DOE/BP--33299-1

FISH RESEARCH PROJECT
OREGON

EARLY LIFE HISTORY STUDY OF GRANDE RONDE RIVER BASIN CHINOOK SALMON

ANNUAL PROGRESS REPORT

Project Period: 1 September 1994 to 31 August 1995

Prepared by:

MaryLouise Keefe
David J. Anderson
Richard W. Carmichael
Brian C. Jonasson

Oregon Department of Fish and Wildlife
LaGrande, OR

Funded by

U. S. Department of Energy
Bonneville Power Administration
Environment, Fish and Wildlife
P.O. Box 3621
Portland, OR 97208-3621

Project Number 92-026-04
Contract Number 94BI33299

This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA.

For additional copies of this report, write to:

Bonneville Power Administration
Public Information Center - CKPS-1
P.O. Box 3621
Portland, OR 97208

Please include title, author, and DOE/BP number from the back cover in the request.

DISCLAIMER

Portions of this document may be illegible electronic image products. Images are produced from the best available original document.

CONTENTS

EXECUTIVE SUMMARY

Objectives

1. Document the annual in basin migration patterns for spring chinook salmon juveniles in the upper Grande Ronde River and Catherine Creek, including the abundance of migrants, migration timing, and duration.

2. Estimate and compare survival indices from tagging to smolt recovery at mainstem Columbia and Snake River dams for juveniles that leave the upper river rearing areas at different times of the year.

3. Determine summer and winter habitat utilization and preference of juvenile spring chinook salmon in the Grande Ronde River and Catherine Creek.

Accomplishments

We accomplished all of our objectives in 1994. Although we did initiate study of the habitat utilized by spring chinook salmon, river conditions and limited access prevented us from surveying a majority of available winter habitat.

Findings

Juvenile spring chinook salmon were captured at the upper Grande Ronde River trap in the fall from 15 October through ice-up on 19 November 1994 and in the spring from 9 February through 28 June 1995. Approximately 90% of the migrants trapped were trapped during the spring migration. A total of 2,350 spring chinook salmon migrants were captured and we estimated that 30,926 migrants passed our upper trap. Juvenile spring chinook salmon were captured at the Catherine Creek trap in the fall from 20 October through ice-up on 19 November 1994, and in the spring from 7 February through 12 July 1995. A total of 5,931 spring chinook salmon migrants were captured and we estimated that 18,680 migrants passed our Catherine Creek trap. Approximately 50% of the spring chinook migrants from Catherine Creek left rearing areas in the fall and the spring. Juvenile spring chinook salmon were captured in our lower Grande Ronde River trap as they left the Grande Ronde valley from 22 October 1994 to 22 June 1995. A total of 2,631 spring chinook salmon migrants were captured and we estimated that 36,405 migrants passed our lower Grande Ronde River trap. Over 99% of migrants passing our lower trap did so during the spring migration.

PIT-tagged spring chinook salmon from the upper Grande Ronde River population were detected at Lower Granite Dam from 11 April to 12 July 1995, with a median passage date of 22 May. Cumulative mainstem dam detection rates by tag group ranged from 13.6 to 55.2%, with fish tagged during the spring migration detected at the highest rate among tag groups. Juvenile salmon tagged during their fall migration were detected at higher rate than fish tagged on winter rearing grounds, 21 and 14 % respectively.

PIT-tagged spring chinook salmon from the Catherine Creek population were detected at Lower Granite Dam from 22 April to 8 July 1995, with a median passage date of 27 May. Cumulative mainstem dam detection rates by tag group ranged from 13.8 to 45.1%, with fish tagged during the spring migration detected at the highest rate among tag groups. Juvenile salmon tagged during their fall migration were detected at similar rate to fish tagged on winter rearing grounds, 20 and 24 % respectively.

Nighttime snorkeling was found to be the most effective method for locating juvenile spring chinook salmon in their winter habitat. Juvenile spring chinook salmon were found in the greatest abundance in pool habitats during winter and summer surveys.

Introduction

The Grande Ronde River originates in the Blue Mountains in northeast Oregon and flows 334 kilometers to its confluence with the Snake River near Rogersburg, Washington. Historically, the Grande Ronde River produced an abundance of salmonids including stocks of spring, summer and fall chinook salmon, sockeye salmon, coho salmon, and summer steelhead (ODFW 1990). During the past century, numerous factors have caused the reduction of salmon stocks such that only stocks of spring chinook salmon and summer steelhead remain. The sizes of spring chinook salmon populations in the Grande Ronde basin also have been declining steadily and are substantially depressed from estimates of historic levels. It is estimated that prior to the construction of the Columbia and Snake River dams, more than 20,000 adult spring chinook salmon returned to spawn in the Grande Ronde River basin (ODFW 1990). A spawning escapement of 12,200 adults was estimated for the Grande Ronde River basin in 1957 (USACE 1975). Recent population estimates have been variable year to year, yet remain a degree of magnitude lower than historic estimates. In 1992, the escapement estimate for the basin was 1,022 adults (2.4 X number of redds observed). In addition to a decline in population abundance, a constriction of spring chinook salmon spawning distribution is evident in the Grande Ronde basin. Historically, 21 streams supported spawning chinook salmon, yet today the majority of production is limited to eight tributary streams and the mainstem upper Grande Ronde River (ODFW 1990).

Numerous factors are thought to contribute to the decline of spring chinook salmon in the Snake River and its tributaries. These factors include passage problems and increased mortality of juvenile and adult migrants at mainstem Columbia and Snake river dams, overharvest, and habitat degradation associated with timber, agricultural, and land development practices. More than 80% of anadromous fish habitat in the upper Grande Ronde

River is considered to be degraded (USFS 1992). Habitat problems throughout the Grande Ronde River basin (reviewed by Bryson 1993) include poor water quality associated with high sedimentation and poor thermal buffering, moderately to severely degraded habitat, and a decline in abundance of large pool habitat.

Precipitous declines in Snake River spring chinook salmon resulted in these stocks, including the Grande Ronde River stocks, being listed as threatened under the Endangered Species Act in October 1992. Development of sound recovery strategies for these salmon stocks require knowledge of stock specific life history strategies and critical habitats for spawning, rearing, and downstream migration (Snake River Recovery Team 1993, NWPPC 1992; ODFW 1990). In addition, we need to increase our knowledge of juvenile migration patterns, smolt production and survival, and winter rearing habitat utilization for juvenile spring chinook salmon in the Grande Ronde basin. Both historic and recent estimates of juvenile production in the basin are lacking. However, given the decrease in total number of adult salmon returning to the basin and the extent of habitat degradation, it is reasonable to assume that juvenile production in the basin also has declined. Recent parr-to-smolt survival estimates for the Grande Ronde basin range from 12.4 to 22.1% (Achord et al. 1992, Sankovich et al. in press). These estimates are based on data from parr that were individually tagged with passive integrated transponders (PIT tags) in late summer and were detected at mainstem Columbia and Snake river dams. Therefore, we can not separate mortality that occurs during the smolt migration from mortality that occurs during the fall and winter prior to the smolt migration.

Nickelson et al. (1992) demonstrated that availability of winter habitat was an important factor limiting coho production in many Oregon Coast streams. Typically the chinook salmon smolt migration occurs in the spring, although data from Lookingglass Creek (Burck 1993), Catherine Creek and mainstem Grande Ronde River (pers. comm. D. West, ODFW, LaGrande OR) indicate that some juveniles move out of summer rearing areas during the fall and overwinter downstream of summer rearing areas. We know little about the extent and importance of this fall migration.

We are also lacking information on where these fall migrants overwinter. Data from 1993 indicated that 99% of fish that left upper Grande Ronde River summer rearing area during fall overwintered somewhere between the upper (river kilometer, rkm, 299) and lower (rkm 164) traps. Much of the habitat in the mid-reaches of the Grande Ronde River is degraded. Stream habitat conditions in the section of the Grande Ronde River below La Grande consist of a meandering and channelized stream which runs through agricultural land. Riparian vegetation in this area is sparse and provides little shade or instream cover. The river is heavily silted due to extensive erosion associated with agricultural and forest management practices and mining activities. It is reasonable to suggest that salmon overwintering in degraded habitat may be subject to increased mortality due to the limited ability of the habitat to buffer against environmental extremes. If the fall migration from rearing areas constitutes a substantial portion of the juvenile production, then overwintering habitat may be an important factor influencing spring chinook salmon smolt production in the Grande Ronde basin.

Goals and Objectives

This study was designed to describe aspects of the life history strategies exhibited by spring chinook salmon in the Grande Ronde basin. During the past year we focused on rearing and migration patterns of juveniles in the upper Grande Ronde River and Catherine Creek. The study design included four objectives: 1) document the annual in-basin migration patterns for spring chinook salmon juveniles in the upper Grande Ronde River and Catherine Creek, including the abundance of migrants, migration timing and duration; 2) estimate and compare smolt survival indices to mainstem Columbia and Snake River dams for fall and spring migrating spring chinook salmon; 3) determine summer and winter habitat utilization and preference of juvenile spring chinook salmon in the upper Grande Ronde River and Catherine Creek.

Methods

In Basin Migration Timing and Abundance

The seasonal migration timing and abundance of juvenile spring chinook salmon in the upper Grande Ronde River and Catherine Creek were determined by operating juvenile migrant traps from ice-out to ice-up. One rotary screw trap was located below spawning and summer rearing areas in the upper Grande Ronde River near the town of La Grande (rkm 257) and another was located in the Grande Ronde River near the town of Elgin (rkm 164). A third rotary screw trap was placed in Catherine Creek below spawning and summer rearing areas (rkm 32, near the town of Union). Catherine Creek enters the Grande Ronde River at rkm 225 and is a major tributary for spring chinook salmon spawning and rearing. At our upper Grande Ronde River trap site, a 1.5 m diameter trap was fished from 10 October to 19 November 1994 and again from 9 February through 19 July 1995. A 1.5 m diameter trap was fished at the Catherine Creek site from 19 October through 19 November 1994 and again from 6 February 1995 to 30 August 1995. (Note: A state ditch was constructed in the Grande Ronde valley in the 1930s. The ditch bypassed 50 kilometers of the natural river channel, decreasing the sinuosity of the river, straightening and shortening the channel. The river now flows approximately 6.4 km in the state ditch between rkm 240 and rkm 190 of the natural channel. The river kilometers we use in this report are based on the natural channel. Thus, a juvenile salmon traveling from the upper trap at rkm 257 to our lower trap at rkm 164 travels only 49 km.)

The rotary screw traps were equipped with live boxes which safely held hundreds of chinook salmon trapped over a 24 to 72 h time interval. The traps were usually checked daily, but were checked as infrequently as every third day when we were catching only a few fish each day. All juvenile spring chinook salmon were removed from the traps for enumeration, measurement, or interrogation of PIT tags. We assumed that all juveniles captured in these traps were migrants. Prior to sampling, juvenile chinook salmon were anesthetized with MS-222 (40-60 mg/L). Fish were sampled as quickly as possible and were allowed to recover fully before release into the river. Scale samples were taken from 24 juvenile spring chinook salmon per week at each trap site for age determination. River height was recorded daily from permanent staff gauges. Water temperatures were recorded daily at each trap location using thermographs. Smolt condition was assessed at the lower Grande Ronde River site using digital photographs from 24 juvenile spring chinook salmon per week during the spring migration. These juvenile spring chinook salmon were lightly anesthetized, placed into a small Plexiglass aquarium, and their picture was taken. These photos were later downloaded into a computer and the smolt condition of each juvenile spring chinook salmon was assessed following the methods outlined in Beeman et al. (1994). To better understand the morphological changes of the spring migrants, their smolt condition will be compared to that of spring chinook parr collected and photographed previously. These data will be analyzed in 1996.

Trap efficiencies were estimated at each trap site by marking and releasing previously captured juvenile chinook salmon upstream of the trap and then counting the number of marked fish recaptured. We injected a small amount of non-toxic paint just below the surface of a fish's skin with a Panjet marking instrument (Hart and Pitcher 1969) to mark fish. Prior to field application, we tested the Panjet marking system on hatchery-reared chinook salmon to test for longevity of paint mark and delayed mortality associated with the marking. Chinook salmon were marked and checked daily for mortality over a four week period. Sham marked controls were also checked daily for mortalities over a four week period. No paint marking related mortalities were evident during this experiment and marks remained visible after four weeks.

Trap efficiency tests were conducted throughout each trapping season at each trap. Trap efficiencies were determined by releasing known numbers of paint marked or PIT-tagged juveniles above the traps and counting the number of recaptures. Trap efficiency was estimated from the equation: E(hat) = R/M, where E(hat) is the estimated trap efficiency, M is the number of marked fish released upstream and R is the number of marked fish recaptured.

Numbers of migrants at each trap site were estimated for the entire trapping season (fall or spring) from the equation: N(hat) = C/E(hat), where N(hat) is the estimated number of fish migrating past the trap, C is the total number of unmarked fish in the catch and E(hat) is the estimated trap efficiency. Variance for each N(hat) was determined by the bootstrap method (Efron and Tibshirani 1986 and Thedinga et al. 1994) with 1,000 iterations. Confidence intervals for N(hat) were calculated from the equation: 95% CI = $1.96\sqrt{V}$, where V is the variance of N(hat) determined from the bootstrap.

Survival and Migration Timing to Mainstem Dams

PIT-tag technology allows for fish to be individually marked and for subsequent observations to be made on marked fish without sacrificing the fish. Therefore, we used data from mainstem detections of PIT-tagged fish to estimate and compare survival among spring and fall migrating spring chinook salmon. Presently, PIT-tag monitors are used at six mainstem Columbia and Snake River dams to monitor PIT-tagged fish passage.

Fish that migrate at different times of the year and overwinter in different habitat types are subject to different environmental conditions which can result in variable survival. There is a fall migration from summer rearing areas in the upper Grande Ronde River and Catherine Creek to areas downstream where fish overwinter and then migrate to the sea the following spring. Other individuals remain in upper rearing areas through the fall and winter and then begin their seaward migration in the spring. To determine if juveniles that overwintered in different locations exhibited differential survival to mainstem dams, we PIT-tagged approximately 500 juvenile spring chinook salmon at both the upper Grande Ronde River and Catherine Creek screw traps during the fall and spring migration and in the winter rearing areas upstream of our traps after the fall migration had ended. We defined the fall migration as downstream movement past our upper trap sites between September and December and the spring migration as downstream movement past our upper trap sites between February and June. These times encompassed a majority of the spring and fall migrations. In addition, 1,000 juvenile spring chinook salmon were PIT-tagged in the upper Grande Ronde River and Catherine Creek as part of a separate study conducted under the Fish Passage Center Smolt Monitoring Program. These fish were tagged as parr in early September and were typically detected at mainstem dams during spring. Thus, there were four tag groups (one per season) for estimating relative smolt survival to mainstem dams. It is important to note that fish tagged in these groups do not necessarily represent unique life history strategies. For example, fish tagged in the summer rearing areas may leave as fall or spring migrants and thus the summer tagged group may contain components of all other tag groups.

PIT-tagged fish were interrogated upon recapture in screw traps and in bypass systems at mainstem dams. All recaptured fish were identified by their original tag group, thereby insuring independence of tag groups for analysis. For example, dam recoveries of fish that were tagged in the summer and were recaptured at a river trap in the fall were analyzed as summer tagged fish. Trap-to-dam survival indices were estimated using the proportion of spill over the dams as expansion factors.

We removed fish from the trap live box daily. We lightly anesthetized and interrogated each chinook salmon collected for a previously implanted PIT tag. We recorded tag numbers and measured lengths and weights of all PIT-tagged recaptures. At the upper Grande Ronde River trap, we PIT-tagged 424 fall and 368 spring migrating spring chinook salmon juveniles that were not previously tagged. In addition, we collected and PIT-tagged 433 parr from rearing areas above the upper Grande Ronde River screw trap after the fall migration had ceased. At the Catherine Creek trap, we PIT-tagged 502 fall and 348 spring migrating spring chinook salmon juveniles that were not previously tagged. Also, we collected and PIT-tagged 483 parr from rearing areas above the Catherine Creek trap after the fall migration had ceased. We monitored PIT-tagged migrants at the lower Grande Ronde River trap. We measured and recorded tag numbers, lengths, and weights for all recaptured PIT-tagged fish. After the migration through the Columbia River was completed, we obtained recovery information for PIT-tagged fish recovered at Lower Granite, Little Goose, Lower Monumental, and McNary dams. We determined and trap-to-dam survival indices for fall and spring migrants and winter-tagged fish. We obtained survival index data from summer-tagged chinook salmon. We compared survival index data among treatment groups. Comparison of survival estimates of fall migrant fish with winter tagged fish will allow us to estimate the relative success of fall versus spring migration as alternate life history strategies. In addition, a comparison of survival estimates for fish tagged as spring migrants versus winter-tagged fish allows us to estimate overwintering mortality, as the winter-tagged fish that survive should become spring migrants. Survival indices data from the summer tagged fish provides information about overall population survival.

Habitat Utilization

We conducted preliminary investigations into the winter habitat utilization of juvenile spring chinook salmon residing in the Grande Ronde River and Catherine Creek. We surveyed the Grande Ronde River from rkm 163 to rkm 257 and Catherine Creek from rkm 0 to rkm 32 after the traps had frozen to begin to understand the rearing distribution, abundance, and habitat utilization of fish that migrate out of summer rearing areas during the fall. Sites were sampled by snorkel observation with two or three persons. Snorkel observations were made during the day and at night. Nighttime observations were made with the use of dive lights. We recorded the fish species present and the following habitat variables: habitat type, substrate composition, and water temperature. In areas of the river where visibility was too poor or the ice was too thick, we deployed minnow traps baited with salmon eggs to attempt to locate juvenile salmon.

We conducted detailed investigations into the summer habitat utilization of juvenile spring chinook salmon residing in the upper Grande Ronde River and Catherine Creek basins. We surveyed the Grande Ronde River from rkm 297 to rkm 327 and Catherine Creek from rkm 32 to rkm 59 to understand the summer rearing distribution, abundance, and habitat utilization of juvenile chinook. We obtained physical habitat data for rkm 257 to rkm 330 of the Grande Ronde River and for rkm 0 to rkm 57 of Catherine Creek collected by the ODFW Aquatic Inventories project and by the U.S. Forest Service during the summer of 1991. We selected sampling sites based on previous physical habitat surveys and accessibility. We stratified sampling by habitat type, starting at the location of the previous year's redds and working out until at least six units of each type were sampled. Sites were sampled by snorkel observation with two to four persons making two passes following transect lines. We recorded fish species presence and abundance and the following habitat variables: habitat type, area, depth, cover, substrate composition, water temperature, water velocity, slope, shade, water visibility, and aspect.

Results and Discussion

In Basin Migration Timing and Abundance

We captured 1,265 fall migrating juvenile spring chinook salmon in the upper Grande Ronde River trap from 15 October 1994 through ice-up on 19 November 1994. We began fishing the trap again on 9 February 1995 after the ice began to clear from the river, and captured 1,085 spring migrating juvenile spring chinook salmon from 10 February through 28 June 1995. The median date of the fall migration was 30 October and for the spring migration was 31 March. Based on estimated trap efficiencies of 42.3% during fall and 4.8% during spring we estimated that 3,204 ± 981 fall migrants and 27,722 ± 14,206 spring migrants left the upper Grande Ronde River rearing areas (Figure 1). These estimate represent approximately 10% of the migrants moving out in the fall with the remaining 90% moving out in the spring.

We captured 4,527 fall migrating juvenile spring chinook salmon in the Catherine Creek trap from 22 October 1994 through ice-up on 19 November 1994. We began fishing the trap again on 6 February 1995 after the ice began to clear from the creek, and captured 1,404 spring migrating juvenile spring chinook salmon from 7 February through 12 July 1995. The median date of the fall migration was 2 November and for the spring migration was 12 March. Based on estimated trap efficiencies of 54.7% during fall and 16.4% during spring we estimated that 8,977 ± 944 fall migrants and 9,703 ± 2,348 spring migrants left the Catherine Creek rearing areas (Figure 2). These estimates represent approximately 50% of the migrants leaving Catherine Creek in the fall with the remaining 50% leaving in the spring.

The lower Grande Ronde River trap was fished continuously from 22 October 1994 to 22 June 1995. We captured 2,631 juvenile spring chinook salmon during this time period. The median migration date for the lower trap was 24 April. Based on estimated trap efficiencies of 15.8% for our 1.5 m trap and 8.2% for our 2.4 m trap, we estimated that 36,405 ± 9,094 juvenile spring chinook salmon migrants left the Grande Ronde valley (Figure 3). Approximately, 99% of the migrants passed during the spring months, versus 1% during fall and winter combined.

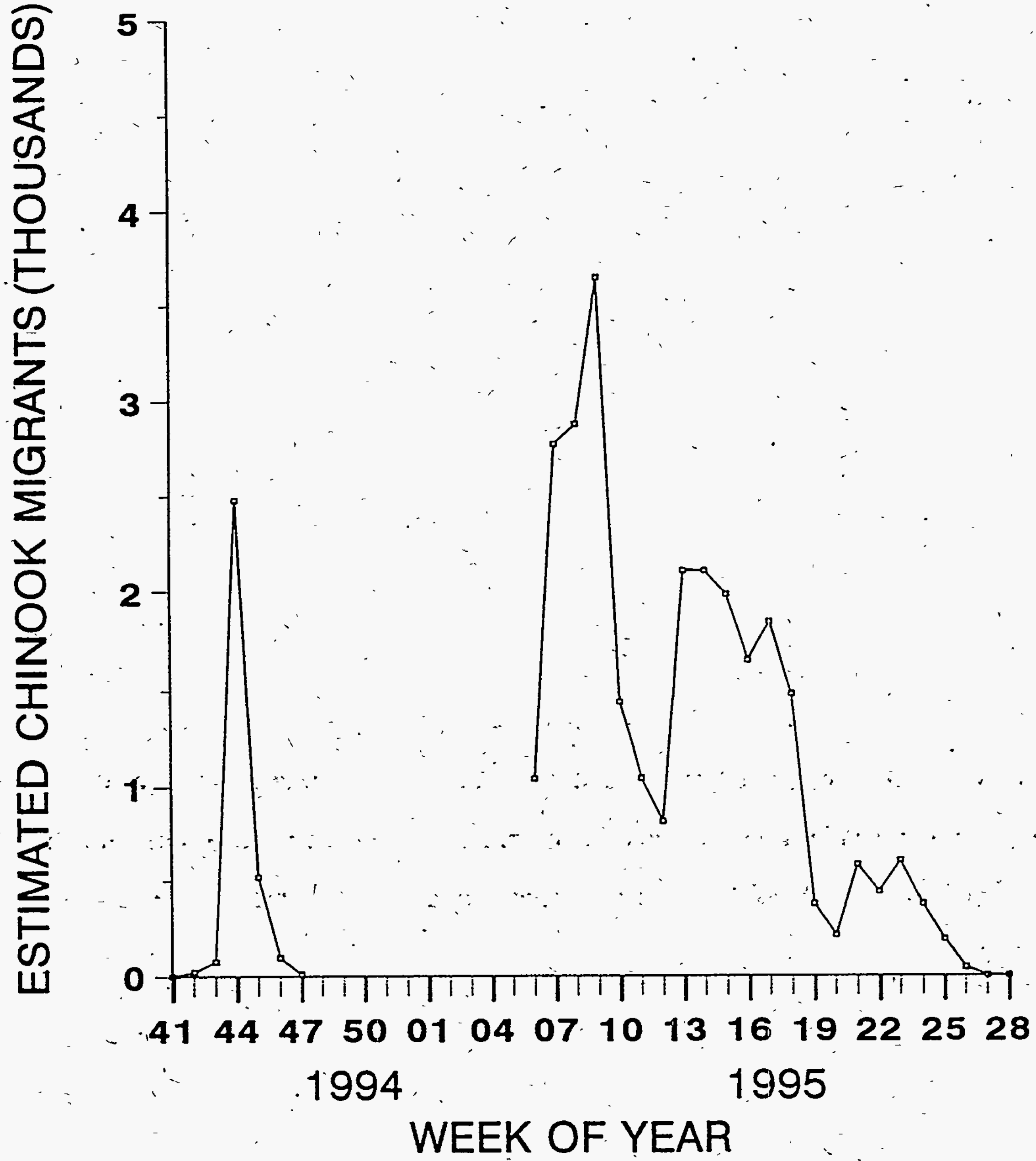

Figure 1. Timing and estimated abundance of juvenile spring chinook salmon migrants captured by a rotary screw trap at rkm 257 on the Grande Ronde River, fall 1994 and spring 1995. We estimated that 3,204 spring chinook salmon migrated in the fall and 27,722 migrated in the spring. The trap was not fished from week 47, 1994 to week 6, 1995 due to icing.

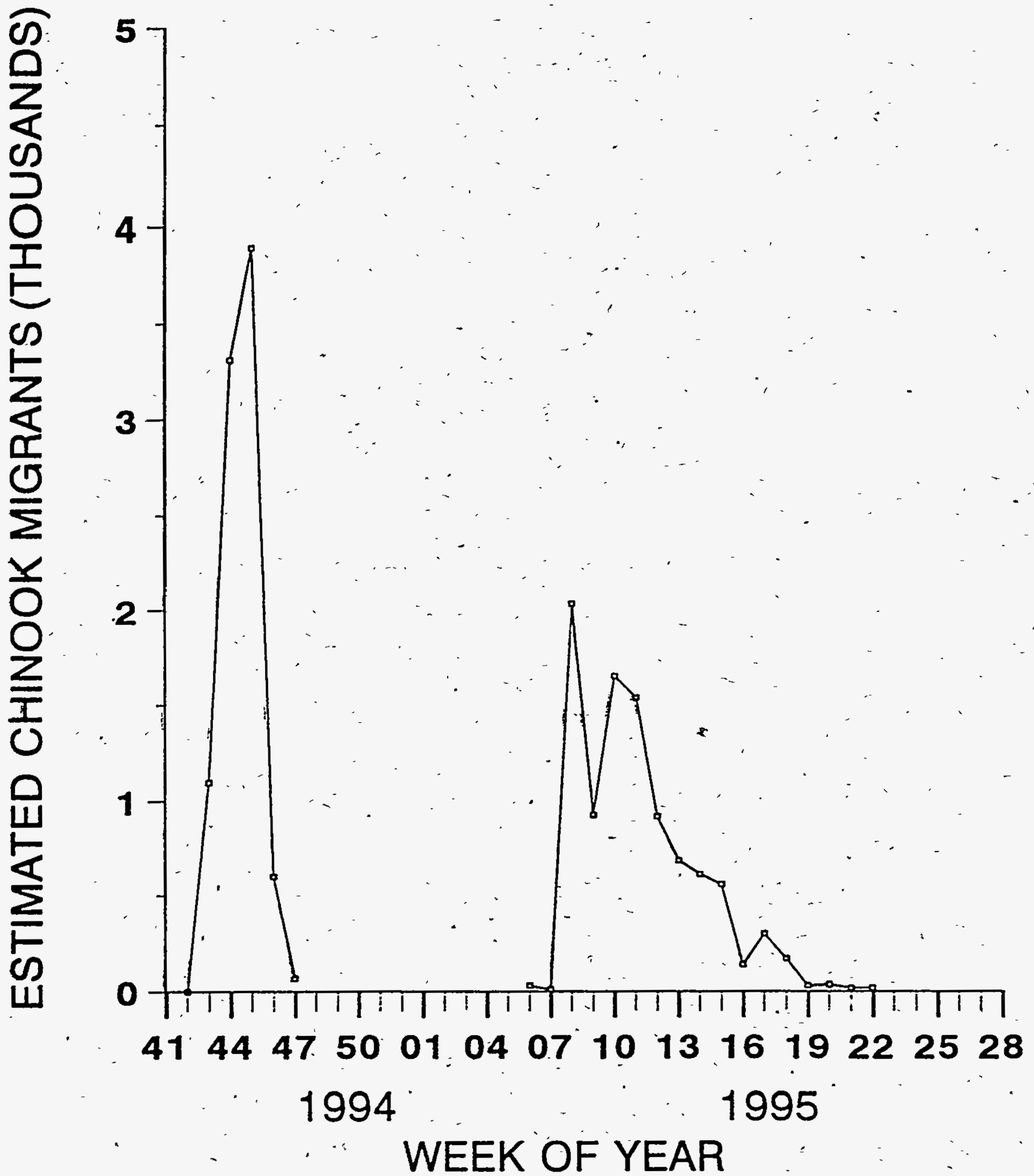

Figure 2. Timing and estimated abundance of juvenile spring chinook salmon migrants captured by a rotary screw trap at rkm 32 on Catherine Creek, fall 1994 through spring 1995. We estimated that 8,977 spring chinook salmon migrated in the fall, and 9,703 migrated in the spring. The trap was not fished from week 47, 1994 to week 6, 1995 due to icing.

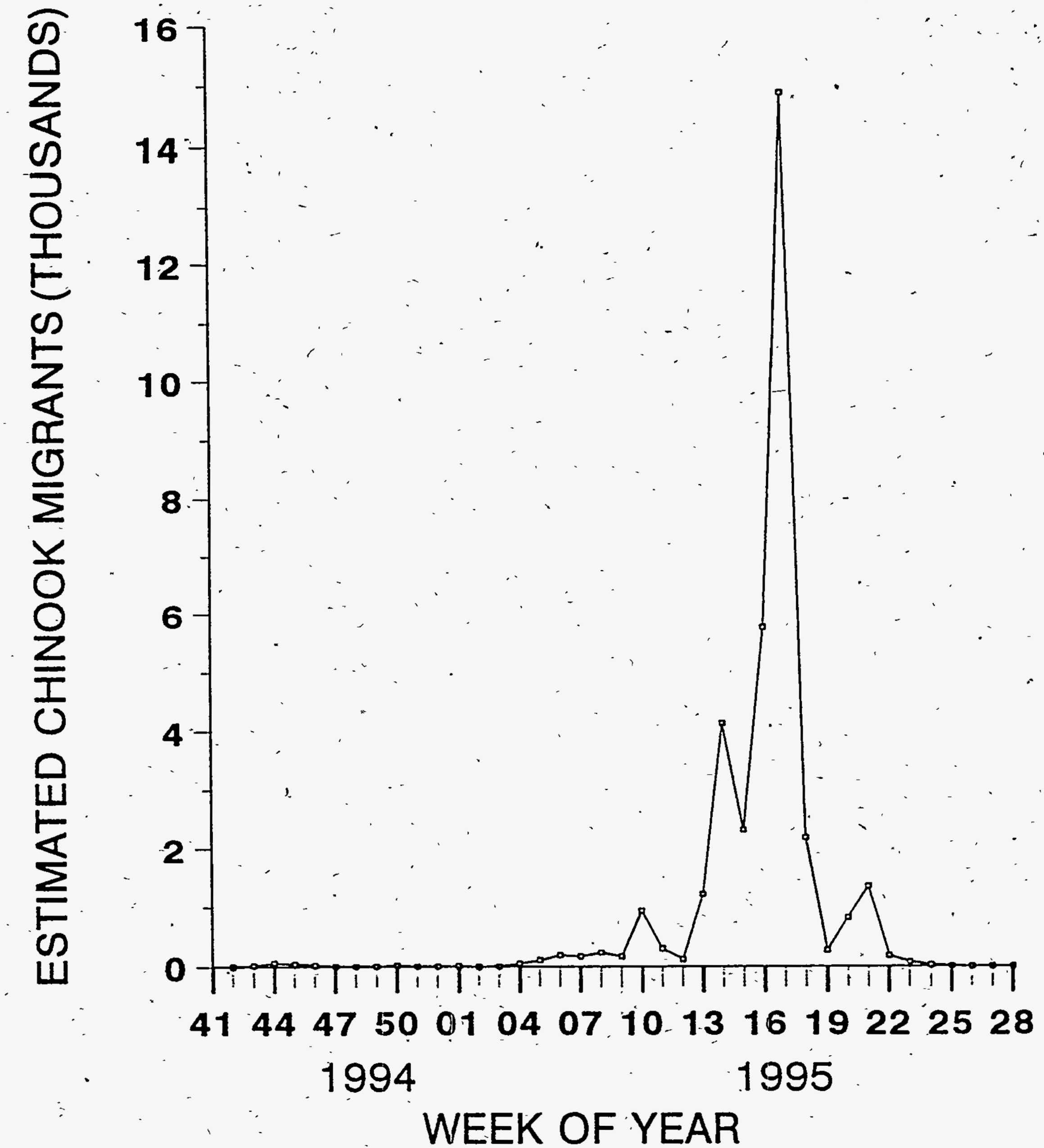

Figure 3. Timing and estimated abundance of juvenile spring chinook salmon migrants captured by a rotary screw trap at rkm 164 on the Grande Ronde River, fall 1994 through spring 1995. We estimated that 36,405 spring chinook salmon migrants passed this lower trap.

Data from 1994-95 showed that approximately 10% of the upper Grande Ronde River juveniles and 48% of the Catherine Creek juveniles migrated from summer rearing areas into the Grande Ronde Valley in the fall. The estimate for the upper Grande Ronde River population is consistent with 1993-94 data and is lower than observed in other chinook salmon populations in the Pacific Northwest. The fall migration from Catherine Creek is of similar proportion to that observed in spring chinook salmon in the Lemhi River of Idaho (Bjornn 1971) and the Warm Springs River in Oregon (Lindsay et al. 1989).

A small proportion (approximately 1%) of salmon moved past the lower Grande Ronde River trap (rkm 164) during the fall and winter, consistent with movements observed in 1993. We estimated that 99% of the total fish caught at the lower trap were captured during the spring outmigration. These data indicate that most juvenile salmon that left the upper rearing areas overwintered in the valley reaches of the Grande Ronde River where considerable habitat degradation and stream alteration has occurred.

The mean lengths of juvenile spring chinook salmon captured from the upper Grande Ronde River and PIT-tagged are shown in Table 1, and the mean weights of these fish are shown in Table 2. The mean lengths of juvenile spring chinook salmon captured from Catherine Creek and PIT-tagged are shown in Table 3, and the mean weights of these fish are shown in Table 4. Length frequency distributions of juvenile chinook salmon caught in all three traps are shown in Figure 4.

Weekly averages of length and weight demonstrated trends for increasing size of migrants over time during both the fall and spring outmigrations. Lengths and weights of migrants by week of the year are shown in Table 5 for the lower Grande Ronde River trap, Table 6 for the upper Grande Ronde River trap, and Table 7 for the Catherine Creek trap. These trends in increasing

Table 1. Fork length (mm) of juvenile chinook salmon collected for an early life history study on the Grande Ronde River for the 1995 migration year. Summer and winter fish were captured with seines in the Grande Ronde River from rkm 319 to 326. Fall and spring fish were captured with a rotary screw trap at rkm 257. SE = standard error, Min = minimum length, Max = maximum length.

	Collected				
Group	N	Mean	SE	Min	Max
Summer[a]	1,780	63.5	0.19	51	109
Fall	533	78.9	0.39	56	111
Winter	463	71.4	0.37	60	108
Spring	948	86.8	0.30	32	118

	Tagged and released				
Release group	N	Mean	SE	Min	Max
Summer[a]	1,007	67.6	0.27	57	109
Fall	425	78.9	0.42	56	103
Winter	433	71.3	0.37	60	108
Spring	406	90.1	0.44	63	112

[a] *From Sankovich et al. in press.*

Table 2. Weight (g) of juvenile chinook salmon collected for an early life history study on the Grande Ronde River for the 1995 migration year. Summer and winter fish were captured with seines in the Grande Ronde River from rkm 319 to 326. Fall and spring fish were captured with a rotary screw trap at rkm 257. SE = standard error, Min = minimum weight, Max = maximum weight.

Group	Collected N	Mean	SE	Min	Max
Summer[a]	1,008	3.52	0.047	1.9	14.2
Fall	529	5.41	0.078	1.8	13.7
Winter	460	4.04	0.071	2.0	14.4
Spring	912	7.16	0.084	0.4	16.6

Release group	Tagged and released N	Mean	SE	Min	Max
Summer[a]	1,005	3.57	0.052	1.9	14.2
Fall	421	5.40	0.085	2.4	11.7
Winter	430	4.00	0.069	2.0	14.4
Spring	390	8.15	0.135	2.7	16.6

[a] *From Sankovich et al. in press.*

Table 3. Fork length (mm) of juvenile chinook salmon collected for an early life history study on Catherine Creek for the 1995 migration year. Summer and winter fish were captured with seines in Catherine Creek from rkm 42 to 50. Fall and spring fish were captured with a rotary screw trap at rkm 32. SE = standard error, Min = minimum length, Max = maximum length.

Group	Collected				
	N	Mean	SE	Min	Max
Summer[a]	1,097	72.8	0.26	52	138
Fall	779	78.1	0.28	60	106
Winter	540	82.2	0.37	61	105
Spring	786	88.5	0.29	57	118

Release group	Tagged and released				
	N	Mean	SE	Min	Max
Summer[a]	1,000	72.7	0.24	59	100
Fall	501	78.0	0.33	60	106
Winter	483	82.8	0.39	61	105
Spring	348	89.1	0.42	66	117

[a] *From Sankovich et al. in press.*

Table 4. Weight (g) of juvenile chinook salmon collected for an early life history study on Catherine Creek for the 1995 migration year. Summer and winter fish were captured with seines in Catherine Creek from rkm 42 to 50. Fall and spring fish were captured with a rotary screw trap at rkm 257. SE = standard error, Min = minimum weight, Max = maximum weight.

Group	Collected				
	N	Mean	SE	Min	Max
Summer[a]	1,000	4.4	0.055	2.0	27.0
Fall	768	5.23	0.056	2.2	12.4
Winter	540	6.03	0.075	2.1	11.9
Spring	819	8.07	0.140	0.5	46.5

Release group	Tagged and released				
	N	Mean	SE	Min	Max
Summer[a]	993	4.33	0.044	2.0	11.0
Fall	501	5.19	0.067	2.2	12.4
Winter	483	6.14	0.079	2.1	11.9
Spring	338	7.77	0.110	2.7	17.1

[a] *From Sankovich et al. in press.*

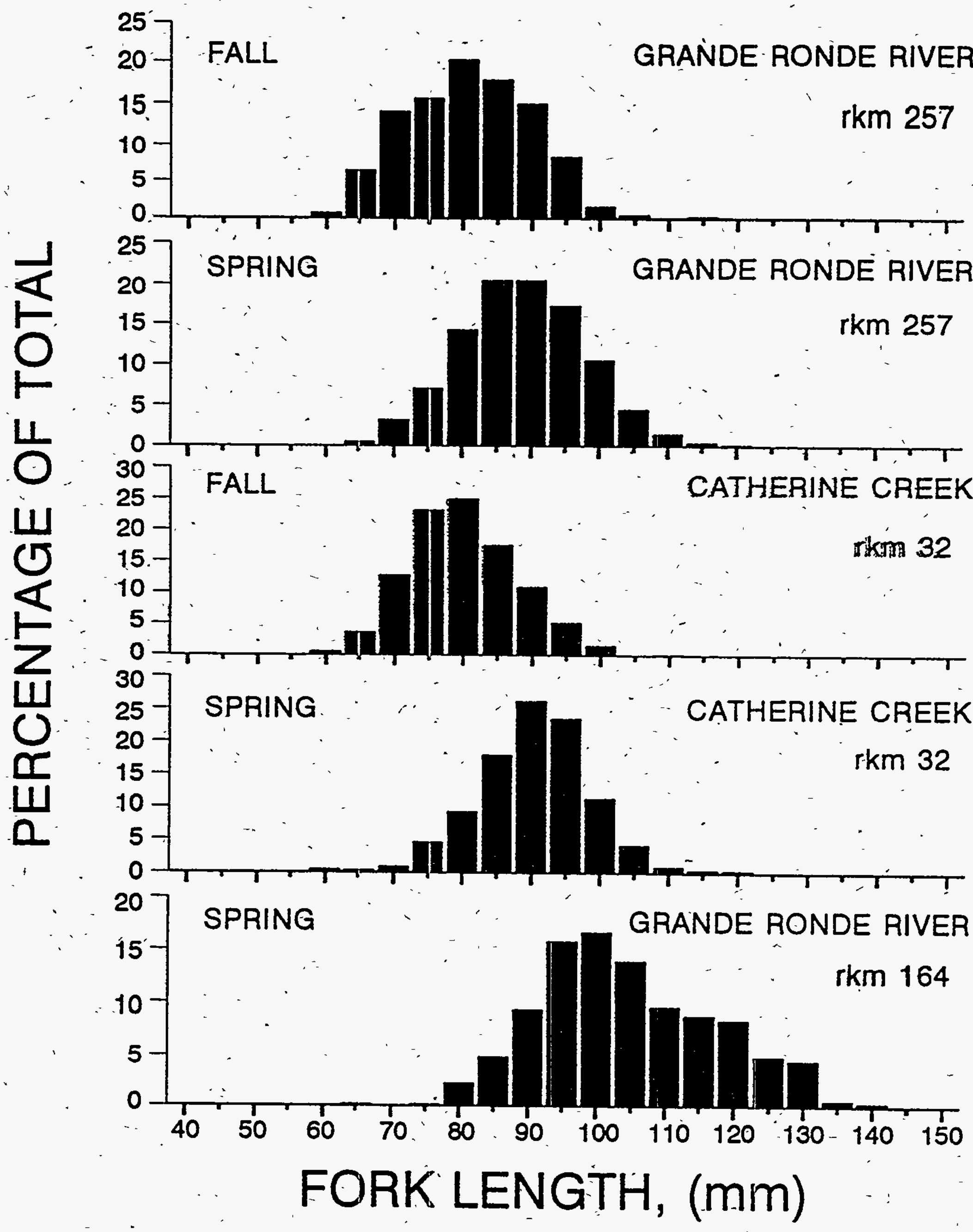

Figure 4. Length frequency (fork length, mm) of juvenile spring chinook salmon migrants captured by rotary screw traps in the Grande Ronde River, fall 1994 and spring 1995.

Table 5. Length (mm) and weight (g) of juvenile spring chinook salmon captured in a rotary screw trap at rkm 164 in the Grande Ronde River, week 43 to 50, 1994 and week 1 to 24, 1995.

Year, week	Length					Weight				
	N	Mean	SE	Min	Max	N	Mean	SE	Min	Max
1994:										
43	3	95.3	6.98	86	109	3	10.40	1.724	8.2	13.8
44	9	86.0	1.94	74	93	8	6.20	0.677	4.1	9.0
45	6	85.3	1.96	78	91	6	6.50	0.547	4.7	8.3
46	3	90.0	3.06	84	94	3	7.53	0.762	6.1	8.7
50	3	84.7	7.13	71	95	3	6.13	0.706	4.8	7.2
1995:										
01	2	80.5	10.50	70	91	2	6.15	2.350	3.8	8.5
04	8	88.0	2.40	77	97	8	6.80	0.445	5.3	8.9
05	3	88.0	0.58	87	89	3	6.90	0.300	6.3	7.2
06	5	85.2	2.27	79	92	5	5.56	0.664	4.1	7.8
07	5	86.2	1.43	82	90	5	6.02	0.296	5.1	6.7
09	7	90.3	5.30	63	103	5	8.72	1.134	4.9	11.4
10	74	91.5	0.87	79	110	74	7.61	0.219	4.9	15.0
12	2	89.5	2.50	87	92	2	7.60	0.100	7.5	7.7
13	81	92.8	0.66	80	107	80	8.40	0.196	5.2	12.4
14	85	98.3	1.22	71	135	79	10.80	0.473	4.1	26.7
15	35	103.3	2.29	78	130	35	12.90	0.991	6.0	27.5
16	80	102.4	1.34	80	136	80	10.85	0.612	3.1	31.2
17	90	108.1	1.29	85	132	89	14.15	0.549	5.6	27.4
18	79	109.5	1.29	80	131	79	15.26	0.534	5.6	25.3
19	12	112.8	1.93	103	122	12	16.68	0.982	11.5	22.2
20	61	111.6	1.05	95	130	61	15.92	0.468	8.6	26.3
21	84	111.2	0.89	94	130	84	16.23	0.407	9.5	25.0
22	14	109.6	2.90	94	127	14	15.69	1.191	9.5	24.4
23	7	99.1	3.81	82	116	7	12.04	1.361	7.0	18.8
24	4	111.8	7.51	101	134	4	16.35	3.684	11.3	27.3

Table 6. Length (mm) and weight (g) of juvenile spring chinook salmon captured in a rotary screw trap at rkm 257 in the Grande Ronde River, week 42 to 47, 1994 and week 6 to 26, 1995.

Year, week	Length					Weight				
	N	Mean	SE	Min	Max	N	Mean	SE	Min	Max
1994:										
42	11	88.0	2.53	72	101	11	7.42	0.555	3.9	10.2
43	32	82.8	1.43	63	96	29	6.28	0.320	2.5	9.3
44	237	77.2	0.54	56	96	236	5.15	0.108	2.4	11.3
45	212	79.8	0.61	57	103	212	5.49	0.121	1.8	11.7
46	29	81.0	2.00	63	111	29	5.79	0.426	2.6	13.7
47	4	76.3	5.98	66	92	4	4.90	1.000	3.2	7.3
1995:										
06	40	84.6	1.07	71	98	40	6.01	0.242	3.8	10.3
07	44	83.6	0.95	69	94	44	5.78	0.203	2.9	8.6
08	65	84.4	1.24	66	118	65	6.45	0.288	2.8	16.5
09	49	82.3	1.10	62	95	30	5.91	0.286	2.8	8.8
10	61	81.6	1.07	65	105	61	5.71	0.235	3.0	11.8
11	21	87.4	1.43	74	101	21	6.78	0.389	4.2	11.5
12	45	79.8	1.12	66	93	45	5.28	0.228	1.8	8.3
13	79	82.5	0.90	65	100	79	5.74	0.186	2.4	10.7
14	89	87.4	0.74	70	105	89	6.88	0.161	3.7	12.8
15	75	83.4	0.95	63	102	75	6.28	0.220	2.7	11.1
16	75	88.0	0.92	75	111	67	7.48	0.294	3.0	15.1
17	89	92.3	0.79	75	112	89	8.66	0.229	4.5	15.9
18	34	90.3	1.28	75	107	34	8.29	0.353	5.1	13.6
19	2	94.0	1.00	93	95	2	9.40	0.300	9.1	9.7
20	21	94.6	1.57	82	110	20	9.92	0.496	6.2	14.6
21	24	95.7	1.44	80	110	24	10.13	0.474	5.3	15.3
22	25	97.5	1.39	83	110	25	10.92	0.563	6.0	16.6
23	15	96.3	1.54	88	112	15	10.51	0.545	7.5	16.3
24	11	94.7	6.36	32	105	11	11.08	1.157	0.4	14.0
25	7	102.3	2.52	91	109	7	11.67	0.708	8.7	14.2
26	2	102.0	1.00	101	103	2	12.70	1.100	11.6	13.8

Table 7. Length (mm) and weight (g) of juvenile spring chinook salmon captured in a rotary screw trap at rkm 32 in Catherine Creek, week 43 to 46, 1994 and week 6 to 35, 1995.

Year, week	Length					Weight				
	N	Mean	SE	Min	Max	N	Mean	SE	Min	Max
1994:										
43	227	75.6	0.48	60	97	217	4.76	0.093	2.3	9.9
44	315	77.8	0.40	60	106	315	5.19	0.084	2.2	12.4
45	162	79.5	0.62	60	98	161	5.52	0.123	2.3	9.8
46	75	83.3	0.91	63	99	75	6.17	0.198	2.6	10.7
1995:										
06	11	78.8	2.99	61	99	11	5.16	0.507	2.5	8.8
07	5	65.6	4.83	57	81	5	3.44	0.580	2.2	5.2
08	71	88.7	0.80	70	105	71	7.32	0.196	3.9	12.1
09	65	87.6	0.87	74	105	42	7.34	0.313	4.4	12.4
10	97	89.3	0.74	63	103	97	7.34	0.178	2.7	11.4
11	116	87.3	0.66	66	106	115	7.13	0.161	2.7	12.0
12	84	87.1	0.83	72	109	84	7.11	0.212	3.9	13.6
13	90	87.7	0.73	73	104	90	7.28	0.197	4.0	12.0
14	73	90.4	0.97	70	118	73	7.94	0.245	3.8	16.4
15	71	90.8	1.03	72	115	56	8.05	0.275	4.3	13.9
16	23	88.5	1.34	75	97	15	7.68	0.594	4.6	12.3
17	38	87.0	2.16	37	102	37	7.85	0.407	0.5	11.9
18	31	91.8	1.55	70	109	31	8.65	0.397	4.2	13.7
19	6	97.5	5.98	74	117	5	12.14	1.373	8.9	17.1
20	5	92.2	1.46	89	96	3	8.67	0.689	7.7	10.0
21	2[a]	96.0	16.00	80	112	2	10.45	4.450	6.0	14.9
23	2[a]	40.5	1.50	39	42	2	0.75	0.150	0.6	0.9
24	2[a]	52.5	2.50	50	55	2	1.70	0.300	1.4	2.0
28	2[a]	66	3.00	63	69	2	3.55	0.750	2.8	4.3
33	22	92.7	3.96	73	140	22	11.81	2.087	3.9	43.1
34	25	90.1	2.70	73	124	25	9.85	1.061	5.0	25.2
35	29	116.3	2.99	79	169	29	20.31	1.579	5.7	46.5

[a] *These fish were identified as age-0 fish.*

size of migrants over time were consistent for both populations and were more pronounced in upper Grande Ronde River salmon. These data also are consistent with the size data from fall migrating fish from the upper Grande Ronde River in 1993.

When comparing mean fork lengths at tagging in the upper Grande Ronde River, we found the mean length of fall-tagged fish was larger than the winter-tagged fish by 7.5 mm (Table 1), suggesting that the fall migration was composed of larger fish moving out of the summer rearing areas. It is interesting to note that when tagged fish from these groups were trapped in the lower river (rkm 164) during the spring, the average fork lengths were similar (Table 8). The phenomenon of larger fish moving out of summer rearing areas during fall was not evident in Catherine Creek. On the contrary, fish that moved out of upper Catherine Creek in the fall were on average 4 mm smaller at the time of tagging than fish that overwintered there (Table 3).

Table 8. Mean fork length of juvenile chinook salmon PIT-tagged in the upper Grande Ronde River and recaptured in a rotary screw trap in the Grande Ronde River at rkm 164, fall 1994 through spring 1995. Standard errors are in parentheses.

Group	N	Mean length	
		Tagging	Recapture
Summer	5	78.2 (4.44)	97.6 (5.18)
Fall	11	83.3 (2.21)	98.5 (2.30)
Winter	5	77.8 (4.44)	94.4 (3.33)
Spring	21	90.0 (1.58)	94.9 (1.74)

Survival and Migration Timing to Mainstem Dams

The first detection of PIT-tagged fish from the upper Grande Ronde River was at Lower Granite Dam (LGD) on 11 April 1995. Migrants continued to be detected at LGD until 12 July 1995. The date that 50% of the Grande Ronde River fish passed LGD was 27 May 1995. A majority of the fish were detected at LGD between 9 April and 18 June (Figure 5). The first dam detection of PIT-tagged fish from Catherine Creek was on 22 April 1995. Catherine Creek migrants continued to be detected at LGD until 8 July 1995. The date that 50% of the Catherine Creek fish passed LGD was 27 May 1995. A majority of these fish were detected at LGD between 23 March and 21 July (Figure 6). These data are consistent with data from another study in Northeast Oregon that has found the median detection dates of wild spring chinook migrants from the Grande Ronde and Imnaha basins ranged from late-April to late-May 1995, with peak migrations occurring from the early April through early June (Sankovich et al. in press).

We examined migration timing past LGD by individual tag group and found considerable variability within the upper Grande Ronde River (Figure 5) and Catherine Creek (Figure 6) populations. In the upper Grande Ronde River, the median arrival date to LGD by tag group was 3 June for summer, 5 May for fall, 28 May for winter, and 2 June for spring. In Catherine Creek the median arrival date to LGD by tag group was 20 May for summer, 7 May for fall, 13 May for winter, and 5 June for spring. For both populations, the earliest fish detected at LGD were the fall-tagged fish that had moved lower into the valley habitat to overwinter. Interestingly, these fall-tagged were similar in size to the other tag groups when passing our lower trap in the Grande Ronde River (Table 8 and 9) and the fall-tagged fish from the Grande Ronde River moved past the trap earlier than fish from the other tag groups (Figure 7).

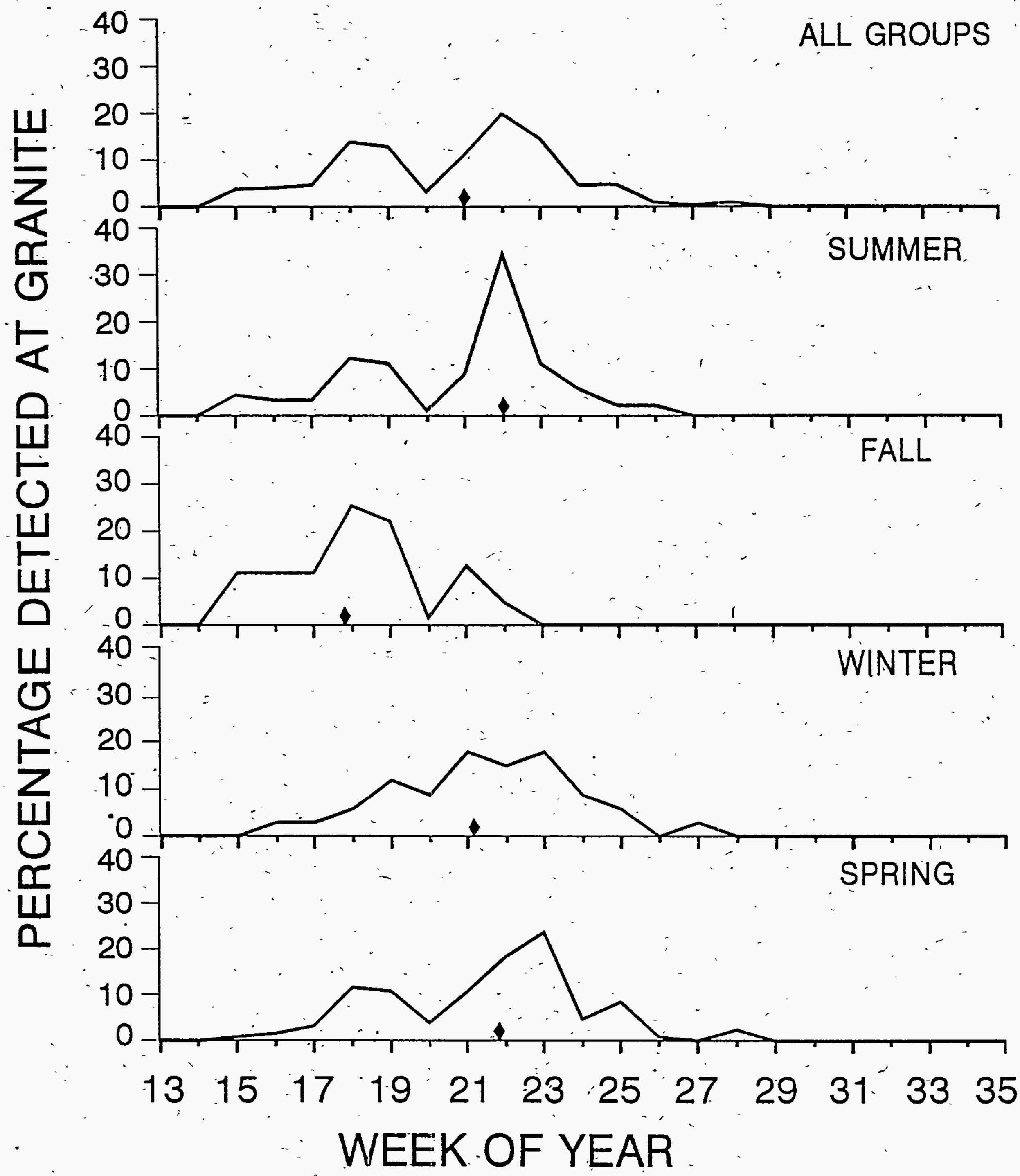

Figure 5. Migration timing at Lower Granite Dam for juvenile spring chinook salmon, by season of PIT-tagging, in the Grande Ronde River, 1995 migration year. ♦ = median arrival date. Data were expanded for spillway flow.

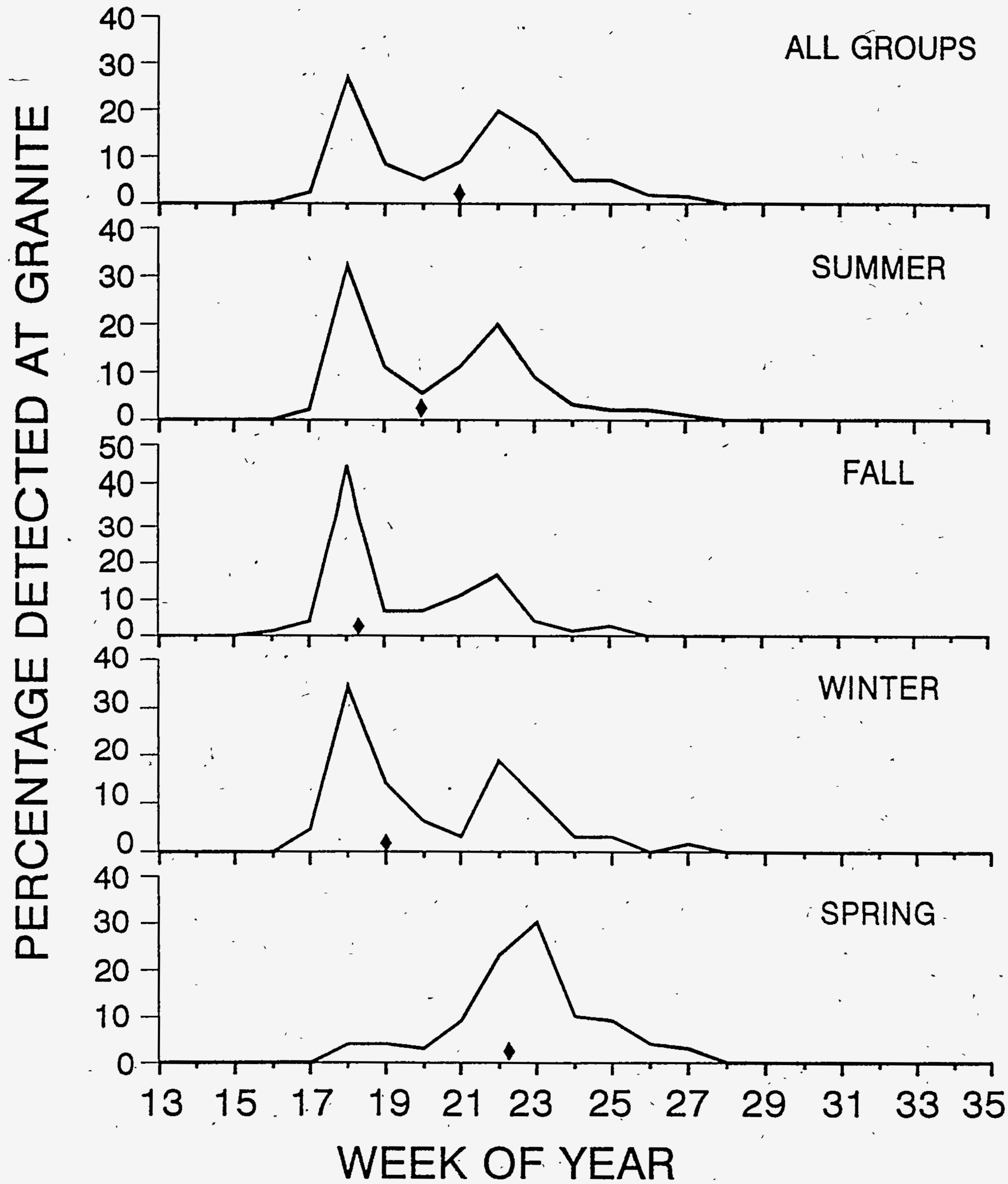

Figure 6. Migration timing at Lower Granite Dam for juvenile spring chinook salmon, by season of PIT-tagging, in Catherine Creek, 1995 migration year. ♦ = median arrival date. Data were expanded for spillway flow.

Table 9. Mean fork length of juvenile chinook salmon PIT-tagged in Catherine Creek and recaptured in a rotary screw trap in the Grande Ronde River at rkm 164, fall 1994 through spring 1995. Standard errors are in parentheses.

Group	N	Mean length: Tagging	Mean length: Recapture
Summer	5	77.6 (0.93)	111.4 (2.84)
Fall	5	81.2 (3.02)	120.4 (1.75)
Winter	1	99.0	120.0
Spring	4	89.0 (3.24)	116.0 (5.96)

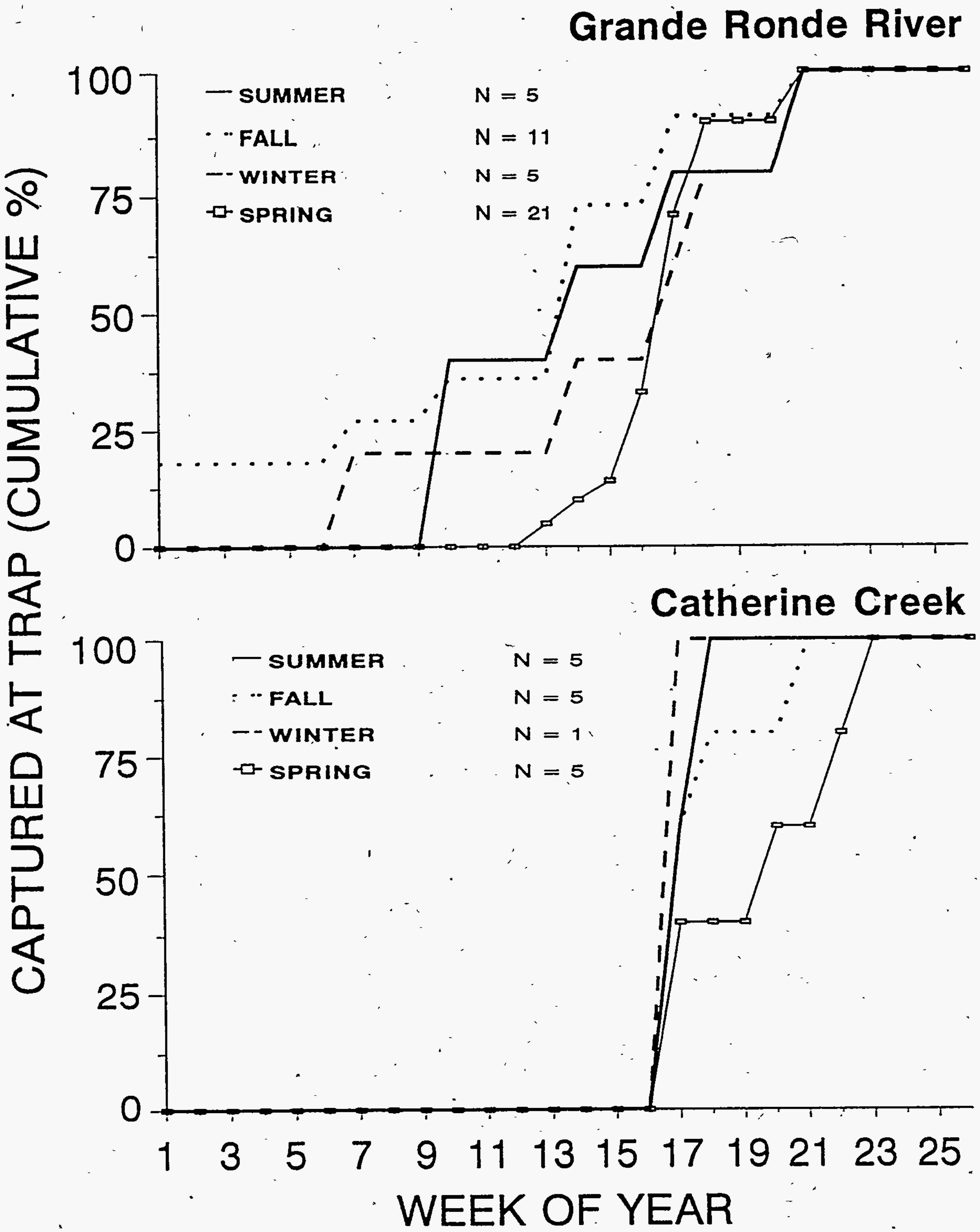

Figure 7. Timing of PIT-tagged juvenile spring chinook salmon migrants captured by a rotary screw trap at rkm 164 on the Grande Ronde River, 1995, by time of tagging.

Examination of detection rates by tag group showed that spring migrants were detected at the highest rate for both populations (Tables 10 and 11). This result was expected because spring migrants were the only group tagged after overwinter mortality had occurred. Detections for other tag groups varied within populations. Fall-tagged fish from the upper Grande Ronde River population were detected at higher rates than both summer and winter groups. Although not as dramatic, this trend was similar to that observed in 1994 and suggests that fish emigrating from the upper rearing areas in fall had a survival advantage over fish that remained in the upper Grande Ronde River rearing areas until spring. Fall-tagged fish from Catherine Creek were detected at lower rates than winter-tagged fish, suggesting better overwinter survival for fish that remained in the upper rearing areas of Catherine Creek. Comparing detection rates of winter-tagged fish to spring-tagged fish from the Grande Ronde River suggests that overwinter survival of fish remaining in the upper rearing areas may be as low as 25%. Comparing detection rates of winter-tagged fish to spring-tagged fish from Catherine Creek suggests that overwinter survival of fish remaining in the upper rearing areas may be approximately 53%.

Table 10. First-time detections, as percentage of total fish released, by dam site during the 1995 migration year. Chinook salmon were PIT-tagged on the Grande Ronde River during the previous seasons as indicated.

Group	Number released	Lower Granite	Little Goose	Lower Monumental	McNary	Total
Summer[a]	1,000	8.2	4.0	1.7	0.3	14.2
Fall	424	13.4	3.5	2.1	1.4	20.5
Winter	433	6.9	4.4	2.1	0.2	13.6
Spring	368	31.0	15.2	6.8	2.2	55.2
TOTAL	2,225	12.7	5.8	2.7	0.81	22.0

[a] *From Sankovich et al. in press.*

Table 11. First-time detections, as percentage of total fish released, by dam site during the 1995 migration year. Chinook salmon were PIT-tagged on Catherine Creek during the previous seasons as indicated.

Group	Number released	Lower Granite	Little Goose	Lower Monumental	McNary	Total
Summer[a]	1,000	8.1	3.4	2.0	0.3	13.8
Fall	502	13.1	3.2	2.6	1.0	19.9
Winter	483	11.8	7.7	3.5	1.0	24.0
Spring	348	25.3	12.6	6.6	0.6	45.1
TOTAL	2,333	12.1	5.6	2.6	0.86	21.2

[a] *From Sankovich et al. in press.*

Habitat Utilization

We explored several different methods for locating spring chinook salmon in their winter habitat. We had limited success trapping with minnow traps (16 chinook salmon captured), and snorkeling during daylight (9 chinook salmon observed). However, snorkeling at night with the use of dive lights proved very successful, as we observed 206 chinook salmon. Spring chinook juveniles were located in all habitats surveyed, and were most abundant in pools. Chinook were usually found in association with some in-stream structure, including surface ice.

We surveyed 30 km of spring chinook salmon habitats in the upper Grande Ronde River and 27 km in Catherine Creek during summer. The abundance of juvenile spring chinook in both streams was very low. We observed a total of 57 young-of-the-year and 163 yearlings in the upper Grande Ronde River and 1,095 young-of-the-year and 114 yearlings in Catherine Creek.

In Catherine Creek, juvenile chinook salmon were found in all habitats sampled during summer (Table 12), usually in association with in-stream structure or cover. The densities of juveniles ranged from an average of 0.09 fish/100 m^2 for yearlings in riffle habitat to an average of 55.32 fish/100 m^2 for young-of-the-year fish in backwater pools. The extremely low abundance of juvenile chinook in the upper Grande Ronde River is reflected in those density estimates (Table 13) which range from a low of 0.00 fish/100 m^2 for both age classes in plunge pools to an average of 4.73 fish/100 m^2 for yearlings in straight scour pools. Given these low abundances of chinook salmon we view the habitat data for the upper Grande Ronde River as equivocal. We hope to be able to repeat habitat surveys in the upper Grande Ronde River in the future when juvenile chinook salmon are more abundant.

Table 12. Habitat selection and density (fish/100 m^2) of juvenile chinook salmon in Catherine Creek (rkm 28 to rkm 54) during summer 1995.

Habitat Type	N	Age 0	Age 1
Glide	11	7.25	0.52
Backwater Pool	5	55.32	0.79
Dam Pool	7	2.65	0.96
Lateral Scour Pool	22	5.72	0.47
Plunge Pool	6	22.14	4.09
Straight Scour Pool	22	8.66	1.01
Rapid	7	1.99	0.27
Riffle	33	2.24	0.09
Riffle with Pockets	11	2.08	0.12

Table 13. Habitat selection and density (fish/100 m^2) of juvenile chinook salmon in the Grande Ronde River (rkm 310 to rkm 331) during summer 1995.

Habitat Type	N	Age 0	Age 1
Glide	21	0.32	0.95
Lateral Scour Pool	12	0.46	0.28
Plunge Pool	2	0.00	0.00
Straight Scour Pool	12	0.00	4.73
Rapid	5	0.05	0.29
Riffle	18	0.06	0.17

References

Achord, S., J.R. Harmon, D.M. Marsh, B.P. Sandford, K.W. McIntyre, K.L. Thomas, N.N. Paasch, and G.M. Mathews. 1992. Research related to transportation of juvenile salmonids of the Columbia and Snake Rivers, 1991. Annual Report. U.S. Army Corps of Engineers, Walla Walla, WA and National Marine Fisheries Service, Seattle, WA.

Beeman, J.W., D.W. Rondorf, and M.E. Tilson. 1994. Assessing smoltification of juvenile spring chinook salmon (*Oncorhynchus tshawytscha*) using changes in body morphology. Canadian Journal of Fisheries and Aquatic Sciences 51:836-844.

Bjornn, T.C. 1971. Trout and salmon movements in two Idaho streams as related to temperature, food, stream flow, cover, and population density. Transactions of the American Fisheries Society 100:423-438.

Bryson, D. 1993. Northeast Oregon Hatchery Grande Ronde River Management Plan. Final Report. Bonneville Power Administration, Portland, OR.

Burck, W.A. 1993. Life history of spring chinook salmon in Lookingglass Creek, Oregon. Oregon Department of Fish and Wildlife, Information Reports (Fish) 94-1, Portland.

Efron, B., and R. Tibshirani. 1986. Bootstrap methods for standard errors, confidence intervals, and other measures of statistical accuracy. Statistical Science 1:54-77.

Hart, P.J.B., and T.J. Pitcher. 1969. Field trials of fish marking using a jet inoculator. Journal of Fish Biology 1:383-385.

Lindsay, R.B., B.C. Jonasson, R.K. Schroeder, and B.C. Cates. 1989. Spring chinook salmon in the Deschutes River, Oregon. Oregon Department of Fish and Wildlife, Information Reports (Fish) 89-4, Portland.

Nickelson, T. E., J. D. Rodgers, S. L. Johnson, and M. F. Solazzi. 1992. Seasonal changes in habitat use by juvenile coho salmon (*Oncorhynchus kisutch*) in Oregon coastal streams. Canadian Journal of Fisheries and Aquatic Sciences 49:783-789.

NWPPC (Northwest Power Planning Council). 1992. Strategy for salmon, Volume VII.

ODFW (Oregon Department of Fish and Wildlife). 1990. Grande Ronde River Subbasin Salmon and Steelhead Production Plan. Oregon Department of Fish and Wildlife, Portland, OR.

Sankovich, P.M., R.W. Carmichael, and M. Keefe,. In press. Smolt migration characteristics and parr-to-smolt survival of naturally produced spring chinook salmon in the Grand Ronde and Imnaha River basins. Oregon Department of Fish and Wildlife, Portland, OR.

Snake River Recovery Team. 1993. Draft Snake River salmon recovery plan recommendations. National Marine Fisheries Service, Portland, OR.

Thedinga, J.F., M.L. Murphy, S.W. Johnson, J.M. Lorenz, and K.V. Koski. 1994. Determination of salmonid smolt yield with rotary-screw traps in the Situk River, Alaska, to predict effects of glacial flooding. North American Journal of Fisheries Management 14:837-851.

USACE (United States Army Corps of Engineers). 1975. Lower Snake River Fish and Wildlife Compensation Plan Special Report. U.S. Army Corps of Engineers, Walla Walla, WA.

USFS (United States Forest Service) and six coauthor agencies. 1992. Upper Grande Ronde River Anadromous Fish Habitat Restoration and Monitoring Plan. U.S. Forest Service, Wallowa-Whitman National Forest, Baker, OR.