at Lower Granite, Little Goose, Lower Monumental, and McNary Dams for naturally produced spring chinook salmon from the Lostine River, 1993 Migration Year. ▲ = Median migration date. Data were expanded for spillway flow.

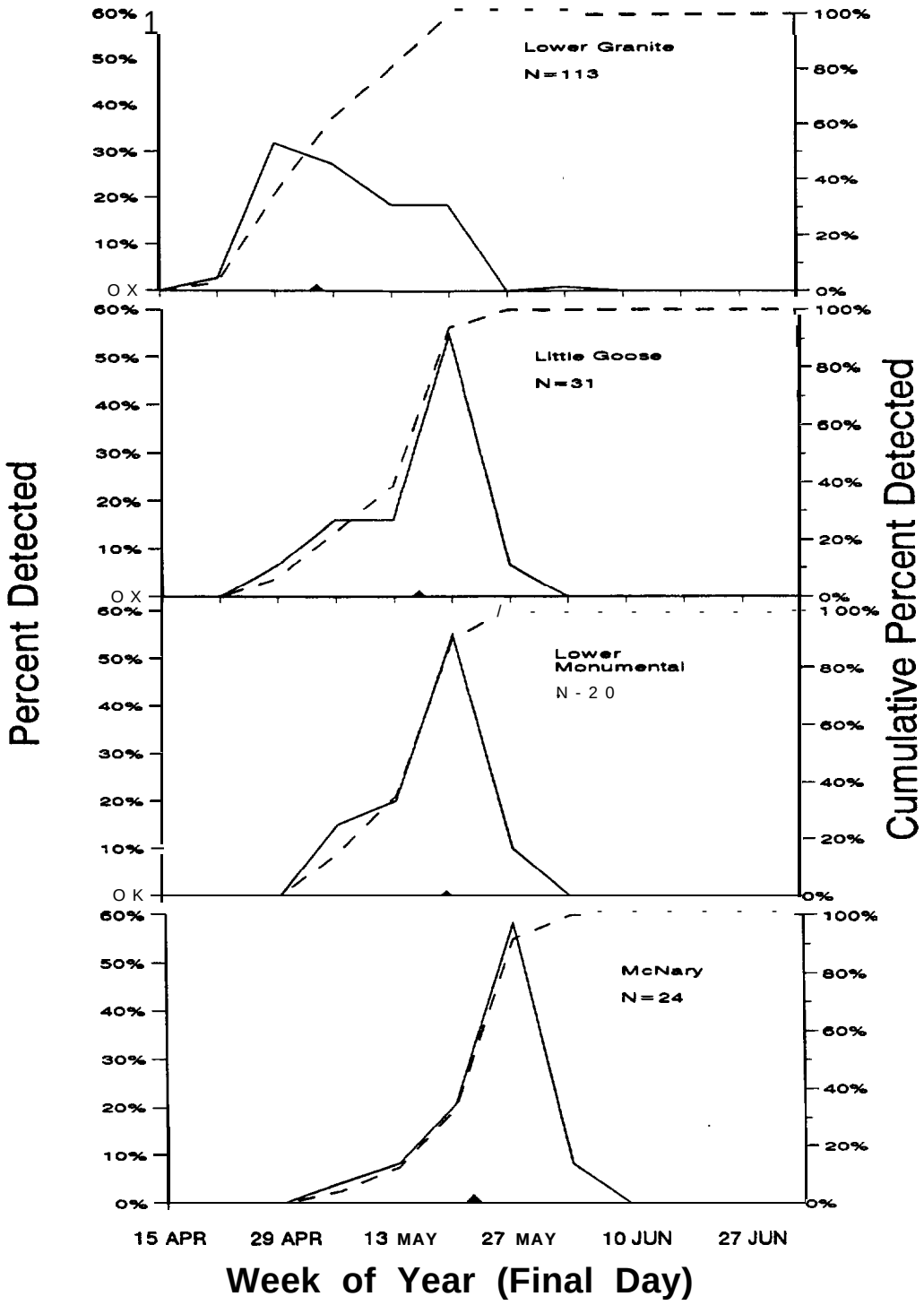

Figure 6. Migration timing at Lower Granite, Little Goose, Lower Monumental, and McNary Dams for naturally produced spring chinook salmon from the Minam River, 1993 Migration Year. ▲ = Median migration date. Data were expanded for spillway flow.

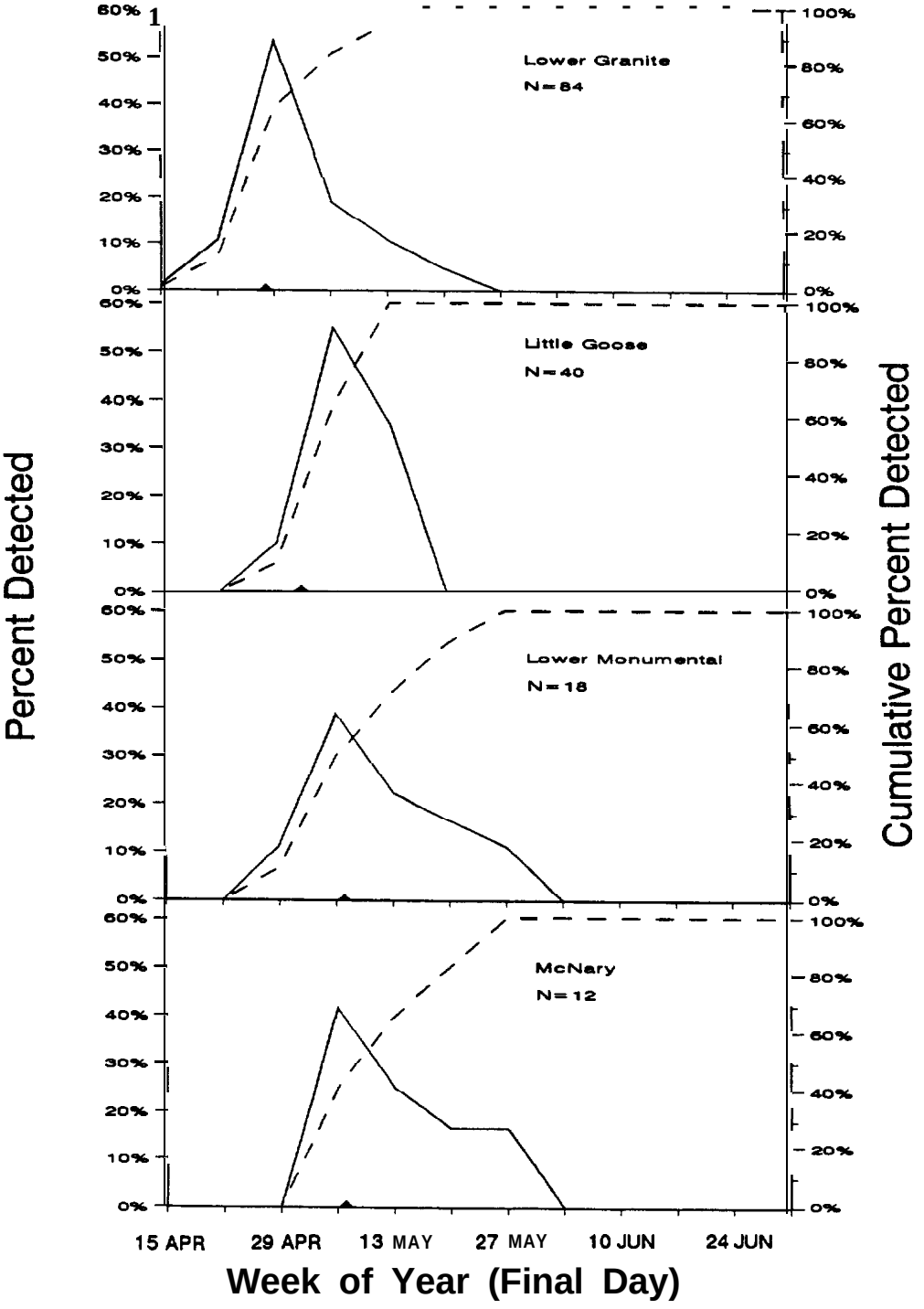

Figure 7. Migration timing at Lower Granite, Little Goose, Lower Monumental, and McNary Dams for naturally produced spring chinook salmon from the Wenaha and South Fork Wenaha Rives, 1993 Migration Year. ▲ = Median migration date. Data were expanded for spillway flow.

Table 5. First-time detections by dam site (% of release) during the 1993 migration year for chinook salmon PIT tagged on six streams in the Grande Ronde and Imnaha River subbasins in 1992. Data were not expanded for spillway flow. Catherine = Catherine Creek. Grande = Upper Grande Ronde.

Stream	Number released	Lower Granite	Little Goose	Lower Monumental	McNary	John Day	Total
Catherine	1,096	102 (9.3)	41 (3.7)	16 (1.5)	12 (1.1)	0 (0)	171 (15.6)
Grande	921	89 (9.7)	69 (7.5)	23 (2.5)	23 (2.5)	0 (0)	204 (22.1)
Imnaha	1,003	63 (6.3)	38 (3.8)	9 (0.9)	7 (0.7)	0 (0)	117 (11.7)
Lostine	1,001	123 (12.3)	37 (3.7)	28 (2.8)	18 (1.8)	1 (0.1)	207 (20.7)
Minam	1,000	105 (10.5)	20 (2.0)	14 (1.4)	13 (1.3)	0 (0)	152 (15.2)
Wenaha	751	83 (11.1)	34 (4.5)	15 (1.9)	10 (1.3)	0 (0)	142 (18.9)
TOTAL	5,772	565 (9.8)	239 (4.1)	105 (1.8)	83 (1.4)	1 (<0.1)	993 (17.2)

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Appendix 1. Observation data for spring chinook salmon PIT tagged on Catherine Creek in 1992, and observed at various dams in 1993. 1 = first observation of individual tag, 2 = second observation of individual tag, 3 = 3rd observation of individual tag, 4 = 4th observation of individual tag, and A = sum of all observations at a particular dam.

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	1	1	2	A	1	2	3	A	1	2	3	4	A
15	4/10/93	0			0				0					0
15	4/11/93	0			0				0					0
15	4/12/93	0			0				0					0
15	4/13/93	0			0				0					0
15	4/14/93	0			0				0					0
15	4/15/93	0			0				0					0
16	4/16/93	0			0				0					0
16	4/17/93	0			0				0					0
16	4/18/93	0			0				0					0
16	4/19/93	0			0				0					0
16	4/20/93	0			0				0					0
16	4/21/93	0			0				0					0
16	4/22/93	0			0				0					0
17	4/23/93	0			0				0					0
17	4/24/93	0			0				0					0
17	4/25/93	0			0				0					0
17	4/26/93	0			0				0					0
17	4/27/93	0			0				0					0
17	4/28/93	0			0				0					0
17	4/29/93	2			0				0					0
18	4/30/93	0			0				0					0
18	5/01/93	3			0				0					0
18	5/02/93	0			0				0					0
18	5/03/93	1			0				0					0
18	5/04/93	2			0	2			2					0
18	5/05/93	1	1		1				0					0
18	5/06/93	11			0	1			1					0
19	5/07/93	2		1	1	1	2		3					0
19	5/08/93	3	2	1	3				0					0
19	5/09/93	2	2		2	3			3					0
19	5/10/93	0	1		1		2	1	3					0
19	5/11/93	1		1	1	1			1					0
19	5/12/93	1	2		2		1		1					0
19	5/13/93	3		1	1			1	1		1		1	2
20	5/14/93	0			0		1		1	1	1	1		3
20	5/15/93	4			0				0					0
20	5/16/93	11			0				0					0
20	5/17/93	2	1	1	2	1			1					0
20	5/18/93	3	4		4				0					0

Appendix 1, continued (Catherine Creek)

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	1	1	2	A	1	2	3	A	1	2	3	4	A
20	5/19/93	0	2	2	4	2	1		3					0
20	5/20/93	2	1		1				0	1				1
21	5/21/93	1	3	1	4		1	1	2	3				3
21	5/22/93	2	3	1	4				0		1			1
21	5/23/93	4	1		1				0		1			1
21	5/24/93	3	1		1				0	1	1			2
21	5/25/93	3	1		1				0					0
21	5/26/93	0		1	1				0		1			1
21	5/27/93	8	1		1			1	1					0
22	5/28/93	1	1		1	1			1	1	1			2
22	5/29/93	2		1	1		2		2	1				1
22	5/30/93	2	2		2				0		1			1
22	5/31/93	6		2	2	3	1	1	5	1	1			2
22	6/01/93	0	1		1	1			1	1				1
22	6/02/93	1	1		1				0					0
22	6/03/93	1			0				0		1	1		2
23	6/04/93	1	2		2		1		1		1			1
23	6/05/93	1	2		2		1		1					0
23	6/06/93	2		1	1		1		1					0
23	6/07/93	1		1	1		2		2					0
23	6/08/93	0			0		1	1	2	1	1			2
23	6/09/93	1			0		1		1					0
23	6/10/93	1	3	2	5				0					0
24	6/11/93	1	2		2				0					0
24	6/12/93	0	1		1				0					0
24	6/13/93	0			0				0					0
24	6/14/93	0			0		1		1		1			1
24	6/15/93	1			0				0			1		1
24	6/16/93	1			0				0					0
24	6/17/93	0			0				0					0
25	6/18/93	1		1	1				0					0
25	6/19/93	1		1	1				0					0
25	6/20/93	1		1	1				0					0
25	6/21/93	0			0				0					0
25	6/22/93	0			0			1	1		1			1
25	6/23/93	0			0				0					0
25	6/24/93	0			0				0					0
26	6/25/93	0			0				0					0
26	6/26/93	1		1	1				0	1				1
26	6/27/93	0			0				0					0
26	6/28/93	0			0				0					0
26	6/29/93	0			0				0					0
26	6/30/93	0		1	1				0					0

Appendix 1, continued (Catherine Creek)

WEEK	DATE	LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
		1	1	2	A	1	2	3	A	1	2	3	4	A
26	7/01/93	0			0				0					0
27	7/02/93	0			0				0					0
27	7/03/93	0			0				0					0
27	7/04/93	0			0				0					0
27	7/05/93	0			0				0					0
27	7/06/93	0			0				0					0
27	7/07/93	0			0				0					0
27	7/08/93	0			0				0					0
28	7/09/93	0			0				0					0
28	7/10/93	0			0				0					0
28	7/11/93	0			0				0					0
28	7/12/93	0			0				0					0
28	7/13/93	0			0				0					0
28	7/14/93	0			0				0					0
28	7/15/93	0			0			1	1					0
29	7/16/93	0			0				0					0
29	7/17/93	0			0				0					0
29	7/18/93	0			0				0					0
29	7/19/93	0			0				0					0
29	7/20/93	0			0				0					0
29	7/21/93	0			0				0					0
29	7/22/93	0			0				0					0
30	7/23/93	0			0				0					0
30	7/24/93	0			0				0					0
30	7/25/93	0			0				0					0
30	7/26/93	0			0				0					0
30	7/27/93	0			0				0					0
30	7/28/93	0			0				0					0
30	7/29/93	0			0				0					0
31	7/30/93	0			0				0					0
31	7/31/93	0			0				0					0
31	8/01/93	0			0				0					0
31	8/02/93	0			0				0					0
31	8/03/93	0			0				0					0
31	8/04/93	0			0				0			1		1
31	8/05/93	0			0				0					0
Total		102	41	22	63	16	19	8	43	12	14	4	1	31

Appendix 2. Observation data for spring chinook salmon PIT tagged on the Upper Grand Ronde River in 1992, and observed at various dams in 1993. 1 = first observation of individual tag, 2 = second observation of individual tag, 3 = 3rd observation of individual tag, and A = sum of all observations at a particular dam.

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY			
WEEK	DATE	1	1	2	A	1	2	3	A	1	2	3	A
15	4/10/93	0			0				0				0
15	4/11/93	0			0				0				0
15	4/12/93	0			0				0				0
15	4/13/93	0			0				0				0
15	4/14/93	0			0				0				0
15	4/15/93	0			0				0				0
16	4/16/93	0			0				0				0
16	4/17/93	0			0				0				0
16	4/18/93	0			0				0				0
16	4/19/93	0			0				0				0
16	4/20/93	0			0				0				0
16	4/21/93	0			0				0				0
16	4/22/93	0			0				0				0
17	4/23/93	1			0				0				0
17	4/24/93	0			0				0				0
17	4/25/93	1			0				0				0
17	4/26/93	0			0				0				0
17	4/27/93	0			0				0				0
17	4/28/93	2			0				0				0
17	4/29/93	0			0				0				0
18	4/30/93	2			0				0				0
18	5/01/93	1			0				0				0
18	5/02/93	1			0				0				0
18	5/03/93	2		1	1				0				0
18	5/04/93	1			0				0				0
18	5/05/93	1	3	1	4			1	1				0
18	5/06/93	6	2	1	3	2			2				0
19	5/07/93	3			0	1	5		6				0
19	5/08/93	3	2		2	1			1				0
19	5/09/93	2			0	1			1				0
19	5/10/93	1			0	1			1	1			1
19	5/11/93	0	1		1	1	4		5			2	2
19	5/12/93	1			0				0				0
19	5/13/93	0			0		1		1			1	1
20	5/14/93	6			0	1			1				0
20	5/15/93	5	1		1				0				0
20	5/16/93	8	2		2				0				0
20	5/17/93	5	2	1	3		1		1				0
20	5/18/93	3	6		6	2	2		4		1		1

Appendix 2, continued (upper Grande Ronde River)

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY			
WEEK	DATE	1	1	2	A	1	2	3	A	1	2	3	A
20	5/19/93	4	6		6	1	2		3	1			1
20	5/20/93	2	2		2	2			2	1			1
21	5/21/93	6	1		1		1		1			1	1
21	5/22/93	2	2	1	3	1	3		4	1			1
21	5/23/93	6	2		2		2		2	2			2
21	5/24/93	1	2		2				0		1	1	2
21	5/25/93	1	3		3		1		1				0
21	5/26/93	2			0				0	1	1		2
21	5/27/93	1	5		5		1		1	2	1	1	4
22	5/28/93	1	2		2	1	2		3	3			3
22	5/29/93	1	1		1				0	3			3
22	5/30/93	2	6		6	1			1	1	1		2
22	5/31/93	1	3	1	4	1	1		2	4			4
22	6/01/93	0	3	1	4	1	1		2				0
22	6/02/93	1	1	1	2	1	2		3		1		1
22	6/03/93	0	1	1	2	1	2		3		1		1
23	6/04/93	0			0		1		1				0
23	6/05/93	0	2	1	3	1	1		2				0
23	6/06/93	0			0	1	1	1	3				0
23	6/07/93	0			0		1	1	2		1		1
23	6/08/93	1	1		1				0	1			1
23	6/09/93	0			0				0	1		1	2
23	6/10/93	1	2		2			1	1			1	1
24	6/11/93	0			0				0				0
24	6/12/93	0			0		1		1				0
24	6/13/93	0			0				0				0
24	6/14/93	0			0				0	1			1
24	6/15/93	0			0				0				0
24	6/16/93	0	1		1				0				0
24	6/17/93	0			0				0		1		1
25	6/18/93	0	1	1	2				0				0
25	6/19/93	0	2		2		1		1				0
25	6/20/93	1	1		1		1		1				0
25	6/21/93	0			0	1			1				0
25	6/22/93	0			0				0				0
25	6/23/93	0			0		1		1				0
25	6/24/93	0			0				0				0
26	6/25/93	0			0				0			1	1
26	6/26/93	0			0				0				0
26	6/27/93	0		1	1				0				0
26	6/28/93	0			0				0				0
26	6/29/93	0			0				0				0
26	6/30/93	0			0				0		1		1

Appendix 2, continued (upper Grande Ronde River)

WEEK	DATE	LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY			
		1	1	2	A	1	2	3	A	1	2	3	A
26	7/01/93	0			0				0			1	1
27	7/02/93	0			0				0				0
27	7/03/93	0			0				0				0
27	7/04/93	0			0				0				0
27	7/05/93	0			0				0				0
27	7/06/93	0			0				0				0
27	7/07/93	0			0				0				0
27	7/08/93	0			0				0				0
28	7/09/93	0			0				0				0
28	7/10/93	0			0				0				0
28	7/11/93	0			0				0				0
28	7/12/93	0			0				0				0
28	7/13/93	0			0				0				0
28	7/14/93	0			0				0				0
28	7/15/93	0			0				0				0
29	7/16/93	0			0				0				0
29	7/17/93	0			0				0				0
29	7/18/93	0			0				0				0
29	7/19/93	0			0				0				0
29	7/20/93	0			0				0				0
29	7/21/93	0			0				0				0
29	7/22/93	0			0				0				0
30	7/23/93	0			0				0				0
30	7/24/93	0			0				0				0
30	7/25/93	0			0				0				0
30	7/26/93	0			0				0				0
30	7/27/93	0			0				0				0
30	7/28/93	0			0				0				0
30	7/29/93	0			0				0				0
31	7/30/93	0			0				0				0
31	7/31/93	0			0				0				0
31	8/01/93	0			0				0				0
31	8/02/93	0			0				0				0
31	8/03/93	0			0				0				0
31	8/04/93	0			0				0				0
31	8/05/93	0			0				0				0
		89	69	12	81	23	39	4	66	23	10	10	43

Appendix 3. Observation data for spring chinook salmon PIT tagged on the Imnaha River in 1992, and observed at various dams in 1993. 1 = first observation of individual tag, 2 = second observation of individual tag, 3 = 3rd observation of individual tag, and A = sum of all observations at a particular dam.

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY			
WEEK	DATE	1	1	2	A	1	2	3	A	1	2	3	A
15	4/10/93	0			0				0				0
15	4/11/93	0			0				0				0
15	4/12/93	0			0				0				0
15	4/13/93	0			0				0				0
15	4/14/93	0			0				0				0
15	4/15/93	1			0				0				0
16	4/16/93	0			0				0				0
16	4/17/93	0			0				0				0
16	4/18/93	0			0				0				0
16	4/19/93	2			0				0				0
16	4/20/93	1			0				0				0
16	4/21/93	0			0				0				0
16	4/22/93	2			0				0				0
17	4/23/93	0			0				0				0
17	4/24/93	1			0				0				0
17	4/25/93	3			0				0				0
17	4/26/93	1			0				0				0
17	4/27/93	3	1	1	2				0				0
17	4/28/93	1	1		1				0				0
17	4/29/93	1	2	1	3				0				0
18	4/30/93	1	3	1	4				0				0
18	5/01/93	0	1	1	2				0				0
18	5/02/93	3	3	1	4				0				0
18	5/03/93	0	1		1	1			1				0
18	5/04/93	3	2		2		2	2	4		1		1
18	5/05/93	0		1	1	1	1		2		1		1
18	5/06/93	4	1		1				0		1	1	2
19	5/07/93	2			0	1		1	2	1			1
19	5/08/93	2	2	1	3				0		1		1
19	5/09/93	1			0				0				0
19	5/10/93	1			0		1		1				0
19	5/11/93	0			0			1	1				0
19	5/12/93	0	1		1		1		1				0
19	5/13/93	2	1		1				0			1	1
20	5/14/93	4		1	1				0				0
20	5/15/93	1			0				0	1			1
20	5/16/93	3		1	1				0				0
20	5/17/93	1			0				0				0
20	5/18/93	1	1		1				0	1			1

Appendix 3, continued (Imnaha River)

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY			
WEEK	DATE	1	1	2	A	1	2	3	A	1	2	3	A
20	5/19/93	1	1		1	2			2		1		1
20	5/20/93	1	1	1	2		1		1				0
21	5/21/93	3	2		2	2			2				0
21	5/22/93	0			0		1		1	2			2
21	5/23/93	0	1	1	2				0				0
21	5/24/93	0			0				0		1	1	2
21	5/25/93	2			0				0			1	1
21	5/26/93	1	1		1				0		1		1
21	5/27/93	0	1	1	2				0				0
22	5/28/93	3			0			1	1				0
22	5/29/93	0			0				0		1		1
22	5/30/93	1	1		1				0		1		1
22	5/31/93	0			0	1			1				0
22	6/01/93	1	1		1				0	1			1
22	6/02/93	0			0				0				0
22	6/03/93	2	1	1	2		1		1				0
23	6/04/93	0	1	1	2				0				0
23	6/05/93	0			0				0				0
23	6/06/93	0			0				0				0
23	6/07/93	0			0				0				0
23	6/08/93	0			0				0				0
23	6/09/93	0			0				0				0
23	6/10/93	0	1		1				0				0
24	6/11/93	0			0				0	1			1
24	6/12/93	0		1	1				0				0
24	6/13/93	0			0				0				0
24	6/14/93	0			0		1		1				0
24	6/15/93	0			0				0		2		2
24	6/16/93	1			0				0				0
24	6/17/93	0	3	1	4				0			1	1
25	6/18/93	0			0				0				0
25	6/19/93	0			0				0				0
25	6/20/93	0	1		1				0				0
25	6/21/93	1	1		1		1	1	2				0
25	6/22/93	0			0				0				0
25	6/23/93	1			0				0				0
25	6/24/93	0			0	1			1				0
26	6/25/93	0			0				0				0
26	6/26/93	0			0				0				0
26	6/27/93	0	1		1				0				0
26	6/28/93	0			0				0		1		1
26	6/29/93	0			0				0				0
26	6/30/93	0			0				0				0

Appendix 3, continued (Imnaha River)

WEEK	DATE	LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY			
		1	1	2	A	1	2	3	A	1	2	3	A
26	7/01/93	0		1	1				0				0
27	7/02/93	0			0				0				0
27	7/03/93	0			0				0				0
27	7/04/93	0			0				0				0
27	7/05/93	0			0				0				0
27	7/06/93	0		1	1				0				0
27	7/07/93	0			0				0				0
27	7/08/93	0			0				0				0
28	7/09/93	0			0				0				0
28	7/10/93	0			0				0				0
28	7/11/93	0			0				0				0
28	7/12/93	0			0				0				0
28	7/13/93	0			0				0			1	1
28	7/14/93	0			0				0				0
28	7/15/93	0			0				0				0
29	7/16/93	0			0				0				0
29	7/17/93	0			0				0				0
29	7/18/93	0			0				0				0
29	7/19/93	0			0				0				0
29	7/20/93	0			0				0				0
29	7/21/93	0			0				0				0
29	7/22/93	0			0				0				0
30	7/23/93	0			0				0				0
30	7/24/93	0			0				0				0
30	7/25/93	0			0				0				0
30	7/26/93	0			0				0				0
30	7/27/93	0			0				0				0
30	7/28/93	0			0				0				0
30	7/29/93	0			0				0				0
31	7/30/93	0			0				0				0
31	7/31/93	0			0				0				0
31	8/01/93	0			0				0				0
31	8/02/93	0			0				0				0
31	8/03/93	0			0				0				0
31	8/04/93	0			0				0				0
31	8/05/93	0			0				0				0
		63	38	18	56	9	10	6	25	7	12	6	25

Appendix 4. Observation data for spring chinook salmon PIT tagged on the Lostine River in 1992, and observed at various dams in 1993. 1 = first observation of individual tag, 2 = second observation of individual tag, 3 = 3rd observation of individual tag, 4 = 4th observation of an individual tag, and A = sum of all observations at a particular dam. Two additional fish were observed at John Day Dam, and one additional fish was observed at Bonneville.

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	1	1	2	A	1	2	3	A	1	2	3	4	A
15	4/10/93	0			0				0					0
15	4/11/93	0			0				0					0
15	4/12/93	0			0				0					0
15	4/13/93	0			0				0					0
15	4/14/93	0			0				0					0
15	4/15/93	0			0				0					0
16	4/16/93	0			0				0					0
16	4/17/93	1			0				0					0
16	4/18/93	1			0				0					0
16	4/19/93	2			0				0					0
16	4/20/93	3			0				0					0
16	4/21/93	1			0				0					0
16	4/22/93	5			0				0					0
17	4/23/93	4			0				0					0
17	4/24/93	4			0				0					0
17	4/25/93	5	1		1				0					0
17	4/26/93	6		1	1				0					0
17	4/27/93	4	1		1				0					0
17	4/28/93	5	2	2	4	1			1					0
17	4/29/93	5		4	4				0					0
18	4/30/93	5	4		4				0					0
18	5/01/93	5	1		1				0					0
18	5/02/93	7	1	4	5				0					0
18	5/03/93	3		2	2	2	2		4		1			1
18	5/04/93	5	1	3	4	4	6		10		1			1
18	5/05/93	3		1	1			3	3		2	1		3
18	5/06/93	3	1	1	2		1		1	1	3			4
19	5/07/93	6	3		3	1	3	1	5			1		1
19	5/08/93	5	4	1	5	2		1	3	1				1
19	5/09/93	5			0	1	1		2	1	1			2
19	5/10/93	1		1	1	5	6	1	12					0
19	5/11/93	0			0	2	1		3		1	1		2
19	5/12/93	4			0		1		1	2	1			3
19	5/13/93	2	1		1	1			1	1				1
20	5/14/93	4		1	1				0		1	2		3
20	5/15/93	5		1	1				0				1	1
20	5/16/93	2			0				0					0
20	5/17/93	5	2		2	1			1	1				1

Appendix 4, continued (Lostine River)

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	1	1	2	A	1	2	3	A	1	2	3	4	A
20	5/18/93	2	2		2	1			1					0
20	5/19/93	1			0				0					0
20	5/20/93	0			0				0	1	1			2
21	5/21/93	0	4		4				0					0
21	5/22/93	0	1		1	2			2	1				1
21	5/23/93	0	1	1	2				0	1				1
21	5/24/93	1	1		1				0	3				3
21	5/25/93	0	2		2				0		1			1
21	5/26/93	1			0				0	1				1
21	5/27/93	0	2		2				0					0
22	5/28/93	1	1		1				0					0
22	5/29/93	0			0				0					0
22	5/30/93	0			0		1		1	1	1			2
22	5/31/93	0			0	2	1		3					0
22	6/01/93	1			0				0		1			1
22	6/02/93	0			0				0					0
22	6/03/93	0			0				0			1		1
23	6/04/93	0			0				0					0
23	6/05/93	0			0				0		1			1
23	6/06/93	0			0				0		1			1
23	6/07/93	0			0				0	1	1			2
23	6/08/93	0			0	1			1					0
23	6/09/93	0	1		1				0					0
23	6/10/93	0			0	1			1					0
24	6/11/93	0			0				0					0
24	6/12/93	0			0				0	1				1
24	6/13/93	0			0		1		1					0
24	6/14/93	0			0				0					0
24	6/15/93	0		1	1				0	1				1
24	6/16/93	0			0				0					0
24	6/17/93	0			0				0					0
25	6/18/93	0			0				0					0
25	6/19/93	0			0			1	1					0
25	6/20/93	0			0				0					0
25	6/21/93	0			0				0					0
25	6/22/93	0			0	1			1					0
25	6/23/93	0			0				0					0
25	6/24/93	0			0				0					0
26	6/25/93	0			0				0					0
26	6/26/93	0			0				0					0
26	6/27/93	0			0				0					0
26	6/28/93	0			0				0					0
26	6/29/93	0			0				0					0

Appendix 4, continued (Lostine River)

WEEK	DATE	LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
		1	1	2	A	1	2	3	A	1	2	3	4	A
26	6/30/93	0			0				0					0
26	7/01/93	0			0				0					0
27	7/02/93	0			0				0					0
27	7/03/93	0			0				0					0
27	7/04/93	0			0				0					0
27	7/05/93	0			0				0					0
27	7/06/93	0			0				0					0
27	7/07/93	0			0				0					0
27	7/08/93	0			0				0					0
28	7/09/93	0			0				0					0
28	7/10/93	0			0				0					0
28	7/11/93	0			0				0					0
28	7/12/93	0			0				0					0
28	7/13/93	0			0				0					0
28	7/14/93	0			0				0					0
28	7/15/93	0			0				0					0
29	7/16/93	0			0				0					0
29	7/17/93	0			0				0					0
29	7/18/93	0			0				0					0
29	7/19/93	0			0				0					0
29	7/20/93	0			0				0					0
29	7/21/93	0			0				0					0
29	7/22/93	0			0				0					0
30	7/23/93	0			0				0					0
30	7/24/93	0			0				0					0
30	7/25/93	0			0				0					0
30	7/26/93	0			0				0					0
30	7/27/93	0			0				0					0
30	7/28/93	0			0				0					0
30	7/29/93	0			0				0					0
31	7/30/93	0			0				0					0
31	7/31/93	0			0				0					0
31	8/01/93	0			0				0					0
31	8/02/93	0			0				0					0
31	8/03/93	0			0				0					0
31	8/04/93	0			0				0					0
31	8/05/93	0			0				0					0
		123	37	24	61	28	24	7	59	18	18	6	1	43

Appendix 5. Observation data for spring chinook salmon PIT tagged on the Minam River in 1992, and observed at various dams in 1993. 1 = first observation of individual tag, 2 = second observation of individual tag, 3 = 3rd observation of individual tag, and A = sum of all observations at a particular dam.

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY			
WEEK	DATE	1	1	2	A	1	2	3	A	1	2	3	A
15	4/10/93	0			0				0				0
15	4/11/93	0			0				0				0
15	4/12/93	0			0				0				0
15	4/13/93	0			0				0				0
15	4/14/93	0			0				0				0
15	4/15/93	0			0				0				0
16	4/16/93	0			0				0				0
16	4/17/93	0			0				0				0
16	4/18/93	1			0				0				0
16	4/19/93	0			0				0				0
16	4/20/93	0			0				0				0
16	4/21/93	1			0				0				0
16	4/22/93	1			0				0				0
17	4/23/93	3			0				0				0
17	4/24/93	2			0				0				0
17	4/25/93	9			0				0				0
17	4/26/93	6			0				0				0
17	4/27/93	2	1		1				0				0
17	4/28/93	3			0				0				0
17	4/29/93	11	1	1	2				0				0
18	4/30/93	5		1	1				0				0
18	5/01/93	4	1	2	3				0				0
18	5/02/93	4	3	1	4				0				0
18	5/03/93	2	1		1		1	1	2				0
18	5/04/93	5		1	1	1		1	2				0
18	5/05/93	1		1	1			1	1	1	1		2
18	5/06/93	10			0	2			2		4		4
19	5/07/93	8			0		2		2	1	1		2
19	5/08/93	4	2	3	5				0		1		1
19	5/09/93	3	1	1	2	2			2				0
19	5/10/93	3			0		1		1	1		1	2
19	5/11/93	1			0	1	2	1	4				0
19	5/12/93	1		2	2				0				0
19	5/13/93	1			0	1	1		2				0
20	5/14/93	3	1	1	2			1	1		3		3
20	5/15/93	3			0				0				0
20	5/16/93	4	1	1	2				0				0
20	5/17/93	0	3	1	4		1		1				0
20	5/18/93	3			0	1			1	2			2

Appendix 5, continued (Minam River)

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY			
WEEK	DATE	1	1	2	A	1	2	3	A	1	2	3	A
20	5/19/93	0	1	1	2	2			2		1		1
20	5/20/93	0	2		2	3			3		1	1	2
21	5/21/93	0			0		1		1	1	1		2
21	5/22/93	0			0	1	1		2	1	2		3
21	5/23/93	0			0		1		1				0
21	5/24/93	0			0				0	2			2
21	5/25/93	0	1		1				0	1			1
21	5/26/93	0	1		1				0	2	1		3
21	5/27/93	0			0				0				0
22	5/28/93	0			0				0	1			1
22	5/29/93	0			0				0				0
22	5/30/93	0			0				0				0
22	5/31/93	0			0		1		1				0
22	6/01/93	0			0		1		1				0
22	6/02/93	0			0				0				0
22	6/03/93	1			0				0				0
23	6/04/93	0			0				0				0
23	6/05/93	0			0				0				0
23	6/06/93	0			0				0				0
23	6/07/93	0			0				0				0
23	6/08/93	0			0				0				0
23	6/09/93	0			0				0				0
23	6/10/93	0			0				0				0
24	6/11/93	0			0				0				0
24	6/12/93	0			0				0				0
24	6/13/93	0			0				0				0
24	6/14/93	0			0				0				0
24	6/15/93	0			0				0				0
24	6/16/93	0			0				0				0
24	6/17/93	0			0				0				0
25	6/18/93	0			0				0				0
25	6/19/93	0			0				0				0
25	6/20/93	0			0				0				0
25	6/21/93	0			0				0				0
25	6/22/93	0			0				0				0
25	6/23/93	0			0				0				0
25	6/24/93	0			0				0				0
26	6/25/93	0			0				0				0
26	6/26/93	0			0				0				0
26	6/27/93	0			0				0				0
26	6/28/93	0			0				0				0
26	6/29/93	0			0				0				0
26	6/30/93	0			0				0				0

Appendix 5, continued (Minam River)

WEEK	DATE	LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY			
		1	1	2	A	1	2	3	A	1	2	3	A
26	7/01/93	0			0				0				0
27	7/02/93	0			0				0				0
27	7/03/93	0			0				0				0
27	7/04/93	0			0				0				0
27	7/05/93	0			0				0				0
27	7/06/93	0			0				0				0
27	7/07/93	0			0				0				0
27	7/08/93	0			0				0				0
28	7/09/93	0			0				0				0
28	7/10/93	0			0				0				0
28	7/11/93	0			0				0				0
28	7/12/93	0			0				0				0
28	7/13/93	0			0				0				0
28	7/14/93	0			0				0				0
28	7/15/93	0			0				0				0
29	7/16/93	0			0				0				0
29	7/17/93	0			0				0				0
29	7/18/93	0			0				0				0
29	7/19/93	0			0				0				0
29	7/20/93	0			0				0				0
29	7/21/93	0			0				0				0
29	7/22/93	0			0				0				0
30	7/23/93	0			0				0				0
30	7/24/93	0			0				0				0
30	7/25/93	0			0				0				0
30	7/26/93	0			0				0				0
30	7/27/93	0			0				0				0
30	7/28/93	0			0				0				0
30	7/29/93	0			0				0				0
31	7/30/93	0			0				0				0
31	7/31/93	0			0				0				0
31	8/01/93	0			0				0				0
31	8/02/93	0			0				0				0
31	8/03/93	0			0				0				0
31	8/04/93	0			0				0				0
31	8/05/93	0			0				0				0
		105	20	17	37	14	13	5	32	13	16	2	31

Appendix 6. Observation data for spring chinook salmon PIT tagged on the Wenaha and South Fork Wenaha Rivers in 1992, and observed at various dams in 1993. 1 = first observation of individual tag, 2 = second observation of individual tag, 3 = 3rd observation of individual tag, 4 = 4th observation of individual tag, and A = sum of all observations at a particular dam. One additional fish was observed at John Day Dam.

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	1	1	2	A	1	2	3	A	1	2	3	4	A
15	4/10/93	0			0				0					0
15	4/11/93	0			0				0					0
15	4/12/93	0			0				0					0
15	4/13/93	0			0				0					0
15	4/14/93	1			0				0					0
15	4/15/93	0			0				0					0
16	4/16/93	0			0				0					0
16	4/17/93	0			0				0					0
16	4/18/93	2			0				0					0
16	4/19/93	1			0				0					0
16	4/20/93	1			0				0					0
16	4/21/93	1		1	1				0					0
16	4/22/93	4			0				0					0
17	4/23/93	10			0				0					0
17	4/24/93	4			1				0					0
17	4/25/93	2	1	1	1	1			1					0
17	4/26/93	6			0				0					0
17	4/27/93	7		2	2				0					0
17	4/28/93	6	1	1	2	1		1	2					0
17	4/29/93	10	2	3	5				0					0
18	4/30/93	3	5	3	8				0					0
18	5/01/93	2	4	3	7				0					0
18	5/02/93	3	6	6	12		5		0					0
18	5/03/93	3	2	2	4	1	4	1	7					0
18	5/04/93	2	1			1	1	2	7	2	1	2		5
18	5/05/93	1	1	2	11	1	1	2	4	1	1			2
18	5/06/93	2	1	1		4			5	2	3	2		7
19	5/07/93	3	1	1	11		1	2	3	3	2			5
19	5/08/93	1	5		5	1	1		1			1		1
19	5/09/93	2	1		1	1	3		2			1		1
19	5/10/93	1	1		0	1			4		1			1
19	5/11/93	0	1		1		2		2					0
19	5/12/93	2			1				0					0
19	5/13/93	0	1	1	2	1	1		2		1			1
20	5/14/93	1			0				0			1		1
20	5/15/93	2			0			1	1					0
20	5/16/93	0			0	1	1		2				1	1
20	5/17/93	0			0				0					0

Appendix 6, continued (Wenaha and South Fork Wenaha Rivers)

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	1	1	2	A	1	2	3	A	1	2	3	4	A
20	5/18/93	0			0				0					0
20	5/19/93	0			0				0	1				1
20	5/20/93	0		1	1				0					0
21	5/21/93	0			0				0					0
21	5/22/93	0			0	1			1					0
21	5/23/93	0			0				0					0
21	5/24/93	0			0				0					0
21	5/25/93	0			0				0					0
21	5/26/93	0			0				0	1		1		2
21	5/27/93	0			0				0					0
22	5/28/93	0			0				0					0
22	5/29/93	0			0				0					0
22	5/30/93	0			0				0					0
22	5/31/93	0			0				0					0
22	6/01 /93	0			0				0					0
22	6/02/93	0			0				0					0
22	6/03/93	0			0				0					0
23	6/04/93	0			0				0					0
23	6/05/93	0			0				0					0
23	6/06/93	0			0				0					0
23	6/07/93	0			0				0					0
23	6/08/93	0			0				0					0
23	6/09/93	0			0				0					0
23	6/10/93	0			0				0					0
24	6/11/93	0			0				0					0
24	6/12/93	0			0				0					0
24	6/13/93	0			0				0					0
24	6/14/93	0			0				0					0
24	6/15/93	0			0				0					0
24	6/16/93	0			0				0					0
24	6/17/93	0			0				0					0
25	6/18/93	0			0				0					0
25	6/19/93	0			0				0					0
25	6/20/93	0			0				0					0
25	6/21/93	0			0				0					0
25	6/22/93	0			0				0					0
25	6/23/93	0			0				0					0
25	6/24/93	0			0				0					0
26	6/25/93	0			0				0					0
26	6/26/93	0			0				0					0
26	6/27/93	0			0				0					0
26	6/28/93	0			0				0					0
26	6/29/93	0			0				0					0
26	6/30/93	0			0				0					0

Appendix 6, continued (Wenaha and South Fork Wenaha Rivers)

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	1	1	2	A	1	2	3	A	1	2	3	4	A
26	7/01/93	0			0				0					0
27	7/02/93	0			0				0					0
27	7/03/93	0			0				0					0
27	7/04/93	0			0				0					0
27	7/05/93	0			0				0					0
27	7/06/93	0			0									0
27	7/07/93	0			0				8					0
27	7/08/93	0			0				0					0
28	7/09/93	0			0				0					0
28	7/10/93	0			0				0					0
28	7/11/93	0			0				0					0
28	7/12/93	0			0				0					0
28	7/13/93	0			0				0					0
28	7/14/93	0			0				0					0
28	7/15/93	0			0				0					0
29	7/16/93	0			0				0					0
29	7/17/93	0			0				0					0
29	7/18/93	0			0				0					0
29	7/19/93	0			0				0					0
29	7/20/93	0			0				0					0
29	7/21/93	0			0				0					0
29	7/22/93	0			0				0					0
30	7/23/93	0			0				0					0
30	7/24/93	0			0				0					0
30	7/25/93	0			0				0					0
30	7/26/93	0			0				0					0
30	7/27/93	0			0				0					0
30	7/28/93	0			0				0					0
30	7/29/93	0			0				0					0
31	7/30/93	0			0				0					0
31	7/31/93	0			0				0					0
31	8/01/93	0			0				0					0
31	8/02/93	0			0				0					0
31	8/03/93	0			0				0					0
31	8/04/93	0			0				0					0
31	8/05/93	0			0				0					0
Total		83	34	28	62	15	20	9	44	10	9	8	1	28

Appendix 7. Expansion factors for spillway flow at mainstem Snake and Columbia River Dams, 1993. Expansion factor is (spillway flow + powerhouse flow)/powerhouse flow.

DATE	GRANITE EXPANSION	GOOSE EXPANSION	LOWER MONUMENTAL EXPANSION	MCNARY EXPANSION
4/10/93	1	1.1	1.01	1
4/11/93	1	1	1	1
4/12/93	1	1	1	1
4/13/93	1	1.09	1	1
4/14/93	1	1	1	1
4/15/93	1	1	1	1
4/16/93	1	1	1	1
4/17/93	1	1	1	1
4/18/93	1	1	1	1
4/19/93	1	1	1	1
4/20/93	1	1	1	1
4/21/93	1	1	1	1
4/22/93	1	1	1	1
4/23/93	1	1	1	1
4/24/93	1	1	1	1
4/25/93	1	1	1	1
4/26/93	1	1	1	1
4/27/93	1	1	1	1
4/28/93	1	1	1	1
4/29/93	1	1	1	1
4/30/93	1	1.01	1	1
5/01/93	1	1.22	1	1
5/02/93	1	1.12	1	1
5/03/93	1	1.17	1	1
5/04/93	1	1.41	1.06	1
5/05/93	1	1.46	1.15	1
5/06/93	1	1.44	1.07	1.07
5/07/93	1	1.47	1.11	1.18
5/08/93	1	1.48	1.1	1.23
5/09/93	1	1.51	1.11	1.21
5/10/93	1	1.37	1.03	1.39
5/11/93	1	1.35	1.03	1.72
5/12/93	1	1.46	1.09	1.71
5/13/93	1.19	1.77	1.33	1.73
5/14/93	1.43	1.59	1.61	2
5/15/93	1.55	1.81	1.73	2.25
5/16/93	1.65	1.89	2.64	3.66
5/17/93	1.87	2.3	2.15	2.59
5/18/93	1.78	1.89	2.11	2.43
5/19/93	1.8	2	1.98	2.25
5/20/93	1.58	1.98	1.75	1.88
5/21/93	1.57	1.97	1.73	2.04
5/22/93	1.59	1.84	1.61	1.92

Appendix 7, continued (spillway expansion factors)

DATE	GRANITE EXPANSION	GOOSE EXPANSION	LOWER MONUMENTAL EXPANSION	MCNARY EXPANSION
5/23/93	1.49	1.89	1.74	1.94
5/24/93	1.27	1.68	1.55	1.85
5/25/93	1.02	1.34	1.29	1.78
5/26/93	1.09	1.1	1.19	1.78
5/27/93	1.37	1.43	1.37	1.78
5/28/93	1.16	1.27	1.27	1.75
5/29/93	1.1	1.33	1.29	1.39
5/30/93	1.07	1.3	1.3	1.58
5/31/93	1	1.13	1.12	1.67
6/01/93	1	1.16	1.09	1.61
6/02/93	1.09	1.43	1.38	1.78
6/03/93	1.15	1.27	1.22	1.77
6/04/93	1.03	1.24	1.24	1.69
6/05/93	1	1	1	1.46
6/06/93	1	1	1	1.4
6/07/93	1	1.06	1.05	1.17
6/08/93	1.07	1.3	1.48	1.41
6/09/93	1	1.16	1.26	1.36
6/10/93	1	1.15	1.1	1.22
6/11/93	1	1.17	1.1	1.31
6/12/93	1	1.2	1.18	1.45
6/13/93	1	1.26	1.21	1.24
6/14/93	1	1.09	1.09	1.16
6/15/93	1.01	1.08	1.18	1.02
6/16/93	1	1.08	1	1
6/17/93	1	1.02	1.04	1.02
6/18/93	1	1.03	1.05	1.18
6/19/93	1	1.02	1.01	1.03
6/20/93	1	1	1	1
6/21/93	1	1	1	1.01
6/22/93	1	1	1	1.04
6/23/93	1	1	1	1
6/24/93	1	1	1	1.03
6/25/93	1	1	1	1.02
6/26/93	1	1	1	1
6/27/93	1	1	1	1
6/28/93	1	1	1	1
6/29/93	1	1	1	1
6/30/93	1	1	1	1
7/01/93	1	1	1	1
7/02/93	1	1	1	1
7/03/93	1	1	1	1
7/04/93	1	1	1	1

Appendix 7, continued (spillway expansion factors)

DATE	GRANITE EXPANSION	GOOSE EXPANSION	LOWER MONUMENTAL EXPANSION	MCNARY EXPANSION
7/05/93	1	1	1	1
7/06/93	1	1	1	1
7/07/93	1	1	1	1
7/08/93	1	1	1	1
7/09/93	1	1	1	1
7/10/93	1	1	1	1
7/11/93	1	1	1	1
7/12/93	1	1	1	1
7/13/93	1	1	1	1
7/14/93	1	1	1	1
7/15/93	1	1	1	1
7/16/93	1	1	1	1
7/17/93	1	1	1	1
7/18/93	1	1	1	1
7/19/93	1	1	1	1
7/20/93	1	1	1	1
7/21/93	1	1	1	1
7/22/93	1	1	1	1
7/23/93	1	1	1	1
7/24/93	1	1	1	1
7/25/93	1	1	1	1
7/26/93	1	1	1	1
7/27/93	1	1	1	1
7/28/93	1	1	1	1
7/29/93	1	1	1	1
7/30/93	1	1	1	1
7/31/93	1	1	1	1
8/01/93	1	1	1	1
8/02/93	1	1	1	1
8/03/93	1	1	1	1
8/04/93	1	1	1	1
8/05/93	1	1	1	1
8/06/93	1	1	1	1
8/07/93	1	1	1	1
8/08/93	1	1	1	1
8/09/93	1	1	1	1
8/10/93	1	1	1	1

FISH RESEARCH PROJECT
OREGON

SMOLT MIGRATION CHARACTERISTICS AND MAINSTEM SNAKE AND COLUMBIA RIVER DETECTION RATES OF PIT-TAGGED GRANDE RONDE AND IMNAHA RIVER NATURALLY PRODUCED SPRING CHINOOK SALMON

Annual Progress Report
Project Period: 1 January 1994 to 31 December 1994

Prepared by:

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Oregon Department of Fish and Wildlife
Portland, OR

CONTENTS

EXECUTIVE SUMMARY

Objectives for 1994

1. Collect and tag with implantable passive integrated transponders (PIT tags) 1,000 naturally produced spring and summer chinook salmon parr on each of six streams (Catherine Creek, and the upper Grande Ronde, Lostine, Imnaha, Wenaha, and Minam rivers).

2. Determine size frequency distribution and mean length and weight for juvenile chinook salmon in six streams in the Grande Ronde and Imnaha River subbasins.

3. Submit PIT-tagging data files to the PIT Tag Information System data base administered by the Pacific States Marine Fisheries Commission.

4. Determine the short-term (24 hrs) effects of PIT tags on survival of juvenile chinook salmon.

5. Compare average length of juvenile chinook salmon in six streams in the Grande Ronde and Imnaha River subbasins. Correlate with relative abundance and habitat quality.

6. Determine and compare cumulative detection rate and downstream migration timing of juvenile chinook salmon from six streams in the Grande Ronde and Imnaha River subbasins.

Accomplishments in 1994

We achieved all of our objectives in 1994 except we did not correlate average length with relative abundance and habitat quality. We have not yet been able to obtain the data necessary to complete the correlations.

Findings in 1994

We collected, tagged and released a total of 5,992 naturally-produced chinook salmon parr on six study streams. Thirty fish were killed during the collection process. Ten fish were killed during the tagging process or died during 24 h mortality tests.

Fork length of collected fish ranged from 32 mm to 198 mm. Mean fork length for each stream ranged from 58.3 mm to 74.4 mm. Fork length of tagged fish ranged from 57 mm to 112 mm, with means for each stream ranging from 65.9 mm to 74.5 mm. Wet weights of tagged fish ranged from 1.7 g to 17.9 g, with means for each stream ranging from 3.30 g to 5.03 g.

Total tagging mortality (instantaneous plus 24-h mortality) never exceeded 0.30% on any stream, and was 0.17% for all streams combined. Collection mortality never exceeded 0.51% on any stream, and was 0.33% for all streams combined. Twenty-four hour mortality data indicated that tagging mortality was the equal to as mortality due to handling alone.

Median migration date at Lower Granite Dam for all six streams combined was 5 May when data were expanded for spillway flow. Peak migration periods occurred during high flows.

Using initial bypass detection data from individual fish, overall median travel time was 5.8 days from Lower Granite Dam to Little Goose Dam, 9.1 days from Lower Granite Dam to Lower Monumental Dam, and 15.1 days from Lower Granite Dam to McNary Dam. These travel times include possible delays in each bypass system.

When 1994 migration year data from all streams were pooled, cumulative detection rate of fish which were less than 60 mm at tagging was 3.3%. Cumulative detection rate of-fish which were greater than or equal to 60 mm at tagging was 15.4%. These detection rates were significantly different at the 0.01 alpha level. As a result, we increased minimum tagging size during the fall of 1994 to 60 mm.

Cumulative detection rates varied among streams. Cumulative detection rates ranged from 8.9% for the Grande Ronde River to 21.4% for the Minam River.

Management Implications

Migration timing of juvenile chinook salmon from naturally produced populations varied extensively both within the Grande Ronde River Basin and between the Grande Ronde and Imnaha River basins. Peak migration was associated with high flows. Overall median passage date at Lower Granite Dam was 5 May, while median passage dates at Lower Granite Dam for each individual population ranged from 24 April to 29 May, showing similar migration patterns as in 1993. In contrast, in a separate study, migration timing of Rapid River and Imnaha stocks of hatchery chinook salmon varied little, with median passage dates at Lower Granite Dam ranging from 26 April to 6 May. In both the 1993 and 1994 migration years, naturally produced fish migration was more protracted compared to hatchery stocks from the same basins. Fish tagged at less than 60 mm had reduced detection rates. This may be a result of higher, naturally-occurring mortality or it may be a tag effect.

Recommendations

To facilitate wild fish passage through the Snake and Columbia River dams, we should continue to monitor migration timing of multiple populations, We need additional data to determine the best time to adjust spillway flows to improve passage of all populations. To minimize handling and tagging mortality, tagging schedules should be arranged so fish are tagged at temperatures of 15" Celsius (C) or less. Two years of recovery data have indicated that fish PIT-tagged at less than 60 mm are detected at the dams at a reduced rate. We are not certain if this is a result of higher naturally occurring mortality or a tag effect. However, we recommend tagging only fish 60 mm or greater in future studies of naturally produced chinook salmon until tag effect is evaluated thoroughly for naturally produced fish. For several reasons, it is important that we determine whether reduced detection rate of these small fish is a result of natural mortality or a tag effect. PIT tags

are a commonly used tool to evaluate response of populations to various environmental changes and management actions, and a common assumption is no tag effect on fish life history. In addition, if low detection rates of smaller fish are the result of induced environmental changes, there are implications for population response to various management strategies, such as supplementation or habitat improvement.

INTRODUCTION

This is the third year of a multi-year study to assess smolt migration characteristics and cumulative detection rates of naturally produced spring chinook salmon *(Oncorhynchus* tshawytscha) from northeast Oregon streams. The goal of this project is to develop an understanding of interpopulational and interannual variation in several early life history parameters of naturally produced spring and summer chinook salmon in the Grande Ronde and Imnaha River subbasins. This project will provide information to assist chinook salmon population recovery efforts. Specific populations included in the study are (1) Catherine Creek, (2) upper Grande Ronde River, (3) Lostine River, (4) Imnaha River, (5) Wenaha River, and (6) Minam River. In this document, we present findings and activities from research completed in 1994.

Naturally produced chinook salmon populations in the Grande Ronde and Imnaha River subbasins have declined drastically in recent years (Carmichael et al. 1991). Habitat alterations (ASET 1979; Carmichael 1989; Raymond 1988) and hydropower (Wedemeyer et al. 1985; Raymond 1988) have contributed to the decline of these populations. Mitigation efforts have included improving fish passage, artificial production, supplementation, and habitat modification (BPA Division of Fish and Wildlife 1990). Despite these extensive mitigation efforts, the National Marine Fisheries Service (NMFS) listed Snake River Basin spring/summer chinook salmon as threatened and then endangered under the Endangered Species Act because of continued population decline (NMFS 1992, 1994).

The continued decline of naturally produced spring and summer chinook salmon populations in the Grande Ronde and Imnaha River subbasins indicates that mitigation efforts have failed to rebuild these depressed stocks, One potential problem with current "water budget" and fish transport mitigation efforts is that they were developed and implemented using data from hatchery populations or from pooled groups of in river migrants. Water budget decisions have been tied to peak fish passage indices (FPI), which usually coincide with hatchery releases and hatchery fish migration timing (DeHart and Karr 1987). In addition, in the past, naturally produced and hatchery spring and summer chinook were indistinguishable when marked as in river migrants (Matthews et al. 1990), and most studies evaluating smolt passage or transport effectiveness have relied on marked hatchery releases or marked groups of in river migrants (Buettner and Nelson 1987, 1990; DeHart and Karr 1987; Fish Passage Center 1987). The introduction of PIT tags in the mid 1980s (Prentice et al 1990a) has allowed evaluation of the downstream migration of naturally produced chinook salmon smolts. Initial evaluation of smolt migration characteristics for naturally produced chinook salmon from northeast Oregon was conducted by Matthews et al. (1990, 1992) and Achord et al. (1992). In 1992, this ongoing study was expanded to investigate additional stocks.

There is considerable evidence that suggests that migration timing differs between wild and hatchery fish (Matthews et al, 1990, 1992). Their work also indicates there is substantial variation in early life history parameters, such as migration timing and duration, among naturally produced chinook salmon populations. Therefore, it is essential to increase our knowledoe of the variation in early life history characteristics of naturally produced chinook salmon populations, and the response of these populations to the numerous management activities being implemented to improve survival and maintain current life history patterns. This can.be accomplished through long-term monitoring of the diversity in migration timing and detection rates of various populations. This study, along with Matthews et al. (1990, 1992) and Achord et al. (1992), will provide data on migration timing of naturally produced chinook salmon. This information can then be incorporated into the smolt monitoring program of the Fish Passage Center (FPC), which provides recommendations to guide modifications of flow, fish passage, and transport (Fish Passage Center 1987). Information on smolt passage timing allows the FPC to anticipate river discharge needs, improve fish passage and migration conditions, and plan collection and transport operations (Buettner and Nelson 1987, 1990).

In addition to fish passage and transport applications, this study has several other management applications. In accordance with the Oregon Department of Fish and Wildlife wild fish management policy, this study will provide information useful in assessing and identifying wild chinook salmon stocks in conjunction with ongoing genetic studies. Furthermore, information on individual populations will be useful in developing broodstock guidelines and supplementation strategies for future hatchery programs.

METHODS

We selected juvenile chinook salmon sampling sites using data collected during 1992 and 1993, and from previous unrelated studies. We then collected and PIT tagged naturally produced spring chinook salmon parr on Catherine Creek, and the upper Grande Ronde, Lostine, Imnaha, Wenaha, and Minam rivers from 15 August through 16 September (Table 1). We collected all fish with seines, occasionally using snorkeling gear to locate concentrations of fish and herd them to seinable areas.

PIT tags were implanted using general methods described by Prentice et al. (1986, 1990b) and Matthews et al. (1990, 1992). We attempted to tag and release fish only at temperatures of 15°C or less, but temperatures did reach 16°C on the Lostine and Miriam.rivers, and 17°C on the Imnaha River. Fish were anesthetized with 40-50 ppm MS-222 (Strange and Schreck 1978; Matthews et al. 1990, 1992), after which we manually injected PIT tags using a modified hypodermic syringe. The syringes were disinfected for 10 minutes in 70% ethanol prior to taggina. We determined fork lenqth (in mm) of all chinook salmon tagged, and weight (in g) of tagged fish when conditions permitted. We attempted to tag only fish of minimum 60 mm fork length that appeared to be in good health. Minimum tagging size was increased from 55 mm to 60 mm fork length because of low recovery rates of small fish in past years. We did not tag precocious males. We also did not tag fish collected in excess of 1,000 per stream or fish collected simultaneously for a separate genetics study. Fish were allowed to recover equilibrium prior to.release, and were then

released as near the collection site as possible. We incorporated data into ASCII files according to criteria developed by the PIT Tag steering committee, and submitted files to the PIT Tag information system data base administered by the Pacific States Marine Fisheries Commission.

Table 1. Collection and tagging information for chinook salmon parr from six streams in the Grande Ronde and Imnaha River subbasins, 1994. Data excludes recaptured PIT tagged fish. Catherine = Catherine Creek. Grande = Upper Grande Ronde. Number collected includes fish collected and incorporated in a separate genetics study.

Stream	Dates collected	Number collected	Collection mortality	Number tagged and released	Overalla tagging mortality
Catherine	9/12-9/13	1,097	0 (0.00%)	1,000	0 (0.00%)
Grande	9/14-9/16	1,782	5 (0.28%)	999	3 (0.30%)
Imnaha	8/15-8/17	2,766	14 (0.51%)	996	1 (0.10%)
Lostine	8/29-8/31	1,173	3 (0.26%)	1,002	3 (0.30%)
Minam	9/01, 9/06-9/08	1,234	4 (0.32%)	996	2 (0.20%)
Wenaha	8/24-8/26	1,109	4 (0.36%)	999	1 (0.10%)
Total	8/15-9/16	9,161	30 (0.33%)	5,992	10 (0.17%)

[a] *One fish on the Minam* River *died during a 24-h morta7ity test. The remainder died immediate7y* after *tagging.*

To determine the short-term effects of PIT tags on survival of juvenile chinook salmon, we held tagged and untagged control groups of chinook salmon for 24 hours (24-h) and recorded all mortalities. Untagged controls were subject to the same handling conditions as PIT-tagged fish, except they were not injected with a PIT tag. At each stream, two groups of approximately 50 tagged fish and ,two groups of approximately 25 untagged fish were held in separate, but similar live cages at equal densities. The cqvered live cages were placed within the stream and received constant streamflow. Mortality rates of tagged and untagged fish during the 24-h test were compared using a binomial test of two independent groups. Instantaneous mortality (collection mortality and mortality observed immediately after tagging) were also

recorded. The two types of mortality (instantaneous and 24 h) were combined for total tagging mortality.

After the 1994 migration year was completed, observation data from Lower Granite, Little Goose, Lower Monumental, and McNary dams for fish tagged in 1993 were downloaded from the PTAGIS data base (see Appendix A). We pooled run-timing data for all six streams at Lower Granite Dam, and then compiled run-timing data for individual streams at all four dams. Run timing at Lower Granite Dam was compared using the Kruskal-Wallis test, followed by a multiple comparison test (Hollander and Wolfe 1973; SAS Institute 1988). We determined travel time between dams two ways. First, we determined arrival dates of fish detected for the first time at each dam, expanded this data daily for spillway flow, and rounded to the nearest integer. The expansion factor was:

(Powerhouse Flow + Spillway Flow)/ Powerhouse Flow

This expansion factor (Appendix Table B-l) accounts for undetected PIT-tagged fish that passed over the spillway at each dam. Many PIT-tagged fish were diverted into the river after passing through the bypass system, while most downstream migrants were barged downstream after going through the bypass system. As a result, first-time detections at downstream dams are more representative of the entire population. Median travel time between dams for fish detected for the first time at each dam was estimated as the difference between median passage dates. In addition, we determined travel time of individual fish between dams and used this data to determine median travel time for each population and all populations pooled. Travel time for individual fish was based on initial detection within the bypass system at each dam. Medians and 95% confidence intervals for the medians were calculated according to Snedecor and Cochran (1980). Cumulative detection rate of chinook salmon from individual streams was determined by dividing the sum of unexpanded first-time tagcode observations at each dam by total number of fish tagged and released.

RESULTS AND DISCUSSION

When 1994 migration year data from all streams were pooled, cumulative detection rate of 447 fish which were less than 60 mm at tagging was 3.3%. Cumulative detection rate of 5,264 fish which were greater than or equal to 60 mm at tagging was 15.4%. When tested using a Chi-square contingency table, these detection rates were significantly different at the 0.01 alpha level. These results were similar to 1993, when none of the 46 fish tagged at 55-59 mm fork length were detected while overall detection rate was 17.2% (Walters et al. 1993). As a result, we increased minimum tagging size to 60 mm fork length.

We collected a total of 9,161 chinook salmon parr on six study streams, and tagged and released 5,992. The number collected and not tagged is high compared to past years, a result of increasing our minimum tagging size to 60 mm fork length and a large abundance of small juvenile chinook salmon in some sample streams. For example, on the Grande Ronde and Imnaha rivers, we released 783 and 1,770 untagged fish, respectively, most of which were smaller than 60 mm fork length (Table 1). We tagged and released approximately 1,000 fish on each stream (Table 1). Overall collection and tagging mortality was

40 of 9,161 fish (0.44%). This is similar to overall collection and tagging mortality rates during other tagging studies in northeast Oregon streams in 1988 and 1989 (Matthews et al. 1990, 1992; Walters et al. 1992, 1993). Collection operations resulted in 30 mortalities out of 9,161 fish (0.33%) (Table 1). We tagged and released 5,992 fish, and 10 tagged fish died (0.17%; Table 1).

There was some variability in length of juvenile chinook salmon. Fork lengths of fish collected ranged from 32 mm to 198 mm (Table 2). Mean fork length (+ SE) ranged from 58.3 mm (+ 0.16) on the Imnaha River to 74.4 mm (± 0.29) on the Wenaha and South Fork Wenaha rivers (Table 2). We attempted to tag only fish ≥ 60 mm fork length, and did not tag precocious males or any fish collected over the 1,000 needed for tagging. Therefore, lengths of tagged and released fish differed from total fish collected. Fork lengths of tagged and released fish ranged from 57 mm to 112 mm, with average length ranging from 65.9 mm (+ 0.19.) on the Imnaha River to 74.5 mm (2 0.24) on the Wenaha and South Fork Wenaha rivers (Table 2).

Wet weight of chinook salmon parr varied among streams. We did not determine weights of untagged fish in 1994. Average wet weight of tagged and released fish ranged from a low of 3.30 g (2 0.036) on the Imnaha River to a high of 5.03 g (& 0.052) on Catherine Creek (Table 3). Wet weight of tagged and released fish ranged from 1.7 g to 17.9 g (Table 3).

PIT tagging chinook parr had little or no effect on instantaneous mortality as indicated by only 10 tagged fish dying after tagging (Table 1). There were too few data to statistically compare average lengths of tagging mortalities to the overall tagged group or mortalities from previous studies. However, in the Grande Ronde and Minam rivers, tagging mortalities averaged 6.3 mm and 4.2 mm smaller than the tagged population. Previous research has indicated there was no effect of PIT tags on growth or survival of salmonids ≥ 55 mm fork length while in a hatchery environment (Prentice et al. 1986, 1990a). The incidence of instantaneous tagging mortality seen in this study is low enough to be indistinguishable from handling mortality.

We held two replicates of tagged and untagged fish in six study streams for 24 h to determine effects of PIT tags on short-term survival. Replicates were not significantly different, so the data were pooled. The 24-h mortality rates were not significantly different between tagged and control groups (P=0.233). No mortalities were detected from a total of 319 untagged fish; while one of 600 (0.17%) tagged fish died (Table 4). The twenty-four hour mortality rate during the present study was consistent with those rates found in other studies. Short-term mortality rates for other PIT tagging studies of wild spring and summer chinook salmon on individual streams ranged from 0% to 6.7X, with most studies reporting mortality below 2.4% (Matthews et al. 1990, 1992; Walters et al. 1992, 1993).

Pooled migration timing for fish from all streams through Lower Granite Dam is presented in Figure 1. When data were expanded for spillway flow, the median migration date was 5 May. Fish began passing Lower Granite Dam as flows began to increase. Migration peaks, which occurred during the weeks ending 29 April and 13 May, were associated with high flows (Figure 1). In contrast, in 1993 over 50% of the fish had passed Lower Granite Dam prior to peak flows (Walters et al. 1993).

Table 2. Length (mm) of chinook salmon parr collected, tagged, and released for a smolt migration study on six streams in the Grande Ronde and Imnaha River subbasins, 1994. SE = std error, Min = minimum length, Max = maximum length. Number collected includes fish collected and incorporated in a separate genetics study.

	Collected				
Stream	N	Mean	SE	Min	Max
Catherine Cr.	1,097	72.8	0.26	52	138
Grande Ronde	1,780	63.5	0.19	51	107
Imnaha	2,753	58.3	0.16	32	122
Lostine	1,169	70.7	0.27	48	103
Minam	1,231	67.0	0.29	50	198
Wenaha	1,102	74.4	0.29	51	144

	Tagged and Released				
Stream	N	Mean	SE	Min	Max
Catherine Cr.	1,000	72.7	0.24	59	100
Grande Ronde	998	67.3	0.25	57	107
Imnaha	996	65.9	0.19	57	112
Lostine	1,001	72.2	0.26	58	103
Minam	995	68.2	0.20	58	95
Wenaha	996	74.5	0.24	58	101

Table 3. Weight (g) of chinook salmon parr tagged and released for a smolt migration study on six streams in the Grande Ronde and Imnaha River subbasins, 1994. SE = std error, Min = minimum weight, Max = maximum weight.

	Tagged and Released				
	N	Mean	SE	Min	Max
Catherine Cr.	993	4.33	0.044	2.0	11.0
Grande Ronde	996	3.49	0.046	1.9	14.2
Imnaha	994	3.30	0.036	1.9	17.9
Lostine	998	4.44	0.053	1.7	12.7
Minam	996	3.56	0.035	1.9	10.5
Wenaha	998	5.03	0.052	2.1	12.7

Migration timing through Lower Granite, Little Goose, Lower Monumental, and McNary dams for chinook from individual streams is presented in Figures 2-7 and Appendix Tables A-l through A-6. At Lower Granite dam, migration timing was significantly different among streams (Kruskal-Wallis test, P=0.000l). Multiple comparisons of migration timing at the 0.05 alpha level indicated that migrants from the Wenaha and South Fork Wenaha rivers were earliest, and migrants from the Grande Ronde River were latest. Median arrival date at Lower Granite Dam ranged from 24 April for the Wenaha and South Fork Wenaha rivers (N=93; Figure 7) to 29 May for the upper Grande Ronde River (N=57; Figure 3). There was some overlap in migration timing of all the other streams. Migration timing data (expanded for spillway flow) are presented in Figures 2-7, and results of the multiple comparisons are presented below (comparisons at the 0.05 alpha level, populations which share a line are not significantly different from each other):

Wenaha & SF	Minam	Lostine	Imnaha	Catherine	Grande Ronde

Overall median migration timing of fish at Lower Granite Dam in the current study occurred near peak flows, and most migration occurred during periods of high flow (Figure 1). This differs from the results of Walters et al. (1993), but is similar to those of Achord et'al. (1992). Achord et al. (1992) noted that peak migration periods of naturally produced spring chinook tagged from 1988-1990 were generally associated with high flows, while Walters et al. (1993) noted an overall median migration date at Lower Granite Dam prior to peak flows, with peak migration periods for Catherine Creek and the upper Grande Ronde concomitant with peak flows at Lower Granite Dam.

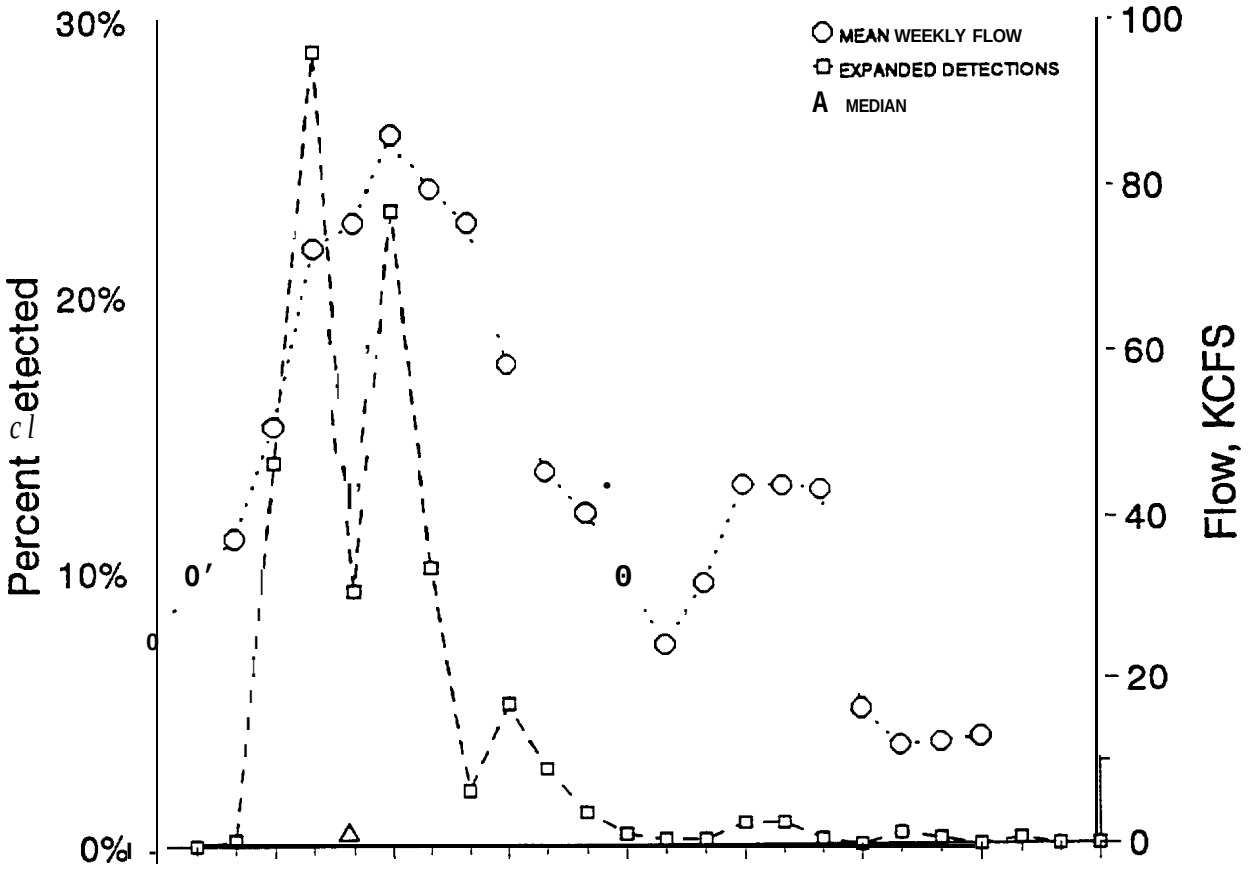

Figure 1. Migration timing for spring chinook salmon from the Grande Ronde and Imnaha River subbasins, and flow at Lower Granite Dam, 1994 migration year. A = median arrival date. Data were expanded for spillway flow.

Table 4. Mortality of chinook salmon parr PIT tagged and held for 24 h during a smolt migration study on six streams in the Grande Ronde and Imnaha River subbasins, 1994. Catherine = Catherine Creek. Ronde = Upper Grande Ronde River.

	Replicate 1				Replicate 2			
	Tagged		Untagged		Tagged		Untagged	
	N	Number dead	N	Number dead	N	Number dead	N	Number dead
Catherine	50	(0)		(0)	50	(0)	25	(0)
Ronde	50	(0)		(0)		(0)	25	(0)
Imnaha	50	(0)	46	(0)	50	(0)	25	(0)
Lostine	50	(0)	25	(0)	50	(0)	25	(0)
Minam	50	(0)	24	(0)	50	(1)	24	(0)
Wenaha	50	(0)	25	(0)	50	(0)	25	(0)
Total	300	(0)	170	(0)	300	(1)	149	(0)

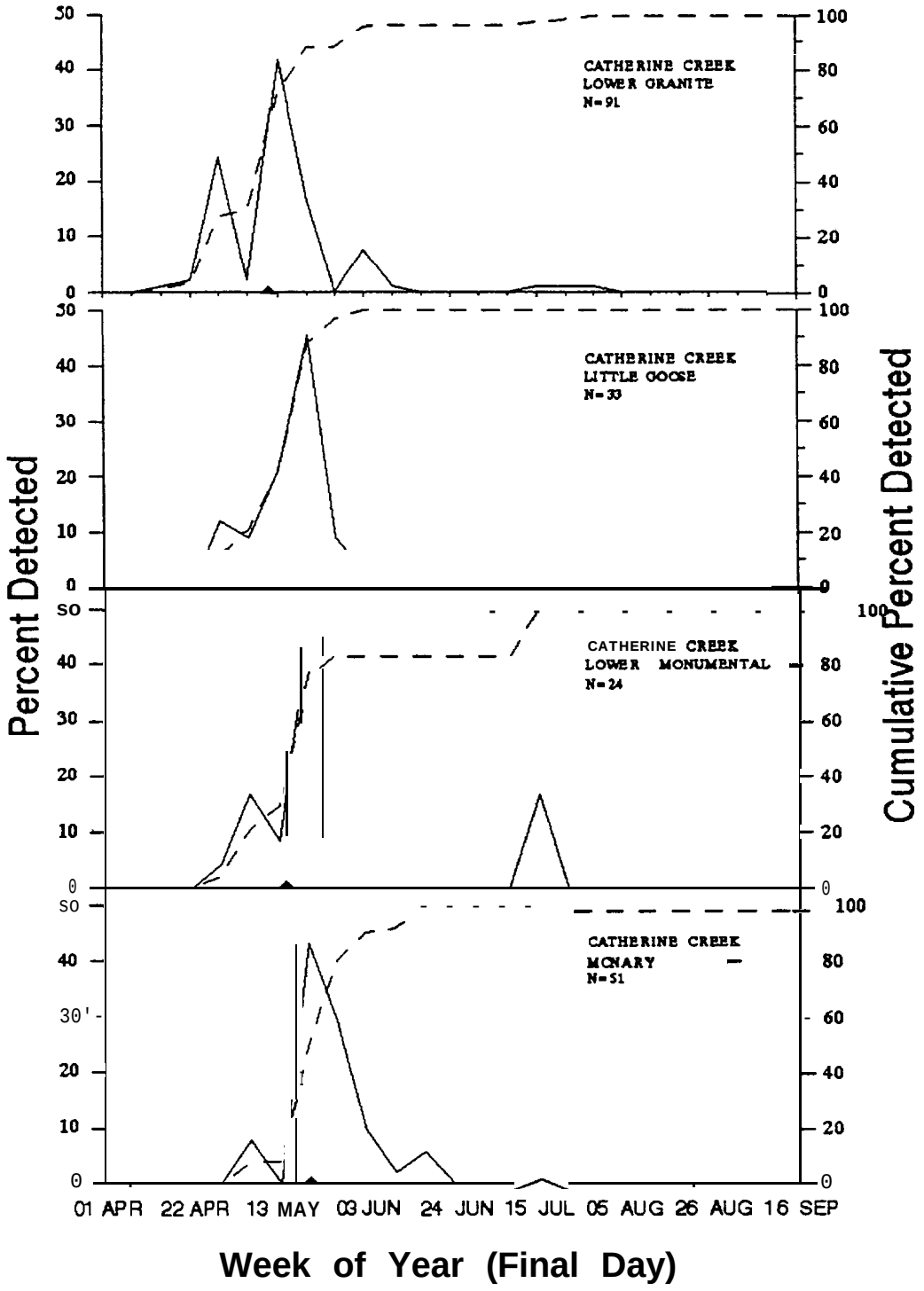

Figure 2. Migration timing at Lower Granite, Little Goose, Lower Monumental, and McNary dams for naturally produced spring chinook salmon from Catherine Creek, 1994 migration year. ▲ = median arrival d;?te. Data were from first-time detections at each dam and were expanded for spillway flow.

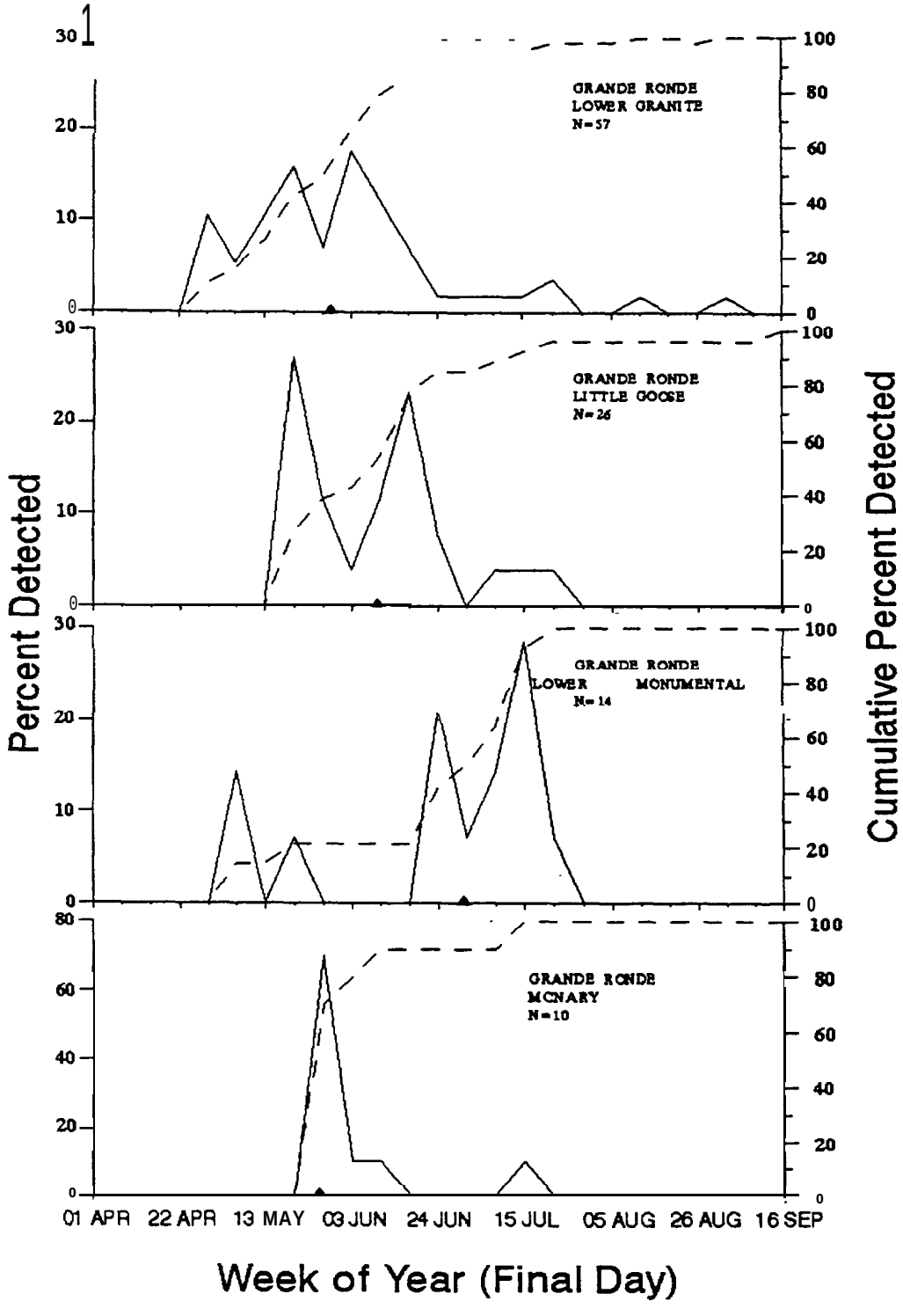

Figure 3. Migration timing at Lower Granite, Little Goose, Lower Monumental, and McNary dams for naturally produced spring chinook salmon from the Grande Ronde River, 1994 migration year. ▲ = median arrival date. Data were from first-time detections at each dam and were expanded for spillway flow.

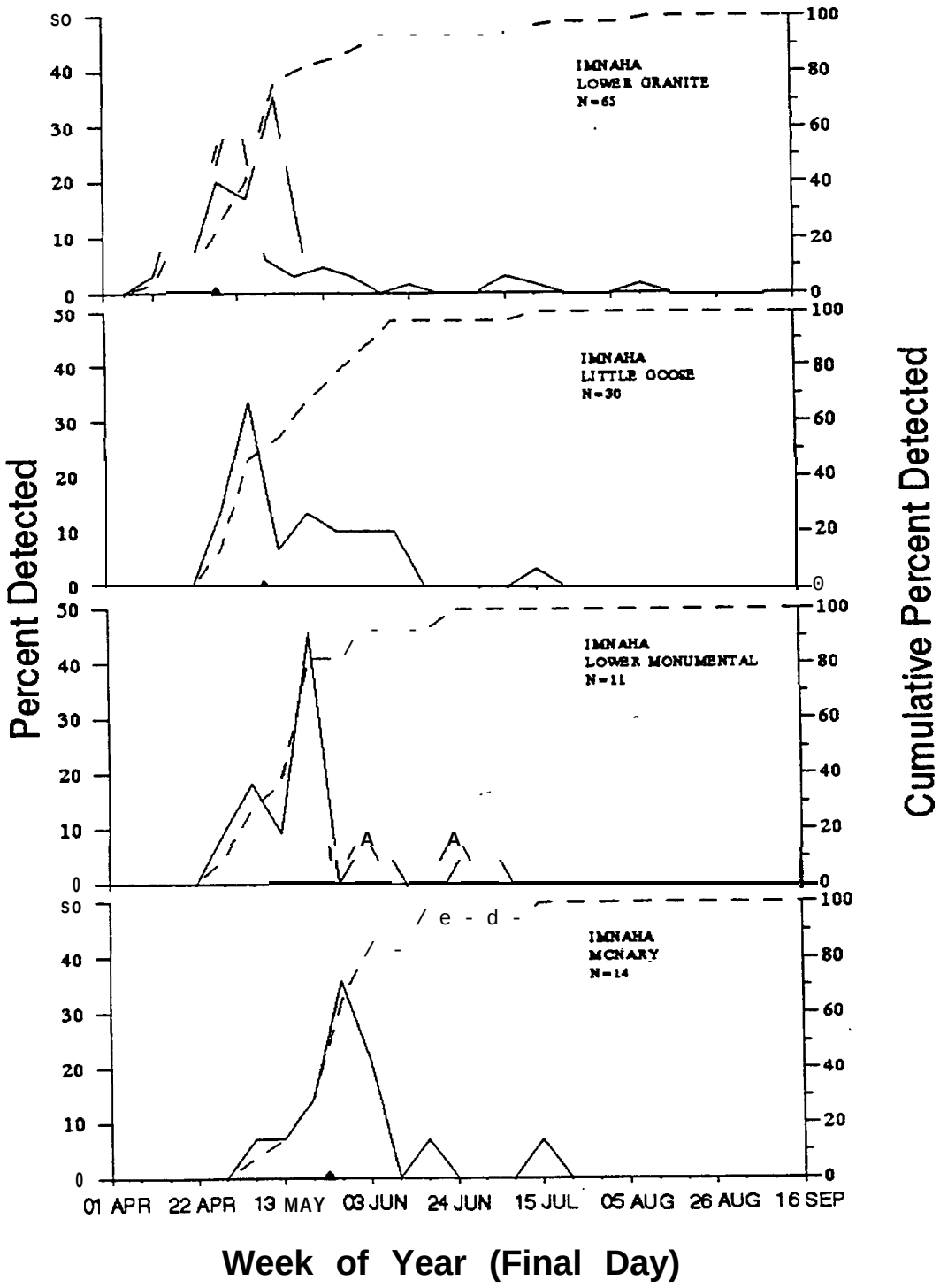

Figure 4. Migration timing at Lower Granite, Little Goose, Lower Monumental, and McNary dams for naturally produced spring chinook salmon from the Imnaha River, 1994 migration year. ▲ = median arrival date. Data were from first-time detections at each dam and were expanded for spillway flow.

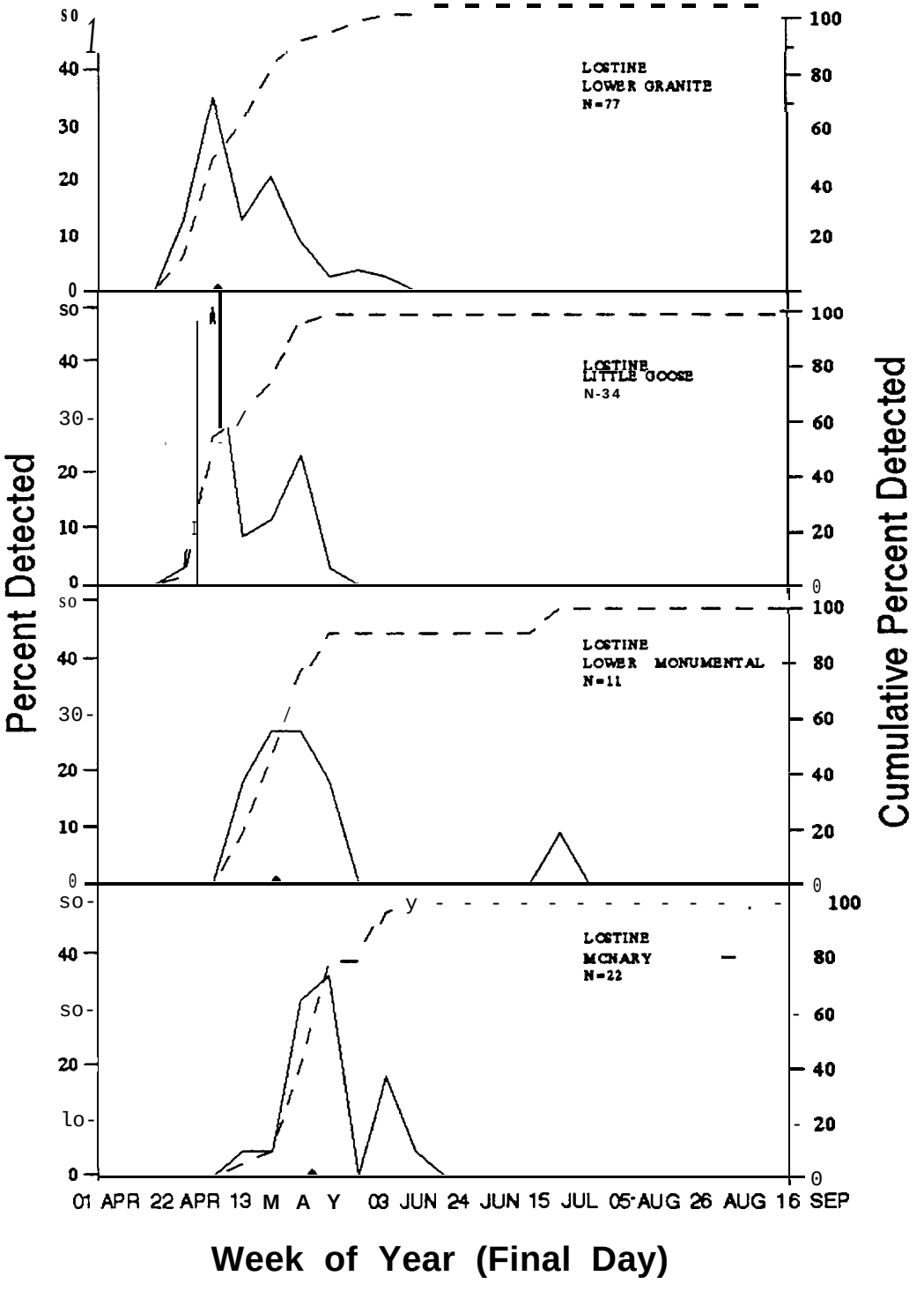

Figure 5. Migration timing at Lower Granite, Little Goose, Lower Monumental, and McNary dams for naturally produced spring chinook salmon from the Lostine River, 1994 migration year., ▲ = median arrival date. Data were from first-time detections at each dam and were expanded for spillway flow.

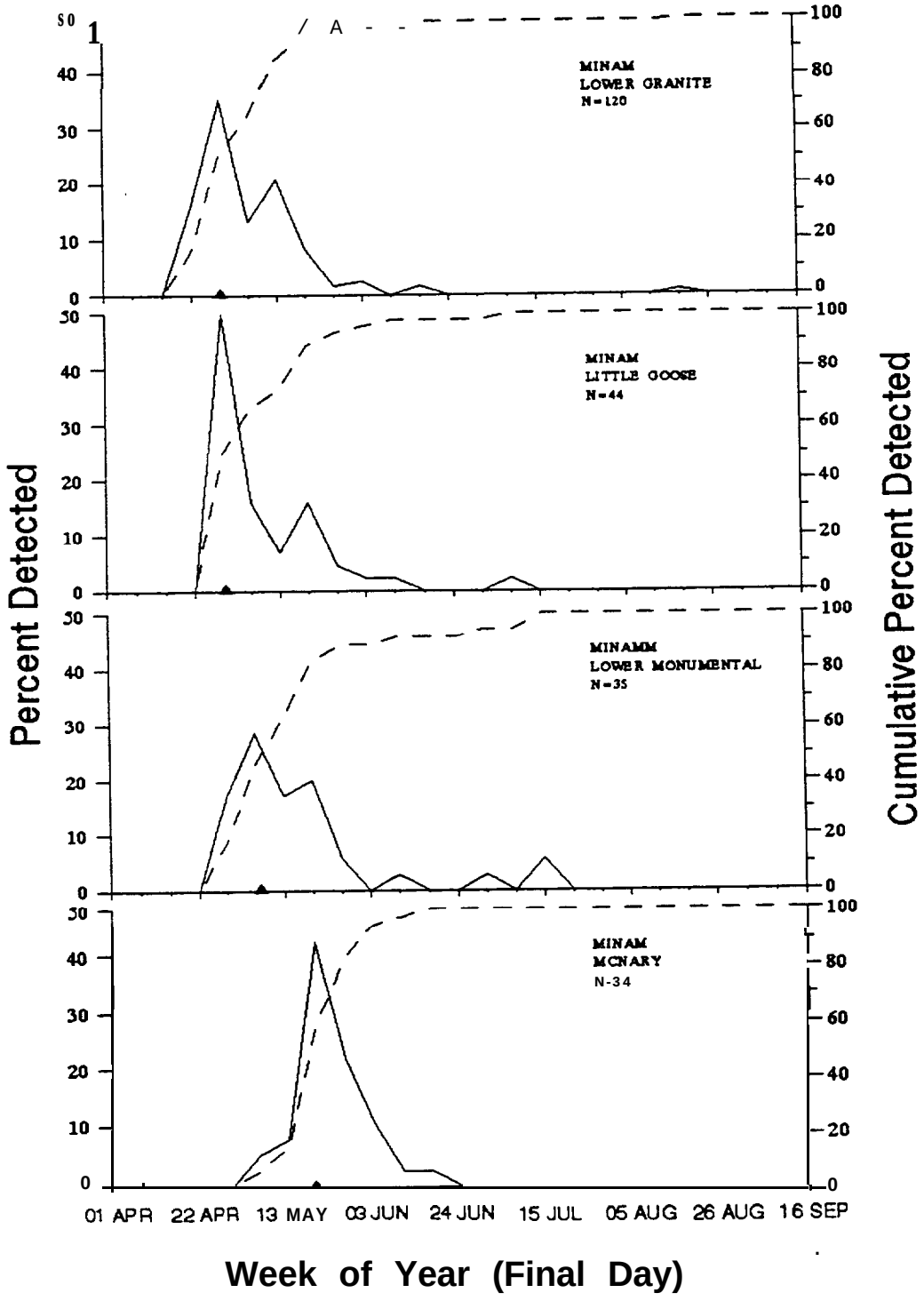

Figure 6. Migration timing at Lower Granite, Little Goose, Lower Monumental, and McNary dams for naturally produced spring chinook salmon from the Minam River, 1994 migration year. ▲ = median arrival date. Data were from first-time detections at each dam and were expanded for spillway flow.

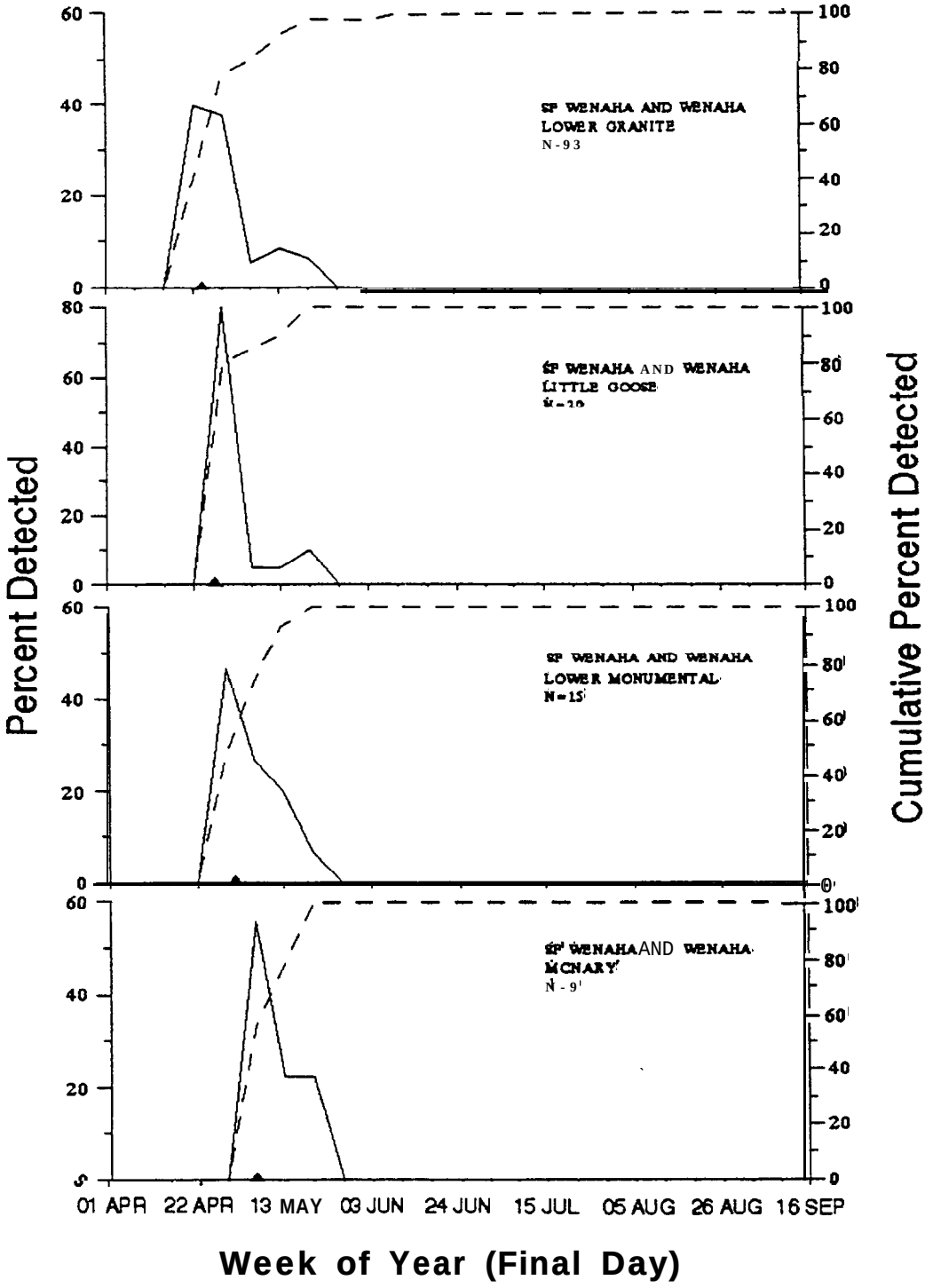

Figure 7. Migration timing at Lower Granite, Little Goose, Lower Monumental, and McNary dams for naturally produced spring chinook salmon from the Wenaha and South Fork Wenaha rivers, 1994 migration year. ▲ = median arrival date. Data were from first-time detections at each dam and were expanded for spillway flow.

Interannual variability in migration associated with flow may be a result of several factors. Total Snake River flow during the migration period was greater in 1993 than in 1994, with mean weekly flow at Lower Granite Dam reaching approximately 180 thousand cubic feet per second (kcfs) and 90 kcfs, respectively. In addition, snowpack levels, timing of spring thaw, and river conditions may differ among streams within a migration year, resulting in interannual variability both within and among streams. Finally, spring chinook salmon outmigration timing may be controlled more by temperature than flow (Raymond 1979).

We determined travel time between dams in two ways. First, we compared median arrival dates of fish observed for the first time at each dam (Figures 2-7). This provides an estimate of the arrival timing of the entire in-river population at each dam. However, this estimate does not portray actual travel time of individual fish. Pooling data from all streams, the median arrival date based on Little Goose Dam first time detections was 2.7 days later than median arrival date at Lower Granite Dam (Figures 2-7). Based on first-time detections, fish from individual streams had estimated median travel times between Lower Granite and Little Goose Dams that ranged from as little as -2 days for the Lostine River to as great as 11 days for the Grande Ronde River. Median arrival date at Little Goose Dam ranged from 27 April for the Wenaha and South Fork Wenaha rivers (N=20) to 9 June for the Grande Ronde River (N=26; Figures 2-7).

To determine actual travel time of each population, we determined travel time for individual fish between dams, and calculated median travel time and 95% confidence intervals (Figure 8, Appendix Table C-1). Using initial bypass detection data from individual fish, the overall median travel time (95% confidence interval) between Lower Granite and Little Goose dams was calculated to be 5.8 (5.0-6.6) days, with median travel times ranging from 4.0 (3.6-6.9) days for the Lostine River to 9.2 (3.3-49.3) days for the Grande Ronde River (Figure 8, Appendix Table C-1). Individual travel times ranged from 2.7 days to 49.3 days (Figure 8, Appendix Table C-1). These travel time estimates include possible passage delays in the bypass system. Preliminary data from multiple bypass detections of individual fish within Lower Granite Dam indicates this delay ranges from 0.0 days to 3.5 days, and averages 0.3 days.

Median arrival date for chinook salmon detected for the first time at Lower Monumental Dam was 11.7 days later than median arrival date at Lower Granite Dam (Figures 2-7). Fish from individual streams had estimated median travel times between Lower Granite and Lower Monumental dams that ranged from as little as 3 days for Catherine Creek to as great as 32 days for the Grande Ronde River. Median arrival date through Lower Monumental Dam ranged from as early as 1 May for the Wenaha and South Fork Wenaha rivers (N=15) to as late as 30 June for the Grande Ronde River (N=14; Figures 2-7). Using initial bypass detection data from individual fish, the overall median travel time (95% confidence interval) between Lower Granite and Lower Monumental dams was 9.1 (8-0-10.6) days, with median travel times ranging from 7.3 (6.3-8.5) days for the Wenaha and South Fork Wenaha rivers to 18.6 (6.8-51.0) days for the Grande Ronde River (Figure 8, Appendix Table C-1). Individual travel times ranged from 3.2 days to 82.3 days (Figure 8, Appepdix Table C-1). These travel time estimates include possible passage delays in the bypass system.

Median arrival date for chinook salmon detected for the first time at McNary Dam was 12.5 days later than median arrival date at Lower Granite Dam (Figures 2-7). Based on first-time detections, fish from individual streams had estimated median travel times between Lower Granite and McNary dams that ranged from as little as -3 days for the Grande Ronde River to as great as 22 days for the Lostine River. Median migration date through McNary Dam ranged from as early as 6 May for the Wenaha and South Fork Wenaha rivers (N=9) to as late as 26 May for the Grande Ronde River (N=lO; Figures 2-7). Using initial bypass detection data from individual fish, the overall median travel time (95% confidence interval) between Lower Granite and McNary dams was 15.1 (13.9-16.9) days, with median travel times ranging from 11.5 (10.8-16.6) days for Catherine Creek to 21.9 (14.5-35.7) days for the Grande Ronde River (Figure 8, Appendix Table C-l). Individual travel times ranged from 8.0 days to 55.0 days (Figure 8, Appendix Table C-l). These travel time estimates include possible passage delays in the bypass system.

The final parameter evaluated was cumulative detection rate of chinook salmon from each stream. Cumulative detection rate varied among streams. Detection rates ranged from 8.9% for the Grande Ronde River to 21.4% for the Minam River. Detection rate for all PIT-tagged chinook salmon was 14.5% (Table 5). With the exception of Catherine Creek and the Minam River, detection rates during the 1994 migration year were generally less than those in the 1993 migration year (Walters et al. 1993). This may be a result of smaller average fish size at tagging in 1993 (1994 migration year) versus 1992 (1993 migration year), lower flows in 1994 as compared with 1993, or different overwinter survival prior to smolt migration.

Migration timing and cumulative detection rates of juvenile chinook salmon varied extensively both within the Grande Ronde River Basin and between the Grande Ronde and Imnaha River basins. To facilitate wild fish passage through the Snake and Columbia River dams, and improve Parr-to-smolt survival, we should continue to monitor both detection rate and migration timing of wild chinook salmon populations. This will allow us to improve passage and flow conditions to benefit all populations, and also provide opportunities to determine and improve limiting factors in Parr-to-smolt survival. This can be best be accomplished through long-term monitoring of the diversity in migration timing and detection rates of various populations.

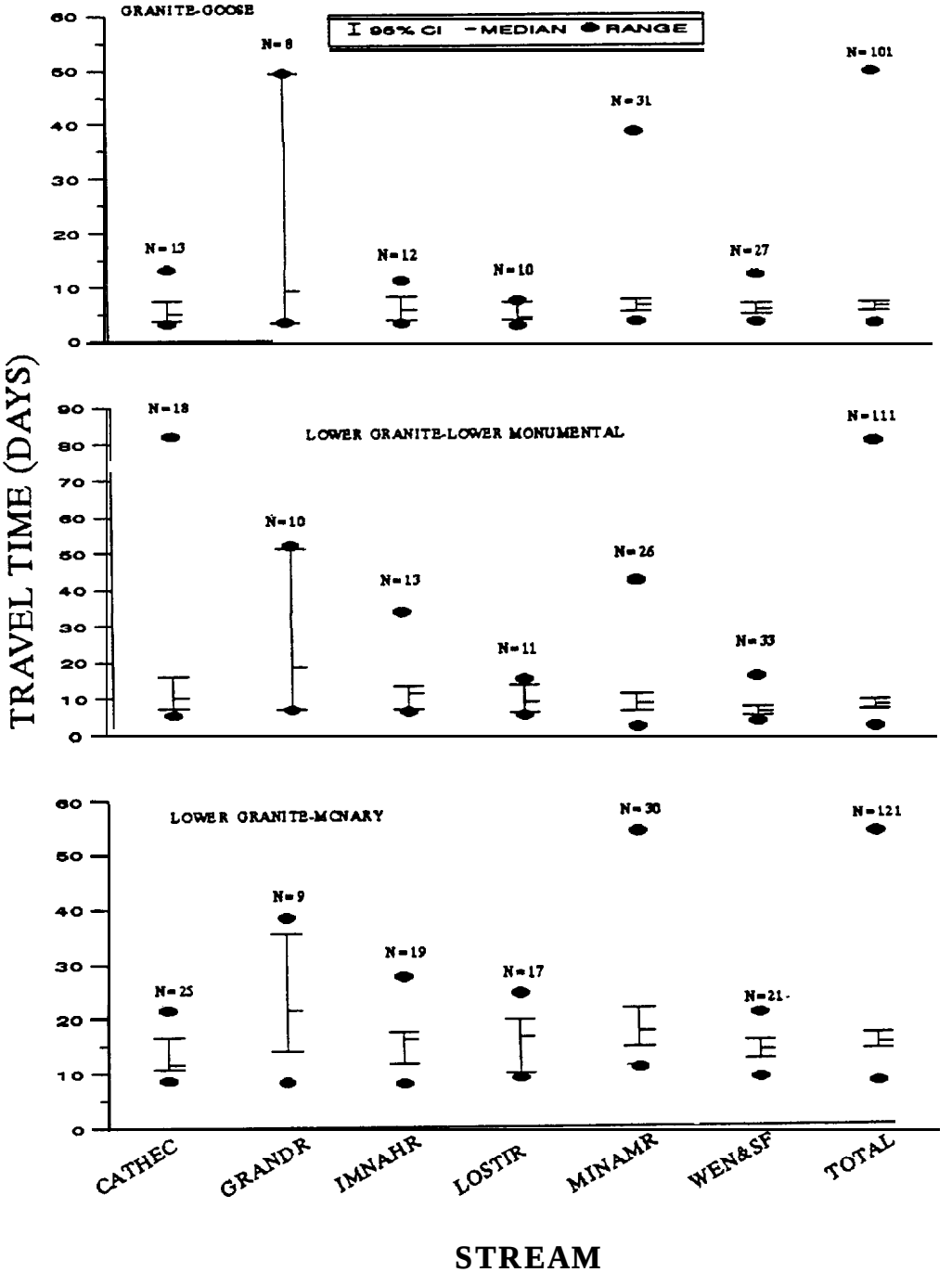

Figure 8. Travel time in days between Lower Granite Dam and Little Goose, **Lower Monumental, and McNary dams for naturally produced spring chinook salmon from northeast Oregon, 1994 migration year. Travel times were based on data from individual fish and were based** on differences **between initial detection times in the bypass systems at each dam. CATHEC = Catherine Creek, GRANDR = Grande Ronde, IMNAHR = Imnaha, LOSTIR = Lostine, MINAMR = Minam, and WEN&SF = Wenaha and South Fork Wenaha.**

Table 5. First-time detections by dam site (% of release) during the 1994 migration year for chinook salmon PIT tagged on six streams in the Grande Ronde and Imnaha River subbasins in 1993. Data were not expanded for spillway flow. Catherine = Catherine Creek. Grande = Upper Grande Ronde.

Stream	Number released	Lower Granite	Little Goose	Lower Monumental	McNary	Total
Catherine	1,000	76 (7.6)	24 (2.4)	23 (2.3)	43 (4.3)	166 (16.6)
Grande	1,001	44 (4.4)	22 (2.2)	14 (1.4)	9 (0.9)	89 (8.9)
Imnaha	998	58 (5.8)	26 (2.6)	10 (1.0)	14 (1.4)	108 (10.8)
Lostine[a]	725	69 (9.5)	24 (3.3)	11 (1.5)	19 (2.6)	123 (17.0)
Minam	997	112 (11.2)	37 (3.7)	35 (3.5)	29 (2.9)	213 (21.4)
Wenaha	998	89 (8.9)	16 (1.6)	15 (1.5)	9 (0.9)	129 (12.9)
TOTAL[a]	5,719	448 (7.8)	149 (2.6)	108 (1.9)	123 (2.2)	828 (14.5)

[a] *Lostine releases were reported as 726 in 1993, but PTAGIS data base summary indicated only 725 fish were re7eased.*

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APPENDIX A

Observation data for spring chinook salmon PIT tagged on various rivers in northeast Oregon in 1993 and observed at various dams in 1994.

Appendix Table A-1. Freqency of observations by date for spring chinook salmon PIT tagged on Catherine Creek in 1993 and observed at various dams in 1994 A = first observation of individual tags, B = tags previously detected at one dam, C = tags previously detected at two dams, D = tags previously detected at three dams, and 1 = sum of all tag observations by date at a particular dam.

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	1	A	B	C	D	Σ
15	4/09/94	0			0				0				0	
15	4/10/94	0			0				0				0	
15	4/11/94	0			0				0				0	
15	4/12/94	0			0				0				0	
15	4/13/94	1			0				0				0	
15	4/14/94	0			0				0				0	
15	4/15/94	0			0				0				0	
16	4/16/94	0			0				0				0	
16	4/17/94	0			0				0				0	
16	4/18/94	0			0				0				0	
16	4/19/94	0			0				0				0	
16	4/20/94	0			0				0				0	
16	4/21/94	1			0				0				0	
16	4/22/94	1			0				0				0	
17	4/23/94	1			0				0				0	
17	4/24/94	2			0	1			1				0	
17	,4/25/94	7	1		1				0				0	
17	4/26/94	6			0				0				0	
17	4/27/94	1			0				0				0	
17	4/28/94	1			0				0				0	
17	4/29/94	4	2		2		1		1				0	
18	4/30/94	2		1	1		2		2				0	
18	5/01/94	0	1	1	2	2			2		1		1	
18	5/02/94	0	1		1	1	1		2	1			1	
18	5/03/94	0		11			1		1	2			2	
18	5/04/94	0		1	1	1			1				0	
18	5/05/94	0	1	2	3		2	1	3	1		1	2	
18	5/06/94	0			0		1	1	2		1	1	2	
19	5/07/94	1		1	1			1	1		1	2	3	
19	5/08/94	5			0		1		1			1	1	
19	5/09/94	5	1	1	2				0				0	
19	5/10/94	4			0		1		1				0	

Appendix Table A-1, Continued (Catherine Creek).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
19	5/11/94	8			0		1	1	2		1			1
19	5/12/94	7	2	1	3	1			1				1	1
19	5/13/94	2	3	1	3	1			1			1		1
20	5/14/94	1			3	4			4	1			1	2
20	5/15/94	3	2	2	4	1			1	4				4
20	5/16/94	0			0				0			1	1	2
20	5/17/94	1			0	1	2		3	2	2	1		5
20	5/18/94	1	2		2	2	1		3	2	5	1		8
20	5/19/94	1	2		2	2	1		3	6	1			7
20	5/20/94	1	1		1		1		1	2	1			3
21	5/21/94	0	2		2	1			1		1	1		2
21	5/22/94	0		1	1				0	3	4	3		10
21	5/23/94	0			0				0	1	1	1		3
21	5/24/94	0			0				0	3	3			6
21	5/25/94	0			0	1			1	4	3			7
21	5/26/94	0			0				0					0
21	5/27/94	0			0				0	1	2			3
22	5/28/94	0			0				0	1				1
22	5/29/94	2	1		1				0					0
22	5/30/94	1			0				0					0
22	5/31/94	0			0				0	1				1
22	6/01/94	1			0				0	2	1			3
22	6/02/94	0			0				0	1		1		2
22	6/03/94	1			0				0					0
23	6/04/94	0			0				0					0
23	6/05/94	1			0				0					0
23	6/06/94	0			0				0					0
23	6/07/94	0			0				0					0
23	6/08/94	0			0				0					0
23	6/09/94	0			0				0	1				1
23	6/10/94	0			0				0		1			1
24	6/11/94	0			0				0					0
24	6/12/94	0			0				0					0
24	6/13/94	0			0				0					0
24	6/14/94	0			0				0	1				1
24	6/15/94	0			0				0	1				1

Appendix Table A-l, Continued (Catherine Creek).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
24	6/16/94	0			0				0					0
24	6/17/94	0			0				0	1				1
25	6/18/94	0			0				0					0
25	6/19/94	0			0				0					0
25	6/20/94	0			0				0					0
25	6/21/94	0			0				0					0
25	6/22/94	0			0				0					0
25	6/23/94	0			0				0					0
25	6/24/94	0			0				0					0
26	6/25/94	0			0				0					0
26	6/26/94	0			0				0					0
26	6/27/94	0			0				0					0
26	6/28/94	0			0				0					0
26	6/29/94	0			0				0					0
26	6/30/94	0			0				0					0
26	7/01/94	0			0				0					0
27	7/02/94	0			0				0					0
27	7/03/94	0			0				0					0
27	7/04/94	0			0				0					0
27	7/05/94	0			0				0					0
27	7/06/94	0			0				0					0
27	7/07/94	0			0				0					0
27	7/08/94	0			0				0					0
28	7/09/94	0			0	1			1					0
28	7/10/94	0			0		1		1					0
28	7/11/94	0			0				0					0
28	7/12/94	0			0	1			1	1				1
28	7/13/94	1			0				0					0
28	7/14/94	0			0				0					0
28	7/15/94	0			0	2			2					0
29	7/16/94	0			0		1		1					0
29	7/17/94	0			0				0					0
29	7/18/94	0			0				0					0
29	7/19/94	0			0				0					0
29	7/20/94	0			0				0					0
29	7/21/94	0			0				0					0

Appendix Table A-1, Continued (Catherine Creek).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	1	A	B	C	D	Σ
29	7/22/94	1			0			0					0	
30	7/23/94	0			0			0					0	
30	7/24/94	0			0			0					0	
30	7/25/94	0			0			0					0	
30	7/26/94	1			0			0					0	
30	7/27/94	0			0			0					0	
30	7/28/94	0			0			0					0	
30	7/29/94	0			0			0					0	
31	7/30/94	0			0			0					0	
31	7/31/94	0			0			0					0	
31	8/01/94	0			0			0					0	
31	8/02/94	0			0			0					0	
31	8/03/94	0			0			0					0	
31	8/04/94	0			0			0					0	
31	8/05/94	0			0			0					0	
32	8/06/94	0			0			0					0	
32	8/07/94	0			0			0					0	
32	8/08/94	0			0			0					0	
32	8/09/94	0			0			0					0	
32	8/10/94	0			0			0					0	
32	8/11/94	0			0			0					0	
32	8/12/94	0			0			0					0	
33	8/13/94	0			0			0					0	
33	8/14/94	0			0			0					0	
33	8/15/94	0			0		1	1					0	
33	8/16/94	0			0			0					0	
33	8/17/94	0			0			0					0	
33	8/18/94	0			0			0					0	
33	8/19/94	0			0			0					0	
34	8/20/94	0			0			0					0	
34	8/21/94	0			0			0					0	
34	8/22/94	0			0			0					0	
34	8/23/94	0			0			0					0	
34	8/24/94	0			0			0					0	
34	8/25/94	0			0			0					0	
34	8/26/94	0			0			0					0	

Appendix Table A-l, Continued (Catherine Creek).

WEEK	DATE	LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
		TAE	AAB		Σ	AB	C	1	A	B	C	D	Σ
35	8/27/94	0	0				0					0	
35	8/28/94	0	0				0					0	
35	8/29/94	0	0				0					0	
35	8/30/94	0	0				0					0	
35	8/31/94	0	0				0					0	
35	9/01/94	0	0				0					0	
35	9/02/94	0	0				0					0	
36	9/03/94	0	0				0					0	
36	9/04/94	0	0				0					0	
36	9/05/94	0	0				0					0	
36	9/06/94	0	0				0					0	
36	9/07/94	0	0				0					0	
36	9/08/94	0	0				0					0	
36	9/09/94	0	0				0					0	
37	9/10/94	0	0				0					0	
37	9/11/94	0	0				0					0	
37	9/12/94	0	0				0					0	
37	9/13/94	0	0				0					0	
37	9/14/94	0	0				0					0	
37	9/15/94	0	0				0					0	
Total		76	24	13	37	23	19	4	46	43	29	15	3	90

Appendix Table A-2. Frequency of tag observations by date for spring chinook salmon PIT tagged on the Upper Grande Ronde River in 1993 and observed at various dams in 1994. A = first observation of individual tags, B = tags previously detected at one dam, C = tags previously detected at two dams, D = tags previously detected at three dams, and Σ = sum of all tag observations by date at a particular dam.

		LOWER GRANITE		LITTLE GOOSE		LOWER MONUMENTAL					MCNARY					
WEEK	DATE	A	Σ	A	Σ	A	B	C	D	Σ	A	B	C	D	Σ	
15	4/15/94	0	0		0			0		0					0	
16	4/16/94	0	0		0			0		0					0	
16	4/17/94	0	0		0			0		0					0	
16	4/18/94	0	0		0			0		0					0	
16	4/19/94	0	0		0			0		0					0	
16	4/20/94	0	0		0			0		0					0	
16	4/21/94	0	0		0			0		0					0	
16	4/22/94	0	0		0			0		0					0	
17	4/23/94	2	0		0			0		0					0	
17	4/24/94	0	0		0			0		0					0	
17	4/25/94	1	0		0			0		0					0	
17	4/26/94	0	0		0			0		0					0	
17	4/27/94	0	0		0			0		0					0	
17	4/28/94	3	0		0			0		0					0	
17	4/29/94	0	0		0		1	1		0					0	
18	4/30/94	2	0		0			0		0					0	
18	5/01/94	1	0		0			0		0					0	
18	5/02/94	0	0		0	1	1	2		0					0	
18	5/03/94	0	0		0			0		0					0	
18	5/04/94	0	0		0			0		0					0	
18	5/05/94	0	0		0	1		1		0					0	
18	5/06/94	0	0		0			0		0					0	
19	5/07/94	0	0		0			0		0			1		1	
19	5/08/94	2	2	2	2			0		0		1			1	
19	5/09/94	2	0		0			0		0					0	
19	5/10/94	0	0		0			0		0					0	
19	5/11/94	1	0		0		1	1	2	0					0	
19	5/12/94	1	0		0			0		0					0	
19	5/13/94	0	0	2	2			0		0		1			1	
20	5/14/94	1	1		1			0		0					0	
20	5/15/94	0	0		0			0		0					0	
20	5/16/94	1	0		0			0		0					0	

Appendix Table A-2, Continued (upper Grand Ronde River).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
20	5/17/94	0	1		1	1			1					2
20	5/18/94	1	1		1				0		1	1		0
20	5/19/94	2	1		1				0			1		1
20	5/20/94	0			0				0		1			1
21	5/21/94	1	2		2				0					0
21	5/22/94	0		1	1				0	2				2
21	5/23/94	1			0				0					0
21	5/24/94	0			0				0	1				1
21	5/25/94	0			0				0	1				1
21	5/26/94	0			0				0					0
21	5/27/94	0			0				0	2				2
22	5/28/94	0			0				0					0
22	5/29/94	2			0				0					0
22	5/30/94	3			0				0					0
22	5/31/94	2			0				0					0
22	6/01/94	0			0				0					0
22	6/02/94	0			0				0		1			1
22	6/03/94	0	1		1				0	1				1
23	6/04/94	2			0				0				1	1
23	6/05/94	0	1		1				0					0
23	6/06/94	1			0				0					0
23	6/07/94	0			0				0					0
23	6/08/94	1			0				0					0
23	6/09/94	0	1		1				0					0
23	6/10/94	0	1		1				0	1				1
24	6/11/94	0	1	1	2				0					0
24	6/12/94	0	1		1				0					0
24	6/13/94	1	1		1				0					0
24	6/14/94	1	2		2				0					0
24	6/15/94	0	1		1				0					0
24	6/16/94	0			0				0					0
24	6/17/94	1			0				0					0
25	6/18/94	1			0	1			1		1			1
25	6/19/94	0	1		1				0					0
25	6/20/94	0	1		1	1			1					0
25	6/21/94	0			0	1			1					0

Appendix Table A-2, Continued (upper Grand Ronde River).

		LOWER GRANITE		LITTLE GOOSE		LOWER MONUMENTAL					MCNARY				
WEEK	DATE	TE	A	A	B	Σ	A	B	C	1	A	B	C	D	Σ
25	6/22/94	0		0					0					0	
25	6/23/94	0		0					0					0	
25	6/24/94	0		0					0					0	
26	6/25/94	0		0		1			1			1		1	
26	6/26/94	0		0					0					0	
26	6/27/94	0		0					0					0	
26	6/28/94	0		0			1		1					0	
26	6/29/94	0		0					0					0	
26	6/30/94	0		0					0					0	
26	7/01/94	1		0					0					0	
27	7/02/94	0		0					0					0	
27	7/03/94	0		0					0					0	
27	7/04/94	0		0					0					0	
27	7/05/94	0		0		1			1			1		1	
27	7/06/94	0	1	1			2		2					0	
27	7/07/94	1		0		1			1					0	
27	7/08/94	0		0					0					0	
28	7/09/94	0	1	1					0					0	
28	7/10/94	0		0		1	1		2			1		1	
28	7/11/94	0		0					0					0	
28	7/12/94	0		0		1			1					0	
28	7/13/94	0		0		1			1					0	
28	7/14/94	1		0					0		1			1	
28	7/15/94	0		0		1			1			1		1	
29	7/16/94	0	1	1		1		1	2					0	
29	7/17/94	0		0					0					0	
29	7/18/94	0		0					0					0	
29	7/19/94	0		0					0					0	
29	7/20/94	1	1	1			1		1					0	
29	7/21/94	1		0			1		1					0	
29	7/22/94	0		0					0					0	
30	7/23/94	0		0					0					0	
30	7/24/94	0		0					0					0	
30	7/25/94	0		0					0					0	
30	7/26/94	0		0					0					0	
30	7/27/94	0		0					0					0	

Appendix Table A-2, Continued (upper Grand Ronde River).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
30	7/28/94	0			0				0					0
30	7/29/94	0			0				0					0
31	7/30/94	0			0				0					0
31	7/31/94	0			0				0					0
31	8/01/94	0			0				0					0
31	8/02/94	0			0				0					0
31	8/03/94	0			0				0					0
31	8/04/94	0			0				0					0
31	8/05/94	0			0				0					0
32	8/06/94	0			0				0					0
32	8/07/94	1			0				0					0
32	8/08/94	0			0				0					0
32	8/09/94	0			0				0					0
32	8/10/94	0			0				0					0
32	8/11/94	0			0				0					0
32	8/12/94	0			0				0					0
33	8/13/94	0			0				0					0
33	8/14/94	0			0				0					0
33	8/15/94	0			0				0					0
33	8/16/94	0			0				0					0
33	8/17/94	0			0				0					0
33	8/18/94	0			0				0					0
33	8/19/94	0			0				0					0
34	8/20/94	0			0				0					0
34	8/21/94	0			0				0					0
34	8/22/94	0			0				0					0
34	8/23/94	0			0				0					0
34	8/24/94	0			0				0					0
34	8/25/94	0			0				0					0
34	8/26/94	0			0				0					0
35	8/27/94	0			0				0					0
35	8/28/94	0			0				0					0
35	8/29/94	1			0				0					0
35	8/30/94	0			0				0					0
35	8/31/94	0			0				0					0
35	9/01/94	0		1	1				0					0

Appendix Table A-2, Continued (upper Grande Ronde River).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
35	9/02/94	0			0				0					0
36	9/03/94	0							0					0
36	9/04/94	0							0					0
36	9/05/94	0			0				0					0
36	9/06/94	0			0				0					0
36	9/07/94	0			0				0					0
36	9/08/94	0			0				0					0
36	9/09/94	0			0				0					0
37	9/10/94	0			0				0					0
37	9/11/94	0	1		1				0					0
37	9/12/94	0			0				0					0
37	9/13/94	0			0				0					0
37	9/14/94	0			0				0					0
37	9/15/94	0			0				0					0
Total		44	22	8	30	14	9	2	25	9	10	3	1	23

Appendix Table A-3. Frequency of tag observations by date for spring chinook salmon PIT tagged on the Imnaha River in 1993 and observed at various dams in 1994. A = first observation of individual tags, B = tags previously detected at one dam, C = tags previously detected at two dams, D = tags previously detected at three dams, and Σ = sum of all tag observations by date at a particular dam.

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
15	4/15/94	0			0				0					0
16	4/16/94	0			0				0					0
16	4/17/94	0			0				0					0
16	4/18/94	0			0				0					0
16	4/19/94	0			0				0					0
16	4/20/94	1			0				0					0
16	4/21/94	0			0				0					0
16	4/22/94	1			0				0					0
17	4/23/94	2			0				0					0
17	4/24/94	5			0				0					0
17	4/25/94	2			0				0					0
17	4/26/94	2	1		1	1			1					0
17	4/27/94	1	1		1				0					0
17	4/28/94	1	1	1	2				0					0
17	4/29/94	0	1	1	2				0					0
18	4/30/94	2	2		2	1			1					0
18	5/01/94	1	1		1				0					0
18	5/02/94	2	1		1	1	1	1	3	1	1			2
18	5/03/94	2	2		2		1		1					0
18	5/04/94	1	1	1	2		2		2					0
18	5/05/94	0	1	1	2		2		2		1			1
18	5/06/94	3			0		2		2					0
19	5/07/94	3			0				0		2			2
19	5/08/94	5	1		1		1		1			1		1
19	5/09/94	2		1	1				0					0
19	5/10/94	5			0		1		1					0
19	5/11/94	3	1		1				0		1	1		2
19	5/12/94	2		1	1	1			1	1			1	2
19	5/13/94	1			0				0		1	1		2
20	5/14/94	1	2	1	3	4	1		5					0
20	5/15/94	0		2	2				0			2		2
20	5/16/94	0			0				0					0

Appendix Table A-3, Continued (Imnaha River).

		LOWER GRANITE	LITTLE GOOSE	LOWER MONUMENTAL					MCNARY				
WEEK	DATE	TAE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
20	5/17/94	0		0			1	1			2	1		3	
20	5/18/94	0		0				0			2			2	
20	5/19/94	1		0			1	1		1	1	1		3	
20	5/20/94	0	1	1				0		1	1	1		3	
21	5/21/94	1	2	2				2		1				1	
21	5/22/94	0	1	1		2		0			2			2	
21	5/23/94	0		0				0		2			1	3	
21	5/24/94	0		0		1		1		1				1	
21	5/25/94	0		0				0						0	
21	5/26/94	0		0				0						0	
21	5/27/94	0		0				0		1				1	
22	5/28/94	0	1	1				0			1	1		2	
22	5/29/94	0		0				1						0	
22	5/30/94	0	1	1	1			0						0	
22	5/31/94	1		0				0				1		1	
22	6/01/94	0	1	1				0						0	
22	6/02/94	1		0				0		2				2	
22	6/03/94	0		0				0		1				1	
23	6/04/94	0	1	1				0						0	
23	6/05/94	0		0				0						0	
23	6/06/94	0		0				0						0	
23	6/07/94	0	1	1				0			1			1	
23	6/08/94	0		0				0						0	
23	6/09/94	1	1	1				0						0	
23	6/10/94	0		0				0						0	
24	6/11/94	0		0				0			1			1	
24	6/12/94	0		0				0						0	
24	6/13/94	0		0				0						0	
24	6/14/94	0		0		1		1		1				1	
24	6/15/94	0		0				0						0	
24	6/16/94	0		0				0						0	
24	6/17/94	0		0				0						0	
25	6/18/94	0		0				0						0	
25	6/19/94	0		0				0						0	
25	6/20/94	0		0				2						0	
25	6/21/94	0		0	1	1		0						0	

Appendix Table A-3, Continued (Imnaha River).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL			MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	1	A	B	C	D	Σ
25	6/22/94	0			0			0					0	
25	6/23/94	0			0			0					0	
25	6/24/94	1			0			0			1		1	
26	6/25/94	0			0			0					0	
26	6/26/94	0			0			0					0	
26	6/27/94	0			0			0					0	
26	6/28/94	0			0			0					0	
26	6/29/94	0			0			0					0	
26	6/30/94	0			0			0					0	
26	7/01/94	0			0			0					0	
27	7/02/94	0			0			0					0	
27	7/03/94	0			0			0					0	
27	7/04/94	0			0			0					0	
27	7/05/94	0			0			0					0	
27	7/06/94	0			0			0					0	
27	7/07/94	0			0			0					0	
27	7/08/94	0			0			0					0	
28	7/09/94	0			0			0					0	
28	7/10/94	2			0			0					0	
28	7/11/94	0			0			0					0	
28	7/12/94	0	1		1			0					0	
28	7/13/94	0			0			0					0	
28	7/14/94	0			0			0					0	
28	7/15/94	0			0			0		1			1	
29	7/16/94	0			0			0					0	
29	7/17/94	1			0			0					0	
29	7/18/94	0			0		1	1					0	
29	7/19/94	0			0			0					0	
29	7/20/94	0			0			0					0	
29	7/21/94	0		1	1			0					0	
29	7/22/94	0			0			0					0	
30	7/23/94	0			0			0					0	
30	7/24/94	0			0			0					0	
30	7/25/94	0		1	1			0					0	
30	7/26/94	0			0			0					0	
30	7/27/94	0			0			0					0	

Appendix Table A-3, Continued (Imnaha River).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
30	7/28/94	0			0				0					0
30	7/29/94	0			0				0					0
31	7/30/94	0												0
31	7/31/94	0			0				11					0
31	8/01/94	0			0				1					0
31	8/02/94	0			0		1		0					0
31	8/03/94	0			0									0
31	8/04/94	0			0				0					0
31	8/05/94	0							0					
32	8/06/94	0			0				0					11
32	8/07/94				0									0
32	8/08/94	0			0				0					0
32	8/09/94	0			0				0					0
32	8/10/94				0				0					0
32	8/11/94	0			0				0					0
32	8/12/94	0			0				0					0
33	8/13/94	0			0				0					0
33	8/14/94	0			0			1	1					0
33	8/15/94	0			0				0					0
33	8/16/94	0			0				0					0
Total		58	26	12	38	10	18	4	32	14	17	11	2	44

Appendix Table A-4. Frequency of tag observations by date for spring chinook salmon PIT tagged on the Lostine River in 1993 and observed at various dams in 1994. A = first observation of individual tags, B = tags previously detected at one dam, C = tags previously detected at two dams, D = tags previously detected at three dams, and Σ = sum of all tag observations by date at a particular dam.

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
15	4/15/94	0			0				0					0
16	4/16/94	0			0				0					0
16	4/17/94	0			0				0					0
16	4/18/94	0			0				0					0
16	4/19/94	1			0				0					0
16	4/20/94	0			0				0					0
16	4/21/94	5			0				0					0
16	4/22/94	4	1		1				0					0
17	4/23/94	5			0				0					0
17	4/24/94	4	2		2				0					0
17	4/25/94	2	4	1	5				0					0
17	4/26/94	7	2		2				0					0
17	4/27/94	4	3		3		1	1	2					0
17	4/28/94	3		2	2		1		1					0
17	4/29/94	2	1		1		4		4					0
18	4/30/94	2	2		2			1	1					0
18	5/01/94	2		1	1		2		2		1			1
18	5/02/94	2		2	2	1	1		2				1	1
18	5/03/94	0			0				0		1			1
18	5/04/94	0			0	1	3		4	1	1			2
18	5/05/94	1			0		3		3			1		1
18	5/06/94	3		1	1				0					0
19	5/07/94	2			0		1		1					0
19	5/08/94	1			0	1		1	2			3		3
19	5/09/94	3			0				0			1		1
19	5/10/94	3			0	1	1		2		1	2		3
19	5/11/94	1			0	1			1					0
19	5/12/94	0	3		3				0	1	1		1	3
19	5/13/94	4		2	2				0			1		1
20	5/14/94	0			0	2			2	1	2			3
20	5/15/94	1			0				0			1		1
20	5/16/94	2	2		2		1		1					0

Appendix Table A-4, Continued (Lostine River),

WEEK	DATE	LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
		A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
20	5/17/94	0	1		1	1			1					0
20	5/18/94	0	1		1		1		1	2	4			6
20	5/19/94	1	1		1				0	1	1	1		3
20	5/20/94	0			0				0	2		1		3
21	5/21/94	0	1		1				0	2	1			3
21	5/22/94	0		1	1				0		1			1
21	5/23/94	0			0				0		1			1
21	5/24/94	0			0				0	1				1
21	5/25/94	0			0				0	2				2
21	5/26/94	1			0	1			1	2				2
21	5/27/94	0			0	1			1					0
22	5/28/94	0			0				0					0
22	5/29/94	0			0				0					0
22	5/30/94	1			0				0					0
22	5/31/94	0			0				0					0
22	6/01/94	0			0				0					0
22	6/02/94	0			0				0					0
22	6/03/94	1			0				0					0
23	6/04/94	0			0				0	2				2
23	6/05/94	0			0				0					0
23	6/06/94	0			0				0	1				1
23	6/07/94	1			0				0					0
23	6/08/94	0			0				0					0
23	6/09/94	0			0				0					0
23	6/10/94	0			0				0					0
24	6/11/94	0			0				0					0
24	6/12/94	0			0				0					0
24	6/13/94	0			0				0					0
24	6/14/94	0			0				0					0
24	6/15/94	0			0				0	1				1
24	6/16/94	0			0				0					0
24	6/17/94	0			0				0					0
25	6/18/94	0			0				0					0
25	6/19/94	0			0				0					0
25	6/20/94	0			0				0					0
25	6/21/94	0			0				0					0

Appendix Table A-4, Continued (Lostine River).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
25	6/22/94	0			0				0					0
25	6/23/94	0			0				0					0
25	6/24/94	0			0				0					0
26	6/25/94	0			0				0					0
26	6/26/94	0			0				0					0
26	6/27/94	0			0				0					0
26	6/28/94	0			0				0					0
26	6/29/94	0			0				0					0
26	6/30/94	0			0				0					0
26	7/01/94	0			0				0					0
27	7/02/94	0			0				0					0
27	7/03/94	0			0				0					0
27	7/04/94	0			0				0					0
27	7/05/94	0			0				0					0
27	7/06/94	0			0				0					0
27	7/07/94	0			0				0					0
27	7/08/94	0			0				0					0
28	7/09/94	0			0				0					0
28	7/10/94	0			0				0					0
28	7/11/94	0			0				0					0
28	7/12/94	0			0				0					0
28	7/13/94	0			0				0					0
28	7/14/94	0			0				0					0
28	7/15/94	0			0				0					0
29	7/16/94	0			0				0					0
29	7/17/94	0			0				0					0
29	7/18/94	0			0				0					0
29	7/19/94	0			0				0					0
29	7/20/94	0			0				0					0
29	7/21/94	0			0				0					0
29	7/22/94	0			0	1			1					0
30	7/23/94	0			0				0					0
30	7/24/94	0			0				0					0
30	7/25/94	0			0				0					0
30	7/26/94	0			0				0					0
30	7/27/94	0			0				0					0

Appendix Table A-4, Continued (Lostine River).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				,MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
30	7/28/94	0			0				0					0
30	7/29/94								0					0
31	7/30/94	0			0				0					0
31	7/31/94	0			0				0					0
31	8/01/94	0												0
31	8/02/94	0			||				||					0
31	8/03/94	0			0				0					0
31	8/04/94	0			0				0					0
31	8/05/94	0												
32	8/06/94	0			||				||					||
32	8/07/94	0												
32	8/08/94	0			0				0					||
32	8/09/94	0			0				0					0
32	8/10/94	0			0				0					0
Total		69	24	10	34	11	19	3	33	19	15	11	2	47

Appendix Table A-5. Frequency of tag observations by date for spring chinook salmon PIT tagged on the Minam River in 1993 and observed at various dams in 1994. A = first observation of individual tags, B = tags previously detected at one dam, C = tags previously detected at two dams, D = tags previously detected at three dams, and Σ = sum of all tag observations by date at a particular dam.

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
15	4/15/94	0			0				0					0
16	4/16/94	0			0				0					0
16	4/17/94	0			0				0					0
16	4/18/94	1			0				0					0
16	4/19/94	0			0				0					0
16	4/20/94	4			0				0					0
16	4/21/94	5			0				0					0
16	4/22/94	9			0				0					0
17	4/23/94	11			0				0					0
17	4/24/94	a		1	1				0					0
17	4/25/94	9	3	3	6				0					0
17	4/26/94	5	1	1	2	1			1					0
17	4/27/94	6	4	4	a	1	1	1	3					0
17	4/28/94	1	7	2	9	2		2	4					0
17	4/29/94	2	3	1	4	2	2	1	5					0
la	4/30/94	3	1	3	4	4	2		6					0
la	5/01/94	4	1	1	2	1	3		4	1				1
la	5/02/94	2	2		2	3	1	2	6	1	1		1	3
18	5/03/94	1		2	2			2	2					0
18	5/04/94	1		2	2	1	1		2					0
la	5/05/94	2	1	1	2	1	3	1	5		1	1	1	3
la	5/06/94	3	1	1	2				0		2	2		4
19	5/07/94	2		1	1	2	1	1	4			2	1	3
19	5/08/94	4			0	1		2	3	2	1	2		5
19	5/09/94	3		1	1	1	1		2	1	1		1	3
19	5/10/94	6	1		1				0			1		1
19	5/11/94	5	1		1				0		3	1		4
19	5/12/94	2	1	1	2	2	1		3			1	1	2
19	5/13/94	1			0		1		1		2	1		3
20	5/14/94	2		1	1				0		1			1
20	5/15/94	1		1	1	1	1		2	1	1	2		4
20	5/16/94	0		1	1				0					1

Appendix Table A-5, Continued (Minam River).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
20	5/17/94	1			0	1	2		3	4	1			5
20	5/18/94	2	3		3	2	1		3	4				4
20	5/19/94	0	1		1	1			1	1	1			2
20	5/20/94	0	1		1	2			2	2			1	3
21	5/21/94	0	1		1		1		1		1	1		2
21	5/22/94	1	1		1				0	2		2		4
21	5/23/94	0		1	1				0		1	1		2
21	5/24/94	0			0	1			1	4	1			5
21	5/25/94	0			0		1		1			1		1
21	5/26/94	0		1	1				0		1			1
21	5/27/94	0			0	1			1		2			2
22	5/28/94	0			0				0		2			2
22	5/29/94	1			0				0					0
22	5/30/94	0			0			1	1					0
22	5/31/94	1			0		1		1					0
22	6/01/94	1	1		1				0	3				3
22	6/02/94	0			0				0	1	1			2
22	6/03/94	0			0				0					0
23	6/04/94	0	1		1				0					0
23	6/05/94	0			0	1			1				1	1
23	6/06/94	0			0				0					0
23	6/07/94	0			0				0					0
23	6/08/94	0			0				0					0
23	6/09/94	0			0				0	1				1
23	6/10/94	0			0				0					0
24	6/11/94	0			0				0					0
24	6/12/94	0			0				0		1			1
24	6/13/94	1			0				0		1			1
24	6/14/94	0			0				0	1				1
24	6/15/94	0			0				0		1			1
24	6/16/94	0			0				0					0
24	6/17/94	0			0				0					0
25	6/18/94	0			0				0		1			1
25	6/19/94	0			0				0					0
25	6/20/94	0			0				0					0
25	6/21/94	0			0				0					0

Appendix Table A-5, Continued (Minam River).

		LOWER GRANITE	Little GOOSE	LOWER MONUMENTAL					MCNARY				
WEEK	DATE	TEA	AAB	ΣABC1					ABCDΣ				
25	6/22/94	0	0				0					0	
25	6/23/94	0	0				0					0	
25	6/24/94	0	0				0					0	
26	6/25/94	0	0	1			1			1		1	
26	6/26/94	0	0				0					0	
26	6/27/94	0	0				0					0	
26	6/28/94	0	0		1		1					0	
26	6/29/94	0	0				0					0	
26	6/30/94	0	0				0					0	
26	7/01/94	0	0				0					0	
27	7/02/94	0	0				0					0	
27	7/03/94	0	1 1				0					0	
27	7/04/94	0	0				0			1		1	
27	7/05/94	0	0				0					0	
27	7/06/94	0	0				0					0	
27	7/07/94	0	0				0					0	
27	7/08/94	0	0				0					0	
28	7/09/94	0	0	1			1					0	
28	7/10/94	0	1 1	1			1					0	
28	7/11/94	0	0				0					0	
28	7/12/94	0	0				0					0	
28	7/13/94	0	0				0					0	
28	7/14/94	0	0		1		1		1			1	
28	7/15/94	0	0			1	1					0	
29	7/16/94	0	0				0					0	
29	7/17/94	0	0				0					0	
29	7/18/94	0	0				0					0	
29	7/19/94	0	0				0					0	
29	7/20/94	0	0				0					0	
29	7/21/94	0	0				0					0	
29	7/22/94	0	0				0					0	
30	7/23/94	0	0				0					0	
30	7/24/94	0	0				0					0	
30	7/25/94	0	0				0					0	
30	7/26/94	0	0				0					0	
30	7/27/94	0	0				0					0	

Appendix Table A-5, Continued (Minam River).

WEEK	DATE	LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL					MCNARY				
			A	A	Σ	B	Σ	A	B	C	Σ	A	B	C	D	Σ
30	7/28/94	0		0					0						0	
30	7/29/94								0						0	
31	7/30/94	0		0											0	
31	7/31/94	0		0					0						0	
31	8/01/94	0		0					0						0	
31	8/02/94	0		0					0						0	
31	8/03/94	0		0					0						0	
31	8/04/94	0		0					0						0	
31	8/05/94			0					0						0	
32	8/06/94	0		0					0						0	
32	8/07/94			0											0	
32	8/08/94	0		0					0						0	
32	8/09/94	0		0					0						0	
32	8/10/94	0		0					0						0	
32	8/11/94	0		0					0						0	
32	8/12/94	0		0					0						0	
33	8/13/94	1														
33	8/14/94	0		||				||						||	
33	8/15/94	0		0					0						0	
Total		112	37	31	68	35	26	14	75		29	30	20	7	86	

Appendix Table A-6. Frequency of tag observations by date for spring chinook salmon PIT tagged on the Wenaha and South Fork Wenaha Rivers in 1993 and observed at various dams in 1994. A = first observation of individual tags, B = tags previously detected at one dam, C = tags previously detected at two dams, D = tags previously detected at three dams, and Σ = sum of all tag observations by date at a particular dam.

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
15	4/15/94	0			0				0					0
16	4/16/94	0			0				0					0
16	4/17/94	0			0				0					0
16	4/18/94	5			0				0					0
16	4/19/94	3			0				0					0
16	4/20/94	7			0				0					0
16	4/21/94	9			0				0					0
16	4/22/94	13			0				0					0
17	4/23/94	a		2	2				0					0
17	4/24/94	10	1	3	4				0					0
17	4/25/94	5	3	2	5	1	1	1	3					0
17	4/26/94	5	3	3	6	1	4		5					0
17	4/27/94	4	4	1	5	2	1	2	5					0
17	4/28/94	0	2	2	4	2	3		5					0
17	4/29/94	3		2	2	1	2		3			1		1
18	4/30/94	0		3	3		6		6					0
la	5/01/94	3	1	1	2	3	3	1	7	1		1	1	3
la	5/02/94	0		2	2	1			1	1	1		1	3
la	5/03/94	1			0		1	1	2	2		2	1	5
la	5/04/94	0			0		1	3	4		2	2		4
la	5/05/94	0		1	1		3		3			1		1
la	5/06/94	1		2	2			1	1	1	1	2		4
19	5/07/94	3	1		1				0	1	1			2
19	5/08/94	0		1	1	1	1		2	1		1	1	3
19	5/09/94	1		1	1	1	1		2					0
19	5/10/94	1			0		1		1		2			2
19	5/11/94	2			0	1	1	3	5		1	1		2
19	5/12/94	0			0				0		1	1		2
19	5/13/94	1			0		1	1	2					0
20	5/14/94	1	1	1	2				0			2		2
20	5/15/94	0			0				0		3	1	1	5
20	5/16/94	1			0				0					0

Appendix Table A-6, Continued (Wenaha and South Fork Wenaha Rivers).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
20	5/17/94	0		1	1	1			1	1				1
					0				0					1
20	5/19/94	1			0				0	1				0
20	5/20/94	0			0				0					0
21	5/21/94	0			0				0					0
21	5/22/94	0			0				0					0
21	5/23/94	0			0				0			1		1
21	5/24/94	0			0				0					0
21	5/25/94	0			0				0					0
21	5/26/94	0			0				0					0
21	5/27/94	0			0				0					0
22	5/28/94	0			0				0					0
22	5/29/94	0			0				0					0
22	5/30/94	0			0				0					0
22	5/31/94	0			0				0					0
22	6/01/94	0			0				0					0
22	6/02/94	0			0				0					0
22	6/03/94	0			0				0					0
23	6/04/94	0			0				0					0
23	6/05/94	0			0				0					0
23	6/06/94	1			0				0					0
23	6/07/94	0			0				0					0
23	6/08/94	0			0				0					0
23	6/09/94	0			0				0					0
23	6/10/94	0			0				0					0
24	6/11/94	0			0				0					0
24	6/12/94	0			0				0					0
24	6/13/94	0			0				0					0
24	6/14/94	0			0				0					0
24	6/15/94	0			0				0					0
24	6/16/94	0			0				0					0
24	6/17/94	0			0				0					0
25	6/18/94	0			0				0					0
25	6/19/94	0			0				0					0
25	6/20/94	0			0				0					0
25	6/21/94	0			0				0					0

Appendix Table A-6, Continued (Wenaha and South Fork Wenaha Rivers).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
25	6/22/94	0			0				0					0
25	6/23/94	0			0				0					0
25	6/24/94				0				0					0
26	6/25/94	0			0				0					0
		0												
26	6/26/94	0			0				0					0
26	6/27/94				0				0					0
26	6/28/94	0			0				0					0
26	6/29/94	0			0				0					0
26	6/30/94	0			0				0					0
26	7/01/94	0			0				0					0
Total		89	16	28	44	15	30	13	58	9	12	16	5	42

APPENDIX B

Expansion factors for spillway flow at mainstem Snake and Columbia River dams, 1994. Expansion factor is (spillway flow + powerhouse flow)/powerhouse flow.

Appendix Table B-1. Expansion factors for spillway flow at mainstem Snake and Columbia River dams, 1994. Expansion factor is (spillway flow + powerhouse flow)/powerhouse flow.

DATE	GRANITE EXPANSION	GOOSE EXPANSION	LOWER MONUMENTAL EXPANSION	MCNARY EXPANSION
4/01/94	1	1	1	1
4/02/94	1	1	1	1
4/03/94	1	1	1	1
4/04/94	1	1	1	1
4/05/94	1	1	1	1
4/06/94	1	1	1	1
4/07/94	1	1	1	1
4/08/94	1	1	1	1
4/09/94	1	1	1	1
4/10/94	1	1	1	1
4/11/94	1	1	1	1
4/12/94	1	1.11	1	1
4/13/94	1	1.12	1	1
4/14/94	1	1.06	1	1
4/15/94	1	1	1	1
4/16/94	1	1	1	1
4/17/94	1	1	1	1
4/18/94	1	1	1	1
4/19/94	1	1	1	1
4/20/94	1	1.09	1	1
4/21/94	1	1.29	1	1
4/22/94	1	1.4	1	1
4/23/94	1	1.56	1	1
4/24/94	1	1.41	1	1
4/25/94	1	1.39	1	1
4/26/94	1	1.26	1	1
4/27/94	1	1.24	1	1
4/28/94	1	1.17	1	1
4/29/94	1	1.4	1	1
4/30/94	1	1.45	1	1.03
5/01/94	1	1.41	1	1
5/02/94	1	1.35	1	1.05
5/03/94	1	1.34	1	1.04
5/04/94	1	1.4	1	1.05
5/05/94	1	1.37	1	1.09
5/06/94	1	1.45	1	1.14

Appendix Table B-1, Continued (spillway expansion factors).

DATE	GRANITE EXPANSION	GOOSE EXPANSION	LOWER MONUMENTAL EXPANSION	MCNARY EXPANSION
5/07/94	1	1.44	1	1
5/08/94	1	1.43	1	1
5/09/94	1	1.39	1	1.06
5/10/94	1	1.38	1	1.11
5/11/94	1.23	1.46	1.15	1.16
5/12/94	1.38	1.47	1.15	1.22
5/13/94	1.4	1.39	1.14	1.19
5/14/94	1.54	1.52	1.22	1.25
5/15/94	1.58	1.42	1.21	1.36
5/16/94	1.54	1.53	1.22	1.28
5/17/94	1.52	1.55	1.16	1.27
5/18/94	1.63	1.55	1.21	1.23
5/19/94	1.6	1.49	1.2	1.25
5/20/94	1.53	1.46	1.24	1.25
5/21/94	1.55	1.5	1.29	1.22
5/22/94	1.52	1.47	1.31	1.31
5/23/94	1.57	1.43	1.3	1.22
5/24/94	1.55	1.65	1.31	1.24
5/25/94	1.49	1.63	1.26	1.2
5/26/94	1.51	1.49	1.31	1.26
5/27/94	1.39	1.36	1.22	1.22
5/28/94	1.27	1.36	1.2	1.17
5/29/94	1.37	1.36	1.23	1.17
5/30/94	1.42	1.29	1.25	1.17
5/31/94	1.42	1.51	1.26	1.14
6/01/94	1.48	1.25	1.26	1.13
6/02/94	1.51	1.24	1.28	1.18
6/03/94	1.5	1.28	1.31	1.26
6/04/94	1.53	1.27	1.3	1.26
6/05/94	1.44	1.26	1.31	1.28
6/06/94	1.58	1.29	1.31	1.24
6/07/94	1.58	1.28	1.34	1.26
6/08/94	1.62	1.29	1.31	1.24
6/09/94	1.55	1.3	1.35	1.25
6/10/94	1.66	1.33	1.37	1.25
6/11/94	1.54	1.3	1.4	1.27

Appendix Table B-l, Continued (spillway expansion factors).

DATE	GRANITE EXPANSION	GOOSE EXPANSION	LOWER MONUMENTAL EXPANSION	MCNARY EXPANSION
6/12/94	1.62	1.32	1.32	1.26
6/13/94	1.64	1.34	1.39	1.24
6/14/94	1.47	1.24	1.25	1.23
6/15/94	1.24	1.11	1.13	1.24
6/16/94	1	1	1	1.26
6/17/94	1	1	1	1.12
6/18/94	1	1	1	1
6/ 19/94	1	1	1	1
6/20/94	1	1	1	1
6/21/94	1	1	1	1
6/22/94	1	1	1	1
6/23/94	1	1	1	1
6/24/ 94	1	1	1.23	1
6/25/94	1	1	1.02	1
6/26/94	1	1	1	1
6/27/94	1	1	1	1
6/28/94	1	1	1	1
6/29/ 94	1	1	1	1
6/30/94	1	1	1	1
7/01/94	1	1	1	1
7/02 /94	1	1	1	1
7/03/94	1	1	1	1
7/04/94	1	1	1	1
7/05/94	1	1	1	1
7/06/94	1	1	1	1
7/07/94	1	1	1	1
7/08/94	1	1	1	1
7/09/94	1	1	1	1
7/10/94	1	1	1	1
7/11/94	1	1	1	1
7/12/94	1	1	1	1
7/13/94	1	1	1	1
7/14/94	1	1	1	1
7/15/94	1	1	1	1
7/16/94	1	1	1	1
7117194	1	1	1	1

Appendix Table B-1, Continued (spillway expansion factors).

DATE	GRANITE EXPANSION	GOOSE EXPANSION	LOWER MONUMENTAL EXPANSION	MCNARY EXPANSION
7/18/94	1	1	1	1.02
7/19/94	1	1	1	1.05
7/20/94	1	1	1	1.08
7/21/94	1	1	1	1.08
7/22/94	1	1	1	1.08
7/23/94	1	1	1	1.13
7/24/94	1	1	1	1.15
7/25/94	1	1	1	1.12
7/26/94	1	1	1	1.12
7/27/94	1	1	1	1.12
7/28/94	1	1	1	1.14
7/29/94	1	1	1	1.09
7/30/94	1	1	1	1
7/31/94	1	1	1	1
8/01/94	1	1	1	1
8/02/94	1	1	1	1
8/03/94	1	1	1	1
8/04/94	1	1	1	1
8/05/94	1	1	1	1
8/06/94	1	1	1	1
8/07/94	1	1	1	1
8/08/94	1	1	1	1
8/09/94	1	1	1	1
8/10/94	1	1	1.62	1
8/11/94	1	1	3.1	1
8/12/94	1	1	1	1
8/13/94	1	1	1	1
8/14/94	1	1	1	1
8/15/94	1	1	1	1
8/16/94	1	1	1	1
8/17/94	1	1	1	1
8/18/94	1	1	1	1
8/19/94	1	1	1	1
8/20/94	1	1	1	1
8/21/94	1	1	1	1
8/22/94	1	1	1	1

Appendix Table B-1, Continued (spillway expansion 'factors).

DATE	GRANITE EXPANSION	GOOSE -EXPANSION	LOWER MONUMENTAL EXPANSION	MCNARY EXPANSION
8/23/94	1.56	1	1	1
		1		1
8/25/94	1.47	1	1	1
8/26/94	1	1	1	1
	1		1	
8/27/94	1	1	1	1.03
8/28/94		1		1.03
8/29/94	1		1	1.03
8/30/94	1	1	1	1.03
8/31/94	1	1	1	1.03

APPENDIX C

Travel time (in days) of individual chinook salmon between Lower Granite Dam and several downstream dams during the 1994 migration year for chinook salmon PIT tagged on six streams in the Grande Ronde and Imnaha river subasins in 1993. Travel times based on intial detection within the bypass system at each dam.

Appendix Table C-1. Travel time (in days) of individua chinook salmon between Lower Granite Dam and several downstream dams during the 1994 migration year for chinook salmon PIT tagged on six.streams in the Grande Ronde and Imnaha River subbasins in 1993. Travel times based on initial detection within the bypass system at each dam.

Stream	Little Goose	Lower Monumental	McNary
Catherine Creek			
Median days	5.0	10.1	11.5
Range	3.1-13.1	5.3-82.3	8.6-21.7
95% CI	3.7- 7.4	7.1-16.0	10.8-16.6
N	13	18	25
Grande Ronde			
Median days	9.2	18.6	21.9
Range	3.3-49.3	6.8-51.8	8.3-38.8
95% CI	3.3-49.3	6.8-51-O	14.5-35.7
N	8	10	9
Imnaha			
Median days	5.6	11.2	16.1
Range	3.1-11.0	6.2-34.6.	8.0-28.1
95% CI	3.6- 8.1	7.0-13.2	11.5-17.5
N	12	13	19
Lostine			
Median days	4.0	8.4	16.6
Range	2.7-7.3	4.9-14.7	9.0-25.3
95% CI	3.6-6.9	5.6-13.2	9.8-19.7
N	10	11	17
Mi nam			
Median days	6.3	9.4	17.4
Range	3.3-38.4	3.2-43.7	10.8-55.0
95% CI	5.1- 7.4	7.5-12.2	14.7-21.7
N	31	26	30
Wenaha and S.F.			
Median days	5.4	7.3	13.9
Range	3.1-11.8	4.7-17.4	8.9-20.7
95% CI	4.5- 6.6	6.3- 8.5	12.2-15.7
N	27	33	21
Total			
Median days	5.8	9.1	15.1
Range	2.7-49.3	3.2-82.3	8.0-55.0
95% CI	5.0- 6.6	8-0-10.6	13.9-16.9
N	101	111	121

FISH RESEARCH PROJECT
OREGON

SMOLT MIGRATION CHARACTERISTICS AND MAINSTEM SNAKE AND COLUMBIA RIVER DETECTION RATES OF PIT-TAGGED GRANDE RONDE AND IMNAHA RIVER NATURALLY PRODUCED SPRING CHINOOK SALMON

Annual Progress Report
Project Period: 1 January 1995 to 31 December 1995

Prepared by:

Paul Sankovich
Richard W. Carmichael
MaryLouise Keefe

Oregon Department of' Fish and Wildlife
Portland, OR

CONTENTS

EXECUTIVE SUMMARY

Objectives for 1995

1. Collect and tag with implantable passive integrated transponder (PIT) tags 500 chinook salmon parr from Catherine Creek and 1,000 chinook salmon parr each from the Imnaha, Lostine, Minam, and Wenaha rivers.

2. Determine size frequency distribution and mean length and weight of juvenile chinook salmon from Catherine Creek and the Imnaha, Lostine, Minam, and Wenaha rivers.

3. Submit PIT-tagging data files to the PIT Tag Information System database administered by the Pacific States Marine Fisheries Commission.

4. Determine the short-term (24 h) effect of PIT-tagging on the survival of juvenile chinook salmon.

5. Compare average length of juvenile chinook salmon from Catherine Creek and the Imnaha, Lostine, Minam, and Wenaha rivers. Correlate average length with relative abundance and habitat quality.

6. Determine and compare cumulative detection rates and downstream migration timing of juvenile chinook salmon that were tagged and released in Catherine Creek and the upper Grande Ronde, Imnaha, Lostine, Minam, and Wenaha rivers in 1994.

Accomplishments in 1995

We achieved all but one of our objectives in 1995. We did not correlate average length with relative abundance and habitat quality because information on abundance was not collected.

Findings in 1995

We tagged and released 4,469 of 6,186 naturally-produced chinook salmon collected in five study streams. Only 67 of the fish that were collected were too small to tag (less than 60 mm fork length). Thus, we tagged fish that were fairly representative, with respect to length, of those collected. Tagged fish from the Lostine River were notably shorter on average than tagged fish from the other streams.

In 24 h mortality tests, mortality rates of fish that were handled and tagged were not significantly different from mortality rates of fish that were only handled. Only one tagged fish and none of the untagged fish (controls) died in the tests. We observed few mortalities among the remaining fish sampled in each stream. No mortalities were observed among fish that were tagged and released immediately after recovering from anesthesia, and only

0.18% of the fish that were collected died due to activities associated with collection.

Based on data expanded for spillway flow, the overall median migration date at Lower Granite Dam for fish from Catherine Creek and the upper Grande Ronde, Imnaha, Lostine, Minam, and Wenaha rivers was 5 May. Migration timing at Lower Granite Dam was significantly different among populations.

Overall median travel times from Lower Granite Dam to Little Goose, Lower Monumental, and McNary dams were five, seven, and 12 d'ays, respectively. Individual fish took as many as 42, 21, and 26 days to travel from Lower Granite Dam to Little Goose, Lower Monumental, and McNary dams, respectively.

Cumulative detection rates of individual populations ranged from 7.3% (Imnaha River) to 18.1% (Lostine River). The overall cumulative detection rate-in 1995 (13.8%) was lower than that in 1993 (17.2%) and 1994 (14.5%).

Thirteen tagged fish from the 1992 brood were detected at dams (in juvenile bypasses) in 1995, one year after they were expected to outmigrate. Sixty-two percent of these fish were between 55 and 59 mm (inclusive) when tagged in 1993, yet only 8% of-the fish tagged that year were in this size class. Of the total detections from the 1992 brood, 1.6% (13 of 841) occurred in 1995.

Management Implications

Over the past three migration years, migration timing at Lower Granite Dam varied among populations of naturally-produced chinook salmon smolts from the Grande Ronde and Imnaha River subbasins. Migrants from the Wenaha and upper Grande Ronde rivers were among the earliest and latest, respectively, to arrive at Lower Granite Dam each year. Hatchery fish released in Lookingglass Creek (Grande Ronde River subbasin) and the Imnaha River arrived at Lower Granite Dam during the early portion of the overall outmigration of naturally-produced fish. If procedures used to improve fish passage are implemented during a limited portion of the outmigration, the various populations probably will not benefit equally.

Recommendations

If mitigation efforts associated with fish passage are to benefit all populations equally, the migration timing of both hatchery and naturally-produced populations must be considered when developing and implementing fish passage procedures. We should continue to monitor the migration characteristics of juvenile chinook salmon from northeast Oregon so that information is continually updated and collected over a range of environmental conditions.

Limited data (due to sample size) from dam recoveries in 1995 indicated that fish that were less than 60 mm fork length at tagging were more likely to migrate to the ocean as age 3_3 smolts (age recorded by the system of' Gilbert

and Rich 1927) than longer fish. To evaluate this issue further, we recommend conducting an investigation to determine if a relationship exists between length at tagging and year of migration.

INTRODUCTION

This is the fourth year of a multi-year study to assess smolt migration characteristics and cumulative detection rates of naturally-produced chinook salmon (Oncorhynchus tshawytscha) from northeast Oregon streams. The goal of this project is to develop an understanding of interpopulation and interannual variation in several early life history characteristics of naturally-produced chinook salmon from the Grande Ronde and Imnaha River subbasins. This project provides information useful in the recovery of listed Snake River spring/summer chinook salmon. Specific populations included in the study are (1) Catherine Creek, (2) upper Grande Ronde River, (3) Lostine River, (4) Imnaha River, (5) Wenaha River, and (6) Minam River. In this document, we present findings from research completed in 1995.

Naturally-produced chinook salmon populations in the Grande Ronde and Imnaha River subbasins have declined drastically in recent years (Carmichael et al. 1991) due in part to habitat alterations (ASET 1979; Carmichael 1989; Raymond 1988) and hydropower development (Wedemeyer et al. 1985; Raymond 1988). Declines have continued despite extensive mitigation efforts, including fish passage improvements, artificial production, supplementation, and habitat modification (BPA Division of Fish and Wildlife 1990). Snake River spring/summer chinook salmon (hereafter referred to as chinook salmon), which include naturally-produced chinook salmon in the Grande Ronde and Inmaha River subbasins, have been listed under the Endangered Species Act of 1973 as threatened or endangered since 1992 (National Marine Fisheries Service 1992, 1994).

Information on smolt migration characteristics is essential to recovery efforts focused on fish passage in the Snake and Columbia rivers. With the development of the passive integrated transponder (PIT) tag (Prentice et al. 1990a) and remote PIT tag monitoring systems (Prentice et al. 1990b) in the mid-1980's, it became possible to identify individual fish and monitor the smolt migrations of specific populations at Snake and Columbia River dams. From 1989 to 1991 National Marine Fisheries Service (NMFS) personnel investigated the migration characteristics of PIT-tagged, naturally-produced chinook salmon smolts from four populations in northeast Oregon (Matthews et al: 1990, 1992; Achord et al. 1992). Since 1992, investigation of these and two additional populations has been conducted by the Oregon Department of Fish and Wildlife. Through long-term monitoring of the migration timing and detectSon rates.of these populations, we can increase our knowledge of population specific migration patterns, abundances, and responses to management actions designed to improve survival and preserve life hlstory patterns. Our study, along with those conducted by Matthews et al. (1990, 1992) and Achord et al. (1992), is providing information that can be used to develop flow targets (NMFS 1995) and be incorporated into the smolt monitoring program of the Fish Passage Center (FPC), which provides recommendations to guide modifications of flow, fish passage, and transport. This study is also providing information useful in assessing and identifying wild chinook salmon

stocks, in accordance with the Oregon Department of Fish and Wildlife's wild fish management policy, and in developing broodstock guidelines and supplementation strategies for future hatchery and captive rearing programs.

METHODS

We used information available from previous segments of this study and 1994 spawning ground surveys to select sampling sites for juvenile chinook salmon in 1995. We collected and PIT-tagged naturally-produced chinook salmon juveniles from Catherine Creek, and the Imnaha, Lostine, Minam, and Wenaha (mainstem and South Fork) rivers from 14 August through 14 September (Table 1). We snorkeled to locate juveniles and collected them either by seining or' by herding them into a seine set perpendicular to the stream flow.

PIT tags were implanted using methods similar to those described by Prentice et al. (1986, 199Oc) and Matthews et al. (1990, 1992). We tagged fish only at stream temperatures of 15°C or less., Fish were anesthetized with 40-50 ppm MS-222 (Strange and Schreck 1978; Matthews et al. 1990, 1992) and tagged manually using a modified 12-gauge hypodermic needle. Needles were disinfected for 10 minutes in 70% ethanol after a single use. We recorded the tag code, fork length (nearest 1 mm), and weight (nearest 0.1 g) of each PIT-tagged chinook salmon. We attempted to tag only fish that were 60 mm fork length or longer and appeared to be in good condition. We did not tag precocious males, fish collected for additional studies, nor fish collected in excess of the numeric goal for each stream. We released fish near the collection site once they had recovered from the anesthesia. Tagging data were incorporated into ASCII files, according to criteria developed by the PIT Tag Steering Committee, and then submitted to the Columbia River Basin PIT Tag Information System (PTAGIS) database, administered by the Pacific States Marine Fisheries Commission.

To determine the short-term effect of PIT-tagging on the survival of juvenile chinook salmon, we held tagged (treatment) and untagged (control) groups for 24 h and recorded all mortalities. Untagged controls were subjected to the same handling conditions as PIT-tagged fish, except they were not injected with a PIT tag. In all streams except Catherine Creek, 100 tagged and 50 untagged fish were held in two live cages, each containing 50 tagged and 25 untagged fish. In Catherine Creek, 50 tagged and 25 untagged fish were held in one live cage. Mortality rates of tagged and untagged groups were compared using a binomial test of two independent groups (Daniel 1990).

After the 1995 outmigration was completed, detection data at Lower Granite, Little Goose, Lower Monumental, and McNary dams were downloaded from the PTAGIS database. We pooled migration timing data for all six populations (Catherine Creek and the upper Grande Ronde, Imnaha, Lostine, Minam, and Wenaha rivers) to determine overall migration timing at Lower Granite Dam in 1995. In addition, we examined population specific migration timing at each of the four dams. Because some PIT-tagged fish may have passed undetected over each dam's spillway, and spill varied throughout the migration, migration timing data for pooled and individual populations were expanded for spillway flow. To expand detection data, we determined the arrival dates of fish

Table 1. Collection and tagging information for naturally-produced juvenile chinook salmon from five streams in the Grande Ronde and Imnaha River subbasins, 1995. Data exclude recaptured, PIT-tagged fish. Number collected includes fish collected for a captive brood program and a genetics study.

Stream	Dates collected	Number collected	Collection mortality	Number tagged and released	Overall tagging mortality
Catherine	8/29-9/1	1,139	1 (0.09%)	499	0 (0.00%)
Imnaha	9/12-9/14	1,134	2 (0.18%)	997	0 (0.00%)
Lostine	8/14-8/17	1,660	3 (0.18%)	978	0 (0.00%)
Minam	9/5-9/7	1,133	3 (0.26%)	998	1 (0.10%)
Wenaha	8/21-8/25	1,120	2 (0.18%)	997	0 (0.00%)
Total	8/14-9/14	6,186	11 (0.18%)	4,469	1 (0.02%)

detected for the first time at each dam, multiplied the number of fish detected each day by an expansion factor (Appendix Table A-1), which was calculated as

(Powerhouse Flow + Spillway Flow)/ Powerhouse Flow,

and rounded the product to the nearest integer. We used expanded daily detections, the Kruskal-Wallis test (Hollander and Wolfe 1973; SAS Institute 1988), and a multiple-comparisons procedure (at alpha=0.15; Daniel 1990) to analyze migration timing at Lower Granite Dam.

To estimate travel time between Lower Granite Dam and Little Goose, Lower Monumental, and McNary dams, we used observations of individual fish detected at Lower Granite and one or more of the downstream dams. Travel time for each individual was calculated as the difference, in days, between the dates of initial detection within the bypass system at Lower Granite Dam and Little Goose,, Lower Monumental, or McNary dams. We calculated median travel times and 95% confidence intervals (Snedecor and Cochran 1980) for each population and all populations pooled.

The final migration characteristic evaluated was cumulative detection rate at Snake and Columbia River dams. To calculate cumulative detection rates for individual populations, we divided the sum of the unexpanded first-time detections for each population by the total number of fish tagged and released in each stream. We combined detection and tagging numbers for individual populations to calculate an overall cumulative detection rate.

RESULTS AND DISCUSSION

We tagged and released 4,469 of 6,186 chinook salmon collected from Catherine Creek and the Imnaha, Lostine, Minam, and Wenaha rivers in 1995. We tagged and released approximately 1,000 fish in each stream except Catherine Creek, where 500 fish were tagged and released (Table 1). Fork lengths of tagged fish were similar to fork lengths of fish that were collected (Table 2), suggesting that, at least with respect to length, tagged fish were representative of the sample population. Only 67 fish were released because they were too small (less than 60 mm fork length) to tag; all but one were from the Lostine River. Mean fork length and weight of tagged fish varied among populations (Tables 2 and 3). Fish from the Lostine River were notably smaller on average than fish from the other streams.

Mortality rates of tagged and control groups in 24 h mortality tests were not significantly different (P=0.239). No fish among the control groups died, and one fish from the Minam River died shortly after being tagged. The overall 24 h mortality rate observed in 1995 (0.22%) was within the range (0.0 - 1.5%) reported in previous years of this study (Walters et al. 1992, 1993, 1994) and in similar studies in Idaho and Oregon (Matthews et al. 1990, 1992; Achord et al . 1992, 1994, 1995).

We observed few mortalities among fish that were sampled but not included in mortality tests. No mortalities were observed among fish that were tagged and released immediately after recovering from anesthesia, and only 11 fish were killed during collections (Table 1). The overall collection mortality rate in 1995 (0.18%; Table 1) was lower than that in 1992 (0.26%), 1993 (0.38%), and 1994 (0.33%). We suspect a change in methods, from seining to primarily herding fish into a seine, reduced collection mortalities.

The pooled migration timing of all study populations at Lower Granite Dam is presented in Figure 1. The overall median date of arrival at Lower Granite Dam was 5 May. Similar overall median dates of arrival were observed in 1993 (8 May) and 1994 (5 May) (Walters et al. 1993, 1994). Detections generally increased with increasing flow (Figure 1) as in 1994, but somewhat in contrast *to 1993, when a large portion of the migrants were detected before* flows began to increase (Walters et al. 1993).

Migration timing of individual populations at Lower Granite, Little Goose, Lower Monumental, and McNary dams is presented in Figures 2-7 and Appendix Tables 8-1 through B-6. The median date of arrival at Lower Granite Dam ranged from 26 April for the Wenaha River population (n=76; Figure 7) to 29 May for the upper Grande Ronde River population (n=89; Figure 3). The median date of arrival at McNary Dam, the farthest downstream of the four

Table 2.' Mean fork length (mm) of all naturally-produced juvenile chinook salmon collected and those PIT-tagged and released in five streams in the Grande Ronde and Imnaha River subbasins, 1995. SE = standard error, Min = minimum length, Max = maximum length. Number collected includes fish collected for a captive brood program and a genetics study.

	Collected				
Stream	N	Mean	SE	Min	Max
Catherine Cr.	1,075	83.0	0.26	65	139
Imnaha	1,083	77.2	0.22	58	119
Lostine	1,605	68.9	0.19	49	129
Mi nam	1,098	80.6	0.22	62	115
Wenaha	1,100	82.8	0.24	60	130

	PIT-tagged and released				
Stream	N	Mean	SE	Min	Max
Catherine Cr.	496	82.3	0.29	66	104
Imnaha	982	76.9	0.21	60	110
Losti ne	975	69.2	0.22	57	97
Minam	991	80.5	0.22	62	115
Wenaha	994	82.3	0.22	64	109

dams, ranged from 5 to 26 May for the Wenaha River (n=9; Figure 7).and Catherine Creek (n=6; Figure 2) populations, respectively. Migration timing at Lower Granite Dam was significantly different among populations (P=0.0001). Multiple comparisons of migration timing indicated that migrants from Catherine Creek and the upper Grande Ronde River arrived later at Lower Granite Dam than the other populations, and that Wenaha River migrants arrived

Table 3. Mean weight (g) of naturally-produced juvenile chinook salmon PIT-tagged and released in five streams in the Grand Ronde and Imnaha River subbasins, 1995. SE = standard error, Min = minimum weight, Max = maximum weight.

	PIT-tagged and released				
	N	Mean	SE	Min	Max
Catherine Cr.	499	6.75	0.075	3.2	13.6
Imnaha	996	5.59	0.049	2.4	16.0
Lostine	971	3.98	0.049	1.8	11.5
Mi nam	997	6.16	0.052	2.7	16.4
Wenaha	992	6.63	0.058	1.7	14.8

earlier than those from the Imnaha River (Figure 8). In each outmigration from 1993 to 1995, migrants from the Wenaha River were among the earliest whereas migrants from the upper Grande Ronde River were among the latest to arrive at Lower Granite Dam.

Estimates of travel time between Lower Granite and the dams downstream are presented in Figure 9 and Appendix Table C-1. When data for all populations were pooled, median travel times (95% 'confidence interval) from Lower Granite Dam to Little Goose, Lower Monumental, and McNary dams were 5 (5-6), 7 (6-7), and 12 (10-13) days, respectively. For individual populations, median travel times ranged from 4 to 6 days (Lower Granite to Little Goose), 6 to 8 days (Lower Granite to Lower Monumental), and 9.5 to 14 days (Lower Granite to McNary). Individual fish took as many as 42, 21, and 26 days to travel from Lower Granite to Little Goose, Lower Monumental, and McNary dams, respectively.

Cumulative detection rates ranged from 7.3% to 18.1% for the Imnaha and Lostine River populations, respectively (Table 4). The overall cumulative detection rate for migrants in 1995 (13.8%; Table 4) was lower than that observed in 1993 and 1994 (17.2 and 14.5%, respectively; Walters et al. 1993, 1994). For all but the Grande Ronde and Lostine River populations, detection rates were lower in 1995 than in the two previous years. Detection rates for the Grande Ronde and Lostine River populations were higher than in 1994 but lower than in 1993. The general reduction of detection rates in 1995 might be attributed to the fact that fish tagged in 1994 were smaller on average than fish tagged in 1992 and 1993. A relationship may exist between size at tagging and detection rates (Walters et al. 1994). Variations-in the amount of spill at dams also might have accounted for the difference in detection

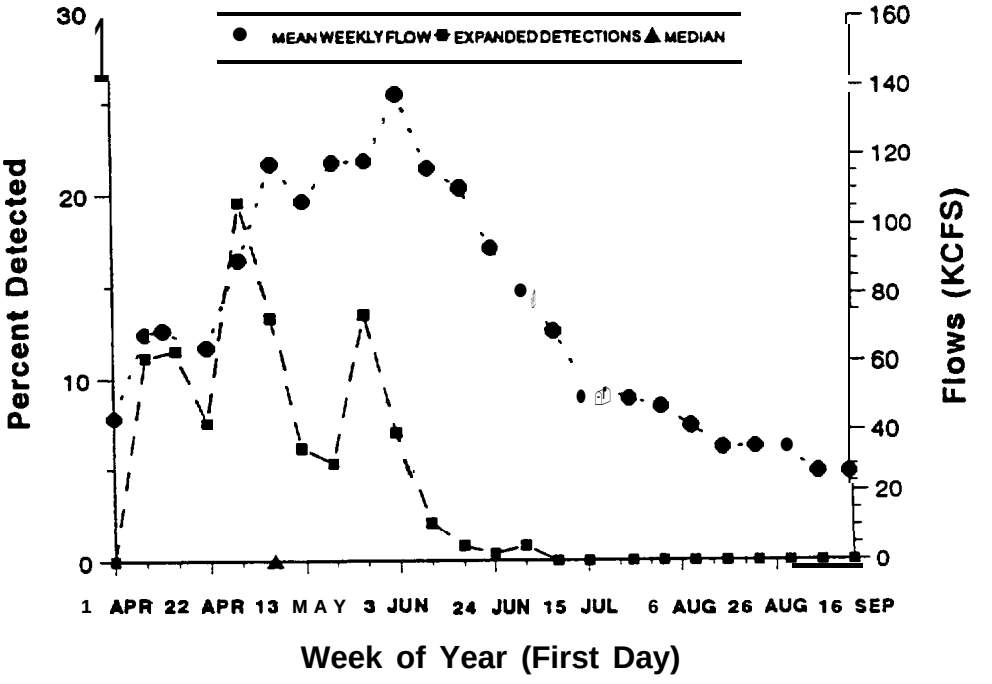

Figure 1. Migration timing of naturally-produced juvenile chinook salmon from the Grande Ronde and Imnaha River subbasins, and flow at Lower Granite Dam, 1995 migration year. ▲ = median arrival date. Daily arrival numbers were expanded for spillway flow.

rates among years. Mean percent spill at Lower Granite, Little Goose, Lower Monumental, and McNary dams was higher in 1995 (19%) than in 1993 (15%) and 1994 (12%). After three years of data collection, trends in detection rates are evident only for the Lostine and Imnaha River populations. Detection rates of fish from the Lostine River have been among the highest observed each year, while detection rates of fish from the Imnaha River have been among the lowest observed each year. Ranks of detection rates for the remaining populations have varied among years.

Thirteen tagged fish from the 1992 brood were detected at dams (in juvenile bypasses) in 1995, one year after they were expected to outmigrate. Sixty-two percent of these fish were between 55 and 59 mm fork length (inclusive) when tagged in 1993, yet only 8% of the fish tagged that year were in this size class. The importance of this finding is uncertain because of the small sample size and lack of replication. However, given the management implications if a relationship between size at tagging and year of migration actually exists, we believe the issue should be investigated further.

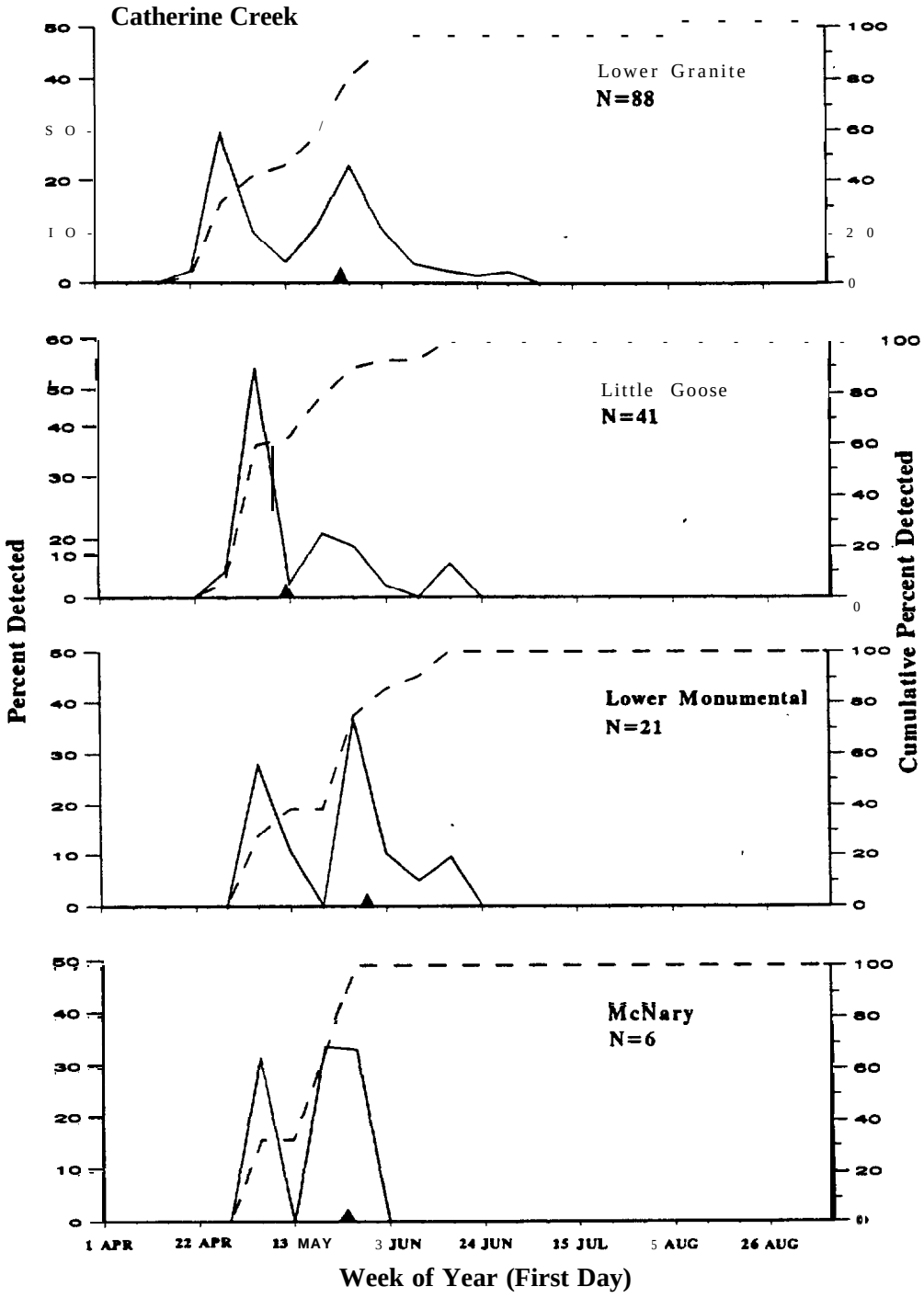

Figure 2. Migration timing at Lower Granite, Little Goose, Lower Monumental, and McNary dams for naturally-produced juvenile chinook salmon from Catherine Creek, 1995 migration year. ▲ = median arrival date. Data were from first-time detections at each dam and were expanded for spillway flow.

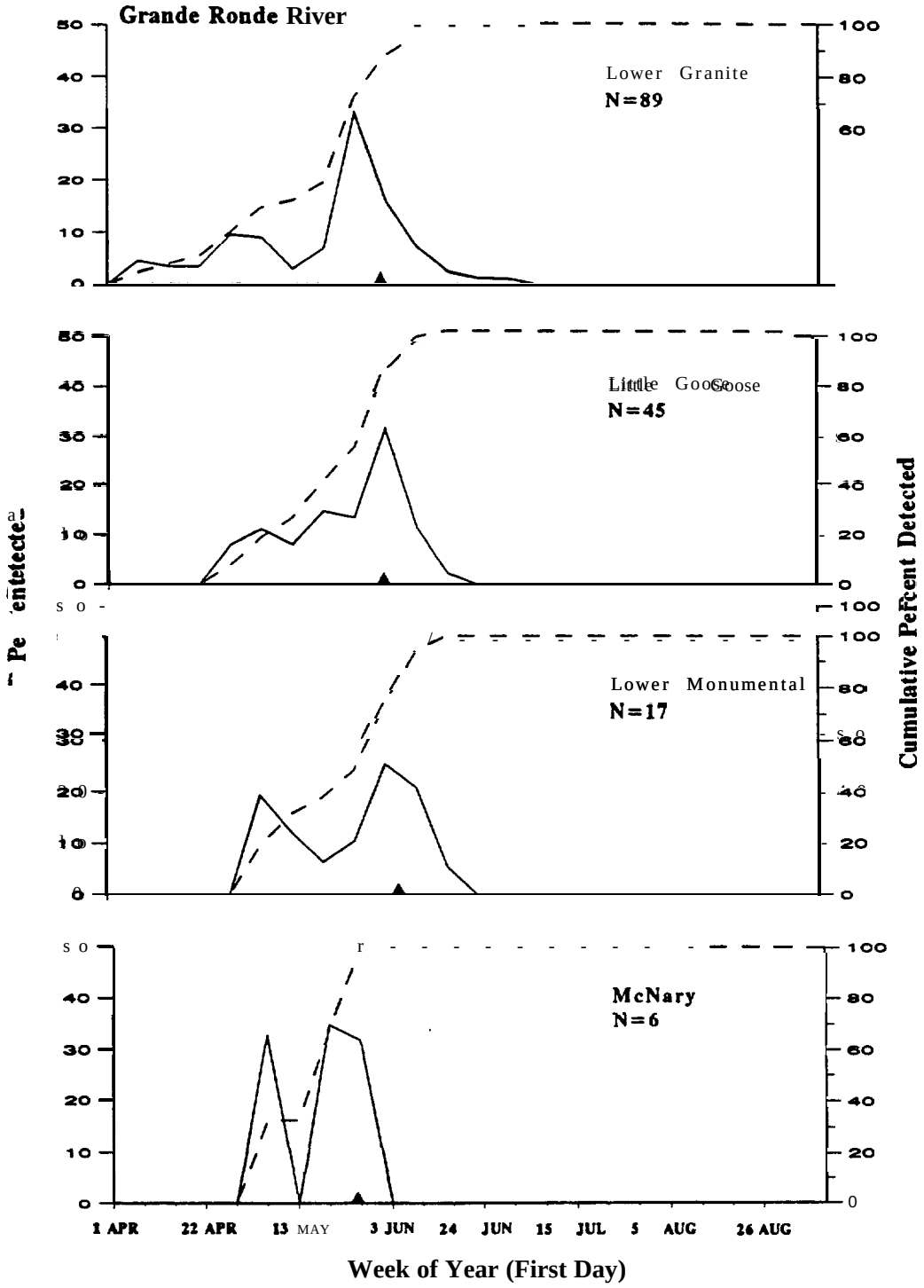

Figure 3. Migration timing at Lower Granite, Little Goose, Lower Monumental, and McNary dams for naturally-produced juvenile chinook salmon from the Grande Ronde River, 1995 migration year. ▲ = median arrival date. Data were from first-time detections at each dam and were expanded for spillway flow.

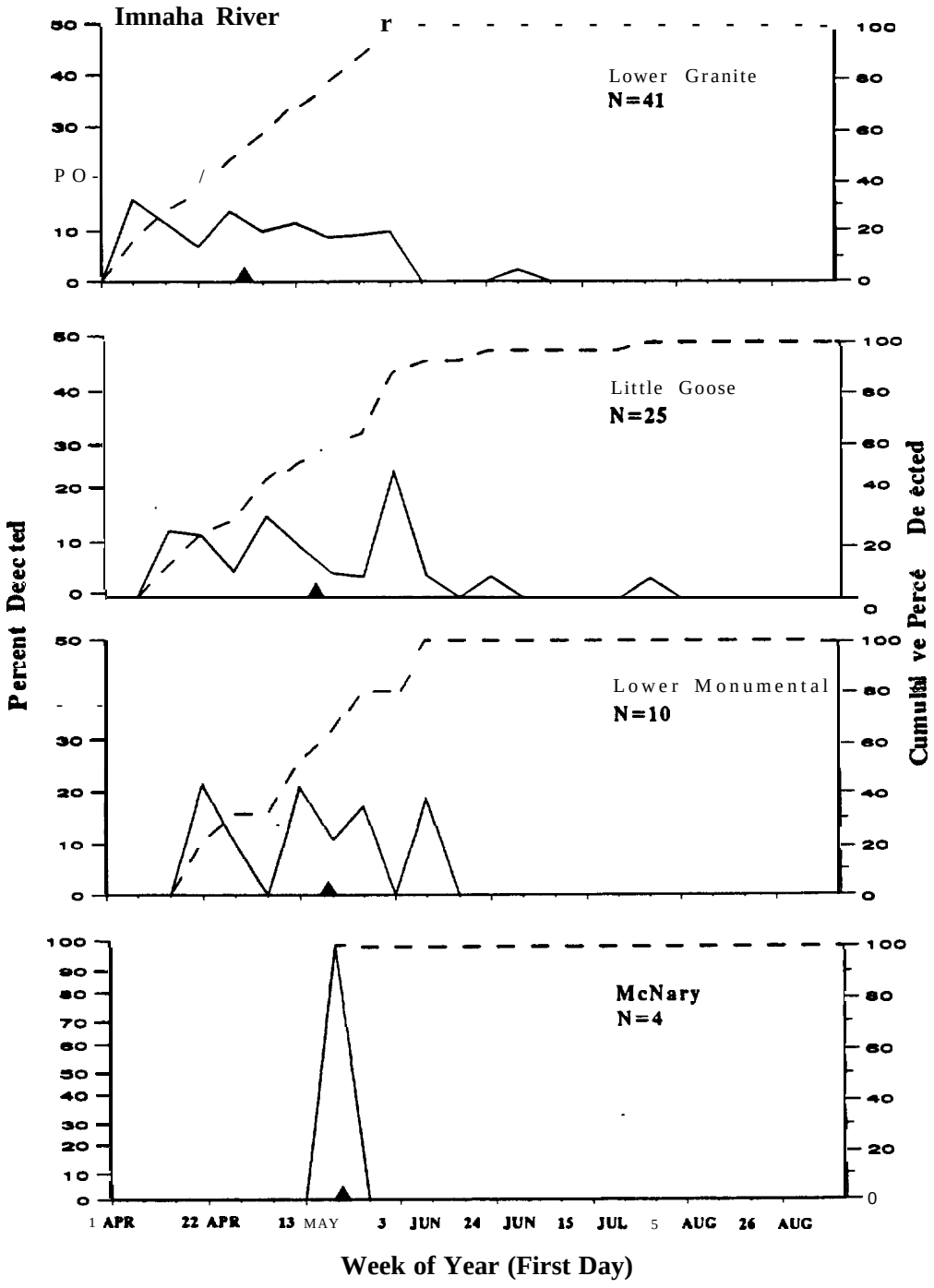

Figure 4. Migration timing at Lower Granite, Little Goose, Lower Monumental, and McNary dams for naturally-produced juvenile chinook salmon from the Imnaha River, 1995 migration year. ▲ = median arrival date. Data were from first-time detections at each dam and were expanded for spillway flow.

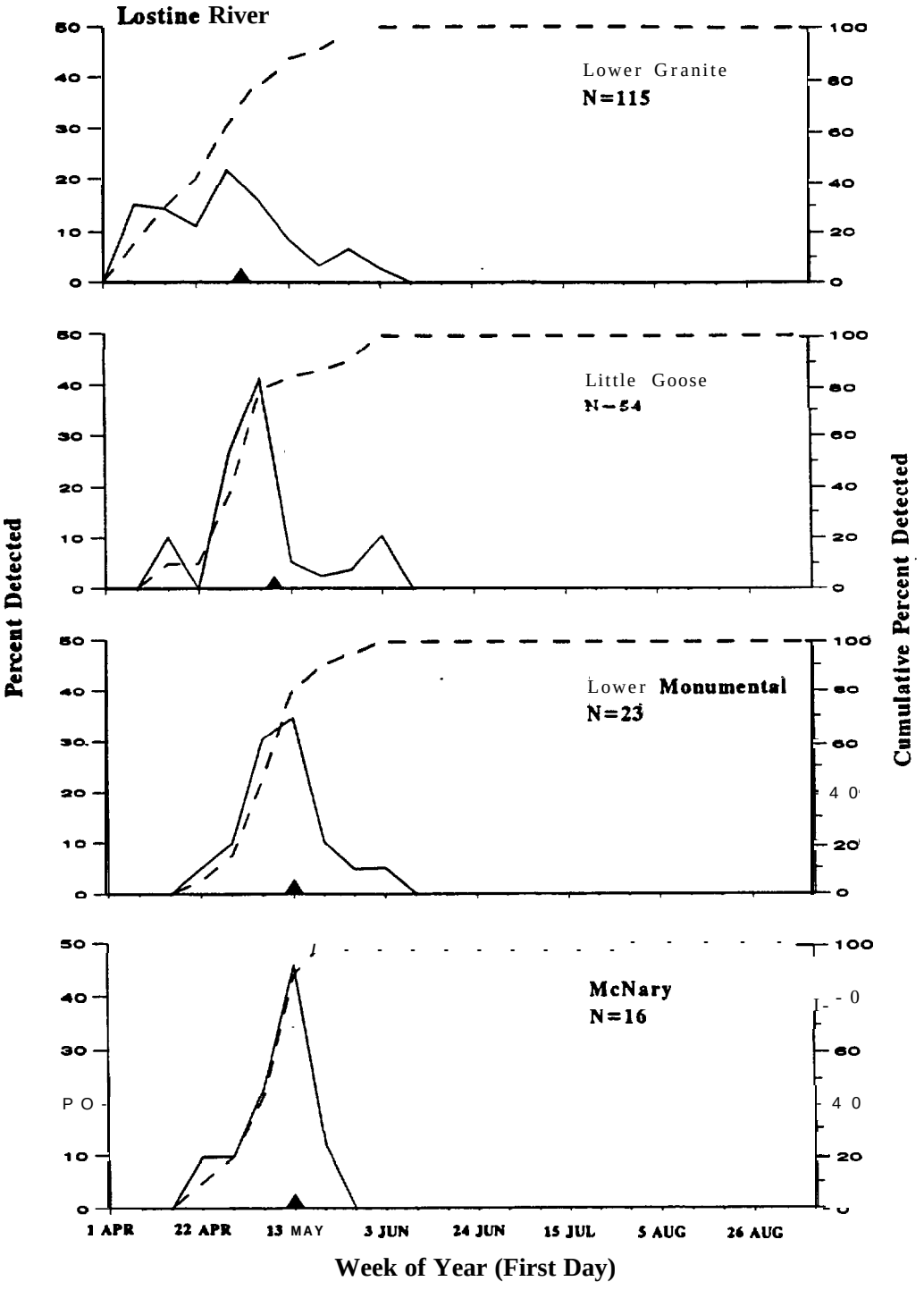

Figure 5. Migration timing at Lower Granite, Little Goose, Lower Monumental, and McNary dams for naturally-produced juvenile chinook salmon from the Lostine River, 1995 migration year. ▲ = median arrival date. Data were from first-time detections at each dam and were expanted for spillway flow.

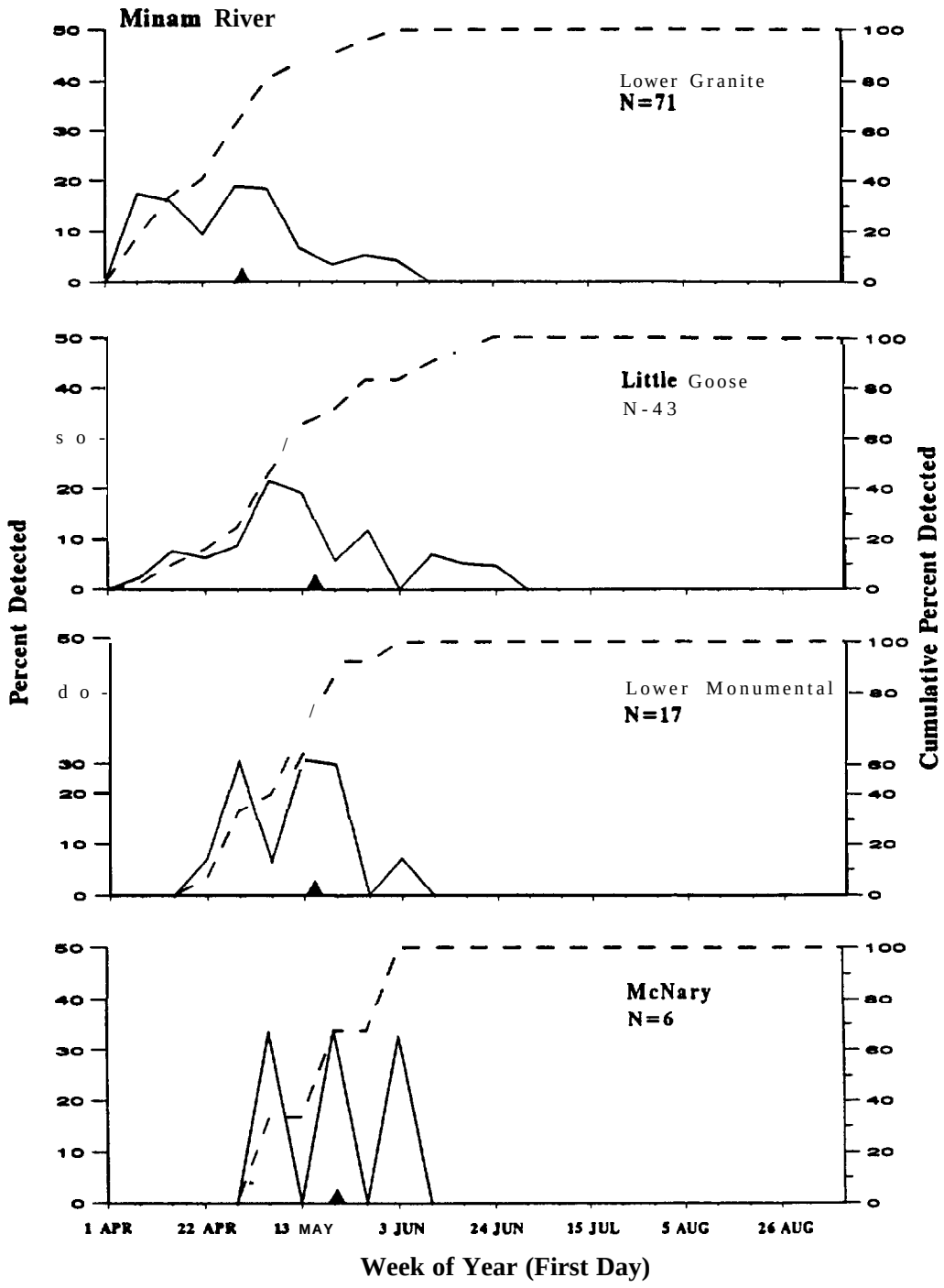

Figure 6. Migration timing at Lower Granite, Little Goose, Lower Monumental, and McNary dams for naturally-produced juvenile chinook salmon from the Minam River, 1995 migration year. ▲ = median arrival date. Data were from first-time detections at each dam and were expanded for spillway flow.

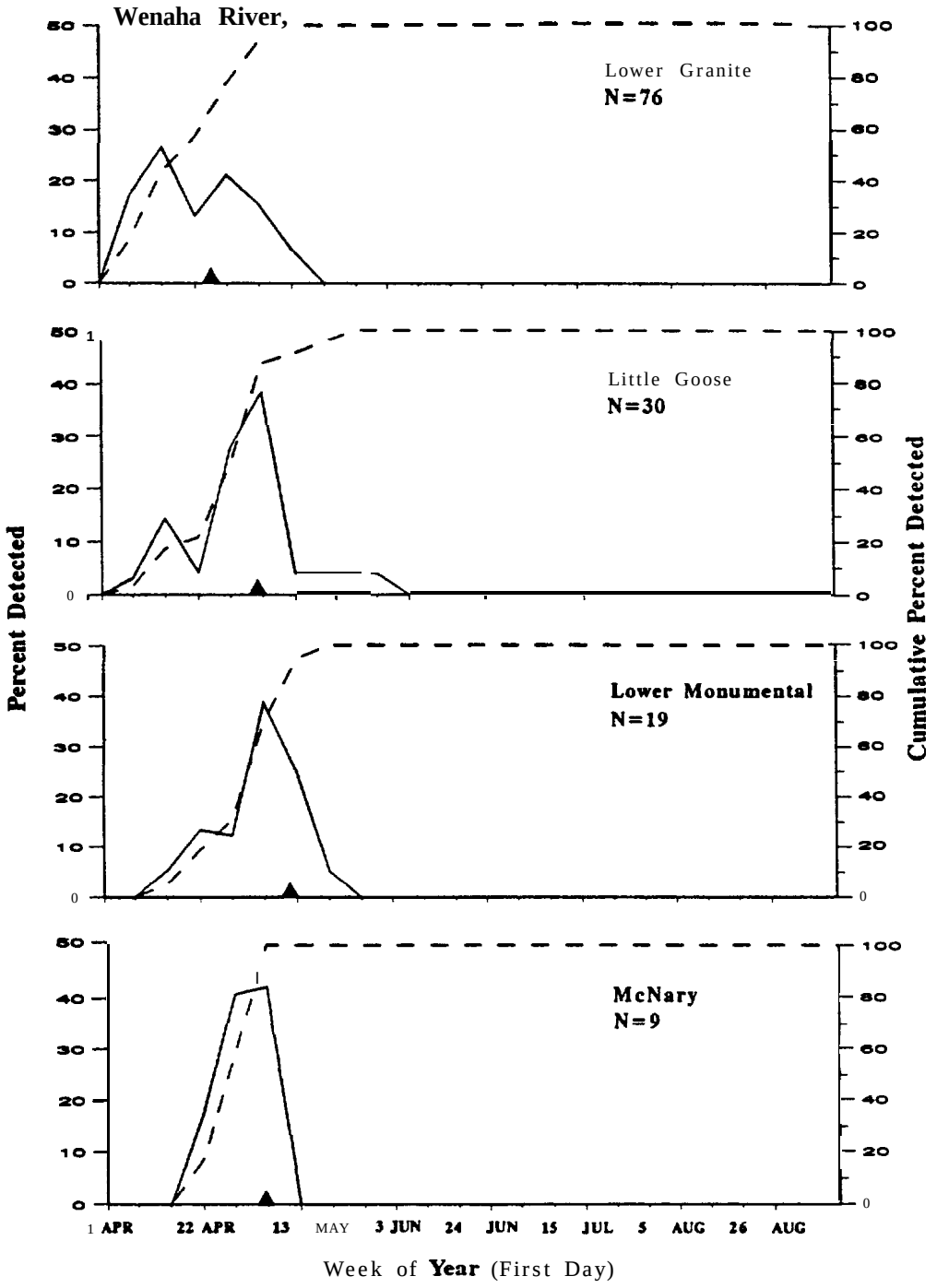

Figure 7. Migration timing at Lower Granite, Little Goose, Lower Monumental, and McNary dams for naturally-produced juvenile chinook salmon from the Wenaha River, 1995 migration year. ▲ = median arrival date. Data were from first-time detections at each dam and were expanded for spillway flow.

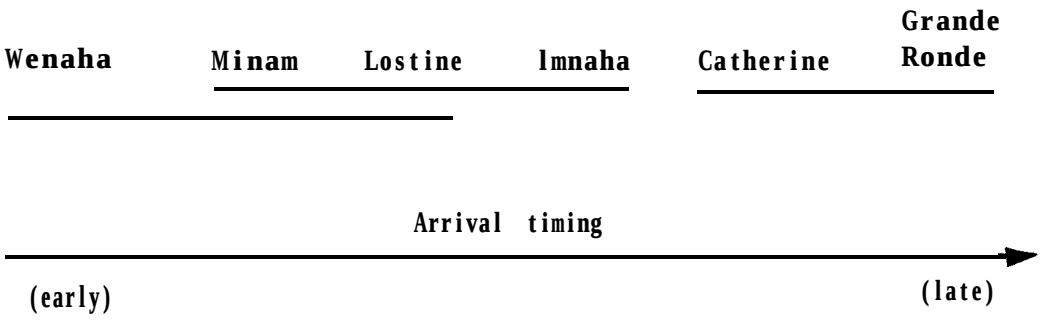

Figure 8. Results of multiple comparisons of arrival timing at Lower Granite Dam for juvenile chinook salmon migrants from Catherine Creek and the Grande Ronde, Imnaha, Lostine, Minam, and Wenaha (mainstem and South Fork) rivers, 1995. Arrival timing was significantly different for populations that do not share a line.

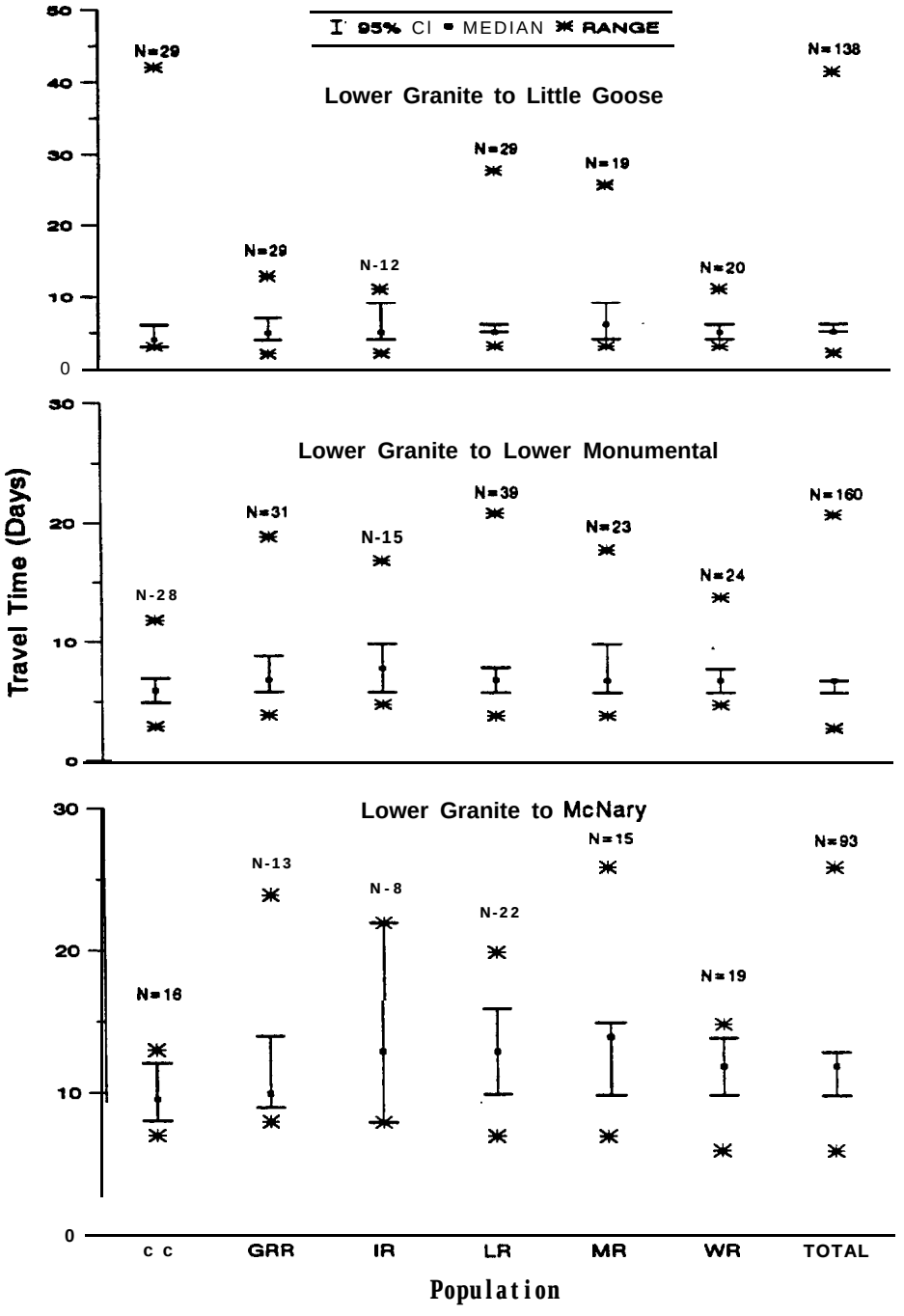

Figure 9. Travel time (in days) between Lower Granite Dam and Little Goose, Lower Monumental, and McNary dams for naturally-produced juvenile chinook salmon from northeast Oregon streams, 1995 migration year. Travel times were based on data from individual fish and on differences between initial detection times in the bypass systems at each dam. CC = Catherine Creek, GRR. = Grande Ronde River, IR = Imnaha River, LR = Lostine River, MR = Minam River, and WR = Wenaha River (mainstem and South Fork).

Table 4. First-time detections by dam site (% of release) during the 1995 migration year for naturally-produced juvenile chinook salmon PIT-tagged on six streams in the Grande Ronde and Imnaha River subbasins in 1994 Data were not expanded for spillway flow.

Stream	Number released	Lower Granite	Little Goose	Lower Monumental	McNary	Total
Catherine	1,000	81 (8.1)	34 (3.4)	20 (2.0)	3 (0.3)	138 (13.8)
Grande	999	82 (8.2)	40 (4.0)	17 (1.7)	3 (0.3)	142 (14.2)
Imnaha	996	40 (4.0)	21 (2.1)	10 (1.0)	2 (0.2)	73 (7.3)
Lostine	1,002	112 (11.2)	40 (4.0)	20 (2.0)	9 (0.9)	181 (18.1)
Minam	996	70 (7.0)	36 (3.6)	15 (1.5)	3 (0.3)	124 (12.4)
Wenaha	999	74 (7.4)	25 (2.5)	16 (1.6)	5 (0.5)	120 (12.0)
TOTAL	5,992	459 (7.7)	196 (3.3)	98 (1.6)	25 (0.4)	778 (13.0)

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APPENDIX A

Expansion factors for spillway flow at mainstem Snake and Columbia River dams, 1995

Appendix Table A-1. Expansion factors for spillway flow at mainstem Snake and Columbia River dams, 1995. Expansion factor is (spillway flow + powerhouse flow)/powerhouse flow.

DATE	GRANITE EXPANSION	GOOSE EXPANSION	LOWER MONUMENTAL EXPANSION	MCNARY EXPANSION
4/01/95	1	1	1	1
4/02/94	1	1	1	1
4/03/95	1	1	1	1
4/04/95	1	1	1	1
4/05/95	1	1	1	1.08
4/06/95	1	1	1	1.31
4/07/95	1	1	1	1.2
4/08/95	1	1	1	1.03
4/09/95	1	1	1	1
4/10/95	1	1	1	1
4/11/95	1	1	1	1.16
4/12/95	1	1	1	1.04
4/13/95	1	1	1	1.02
4/14/95	1	1.03	1.03	1.33
4/15/95	1	1.09	1.07	1.21
4/16/95	1	1.12	1.07	1.19
4/17/95	1	1.15	1.07	1.1
4/18/95	1	1.24	1.08	1.25
4/19/95	1	1.31	1.12	1.23
4/20/95	1	1.32	1.15	1.23
4/21/95	1	1.43	1.2	1.14
4/22/95	1	1.51	1.27	1.34
4/23/95	1	1.67	1.43	1.3
4/24/95	1	1.68	1.38	1.46
4/25/95	1	1.53	1.32	1.38
4/26/95	1	1.5	1.32	1.55
4/27/95	1	1.4	1.24	1.48
4/28/95	1	1.36	1.23	1.41
4/29/95	1	1.31	1.2	1.33
4/30/95	1	1.3	1.2	1.44
5/01/95	1	1.32	1.23	1.49
5/02/95	1	1.32	1.26	1.68
5/03/95	1.12	1.3	1.22	1.6
5/04/95	1.28	1.31	1.22	1.63
5/05/95	1.29	1.33	1.24	1.81
5/06/95	1.28	1.34	1.26	1.78
5/07/95	1.25	1.4	1.27	1.64
5/08/95	1.27	1.45	1.33	1.68
5/09/95	1.24	1.45	1.32	1.74
5/10/95	1.24	1.42	1.32	1.67
5/11/95	1.27	1.4	1.27	1.78
5/12/95	1.22	1.35	1.23	1.68
5/13/95	1.24	1.57	1.27	1.71

Appendix Table A-l, Continued (spillway expansion factors).

DATE	GRANITE EXPANSION	GOOSE EXPANSION	LOWER MONUMENTAL EXPANSION	MCNARY EXPANSION
5/14/95	1.27	1.57	1.21	1.61
5/15/95	1.3	1.49	1.25	1.85
5/16/95	1.28	1.34	1.24	1.88
5/17/95	1.26	1.32	1.23	1.89
5/18/95	1.26	1.34	1.21	1.84
5/19/95	1.28	1.29	1.24	1.8
5/20/95	1.32	1.35	1.29	1.86
5/21/95	1.31	1.34	1.29	1.8
5/22/95	1.3	1.49	1.28	1.82
5/23/95	1.29	1.4	1.28	1.9
5/24/95	1.3	1.35	1.25	1.84
5/25/95	1.21	1.24	1.18	1.95
5/26/95	1.22	1.06	1.04	1.85
5/27/95	1.06	1.03	1.02	1.72
5/28/95	1.06	1.03	1.02	1.6
5/29/95	1.07	1.02	1.19	1.7
5/30/95	1.06	1.12	1.11	1.87
5/31/95	1.06	1.14	1.1	1.65
6/01/95	1.09	1.27	1.25	1.69
6/02/95	1.08	1.31	1.36	1.63
6/03/95	1.09	1.31	1.26	1.73
6/04/95	1.1	1.35	1.32	1.73
6/05/95	1.14	1.44	1.35	1.74
6/06/95	1.2	1.45	1.38	1.8
6/07/95	1.13	1.36	1.27	1.89
6/08/95	1.1	1.25	1.24	1.89
6/09/95	1.07	1.15	1.14	1.8
6/10/95	1.06	1.1	1.08	1.82
6/11/95	1.07	1.03	1	1.83
6/12/95	1.06	1.07	1.06	1.88
6/13/95	1.06	1.12	1.15	1.85
6/14/95	1.06	1.25	1.16	1.89
6/15/95	1.09	1.2	1.18	1.83
6/16/95	1.12	1.19	1.18	1.67
6/17/95	1.12	1.14	1.12	1.57
6/18/95	1.12	1.17	1.13	1.63
6/19/95	1.18	1.17	1.14	1.71
6/20/95	1.23	1.17	1.16	1.78
6/21/95	1.25	1.13	1.12	1.67
6/22/95	1.13	1.11	1.11	1.7
6/23/95	1	1.14	1.13	1.82
6/24/95	1	1.2	1.13	1.75
6/25/95	1	1.29	1.13	1.83
6/26/95	1	1.15	1.16	1.76

Appendix Table A-1, Continued (spillway expansion factors).

DATE	GRANITE EXPANSION	GOOSE EXPANSION	LOWER MONUMENTAL EXPANSION	MCNARY EXPANSION
6/27/95	1	1	1.21	1.81
6/28/95	1	1.06	1.09	1.8
6/29/95	1	1.12	1	1.77
6/30/95	1	1	1	1.74
7/01/95	1	1	1	1.53
7/02/95	1	1	1	1.23
7/03/95	1	1	1	1.24
7/04/95	1	1	1	1.25
7/05/95	1	1	1	1.3
7/06/95	1	1	1	1.34
7/07/95	1	1	1	1.33
7/08/95	1	1	1	1.08
7/09/95	1	1	1	1
7/10/95	1	1	1	1
7/11/95	1	1	1	1
7/12/95	1	1	1	1.03
7/13/95	1	1	1	1.03
7/14/95	1	1	1	1
7/15/95	1	1	1	1
7/16/95	1	1	1	1
7/17/95	1	1	1	1
7/18/95	1	1	1	1
7/19/95	1	1	1	1
7/20/95	1	1	1	1
7/21/95	1	1	1	1
7/22/95	1	1	1	1
7/23/95	1	1	1	1
7/24/95	1	1	1	1
7/25/95	1	1	1	1
7/26/95	1	1	1	1
7/27/95	1	1	1	1.04
7/28/95	1	1	1	1.11
7/29/95	1	1	1	1
7/30/95	1	1	1	1
7/31/95	1	1	1	1
8/01/95	1	1	1	1
8/02/95	1	1	1	1
8/03/95	1	1	1	1
8/04/95	1	1	1	1
8/05/95	1	1	1	1
8/06/95	1	1	1	1
8/07/95	1	1	1	1
8/08/95	1	1	1	1
8/09/95	1	1	1	1

Appendix Table A-1, Continued (spillway expansion factors).

DATE	GRANITE EXPANSION	GOOSE EXPANSION	LOWER MONUMENTAL EXPANSION	MCNARY EXPANSION
8/10/95	1	1	1	1
8/11/95	1	1	1	1
8/12/95	1	1	1	1
8/13/95	1	1	1	1
8/14/95	1	1	1	1
8/15/95	1	1	1	1
8/16/95	1	1	1	1
8/17/95	1	1	1	1
8/18/95	1	1	1	1
8/19/95	1	1	1	1
8/20/95	1	1	1	1
8/21/95	1	1	1	1
8/22/95	1	1	1	1
8/23/95	1	1	1	1
8/24/95	1	1	1	1
8/25/95	1	1	1	1
8/26/95	1	1	1	1
8/27/95	1	1	1	1
8/28/95	1	1	1	1
8/29/95	1	1	1	1
8/30/95	1	1	1	1
8/31/95	1	1	1	1

APPENDIX B

Observation data for juvenile chinook salmon PIT-tagged on various rivers in northeast Oregon in 1994 and observed at various dams in 1995

Appendix Table B-1. Freqency of tag observations by date for spring chinook salmon PIT tagged on Catherine Creek in 1994 and observed at various dams in 1995. A = first observation of individual tags, B = tags previously detected at one dam, C = tags previously detected at two dams, D = tags previously detected at three dams, and Σ = sum of all tag observations by date at a particular dam.

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
15	4/09/95	0			0				0					0
15	4/10/95	0			0				0					0
15	4/11/95	0			0				0					0
15	4/12/95	0			0				0					0
15	4/13/95	0			0				0					0
15	4/14/95	0			0				0					0
15	4/15/95	0			0				0					0
16	4/16/95	0			0				0					0
16	4/17/95	0			0				0					0
16	4/18/95	0			0				0					0
16	4/19/95	0			0				0					0
16	4/20/95	0			0				0					0
16	4/21/95	0			0				0					0
16	4/22/95	0			0				0					0
17	4/23/95	0			0				0					0
17	4/24/95	0			0				0					0
17	4/25/95	0			0				0					0
17	4/26/95	1			0				0					0
17	4/27/95	0			0				0					0
17	4/28/95	1			0				0					0
17	4/29/95	0			0				0					0
18	4/30/95	3		1	1				0					0
18	5/01/95	4			0				0					0
18	5/02/95	9			0				0					0
18	5/03/95	6	1	1	2				0					0
18	5/04/95	2	1	1	2				0					0
18	5/05/95	2		1	1		1	1	2					0
18	5/06/95	1	5	0	5		3	1	4					0
19	5/07/95	3	1	2	3	1			1					0
19	5/08/95	2	3	4	7	1	3	1	5					0
19	5/09/95	3		0	0	2	5		7					0
19	5/10/95	0	3	3	6		1	1	2				1	1
19	5/11/95	0	3	1	4	1	2	1	4	1				1
19	5/12/95	0	2	1	3		1	1	2		1	3	1	5
19	5/13/95	0			0	1	1		2		1	2		3
20	5/14/95	0			0	1			1					0
20	5/15/95	0			0				0			1	1	2

Appendix Table B-l, Continued (Catherine Creek).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	.	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
20	5/16/95	0			0					0		2		1	3
20	5/17/95	0	1		1					0		1			1
20	5/18/95	0			0					0		1			1
20	5/19/95	3			0					0					0
20	5/20/95	1			0					0					0
21	5/21/95	1	1		1					0					0
21	5/22/95	0	1		1					0					0
21	5/23/95	1			0					0	1	1			2
21	5/24/95	4		1	1					0					0
21	5/25/95	0	3		3					0					0
21	5/26/95	1			0			2		2					0
21	5/27/95	1	2		2		3	1		4					0
22	5/28/95	2	1	2	3		2	1	1	4					0
22	5/29/95	0	1	1	2		1	1		2					0
22	5/30/95	3	1		1		1		1	2	1	1	1		3
22	5/31/95	3			0					0			1		1
22	6/01/95	3			0		1			1		3			3
22	6/02/95	4			0			1		1					0
22	6/03/95	2			0		1	2		3					0
23	6/04/95	2		1	1			1		1					0
23	6/05/95	1			0					0		1	2		3
23	6/06/95	2			0					0		1			1
23	6/07/95	0		1	1			1		1					0
23	6/08/95	1	1	1	2					0					0
23	6/09/95	1		1	1		1			1		1			1
23	6/10/95	0			0				1	1		1			1
24	6/11/95	1		1	1					0					0
24	6/12/95	0			0					0					0
24	6/13/95	0			0					0		1			1
24	6/14/95	0			0			1		1					0
24	6/15/95	2			0		1			1					0
24	6/16/95	0			0					0					0
24	6/17/95	0	1		1		1			1					0
25	6/18/95	1		1	1		1			1					0
25	6/19/95	0			0					0		1			1
25	6/20/95	0	1		1					0					0
25	6/21/95	1			0					0		1			1
25	6/22/95	0	1		1			1		1		1			1
25	6/23/95	0		1	1					0					0
25	6/24/95	0			0					0					0
26	6/25/95	0			0					0					0
26	6/26/95	0			0					0					0

Appendix Table B-l, Continued (Catherine Creek).

		LOWER GRANITE		LITTLE GOOSE		LOWER MONUMENTAL						MCNARY				
WEEK	DATE	TE		A	A	B	Σ	A	B	C	1	A	B	C	D	Σ
26	6/27/95	0			0					0					0	
26	6/28/95	1		1	1					0					0	
26	6/29/95	0			0					0					0	
26	6/30/95	0			0				1	1					0	
26	7/01/95	1			0					0					0	
27	7/02/95	1			0					0					0	
27	7/03/95	0			0					0					0	
27	7/04/95	0		1	1					0					0	
27	7/05/95	0			0					0					0	
27	7/06/95	0			0					0					0	
27	7/07/95	0			0					0					0	
27	7/08/95	0			0					0					0	
28	7/09/95	0			0					0					0	
28	7/10/95	0			0				1	1					0	
28	7/11/95	0			0					0					0	
28	7/12/95	0			0					0					0	
28	7/13/95	0			0					0					0	
28	7/14/95	0			0					0					0	
28	7/15/95	0			0					0					0	
29	7/16/95	0			0					0					0	
29	7/17/95	0			0					0					0	
29	7/18/95	0			0					0					0	
29	7/19/95	0			0					0					0	
29	7/20/95	0			0					0					0	
29	7/21/95	0			0					0					0	
29	7/22/95	0			0					0					0	
30	7/23/95	0			0					0					0	
30	7/24/95	0			0					0					0	
30	7/25/95	0			0					0					0	
30	7/26/95	0			0					0					0	
30	7/27/95	0			0					0					0	
30	7/28/95	0			0					0					0	
30	7/29/95	0			0					0					0	
31	7/30/95	0			0					0					0	
31	7/31/95	0			0					0					0	
31	8/01/95	0			0					0					0	
31	8/02/95	0			0					0					0	
31	8/03/95	0			0					0					0	
31	8/04/95	0			0					0					0	
31	8/05/95	0			0					0					0	
32	8/06/95	0			0					0					0	
32	8/07/95	0			0					0					0	
32	8/08/95	0			0					0					0	

Appendix Table B-1 Continued (Catherine Creek).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
32	8/09/95	0			0				0					0
32	8/10/95	0			0				0					0
32	8/11/95	0			0				0					0
32	8/12/95	0			0				0					0
33	8/13/95	0			0				0					0
33	8/14/95	0			0				0					0
33	8/15/95	0			0				0					0
33	8/16/95	0			0				0					0
33	8/17/95	0			0				0					0
33	8/18/95	0			0				0					0
33	8/19/95	0			0				0					0
34	8/20/95	0			0				0					0
34	8/21/95	0			0				0					0
34	8/22/95	0			0				0					0
34	8/23/95	0			0				0					0
34	8/24/95	0			0				0					0
34	8/25/95	0			0				0					0
34	8/26/95	0			0				0					0
35	8/27/95	0			0				0					0
35	8/28/95	0			0				0					0
35	8/29/95	0			0				0					0
35	8/30/95	0			0				0					0
35	8/31/95	0			0				0					0
35	9/01/95	0			0				0					0
35	9/02/95	0			0				0					0
36	9/03/95	0			0				0					0
36	9/04/95	0			0				0					0
36	9/05/95	0			0				0					0
36	9/06/95	0			0				0					0
36	9/07/95	0			0				0					0
36	9/08/95	0			0				0					0
36	9/09/95	0			0				0					0
37	9/10/95	0			0				0					0
37	9/11/95	0			0				0					0
37	9/12/95	0			0				0					0
37	9/13/95	0			0				0					0
37	9/14/95	0			0				0					0
37	9/15/95	0			0				0					0
Total		81	34	28	62	20	29	11	60	3	19	10	4	36

Appendix Table B-2. Frequency of tag observations by date for spring chinook salmon PIT tagged on the upper Grande Ronde River in 1994 and observed at various dams in 1995. A = first observation of individual tags, B = tags previously detected at one dam, C = tags previously detected at two dams, D = tags previously detected at three dams, and Σ = sum of all tag observations by date at a particular dam.

		LOWER GRANITE			LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE															
		D	A	T	E	A	A	B	Σ	A	B	C	1	A	B	C	D	Σ
15	4/12/95			2			0					0						0
15	4/13/95			0			0					0						0
15	4/14/95			2			0					0						0
15	4/15/95			0			0					0						0
16	4/16/95			0			0					0						0
16	4/17/95			0			0					0						0
16	4/18/95			1			0					0						0
16	4/19/95			0		1	1					0						0
16	4/20/95			2			0					0						0
16	4/21/95			0		1	1				1	1						0
16	4/22/95			0			0					0						0
17	4/23/95			0			0					0						0
17	4/24/95			0			0					0						0
17	4/25/95			0			0					0						0
17	4/26/95			0			0					0						0
17	4/27/95			2			0			1		1						0
17	4/28/95			1		1	1			1		1						0
17	4/29/95			0			0					0						0
18	4/30/95			2	1		1					0						0
18	5/01/95			3			0					0						0
18	5/02/95			0			0					0						0
18	5/03/95			2			0			1		1						0
18	5/04/95			2	1		1					0						0
18	5/05/95			0	1		1			1		1				1		1
18	5/06/95			1	1	1	2			1		1						0
19	5/07/95			0			0		1	1		2						0
19	5/08/95			2		1	1			1	1	2			1			1
19	5/09/95			1			0		1	2		3		1				1
19	5/10/95			4	1		1		1		1	2				1		1
19	5/11/95			0	2	1	3			1		1				1		1
19	5/12/95			0		1	1			1		1						0
19	5/13/95			1		1	1			1		1				2		2
20	5/14/95			0			0				1	1			1		1	2
20	5/15/95			0			0					0						0
20	5/16/95			0			0			1		1						0
20	5/17/95			0			0		1			1						0
20	5/18/95			1	2		2					0					1	1

Appendix Table B-2, Continued (upper Grande Ronde River).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
20	5/19/95	0	1		1	1								0
20	5/20/95	0	1		1		1		:					0
21	5/21/95	1			0	1			1					0
21	5/22/95	1			0		1		1					0
21	5/23/95	0	1	1	2				0			1		1
21	5/24/95	3			0				0					0
21	5/25/95	0	2		2				0			1		1
21	5/26/95	0	2		2				0	1				1
21	5/27/95	1		1	1	1			1					0
22	5/28/95	4	2	1	3				0					0
22	5/29/95	3			0		1		1					0
22	5/30/95	3	1		1			1	1					0
22	5/31/95	6	2		2	1	1		2					0
22	6/01/95	3	1		1		1	1	2	1	1			2
22	6/02/95	4			0		1		1			1		1
22	6/03/95	6	1		1	1	1		2					0
23	6/04/95	2		2	2		2		2			1	1	2
23	6/05/95	2		2	2	1	1		2		1			1
23	6/06/95	1	3		3	1		2	3					0
23	6/07/95	1	3	3	6		2		2					0
23	6/08/95	1	2	2	4				0					0
23	6/09/95	1	3	1	4	1	2	1	4				1	1
23	6/10/95	1	2	1	3	2	2		4				1	1
24	6/11/95	0	1		1	1	1		2		2			2
24	6/12/95	1		1	1	1			1					0
24	6/13/95	0			0		3	1	4					0
24	6/14/95	2	1		1		1	1	2					0
24	6/15/95	2			0		1		1		1			1
24	6/16/95	0	1		1				0		1			1
24	6/17/95	0		1	1				0		1			1
25	6/18/95	0			0	1	1		2					0
25	6/19/95	0		1	1		1		1					0
25	6/20/95	1			0				0					0
25	6/21/95	1		1	1				0					0
25	6/22/95	0	1		1				0					0
25	6/23/95	0		1	1				0					0
25	6/24/95	0			0			1	1					0
26	6/25/95	0			0		1		1					0
26	6/26/95	0			0				0					0
26	6/27/95	0			0				0					0
26	6/28/95	0			0				0					0
26	6/29/95	1			0				0					0
26	6/30/95	0			0		1		1					0
26	7/01/95	1			0			1	1					0

Appendix Table B-2, Continued (upper Grand Ronde River).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	1	A	B	C	D	Σ
27	7/02/95	0			0				0				0	
27	7/03/95	0			0				0				0	
27	7/04/95	0			0				0				0	
27	7/05/95	0			0				0				0	
27	7/06/95	0		1	1				0				0	
27	7/07/95	0			0				0				0	
27	7/08/95	0			0				0				0	
28	7/09/95	0		1	1				0				0	
28	7/10/95	0			0				0				0	
28	7/11/95	0			0				0				0	
28	7/12/95	0			0			1	1				0	
28	7/13/95	0			0				0				0	
28	7/14/95	0			0				0			1	1	
28	7/15/95	0			0				0				0	
29	7/16/95	0			0				0				0	
29	7/17/95	0			0				0				0	
29	7/18/95	0			0				0				0	
29	7/19/95	0			0				0				0	
29	7/20/95	0			0				0				0	
29	7/21/95	0			0				0				0	
29	7/22/95	0			0				0				0	
30	7/23/95	0			0				0				0	
30	7/24/95	0			0				0				0	
30	7/25/95	0			0				0				0	
30	7/26/95	0			0				0				0	
30	7/27/95	0			0				0				0	
30	7/28/95	0			0				0				0	
30	7/29/95	0			0				0				0	
31	7/30/95	0			0				0				0	
31	7/31/95	0			0				0				0	
31	8/01/95	0			0				0				0	
31	8/02/95	0			0				0				0	
31	8/03/95	0			0				0				0	
31	8/04/95	0			0				0				0	
31	8/05/95	0			0				0				0	
32	8/06/95	0			0				0				0	
32	8/07/95	0			0				0				0	
32	8/08/95	0			0				0				0	
32	8/09/95	0			0				0				0	
32	8/10/95	0			0				0				0	
32	8/11/95	0			0				0				0	
32	8/12/95	0			0				0				0	
33	8/13/95	0			0				0				0	
33	8/14/95	0			0				0				0	

Appendix Table B-2, Continued (upper Grande Ronde River).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	1	A	B	C	D	Σ
33	8/15/95	0			0			0					0	
33	8/16/95	0			0			0					0	
33	8/17/95	0			0			0					0	
33	8/18/95	0			0			0					0	
33	8/19/95	0			0			0					0	
34	8/20/95	0			0			0					0	
34	8/21/95	0			0			0					0	
34	8/22/95	0			0			0					0	
34	8/23/95	0			0			0					0	
34	8/24/95	0			0			0					0	
34	8/25/95	0			0			0					0	
34	8/26/95	0			0			0					0	
35	8/27/95	0			0			0					0	
35	8/28/95	0			0			0					0	
35	8/29/95	0			0			0					0	
35	8/30/95	0			0			0					0	
35	8/31/95	0			0			0					0	
35	9/01/95	0			0			0					0	
35	9/02/95	0			0			0					0	
36	9/03/95	0			0			0					0	
36	9/04/95	0			0			0					0	
36	9/05/95	0			0			0					0	
36	9/06/95	0			0			0					0	
36	9/07/95	0			0			0					0	
36	9/08/95	0			0			0					0	
36	9/09/95	0			0			0					0	
37	9/10/95	0			0			0					0	
37	9/11/95	0			0			0					0	
37	9/12/95	0			0			0					0	
37	9/13/95	0			0			0					0	
37	9/14/95	0			0			0					0	
37	9/15/95	0			0			0					0	
Total		82	40	29	69	17	39	14	70	3	9	9	6	27

Appendix Table B-3. Frequency of tag observations by date for spring chinook salmon PIT tagged on the Imnaha River in 1994 and observed at various dams in 1995. A = first observation of individual tags, B = tags previously detected at one dam, C = tags previously detected at two dams, D = tags previously detected at three dams, and Σ = sum ,of all tag observations by date at a particular dam.

		LOWER GRANITE		LITTLE GOOSE			LOWER MONUMENTAL					MCNARY				
WEEK	DATE															
		A	E	A	B	Σ	A	B	C	1	A	B	C	D	Σ
15	4/10/95	2							0						0
15	4/11/95	1							0						0
15	4/12/95	0							0						0
15	4/13/95	2							0						0
15	4/14/95	2							0						0
15	4/15/95	1		1	1				0						0
16	4/16/95	1	1		1				0						0
16	4/17/95	1	2		2				0						0
16	4/18/95	1		1	1				0						0
16	4/19/95	0			0				0						0
16	4/20/95	1			0		1	1	2						0
16	4/21/95	0			0				0						0
16	4/22/95	0	1		1		1		1						0
17	4/23/95	1			0		1		1						0
17	4/24/95	0	1		1				0						0
17	4/25/95	0			0	1			1						0
17	4/26/95	0			0				0						0
17	4/27/95	1			0				0					1	1
17	4/28/95	1		1	1	1			1						0
17	4/29/95	2			0	1			1						0
18	4/30/95	0			0				0						0
18	5/01/95	2			0				0						0
18	5/02/95	1	1		1				0						0
18	5/03/95	1		2	2				0		1				1
18	5/04/95	0			0				0						0
18	5/05/95	0			0				0		1				1
18	5/06/95	0		1	1				0		1				1
19	5/07/95	1		1	1				0						0
19	5/08/95	1			0			1	1		1				1
19	5/09/95	1			0				0			1			1
19	5/10/95	0			0				0						0
19	5/11/95	1	2		2				0						0
19	5/12/95	0	1		1				0					1	1
19	5/13/95	0			0		1		1			1			1
20	5/14/95	1		1	1				0						0
20	5/15/95	1			0		2	1	3						0
20	5/16/95	0			0	1	1		2						0
20	5/17/95	1	1		1				0			1			1

Appendix Table B-3, Continued (Imnaha River).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	1	A	B	C	D	Σ
20	5/18/95	0			0				0				0	
20	5/19/95	1	1		1	1	1		2				0	
20	5/20/95	1			0				0	1	1		2	
21	5/21/95	0			0				0	1			1	
21	5/22/95	0			0				0				0	
21	5/23/95	1			0	1			1				0	
21	5/24/95	1		1	1				0				0	
21	5/25/95	0	1		1				0	1			1	
21	5/26/95	1			0		1	1	2				0	
21	5/27/95	1	1		1	2			2				0	
22	5/28/95	0			0		1		1				0	
22	5/29/95	0			0				0				0	
22	5/30/95	1			0				0				0	
22	5/31/95	0			0				0				0	
22	6/01/95	0			0		1		1				0	
22	6/02/95	0			0				0				0	
22	6/03/95	2		1	1				0				0	
23	6/04/95	2			0				0		1		1	
23	6/05/95	0			0			1	1				0	
23	6/06/95	0	1		1				0				0	
23	6/07/95	0	1		1				0				0	
23	6/08/95	0	2		2		1		1				0	
23	6/09/95	0	1	1	2				0			1	1	
23	6/10/95	0	1	1	2		1		1				0	
24	6/11/95	0			0		1		1				0	
24	6/12/95	0			0	1	2		3				0	
24	6/13/95	0			0		1		1				0	
24	6/14/95	0			0	1			1				0	
24	6/15/95	0			0				0				0	
24	6/16/95	0			0				0				0	
24	6/17/95	0			0				0				0	
25	6/18/95	0			0				0				0	
25	6/19/95	0			0		1		1				0	
25	6/20/95	0			0				0				0	
25	6/21/95	0			0				0	1			1	
25	6/22/95	0			0				0				0	
25	6/23/95	0			0				0				0	
25	6/24/95	0			0				0				0	
26	6/25/95	0			0				0				0	
26	6/26/95	0			0				0				0	
26	6/27/95	0			0				0				0	
26	6/28/95	0	1		1				0				0	
26	6/29/95	0			0				0				0	
26	6/30/95	0			0				0				0	

Appendix Table B-3, Continued (Imnaha River).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
26	7/01/95	0			0				0					0
27	7/02/95	0			0				0					0
27	7/03/95	0			0				0					0
27	7/04/95	0			0				0					0
27	7/05/95	0			0				0					0
27	7/06/95	0			0				0					0
27	7/07/95	1			0				0					0
27	7/08/95	0			0				0					0
28	7/09/95	0			0				0					0
28	7/10/95	0			0				0					0
28	7/11/95	0			0				0					0
28	7/12/95	0			0				0					0
28	7/13/95	0			0				0					0
28	7/14/95	0			0				0					0
28	7/15/95	0			0				0					0
29	7/16/95	0			0				0					0
29	7/17/95	0			0				0					0
29	7/18/95	0			0				0					0
29	7/19/95	0			0				0					0
29	7/20/95	0			0				0					0
29	7/21/95	0			0				0					0
29	7/22/95	0			0				0					0
30	7/23/95	0			0				0					0
30	7/24/95	0			0				0					0
30	7/25/95	0			0				0					0
30	7/26/95	0			0				0					0
30	7/27/95	0			0				0					0
30	7/28/95	0			0				0					0
30	7/29/95	0			0				0					0
31	7/30/95	0	1		1				0					0
31	7/31/95	0			0				0					0
31	8/01/95	0			0				0					0
31	8/02/95	0			0				0					0
31	8/03/95	0			0				0					0
31	8/04/95	0			0				0					0
31	8/05/95	0			0				0					0
32	8/06/95	0			0				0					0
32	8/07/95	0			0				0					0
32	8/08/95	0			0				0					0
32	8/09/95	0			0				0					0
32	8/10/95	0			0				0					0
32	8/11/95	0			0				0					0
Total		40	21	12	33	10	18	5	33	2	6	5	3	16

Appendix Table B-4. Frequency of tag observations by date for spring chinook salmon PIT tagged on the Lostine River in 1994 and observed at various dams in 1995. A = first observation of individual tags, B = tags previously detected at one dam, C = tags previously detected at two dams, D = tags previously detected at three dams, and Σ = sum of all tag observations by date at a particular dam.

		LOWER GRANITE			LITTLE GOOSE			LOWER MONUMENTAL					MCNARY					
WEEK	D	A	T	E	A		A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
14	4/08/95		1				0					0					0	
15	4/09/95		0				0					0					0	
15	4/10/95		3				0					0					0	
15	4/11/95		7				0					0					0	
15	4/12/95		4				0					0					0	
15	4/13/95		2				0					0					0	
15	4/14/95		1				0					0					0	
15	4/15/95		3			1	1					0					0	
16	4/16/95		5		1	3	4			1		1					0	
16	4/17/95		0			1	1					0					0	
16	4/18/95		4				0				1	1					0	
16	4/19/95		3			2	2			1		1					0	
16	4/20/95		1			1	1				1	1					0	
16	4/21/95		1		3		3			1	1	2					0	
16	4/22/95		1			1	1					0					0	
17	4/23/95		0			2	2					0					0	
17	4/24/95		0				0					0					0	
17	4/25/95		1				0			2		2					0	
17	4/26/95		3				0					0					0	
17	4/27/95		4				0			1		1	1					1
17	4/28/95		4				0	1	1			2		1				1
17	4/29/95		1				0					0		1		1		2
18	4/30/95		1		2	2	4					0		1				1
18	5/01/95		7		1		1	1	1			2	1		3			4
18	5/02/95		6				0					0						0
18	5/03/95		3		2	1	3					0			1			1
18	5/04/95		4		1		1			1		1		1				1
18	5/05/95		4		5	1	6	1				1						0
18	5/06/95		2		2	1	3			1		1	1	1				2
19	5/07/95		4		2	2	4	2	5		1	8			1			1
19	5/08/95		3			1	1			2	1	3						0
19	5/09/95		4			1	1			1	2	3		1				1
19	5/10/95		2		5	2	7			1	1	2		2				2
19	5/11/95		3		5		5	3	3		1	7						0
19	5/12/95		0		2		2	1	3			4	1	1	2			4
19	5/13/95		1				0	2				2	1	2				3
20	5/14/95		4		1	1	2	2	4			6	1	1	1			3
20	5/15/95		1				0		1			1	1		1			2

Appendix Table B-4, Continued (Lostine River).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
20	5/16/95	1			0	1	2	1	4		1	2		3
20	5/17/95	1	1	1	2	2			2		2			2
20	5/18/95	0		1	1				0	1		2		3
20	5/19/95	0			0				0					0
20	5/20/95	1			0				0		1			1
21	5/21/95	1			0				0			1		1
21	5/22/95	0			0				0				1	1
21	5/23/95	0			0	1	2		3					0
21	5/24/95	0	1		1	1			1	1				1
21	5/25/95	1		1	1		1		1					0
21	5/26/95	0			0				0					0
21	5/27/95	1	1		1		1	1	2		1	1		2
22	5/28/95	0	1	1	2				0					0
22	5/29/95	1			0	1			1					0
22	5/30/95	3			0			1	1		1			1
22	5/31/95	1			0				0			1	1	2
22	6/01/95	0			0				0					0
22	6/02/95	0			0				0					0
22	6/03/95	2			0	1			1					0
23	6/04/95	0			0				0					0
23	6/05/95	0	1		1		1		1		1			1
23	6/06/95	0	2		2				0					0
23	6/07/95	0		1	1		1		1					0
23	6/08/95	0	1		1		1		1					0
23	6/09/95	1			0				0					0
23	6/10/95	0		1	1				0					0
24	6/11/95	0			0				0					0
24	6/12/95	0			0				0					0
24	6/13/95	0			0				0					0
24	6/14/95	0			0				0					0
24	6/15/95	0			0			1	1					0
24	6/16/95	0			0				0					0
24	6/17/95	0			0				0					0
25	6/18/95	0			0				0					0
25	6/19/95	0			0				0					0
25	6/20/95	0			0				0					0
25	6/21/95	0			0				0					0
25	6/22/95	0			0				0					0
25	6/23/95	0			0				0					0
25	6/24/95	0			0				0					0
26	6/25/95	0			0				0					0
26	6/26/95	0			0				0					0
26	6/27/95	0			0				0					0
26	6/28/95	0			0				0					0

Appendix Table B-4, Continued (Lostine River).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	ABC1				ABC			D	Σ
26	6/29/95	0		0				0						0
26	6/30/95	0		0				0						0
26	7/01/95	0		0				0						0
27	7/02/95	0		0				0						0
27	7/03/95	0		0				0						0
27	7/04/95	0		0				0						0
27	7/05/95	0		0				0						0
27	7/06/95	0		0				0						0
27	7/07/95	0		0				0						0
27	7/08/95	0		0				0						0
28	7/09/95	0		0				0						0
28	7/10/95	0		0				0						0
28	7/11/95	0		0				0						0
28	7/12/95	0		0				0						0
28	7/13/95	0		0				0						0
28	7/14/95	0		0				0						0
28	7/15/95	0		0				0						0
29	7/16/95	0		0				0						0
29	7/17/95	0		0				0						0
29	7/18/95	0		0				0						0
29	7/19/95	0		0				0						0
29	7/20/95	0		0				0						0
29	7/21/95	0		0				0						0
29	7/22/95	0		0				0						0
30	7/23/95	0		0				0						0
30	7/24/95	0		0				0						0
30	7/25/95	0		0				0						0
30	7/26/95	0		0				0						0
30	7/27/95	0		0				0						0
30	7/28/95	0		0				0						0
30	7/29/95	0		0				0						0
31	7/30/95	0		0				0						0
31	7/31/95	0		0				0						0
31	8/01/95	0		0				0						0
31	8/02/95	0		0				0						0
31	8/03/95	0		0				0						0
31	8/04/95	0		0				0						0
31	8/05/95	0		0				0						0
32	8/06/95	0		0				0						0
32	8/07/95	0		0				0						0
32	8/08/95	0		0				0						0
32	8/09/95	0		0				0						0
Total		112	40	29	69	20	39	13	72	9	19	16	3	47

Appendix Table B-5. Frequency of tag observations by date for spring chinook salmon PIT tagged on the Minam River in 1994 and observed at various dams in 1995. A = first observation of individual tags, B = tags previously detected at one dam, C = tags previously detected at two dams, D = tags previously detected at three dams, and Σ = sum of all tag observations by date at a particular dam.

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
14	4/08/95	1			0				0					0
15	4/09/95	0			0				0					0
15	4/10/95	4			0				0					0
15	4/11/95	0			0				0					0
15	4/12/95	4			0				0					0
15	4/13/95	2			0				0					0
15	4/14/95	2	1		1				0					0
15	4/15/95	2			0				0					0
16	4/16/95	3	1		1				0					0
16	4/17/95	3	1		1				0					0
16	4/18/95	1	1	1	2				0					0
16	4/19/95	1		1	1				0					0
16	4/20/95	1		1	1		2	1	3					0
16	4/21/95	1			0		1	1	2					0
16	4/22/95	0			0		1		1					0
17	4/23/95	1		1	1				0					0
17	4/24/95	0		1	1			1	1					0
17	4/25/95	1			0				0					0
17	4/26/95	1	1		1	1			1					0
17	4/27/95	2			0				0					0
17	4/28/95	2	1		1				0			1	1	2
17	4/29/95	2			0				a		2			2
18	4/30/95	2		1	1				0					0
18	5/01/95	2	1		1		1		1		1	1		2
18	5/02/95	2		1	1				0		1			1
18	5/03/95	1			0	1			1					0
18	5/04/95	3		2	2	3	1	1	5		1			1
18	5/05/95	2	2		2		1		1					0
18	5/06/95	0			0		1		1	1	1			2
19	5/07/95	0		1	1		2		2		1			1
19	5/08/95	3	2	1	3			1	1		1		1	2
19	5/09/95	1			0			1	1					0
19	5/10/95	4	2		2		1		1		2	2		4
19	5/11/95	1	3		3				0					0
19	5/12/95	3			0	1	1		2					0
19	5/13/95	1	3		3	2	3		5		1			1
20	5/14/95	0			0	1			1			1	1	2
20	5/15/95	0	1	1	2		1		1		2	1		3

Appendix Table B-5, Continued (Minam River).

WEEK	DATE	LOWER GRANITE A	LITTLE GOOSE A	LITTLE GOOSE B	LITTLE GOOSE Σ	LOWER MONUMENTAL A	LOWER MONUMENTAL B	LOWER MONUMENTAL C	LOWER MONUMENTAL 1	MCNARY A	MCNARY B	MCNARY C	MCNARY D	MCNARY Σ
20	5/16/95	1	1		1		1		1	2			2	
20	5/17/95	0			0		2	1	3	1	1		2	
20	5/18/95	1			0	1	1		2	1			1	
20	5/19/95	1	1		1				0	1			1	
20	5/20/95	0	1	1	2				0				0	
21	5/21/95	1		3	3	1	1		2	1			1	
21	5/22/95	0			0	1			1				0	
21	5/23/95	0			0			1	1			1	1	
21	5/24/95	1			0				0				0	
21	5/25/95	0	1	1	2	1			1				0	
21	5/26/95	0			0	1		1	2				0	
21	5/27/95	0	1		1			1	1				0	
22	5/28/95	2	1		1		1		1				0	
22	5/29/95	0			0				0				0	
22	5/30/95	1	2	1	3				0				0	
22	5/31/95	0	1		1		1		1				0	
22	6/01/95	0			0				0				0	
22	6/02/95	0			0				0	1			1	
22	6/03/95	0			0				0				0	
23	6/04/95	0			0				0				0	
23	6/05/95	0			0	1			1	1			1	
23	6/06/95	2			0		1		1				0	
23	6/07/95	1		1	1				0				0	
23	6/08/95	0			0				0				0	
23	6/09/95	0			0		1	1	2				0	
23	6/10/95	0	1		1				0				0	
24	6/11/95	0	2		2				0				0	
24	6/12/95	0			0				0				0	
24	6/13/95	0			0				0				0	
24	6/14/95	0			0				0				0	
24	6/15/95	0			0				0				0	
24	6/16/95	0			0				0				0	
24	6/17/95	0			0				0				0	
25	6/18/95	0			0				0				0	
25	6/19/95	0			0				0				0	
25	6/20/95	0	1		1				0	1			1	
25	6/21/95	0			0				0				0	
25	6/22/95	0			0				0				0	
25	6/23/95	0	1		1				0				0	
25	6/24/95	0			0				0				0	
26	6/25/95	0			0				0				0	
26	6/26/95	0	1		1				0				0	
26	6/27/95	0	1		1				0				0	
26	6/28/95	0			0				0				0	

Appendix Table B-5, Continued (Minam River).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	B	C	D	Σ
26	6/29/95	0			0		1		1					0
26	6/30/95	0			0		1		1					0
26	7/01/95	0			0				0					0
27	7/02/95	0			0				0			1		1
27	7/03/95	0			0				0					0
27	7/04/95	0			0				0					0
27	7/05/95	0			0				0					0
27	7/06/95	0			0				0					0
27	7/07/95	0			0				0					0
27	7/08/95	0			0				0					0
28	7/09/95	0			0				0					0
28	7/10/95	0			0				0					0
28	7/11/95	0			0				0					0
28	7/12/95	0			0				0					0
28	7/13/95	0			0				0					0
28	7/14/95	0			0				0					0
28	7/15/95	0			0				0					0
29	7/16/95	0			0				0					0
29	7/17/95	0			0				0					0
29	7/18/95	0			0				0					0
29	7/19/95	0			0				0					0
29	7/20/95	0			0				0					0
29	7/21/95	0			0				0					0
29	7/22/95	0			0				0					0
30	7/23/95	0			0				0					0
30	7/24/95	0			0				0					0
30	7/25/95	0			0				0					0
30	7/26/95	0			0				0					0
30	7/27/95	0			0				0					0
30	7/28/95	0			0				0					0
30	7/29/95	0			0				0					0
31	7/30/95	0			0				0					0
31	7/31/95	0			0				0					0
31	8/01/95	0			0				0					0
31	8/02/95	0			0				0					0
31	8/03/95	0			0				0					0
31	8/04/95	0			0				0					0
31	8/05/95	0			0				0					0
32	8/06/95	0			0				0					0
32	8/07/95	0			0				0					0
32	8/08/95	0			0				0					0
32	8/09/95	0			0				0					0
Total		70	36	19	55	15	27	11	53	3	20	8	4'	35

Appendix Table B-6. Frequency of tag observations by date for spring chinook salmon PIT tagged on the Wenaha River in 1994 and observed at various dams in 1995. A = first observation of individual tags, B = tags previously detected at one dam, C = tags previously detected at two dams, D = tags previously detected at three dams, and Σ = sum of all tag observations by date at a particular dam.

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	B	Σ	A	B	C	Σ	A	8	C	D	Σ
15	4/09/95	2			0				0					0
15	4/10/95	2			0				0					0
15	4/11/95	0			0				0					0
15	4/12/95	2			0				0					0
15	4/13/95	5			0				0					0
15	4/14/95	2	1		1				0					0
15	4/15/95	2	1		1	1			1					0
16	4/16/95	5	1		1				0					0
16	4/17/95	2		2	2		2		2					0
16	4/18/95	5	1	2	3		1		1					0
16	4/19/95	0	1		1			2	2					0
16	4/20/95	3			0				0					0
16	4/21/95	3			0				0					0
16	4/22/95	2			0				0					0
17	4/23/95	0			0	1			1					0
17	4/24/95	1			0				0					0
17	4/25/95	1			0		2		2					0
17	4/26/95	1		1	1				0				2	2
17	4/27/95	3			0		1		1	1	1			2
17	4/28/95	2	1		1	1	1		2			1		1
17	4/29/95	2			0	1	2	1	4		1			1
18	4/30/95	3			0		1		1		3			3
18	5/01 /95	4	1	1	2	1			1		1	1		2
18	5/02/95	3			0				0					0
18	5/03/95	1	2		2		1		1		1			1
18	5/04/95	2	2	4	6				0	1		1		2
18	5/05/95	1	2	1	3				0	1	1			2
18	5/06/95	0		2	2		2		2	2				2
19	5/07/95	5	1		1		1	1	2					0
19	5/08/95	1	2	1	3	2	2		4			1		1
19	5/09/95	2	1		1	1			1		1	2		3
19	5/10/95	1	1		1		2	1	3			1		1
19	5/11/95	1	3	2	5		1		1		1	1		2
19	5/12/95	1	1	1	2	3	1	1	5		1			1
19	5/13/95	0			0		3		3				1	1
20	5/14/95	2			0			1	1					0
20	5/15/95	2			0	2			2					0
20	5/16/95	0			0				0		2	1		3

Appendix Table B-6, Continued (Wenaha River).

		LOWER GRANITE	LITTLE GOOSE			LOWER MONUMENTAL				MCNARY				
WEEK	DATE	A	A	8	Σ	A	8	C	Σ	A	B	C	D	Σ
20	5/17/95	0			0	1	1		2		1	1		2
20	5/18/95	0		1	1	1			1		1			1
20	5/19/95	0	1	1	2				0		1			1
20	5/20/95	0			0				0					0
21	5/21/95	0			0		1		1		1			1
21	5/22/95	0	1		1		1		1					0
21	5/23/95	0			0				0			1		1
21	5/24/95	0			0		1		1					0
21	5/25/95	0		1	1				0					0
21	5/26/95	0			0	1			1					0
21	5/27/95	0			0				0			1		1
22	5/28/95	0			0			1	1					0
22	5/29/95	0			0				0					0
22	5/30/95	0			0				0					0
22	5/31/95	0			0				0					0
22	6/01/95	0	1		1				0					0
22	6/02/95	0			0				0					0
22	6/03/95	0			0				0					0
23	6/04/95	0			0				0					0
23	6/05/95	0			0		1		1					0
23	6/06/95	0			0				0					0
23	6/07/95	0			0				0					0
23	6/08/95	0			0				0					0
23	6/09/95	0			0				0					0
23	6/10/95	0			0				0					0
24	6/11/95	0			0				0					0
24	6/12/95	0			0				0					0
24	6/13/95	0			0				0					0
24	6/14/95	0			0				0					0
24	6/15/95	0			0				0					0
24	6/16/95	0			0				0					0
24	6/17/95	0			0				0					0
25	6/18/95	0			0				0					0
25	6/19/95	0			0				0					0
25	6/20/95	0			0				0					0
25	6/21/95	0			0				0					0
25	6/22/95	0			0				0					0
25	6/23/95	0			0				0					0
25	6/24/95	0			0				0					0
26	6/25/95	0			0				0					0
26	6/26/95	0			0				0					0
26	6/27/95	0			0				0					0
Total		74	25	20	45	16	28	8	52	5	17	12	3	37

APPENDIX C

Travel times (in days) of juvenile chinook salmon between Lower Granite Dam and mainstem dams during the 1995 migration year

Appendix Table C-1. Travel time (in days) of individual chinook salmon between Lower Granite Dam and mainstem dams during the 1995 migration year. Fish were PIT-tagged and released in six streams in the Grande Ronde and Imnaha River subbasins in 1994. Travel times were based on initial detection within the bypass system at each dam.

Stream	Little Goose	Lower Monumental	McNary
Catherine Creek			
Median days	4	6	9.5
Range	3-42	3-12	7-13
95% CI	3-6	5-7	8-12
N	29	28	16
Grande Ronde River			
Median days	5	7	10
Range	2-13	4-19	8-24
95% CI	4-7	6-9	9-14
N	29	31	13
Imnaha River			
Median days	5	8	13
Range	2-11	5-17	8-22
95% CI	4-9	6-10	8-22
N	12	15	8
Lostine River			
Median days	5	7	13
Range	3-28	4-21	7-20
95% CI	5-6	6-8	10-16
N	29	39	22
Minam River			
Median days	6	7	14
Range	3-26	4-18	7-26
95% CI	4-9	6-10	10-15
N	19	23	15
Wenaha River			
Median days	5	7	12
Range	3-11	5-14	6-15
95% CI	4-6	6-8	10-14
N	20	24	19
Total			
Median days	5	7	12
Range	2-42	3-21	6-26
95% CI	5-6	6-7	10-13
N	138	160	93