FISH RESEARCH PROJECT OREGON

INVESTIGATIONS INTO THE EARLY LIFE HISTORY OF NATURALLY PRODUCED SPRING CHINOOK SALMON IN THE GRANDE RONDE RIVER BASIN

Project Period: 1 September 1996 to 31 August 1997

Annual Progress Report

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ANNUAL PROGRESS REPORT

Project Period: 1 September 1996 to 31 August 1997

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Abstract

We have documented two general life history strategies utilized by juvenile spring chinook salmon in the Grande Ronde River basin: 1) juveniles migrate downstream out of summer rearing areas in the fall, overwinter in river valley habitats, and begin their seaward migration in the spring, and 2) juveniles remain in summer rearing areas through the winter and begin seaward migration in the spring. In migration year 96-97, the patterns evident from migrant trap data were similar for the three Grande Ronde River populations studied, with 42% of the Lostine River migrants and 76% of the Catherine Creek migrants leaving upper rearing areas in the fall. Contrary to past years, the majority (98%) of upper Grande Ronde River migrants moved out in the fall. Total trap catch for the upper Grande Ronde River was exceedingly low (29 salmon), indicating that patterns seen this year may be equivocal. As in previous years, approximately 99% of chinook salmon juveniles moved past our trap at the lower end of the Grande Ronde River valley in the spring, reiterating that juvenile chinook salmon overwinter within the Grande Ronde valley section of the river.

PIT-tagged fish were recaptured at Grande Ronde River traps and mainstem dams. Recapture data showed that fish that overwintered in valley habitats left as smolts and arrived at Lower Granite Dam earlier than fish that overwintered in upstream rearing areas. Fish from Catherine Creek that overwintered in valley habitats were recaptured at the dams at a higher rate than fish that overwintered upstream. In this first year of data for the Lostine River, fish tagged during the fall migration were detected at a similar rate to fish that overwintered upstream. Abundance estimates for migration year 96-97 were 70 for the upper Grande Ronde River, 4,316 for the

Catherine Creek, and 4,323 for the Lostine River populations. Although present in most habitats, juvenile spring chinook salmon were found in the greatest abundance in pool habitats, particularly alcove and backwater pools. These results were consistent for both summer and winter surveys.

Management Recommendations

The Grande Ronde Valley and Wallowa Valley (Wallowa River below the mouth of the Lostine River) provide more than a migration corridor for juvenile spring chinook salmon. A large proportion of juveniles from at least three Grande Ronde Basin populations overwinter in these habitats and grow substantially before leaving the system. Enhancing habitat conditions to improve overwinter survival should be given a priority in these habitats.

Juvenile spring chinook salmon that move out of upper rearing areas in the fall and overwinter lower in the system arrive at Lower Granite Dam earlier in the spring than fish that overwinter in upper rearing areas. As annual spring flow patterns change on the mainstem Snake and Columbia rivers, survival rates may change for fish arriving at the dams at different times. In 1996, fish that overwintered in the Grande Ronde Valley had higher overwinter survival than fish that remained in upper rearing areas, yet in 1995, this pattern was reversed. This indicates that the success of migration strategies may vary with annual changes in environmental conditions, thus highlighting the importance of maintaining a diversity of life history strategies within local populations.

Juvenile spring chinook salmon utilize non-natal areas for rearing in the Grande Ronde River basin. Thus, habitat should be protected or enhanced in natal and non-natal areas alike. Maintenance of existing pool habitat and increasing habitat complexity should be a component of habitat management as juvenile salmon are more abundant in pools than glides or riffles during both summer and winter.

TABLE OF CONTENTS

Page

FIGURES

Number Page

TABLES

TABLES (continued)

EXECUTIVE SUMMARY

Objectives

1. Document the annual in-basin migration patterns, including abundance, timing and duration, of juvenile spring chinook salmon in the upper Grande Ronde River, Catherine Creek and the Wallowa River subbasin.

2. Estimate and compare survival indices from tagging to smolt detection at mainstem Snake and Columbia 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, Catherine Creek and the Wallowa River subbasin.

Accomplishments

We accomplished all of our objectives in 1997 with the following exceptions. Due to a low abundance of spring chinook salmon, we were unable to meet our goals for PIT-tagging juvenile spring chinook salmon in the upper Grande Ronde River during fall, winter, and spring and thus we were unable to estimate and compare survival indices for these tag groups.

Findings

Juvenile spring chinook salmon were captured at the upper Grande Ronde River trap in the fall from 1 October through 25 October 1996 and in the spring on 18 March 1997. A total of 29 spring chinook salmon migrants were captured, and we estimated that a minimum of 65 migrants passed our upper trap. Approximately 98% of the migrant population moved past the upper trap during the fall period. Juvenile spring chinook salmon were captured at the Catherine Creek trap from 27 September 1996 through 6 May 1997. A total of 726 spring chinook salmon migrants were captured, and we estimated that a minimum of 3,951 migrants passed our Catherine Creek trap. Approximately 76% of the spring chinook migrants from Catherine Creek left upper river rearing areas in the fall, 13% left in the winter, and 11% left in the spring. Juvenile spring chinook salmon were captured at our lower Grande Ronde River trap as they left the Grande Ronde Valley from 31 October 1996 through 7 June 1997. A total of 178 spring chinook salmon migrants were captured, and we estimated that a minimum of 2,475 migrants passed our lower Grande Ronde River trap. Approximately 99% of the migrants moved past our lower trap during the spring migration period. Juvenile spring chinook salmon were captured at the Lostine River trap from 25 October 1996 through 9 May 1997. A total of 2,036 juvenile spring chinook salmon migrants were captured, and we estimated that a minimum of 4,274 migrants moved past our Lostine River trap. Approximately, 42% of the total migrant population left upper rearing areas in the fall, 10% in winter, and 48% in the spring.

PIT-tagged spring chinook salmon from the upper Grande Ronde River population were detected at Lower Granite Dam from 22 April to 14 May 1997, with a median passage date of 23 April. The cumulative mainstem dam detection rate for the 27 fish tagged in fall was 14.8%. PIT-tagged spring chinook salmon from the Catherine Creek population were detected at Lower Granite Dam from 17 April to 13 June 1997, with a median passage date of 14 May. Cumulative mainstem dam detection rates by tag group ranged from 6.9 to 37.2%, 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 20.3%, whereas fish tagged during winter in the upper rearing areas were detected at 6.9%. PIT-tagged juvenile spring chinook salmon from the Lostine River were detected at Lower Granite Dam from 2 April to 27 May 1997, with a median passage date of 24 April 1997. Cumulative dam detection rates by tag group ranged from 15.7 to 51.7%, with fish tagged during the spring migration detected at the highest rate among tag groups. Fish tagged during the fall migration were detected at a similar rate to fish tagged during winter in upper rearing areas, 26.0% and 27.2%, respectively.

Juvenile spring chinook salmon were found in the greatest abundance in pool habitats during winter and summer surveys. During summer we observed juvenile spring chinook salmon from river kilometer (rkm) 30 to 52 in Catherine Creek and in the lower 1.5 km of Little Catherine, North Fork Catherine and South Fork Catherine creeks. In the upper Grande Ronde River we observed juvenile spring chinook salmon in the Grande Ronde River from rkm 290 to 325 and in the lower 1 km of Fly Creek during summer. Juvenile spring chinook salmon from the Lostine River were found in the greatest abundance in backwater pools during winter surveys (rkm 19-21). In the summer, juvenile spring chinook salmon were observed rearing below Walla Walla Campground to Williamson Campground (rkm 32-33) and from Six-mile Bridge to the mouth (21 rkm). Juvenile chinook salmon were most abundant in alcoves, backwater and dammed pools during summer surveys in the Lostine River and were generally associated with low velocity habitat types during winter and summer surveys.

Management Implications and Recommendations

The Grande Ronde Valley and the Wallowa River below the Lostine River provide more than a migration corridor for juvenile spring chinook salmon. Portions of the Grande Ronde River, Catherine Creek, and Lostine River populations leave the upper rearing areas during the fall to overwinter in downstream areas before leaving the Grande Ronde River basin in the spring. The majority of the Grande Ronde River and Catherine Creek populations overwinter in the Grande Ronde Valley and put on significant growth during the spring before leaving the valley. Enhancing habitat conditions to improve overwinter survival should be given priority in the Grande Ronde Valley and the Wallowa River.

Juvenile spring chinook salmon that leave the upper rearing areas of Catherine Creek and the Lostine River during the fall overwinter in lower river rearing areas and arrive at Lower Granite Dam earlier in the spring than fish that overwinter in the upper rearing areas. As spring flow patterns change in the Snake and Columbia rivers from year to year, survival rates may change for fish arriving at the dams during different periods of the migration season. In 1996, spring chinook salmon that overwintered in the Grande Ronde Valley had higher overwinter survival than fish that overwintered in the upper rearing areas, whereas in 1995, fish that overwintered in the upper rearing areas had higher overwinter survival. These differences point out the need to maintain the diversity in life history strategies observed in the Grande Ronde River basin, as environmental conditions change from year to year. What may be a successful strategy one year, may not be as successful in another year under different conditions.

Habitat should be protected or enhanced not only in the spawning streams but also in the tributaries as juvenile spring chinook salmon use the lower reaches of non-natal tributaries in addition to the spawning streams for rearing in both the Grande Ronde River and Catherine Creek. Maintenance of existing pool habitat and increasing habitat complexity should be a component of habitat management as juvenile spring chinook salmon are more abundant in pools than glides or riffles during both summer and winter.

INTRODUCTION

The Grande Ronde River originates in the Blue Mountains in northeast Oregon and flows 334 km 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 spring chinook salmon and summer steelhead remain. The size of spring chinook salmon populations in the Grande Ronde River basin have been declining steadily and are substantially depressed from estimates of historic levels. It is estimated that prior to the construction of the Snake and Columbia 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 basin in 1957 (USACE 1975). Recent population estimates vary year to year, but remain at least an order of magnitude lower than historic estimates. In 1995, the escapement estimate for the basin was 310 adults ($3.1 \text{ adults} / \text{redd} \times 100 \text{ redds}$). In addition to declining population abundance, a reduction of spring chinook salmon spawning distribution is also evident in the Grande Ronde River basin. Historically, 21 streams supported spawning chinook salmon, yet today most production is limited to eight tributary streams and the 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 Snake and Columbia river dams, overharvest, habitat degradation associated with timber, agricultural, and land development practices and cyclic changes in ocean productivity. 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 have resulted in these stocks, including 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 requires 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 River 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 River basin range from 8.9% to 22.1% (Walters et al. 1993, 1994; Sankovich et al. 1995). These estimates are based on data from parr that were individually tagged with passive integrated transponder (PIT) tags in late summer and were detected at mainstem Snake and Columbia river dams. Previously, we were unable to separate mortality that occurs during the smolt migration from mortality that occurs during the fall and winter rearing.

Nickelson et al. (1992) demonstrated that availability of winter habitat was an important factor limiting salmon production in many Oregon coastal streams based on work with coho salmon. Typically the chinook salmon smolt migration occurs in the spring, although data from Lookingglass Creek (Burck 1993), Catherine Creek (Keefe et al. 1995) and mainstem Grande Ronde River (Keefe et al. 1994, 1995) indicate that some juveniles move out of summer rearing areas during the fall and overwinter downstream of summer rearing areas. In this study we are acquiring information 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 rearing areas during fall overwintered somewhere between the upper (rkm 299) and lower (rkm 164) traps. Much of the habitat in these mid-reaches of the Grande Ronde River is degraded. Stream conditions in the Grande Ronde River below La Grande consist of both meandering and channelized sections of stream which run 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. The fall migration from rearing areas in Catherine Creek constitutes a substantial portion of the juvenile production (Keefe et al. 1995, Jonasson et al. 1996), thus overwintering habitat quantity and quality in the Grande Ronde Valley may be important factors influencing spring chinook salmon smolt production in the Grande Ronde River basin.

Numerous enhancement activities are being undertaken in effort to recover spring chinook salmon populations in the Grande Ronde River basin. Supplementation programs have been initiated using endemic broodstock in Catherine Creek and the Lostine and upper Grande Ronde rivers. The information we are collecting will serve as the foundation for assessing the effectiveness of the hatchery supplementation efforts that are underway.

GOALS AND OBJECTIVES

This study was designed to describe aspects of the early life history strategies exhibited by spring chinook salmon in the Grande Ronde River basin. During the past year we focused on rearing and migration patterns of juveniles in the upper Grande Ronde River, Catherine Creek and the Lostine River. The objectives of this study in the upper Grande Ronde River, Catherine Creek and the Wallowa subbasin are to: (1) document the annual in-basin migration patterns including abundance, timing and duration, of juvenile spring chinook salmon; (2) estimate and compare survival indices from tagging to smolt detection at mainstem Snake and Columbia River dams for juvenile spring chinook salmon that leave the upper river rearing areas at different times of the year; and (3) determine summer and winter habitat utilization and preference of juvenile spring chinook salmon.

METHODS

In-Basin Migration Timing and Abundance

The seasonal migration timing and abundance of juvenile spring chinook salmon in the upper Grande Ronde River, Catherine Creek and the Lostine River were determined by operating juvenile migrant traps from fall through spring with stoppages during periods of ice-up in the winter. In the Grande Ronde River subbasin, one rotary screw trap was located below spawning and upper rearing areas in the upper Grande Ronde River near the town of Starkey (rkm 299) and another trap was located in the middle Grande Ronde River at the lower end of the Grande Ronde Valley near the town of Elgin (rkm 164, Figure 1). A third rotary screw trap was located in Catherine Creek below spawning and upper 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 8 September to 2 December 1996 and again from 26 February through 30 June 1997. At our lower Grande Ronde River trap site, a 1.5 m diameter trap was fished from 23 October 1996 to 4 February 1997. We fished a 2.4 m diameter trap at this site from 7 February 1997 to 12 June 1997. A 1.5 m diameter trap was fished continuously at the Catherine Creek site from 25 September 1996 through 26 June 1997.

In the Wallowa River subbasin, one rotary screw trap was located on the Lostine River below the majority of spawning and rearing areas near the town of Lostine at rkm 3 (Figure 1). A 1.5 m diameter trap was fished at this site continuously from 25 October 1996 through 30 June 1997. A second rotary screw trap was located on the upper Wallowa River below the spawning and rearing areas of the upper Wallowa River, Hurricane Creek, and Prairie Creek near the town of Enterprise (rkm 64). A 1.5 m diameter trap was fished at this site from 28 March 1997 to 27 April 1997. This site was abandoned at the onset of juvenile hatchery steelhead releases from Wallowa Hatchery. The trap was relocated to rkm 66 to avoid catching the hatchery steelhead smolts, and fished from 30 April to 4 August 1997. A third rotary screw trap was located on the lower Wallowa River near Minam (rkm 16), below spawning and rearing areas of Hurricane, Prairie, Bear, and Parsnip creeks, the upper Wallowa River and the Lostine River. A 1.5 m diameter trap was fished at this site from 5 December 1996 to 7 January 1997. The smaller trap was removed from this site and was replaced with a 2.4 m diameter trap located near the town of Wallowa (rkm 27). The trap operated for two days at this new site beginning on 9 May 1997 before trees dislodged during high spring flows damaged the anchoring structure. The anchoring structure has subsequently been redesigned and the trap will be in operation for the beginning of the 1997 fall migration. Given the limited duration of trapping and necessity of trap relocations, no migrant abundance estimates were made for the Wallowa River traps.

In this report, we refer to spring chinook salmon from the 1995 brood year as "juvenile" spring chinook salmon at our migrant traps. "Fry" refers to the 1996 brood year, and "precocious" spring chinook salmon refers to the 1994 brood year.

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 only a few fish were caught each day. All juvenile spring chinook salmon were removed from the traps for enumeration and interrogation of PIT tags. We measured fork length (mm) and weight (g) of up to 100 juvenile spring chinook salmon each week. We assumed that all juveniles captured in these traps were migrants. Prior to sampling, juvenile spring 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. River height was recorded daily from permanent staff gauges. Water temperatures were recorded daily at each trap location using thermographs or hand held thermometers.

Trap efficiency tests were conducted throughout each trapping season at each trap. A small amount of non-toxic paint was injected just below the surface of a fish's skin with a Panjet marking instrument (Hart and Pitcher 1969) to mark fish for estimating trap efficiency. Trap efficiencies were determined by releasing known numbers of paint marked or PIT-tagged juveniles above the traps and counting the number of recaptures. The number of fish released for trap efficiency tests was adjusted for days when the trap stopped operating due to debris or freezing and no fish were recaptured. Trap efficiency was estimated by

$$\hat{E} = R \;/\; M ; \qquad (1)$$

where $\hat{E}$ is the estimated trap efficiency, M is the number of marked fish released upstream and R is the number of marked fish recaptured.

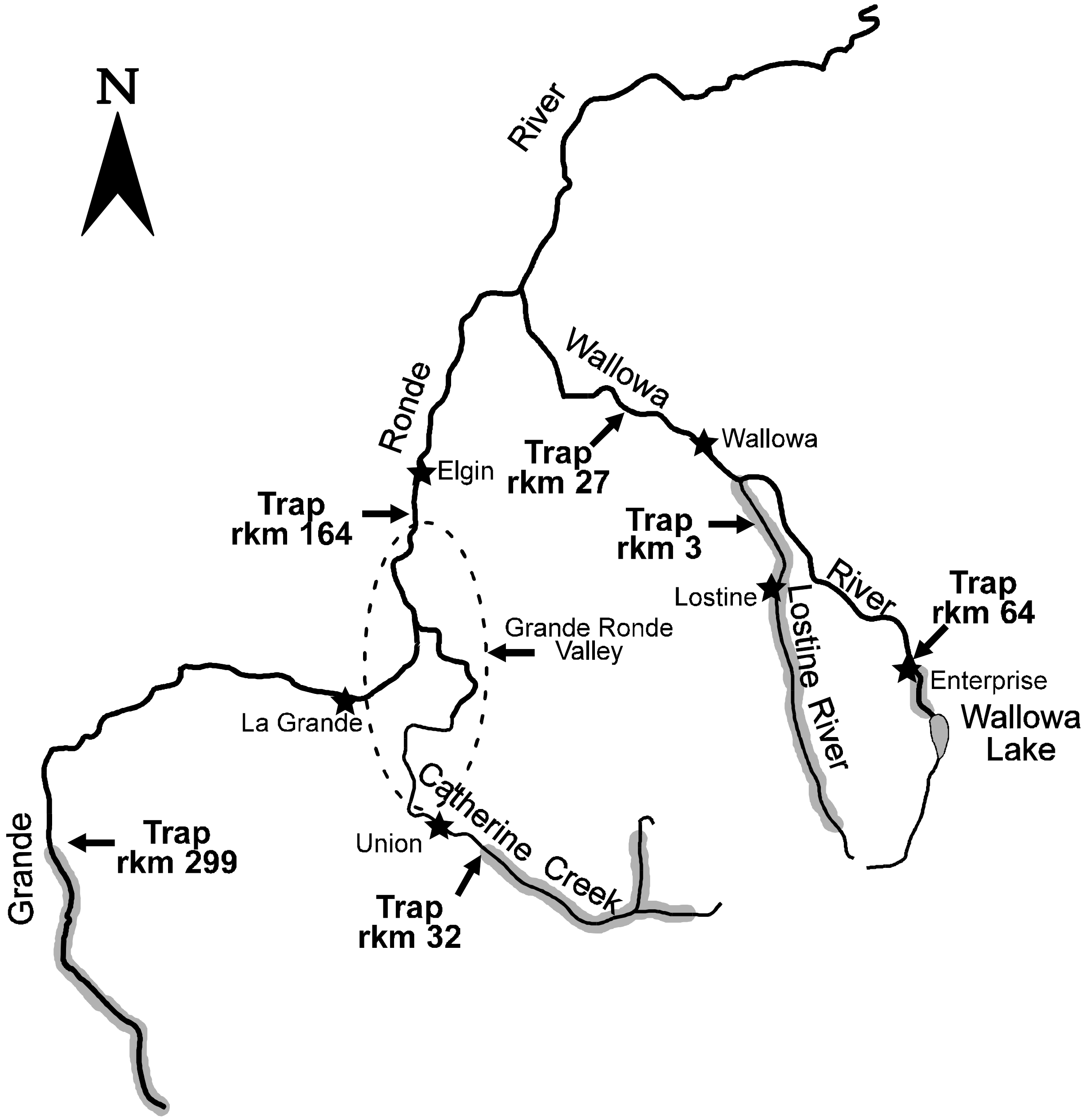

Figure 1. Locations of fish traps on the Grande Ronde, Lostine and Wallowa rivers and Catherine Creek during the study period. The shaded areas delineate the spring chinook salmon spawning and upper rearing areas in the study streams.

Numbers of migrants at each trap site for the entire trapping season (fall, winter, or spring) were estimated by

$$\hat{N} = C \ / \ \hat{E} \ ; \tag{2}$$

where $\hat{N}$ is the estimated number of fish migrating past the trap, C is the total number of unmarked fish in the catch and $\hat{E}$ is the estimated trap efficiency. Variance for each $\hat{N}$ was determined by the bootstrap method (Efron and Tibshirani 1986; Thedinga et al. 1994) with 1,000 iterations. Confidence intervals for $\hat{N}$ were calculated by

$$95\% CI = 1.96\sqrt{V} \ ; \tag{3}$$

where V is the variance of $\hat{N}$ determined from the bootstrap.

The abundance of juvenile spring chinook salmon migrating within the Grande Ronde River basin was determined by dividing the daily catch at each trap by the appropriate trap efficiency to estimate the number of juvenile spring chinook salmon migrants passing each trap daily. In previous years, we used ice-up and ice-out to define the end of the fall and the beginning of the spring migrations. However, a mild winter in 1997 allowed us to fish the Catherine Creek and Lostine River traps without major interruptions from fall through spring. We used the distribution of catch as well as periods of icing during previous years to define fall, winter, and spring migrations in 1996-97. Trapping seasons for our four migrant traps are shown in Table 1.

Table 1. Dates and number of days that migrant traps were fished for the fall, winter, and spring migration seasons at four trap locations in the Grande Ronde River basin.

Trap location	Season	Dates	Days in season	Days fished
Grande Ronde River, rkm 299	fall	09/18/96 - 12/02/96	75	67
	spring	02/26/97 - 06/30/97	124	120
Grande Ronde River, rkm 164	fall	10/23/96 - 02/04/97	104	87
	spring	02/07/97 - 06/12/97	125	96
Catherine Creek, rkm 32	fall	09/25/96 - 12/20/96	86	71
	winter	12/21/96 - 02/09/97	50	14
	spring	02/10/97 - 06/26/97	136	110
Lostine River, rkm 3	fall	10/25/96 - 12/31/97	67	64
	winter	01/01/97 - 03/08/97	66	53
	spring	03/09/97 - 06/30/97	113	86

Migration Timing and Survival to Mainstem Dams

PIT-tag technology allows fish to be individually marked and subsequent observations to be made without sacrificing the fish. Detections of PIT-tagged fish at Snake and Columbia river dams were used to estimate and compare survival among spring and fall migrating juvenile spring chinook salmon. Presently, PIT-tag monitors are used in juvenile bypass systems at six mainstem Snake River and Columbia 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 may result in variable survival. There is a fall migration from summer rearing areas in the upper Grande Ronde River, Catherine Creek, and the Lostine River 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 had planned to tag 500 juvenile spring chinook salmon in the fall and spring at our screw traps in the upper Grande Ronde River, Catherine Creek, and the Lostine River and 500 juvenile spring chinook salmon above these traps during winter. For tagging purposes and to be consistent with previous years of this study, 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, 586 juvenile spring chinook salmon in Catherine Creek and 527 juvenile spring chinook salmon in the Lostine River were PIT-tagged as part of a separate study conducted under the Fish Passage Center Smolt Monitoring Program. These fish were tagged as parr in late August 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. 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 contains fish with life history strategies of all the other tag groups. PIT-tagged fish were interrogated upon recapture in screw traps and in bypass systems at mainstem dams. All recaptured and interrogated fish were identified by their original tag group, thereby insuring independence of tag groups for analysis. For example, dam detections of fish that were tagged in the summer and were recaptured at a river trap in the fall were analyzed as summer tagged fish.

After the migration through the Columbia River was completed, we obtained tag detection information for interrogations at Lower Granite, Little Goose, Lower Monumental, McNary, John Day, and Bonneville dams. We examined migration timing to Lower Granite Dam for each of the tag groups. Because some PIT-tagged fish may have passed undetected over the spillway at Lower Granite Dam and the amount of spill varied throughout the migration, arrival timing data for the tag groups were adjusted for spillway flow. We determined the arrival dates of fish detected at Lower Granite Dam and multiplied the number of fish detected each day by a daily expansion factor, which was calculated as

$$\text{Expansion factor} = (\text{powerhouse flow} + \text{spillway flow}) \,/\, \text{powerhouse flow}. \qquad (4)$$

We added the daily products and then rounded the sum to the nearest integer to estimate the number of fish arriving by week at Lower Granite Dam.

We calculated survival indices for the individual tag groups by dividing the number of individual fish detected at the Snake and Columbia river interrogation sites by the total number of fish tagged within a tag group, and this proportion was expressed as a percentage. We did not adjust the number of fish detected at the dams to compensate for tagged fish passing the dams without being detected as we are unsure of the most appropriate estimate of collection efficiencies at each dam at the time of this report. Comparison of survival indices of fall tagged fish and winter tagged fish allowed us to estimate the relative success of fish that leave the upper rearing areas in the fall versus fish that overwinter in the upper rearing areas and leave in the spring as alternate life history strategies. In addition, a comparison of survival indices of fish tagged as spring migrants versus winter-tagged fish allowed us to estimate overwintering survival, as the winter-tagged fish that survive should become spring migrants. Survival index data from the summer-tagged fish provides information about overall population survival from late summer to the following spring migration.

Habitat Utilization

We assessed habitat utilization and rearing distribution of spring chinook salmon parr during the summer in Catherine Creek and several tributaries, in the upper Grande Ronde River and several tributaries and the Lostine River. We conducted surveys to determine winter habitat utilization in Catherine Creek and the Lostine River, but winter rearing distribution was not assessed. Sites were sampled by snorkel observation with two or three persons in an upstream direction. Winter observations were made during night with the use of dive lights, while summer observations were made during daylight. We used the habitat classification system described in Bisson et al. (1982) with modifications for backwater pools (Nickelson et al. 1992) to identify habitat types. We recorded the fish species present and the following habitat variables: habitat type, area, depth, cover, substrate composition, water temperature, water velocity, slope, shade, and underwater visibility. We observed only one year class (1995 brood year) of spring chinook salmon parr during winter sampling in January and February 1997, whereas during summer sampling in Catherine Creek in July and early August 1997 we identified juvenile spring chinook salmon parr as either age-0 (1996 brood year, generally less than 75 mm fork length), or age-1 (1995 brood year, generally greater than 85 mm fork length). We were not able to distinguish between age-0 and age-1 spring chinook salmon in the Grande Ronde or Lostine rivers during summer.

During winter, we surveyed Catherine Creek from rkm 18 to 19 and from rkm 27 to 46. During summer, we surveyed Catherine Creek from rkm 30 to 52, the lower 1 km of Little Catherine Creek, the lower 1 km of North Fork Catherine Creek, and the lower 1 km of South Fork Catherine Creek. We also surveyed the Grande Ronde River from rkm 288 to 306 and from rkm 318 to 325, the lower 1 km of Fly Creek, and Clear Creek near its confluence with the Grande Ronde River during summer. We surveyed the Lostine River from rkm 16 to 21 during winter, and from rkm 0 to 43 during summer. We selected sampling sites based on redd and rearing distribution surveys from previous years, physical habitat surveys, and accessibility.

RESULTS AND DISCUSSION

In-Basin Migration Timing and Abundance

We captured 28 fall migrating juvenile spring chinook salmon and seven precocious male spring chinook salmon in the upper Grande Ronde River trap from 18 September through ice-up on 2 December 1996 (Figure 2). Juvenile spring chinook salmon were captured between 1 October and 25 November 1996, and all precocious males were captured between 19 September and 30 September 1996. We began fishing the trap again on 26 February 1997 after the ice began to clear from the river, and captured one spring migrating juvenile spring chinook salmon on 18 March 1997. The date when the median fall migrant moved past the trap was 13 November.

A minimum of 66 ± 46 juvenile spring chinook salmon moved past our upper Grande Ronde River trap site from fall through spring. Based on seasonal trap efficiencies of 42.9% during fall and 100% during spring, we estimated that 65 ± 46 fall migrants and one spring migrant left the upper Grande Ronde River rearing areas. Approximately 98% of the migrants moved out of the upper rearing areas in the fall and 2% moved out in the spring. We did not estimate the number of precocious male chinook salmon passing our trap.

Juvenile chinook salmon abundance in rearing areas may influence the proportion of fall migrants. In 1996-97, 98% of the upper Grande Ronde River juveniles migrated from upper rearing areas into the Grande Ronde Valley in the fall. Typically we have seen the majority of the migrants leave the upper Grande Ronde River in the spring since the study began in 1993. In the three previous years of the study, our estimates of migrants ranged from 1,151 to 30,926 fish.

We captured 726 migrating juvenile spring chinook salmon in the Catherine Creek trap from 25 September 1996 through 26 June 1997 (Figure 2). We captured 494 juveniles in the fall from 25 September to 17 December 1996, 135 juveniles in the winter from 3 January to 5 February 1997, and 97 juveniles in the spring from 9 February to 6 May 1997. The dates when the median migrant moved past the trap were 12 November for the fall migration, 6 January for the winter migration, and 19 March for the spring migration.

A minimum of 3,951 ± 992 juvenile spring chinook salmon moved past our Catherine Creek trap site from fall through spring. Based on seasonal trap efficiencies of 16.4% during fall, 26.9% during winter, and 22.2% during spring, we estimated 3,012 ± 959 fall migrants, 502 ± 170 winter migrants, and 437 ± 189 spring migrants left the Catherine Creek rearing areas. Approximately 76% of the migrants left Catherine Creek in the fall, 13% in the winter, and 11% in the spring. Recently emerged chinook salmon fry were first captured in the Catherine Creek trap on 8 March and are not included in our estimate of chinook salmon migrants.

Juvenile spring chinook salmon were captured in our Catherine Creek trap through the winter whenever it was not stopped due to ice. An unknown number of juvenile spring chinook salmon may have passed our trap site for the several weeks the stream was iced up and the trap was not fishing. If this is the case, our estimate of total migrants leaving Catherine Creek would be conservative.

The proportion of juveniles leaving the upper rearing areas of Catherine Creek during fall are similar to what we found in 1995-96 (74% fall migrants) and is greater than our estimate in 1994-95 (48% fall migrants). We operated the trap longer into the winter months in 1995-96 and 1996-97 than we did in 1994-95 and may have captured later migrating chinook salmon which we included in the total for fall migrants. We found that juvenile chinook salmon continue to move out of the upper rearing areas through the winter months, as we captured juveniles whenever we were able to operate our trap. If fish continue to move downstream when our traps and the river are iced-up, then our past estimates of the proportion of fall versus spring migrants may reflect when we were able to trap rather than the actual timing of the migration from the upper rearing areas.

The lower Grande Ronde River trap was fished from 23 October 1996 to 12 June 1997. We captured six juvenile spring chinook salmon during fall and 172 during spring (Figure 2). The date when the median spring migrant moved past the trap was 8 May.

Based on estimated trap efficiencies of 33.3% for our 1.5 m trap and 7.0% for our 2.4 m trap, we estimated that a minimum of 2,475 ± 2,375 juvenile spring chinook salmon migrants left the Grande Ronde Valley. More than 99% of the migrants passed our trap during the spring, compared to less than 1% during fall and winter combined, consistent with movements observed in the three previous years. These data indicate that most juvenile salmon that left the upper rearing areas during the fall overwintered in the valley reaches of the Grande Ronde River. Protection and enhancement of habitat in the Grande Ronde Valley should be given high priority to maintain or enhance overwinter survival of these juvenile chinook salmon that reside in the valley during winter.

We captured 2,036 migrating juvenile spring chinook salmon at our Lostine River trap site from 25 October 1996 through 9 May 1997. Three seasonal migrations were observed during this time period (Figure 2). In the fall, 843 migrants were captured from 25 October through 31 December 1996. The date when the median fall migrant moved past the trap was 29 November 1996. A winter migration of 183 fish was observed from 1 January through 8 March 1997. The date when the median winter migrant moved past the trap was 21 January 1997. In the spring, 1,010 migrants were captured from 9 March through 9 May 1997. The date when the median spring migrant moved past the trap was 3 April 1997.

A minimum of 4,274 ± 307 juvenile spring chinook salmon moved past our Lostine River trap site from fall through spring. Trap efficiency was 46.6% in the fall, 42.7% in winter, and 49.6% in the spring. Based on these seasonal trap efficiencies 1,809 ± 191 migrants moved out of upper rearing areas in the fall, 429 ± 100 in the winter, and 2,036 ± 302 in the spring. Approximately 42% of the total migrant population left upper rearing areas in the fall, 10% in the winter, and 48% in the spring.

The Lostine River trap did not fish for 20 of 194 days during the fall, winter and spring migration periods and did not start fishing until 25 October 1997. An unknown number of juvenile spring chinook salmon may have passed the trap site before it started fishing and while the trap was stopped. Thus, the estimates for the Lostine River are conservative.

Due to limited operating time, trap relocations, and limited catch, no abundance estimates are available for the Wallowa River traps. Actual catch data for Wallowa River traps can be found in Table 2.

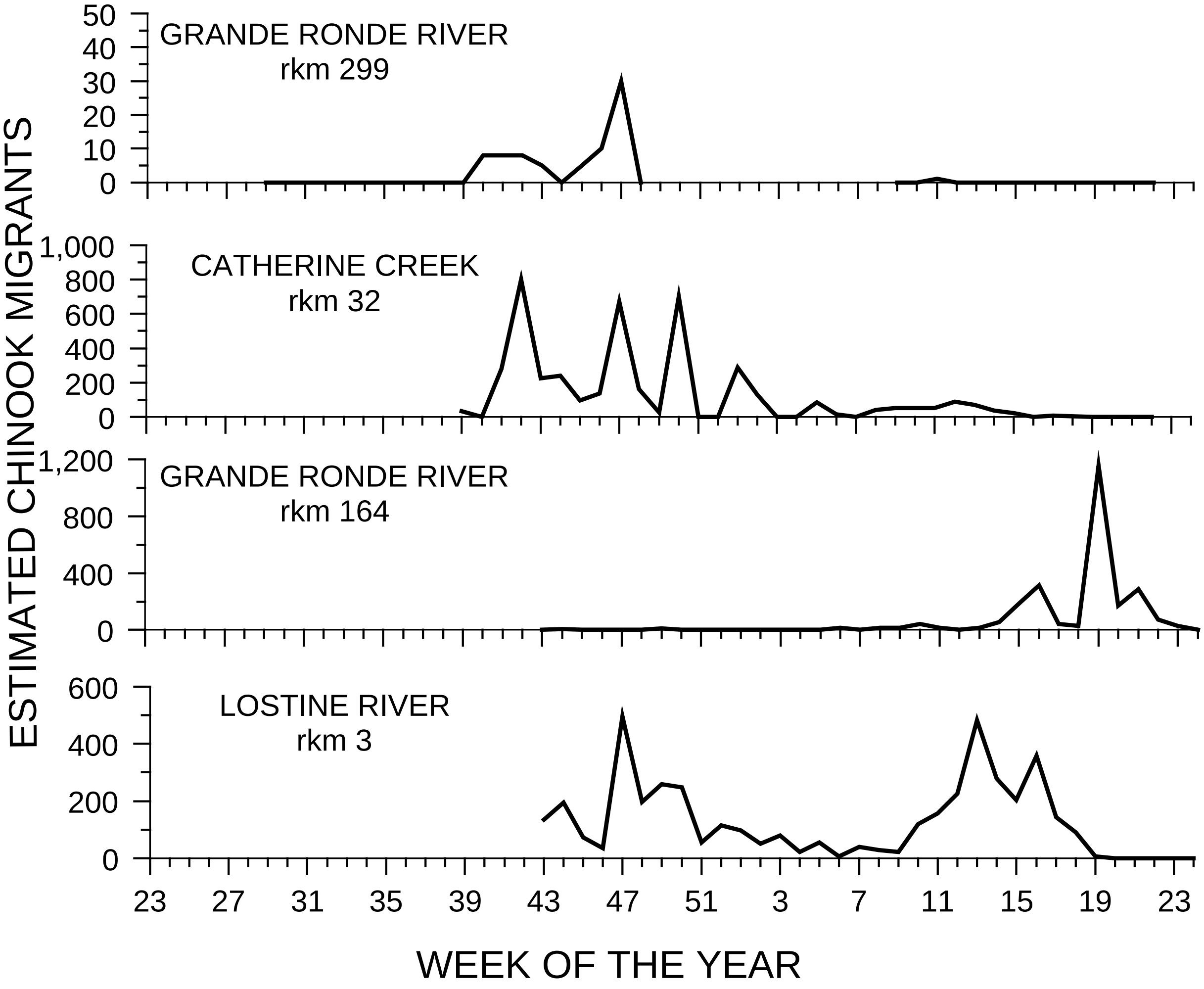

Figure 2. Timing and estimated abundance of juvenile spring chinook salmon migrants captured by rotary screw traps at rkm 299 and 164 of the Grande Ronde River, rkm 32 of Catherine Creek, and rkm 3 of the Lostine River, fall 1996 through spring 1997.

Table 2. Location, dates of operation, and number of spring chinook salmon migrants captured in rotary screw traps operated on the Wallowa River.

Trap location, rkm	Dates of operation	Spring chinook salmon migrants captured
16	12/05/96 - 01/07/97	39
64	03/28/97 - 04/27/97	3
66	04/30/97 - 06/30/97	7

The mean lengths and weights of juvenile spring chinook salmon captured from the upper Grande Ronde River and PIT-tagged are shown in Tables 3 and 4. The mean lengths and weights of juvenile spring chinook salmon captured from Catherine Creek and PIT-tagged are shown in Tables 5 and 6. The mean lengths and weights of juvenile spring chinook salmon captured from the Lostine River and PIT-tagged are shown in Tables 7 and 8. Length frequency distributions of juvenile chinook salmon caught in all traps are shown in Figure 3.

Mean fork lengths of fall and winter migrants captured at our Lostine River trap were larger than the mean fork length of fish captured and PIT-tagged in upstream winter rearing areas of the Lostine River. However, the mean fork lengths of fall and winter migrants captured at our Catherine Creek trap were not different than the mean fork length of fish captured and PIT-tagged in upstream winter rearing areas of Catherine Creek.

Weekly mean lengths and weights demonstrated trends for increasing size of migrants over time from the upper Grande Ronde River (Table 9), Catherine Creek (Table 10), and from the Grande Ronde Valley (Table 11). These trends in increasing size of migrants over time are similar to what we observed in previous years. However, weekly mean lengths and weights of migrants from the Lostine River (Table 12) demonstrated a trend for decreasing size of migrants over time in the fall, and a trend for increasing size over time in the spring, suggesting that larger fish move out of upstream rearing areas earlier in the fall.

Table 3. Fork lengths (mm) of juvenile spring chinook salmon collected from the Grande Ronde River, fall 1996 and spring 1997. All fish were captured with a rotary screw trap at rkm 299. Min. = minimum, Max. = maximum.

	Collected				
Group	*N*	Mean	SE	Min.	Max.
Fall	27	91.7	0.927	83	100
Spring	1	95.0			
Release	Tagged and Released				
Group	*N*	Mean	SE	Min.	Max.
Fall	26	91.8	0.961	83	100
Spring	1	95.0			

Table 4. Weights (g) of juvenile spring chinook salmon collected from the Grande Ronde River, fall 1996 and spring 1997. All fish were captured with a rotary screw trap at rkm 299.

	Collected				
Group	*N*	Mean	SE	Min.	Max.
Fall	27	8.39	0.281	6.0	11.8
Spring	1	9.00			
Release	Tagged and Released				
Group	*N*	Mean	SE	Min.	Max.
Fall	26	8.38	0.292	6.0	11.8
Spring	1	9.00			

Table 5. Fork lengths (mm) of juvenile spring chinook salmon collected from Catherine Creek, summer 1996 to spring 1997. Summer fish were captured with seines and winter fish were captured with seines or dipnets in Catherine Creek from rkm 42 to 50. Fall and spring fish were captured with a rotary screw trap at rkm 32.

	Collected				
Group	*N*	Mean	SE	Min.	Max.
Summer[a]	1,106	84.8	0.21	60	109
Fall	558	90.9	0.28	70	113
Winter	102	92.8	0.80	70	115
Spring	98	94.1	0.67	75	109

Release	Tagged and Released				
Group	*N*	Mean	SE	Min.	Max.
Summer[a]	585	84.5	0.30	60	109
Fall	403	90.3	0.32	70	109
Winter	102	92.8	0.80	70	115
Spring	78	94.2	0.72	81	109

[a] *From Sankovich, et al., 1996.*

Table 6. Weights (g) of juvenile spring chinook salmon collected from Catherine Creek, summer 1996 to spring 1997. Summer fish were captured with seines and winter fish were captured with seines or dipnets in Catherine Creek from rkm 42 to 50. Fall and spring fish were captured with a rotary screw trap at rkm 32.

	Collected				
Group	*N*	Mean	SE	Min.	Max.
Summer[a]	776	7.24	0.07	2.0	16.9
Fall	557	8.45	0.08	3.7	15.9
Winter	102	8.32	0.22	3.6	15.9
Spring	75	9.05	0.24	5.7	14.5
Release	Tagged and Released				
Group	*N*	Mean	SE	Min.	Max.
Summer[a]	585	7.02	0.08	2.0	16.9
Fall	402	8.32	0.9	4.2	15.0
Winter	102	8.32	0.22	3.6	15.9
Spring	58	9.08	0.28	5.7	14.5

[a] *From Sankovich, et al., 1996.*

Table 7. Fork lengths (mm) of juvenile spring chinook salmon collected from the Lostine River, summer 1996 to spring 1997. Summer fish were captured with seines and winter fish were captured with dipnets in the Lostine River from rkm 16 to 21. Fall and spring fish were captured with a rotary screw trap at rkm 3.

	Collected				
Group	*N*	Mean	SE	Min.	Max.
Summer[a]	1,008	77.7	0.29	55	105
Fall	815	98.3	0.31	74	128
Winter	390	91.9	0.47	73	126
Spring	765	102.2	0.44	79	141
Release	Tagged and Released				
Group	*N*	Mean	SE	Min.	Max.
Summer[a]	527	76.5	0.38	59	105
Fall	519	99.5	0.39	78	128
Winter	390	91.9	0.47	73	126
Spring	476	102.3	0.56	79	141

[a] *From Sankovich, et al., 1996.*

Table 8. Weights (g) of juvenile spring chinook salmon collected from the Lostine River, summer 1996 to spring 1997. Summer fish were captured with seines and winter fish were captured with dipnets in the Lostine River from rkm 16 to 21. Fall and spring fish were captured with a rotary screw trap at rkm 3.

	Collected				
Group	*N*	Mean	SE	Min.	Max.
Summer[a]	1,007	5.73	0.07	1.9	13.8
Fall	815	10.86	0.11	4.3	26.6
Winter	390	8.98	0.14	4.6	22.9
Spring	765	12.77	0.18	5.2	34.2
Release	Tagged and Released				
Group	*N*	Mean	SE	Min.	Max.
Summer[a]	527	5.51	0.09	1.9	13.8
Fall	519	11.36	0.14	5.1	26.6
Winter	390	8.98	0.14	4.6	22.9
Spring	476	12.83	0.23	5.7	34.2

[a] *From Sankovich, et al., 1996.*

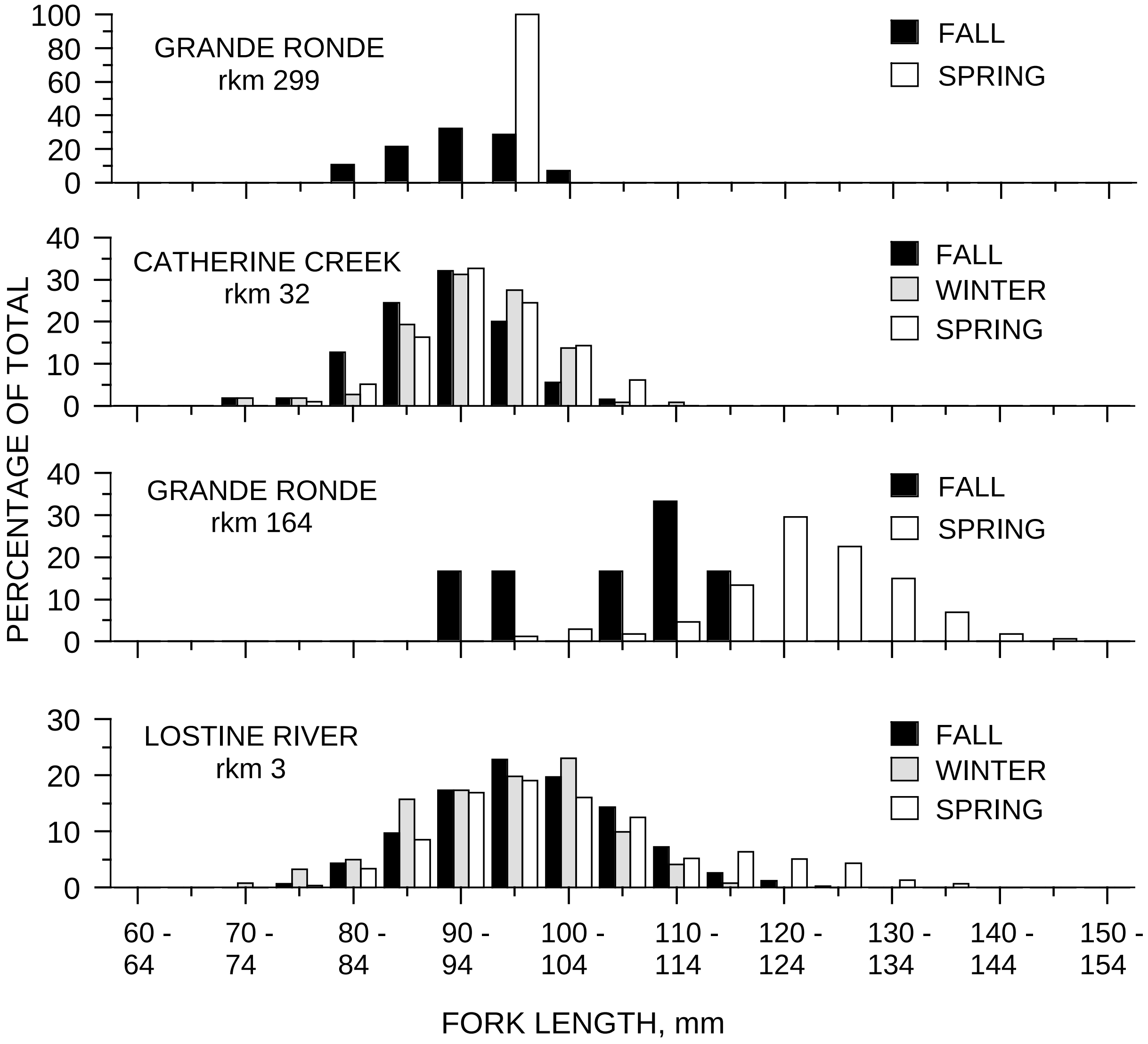

Figure 3. Length frequency (fork length, mm) of juvenile spring chinook salmon migrants captured by rotary screw traps on the Grande Ronde and Lostine rivers and Catherine Creek, fall 1996, winter 1996-97, and spring 1997.

Table 9. Fork lengths (mm) and weights (g) of juvenile spring chinook salmon captured by a rotary screw trap at rkm 299 of the Grande Ronde River, weeks 40 to 47, 1996 and week 11, 1997.

Year,	Length					Weight				
week	*N*	Mean	SE	Min.	Max.	*N*	Mean	SE	Min.	Max.
1996:										
40	2	91.5	1.50	90	93	2	9.65	0.950	8.7	10.6
41	2	92.0	5.00	87	97	2	9.50	1.200	8.3	10.7
42	3	92.0	3.22	87	98	3	8.10	0.643	7.1	9.3
43	2	90.5	1.50	89	92	2	7.90	0.800	7.1	8.7
45	2	88.5	1.50	87	90	2	7.60	0.200	7.4	7.8
46	4	89.0	2.27	83	93	4	7.43	0.343	6.9	8.4
47	12	93.3	1.59	83	100	12	8.60	0.505	6.0	11.8
1997:										
11	1	95.0				1	9.00			

Table 10. Fork lengths (mm) and weights (g) of juvenile spring chinook salmon captured by a rotary screw trap at rkm 32 of Catherine Creek, weeks 39 to 50, 1996 and weeks 1 to 17, 1997.

Year,	Length					Weight				
week	*N*	Mean	SE	Min.	Max.	*N*	Mean	SE	Min.	Max.
1996:										
39	5	80.0	3.72	71	87	5	6.22	0.803	4.2	8.1
41	42	91.0	1.01	80	109	42	9.31	0.375	5.8	15.0
42	113	90.0	0.52	74	100	113	8.33	0.151	4.6	12.7
43	31	88.2	1.25	70	102	31	7.96	0.320	4.4	13.1
44	32	91.5	1.16	82	107	32	8.79	0.403	4.8	14.7
45	12	93.2	1.97	85	105	12	9.42	0.656	7.2	13.0
46	20	91.8	1.53	77	105	20	8.54	0.440	4.5	12.4
47	78	90.2	0.78	70	105	78	8.30	0.226	4.5	13.5
48	18	88.8	1.31	80	98	17	7.71	0.354	4.9	10.5
49	5	91.8	2.01	88	98	5	8.66	0.781	7.2	10.7
50	93	91.1	0.62	72	106	93	8.15	0.167	4.5	12.6
1997										
1	54	94.3	0.85	80	113	54	9.23	0.288	5.7	15.9
2	32	92.1	1.19	74	103	32	8.47	0.300	4.3	11.2
5	23	91.7	1.30	72	102	23	8.00	0.329	3.7	11.4
6	2	92.5	4.50	88	97	2	7.85	0.850	7.0	8.7
8	7	93.1	3.30	75	101	7	8.79	0.780	5.8	12.0
9	18	95.2	1.67	86	109	17	9.36	0.534	6.9	13.3
10	10	92.8	2.50	84	108	10	8.64	0.847	5.7	13.6
11	13	96.0	2.05	81	106	13	9.33	0.628	6.1	13.1
12	18	95.3	1.14	89	106	18	8.72	0.318	6.8	11.7
13	14	92.3	1.68	85	102	0				
14	7	93.6	1.46	89	99	3	8.73	1.286	7.3	11.3
15	7	90.0	2.27	82	97	3	9.53	0.722	8.1	10.4
17	2	99.5	6.50	93	106	2	11.65	2.850	8.8	14.5

Table 11. Fork lengths (mm) and weights (g) of juvenile spring chinook salmon captured by a rotary screw trap at rkm 164 of the Grande Ronde River, weeks 44 to 49, 1996 and weeks 6 to 23, 1997.

Year,	Length					Weight				
week	*N*	Mean	SE	Min.	Max.	*N*	Mean	SE	Min.	Max.
1996:										
44	2	109.5	1.50	108	111	2	15.25	0.050	15.2	15.3
47	1	118.0				1	18.00			
49	3	100.0	6.81	90	113	3	11.50	2.001	9.4	15.5
1997:										
6	1	121.0				1	17.10			
8	1	112.0				1	17.10			
9	1	107.0				1	13.20			
10	2	100.5	2.50	98	103	2	10.90	0.400	10.5	11.3
11	1	99.0				1	10.90			
13	1	111.0				0				
14	4	113.0	6.52	100	127	3	14.97	3.830	10.6	22.6
15	13	117.2	2.98	101	135	13	18.46	1.707	11.3	30.1
16	22	121.5	1.32	110	137	18	19.65	0.638	15.9	24.2
17	3	124.0	2.02	110	132	3	23.37	3.122	17.2	27.3
18	2	121.0	4.00	117	125	2	19.40	1.700	18.2	21.6
19	82	125.1	0.74	111	145	82	22.72	0.397	15.3	34.8
20	12	125.6	1.46	119	133	12	24.00	0.740	20.8	27.8
21	21	129.6	1.53	115	140	21	27.06	0.873	20.9	33.3
22	5	131.2	4.14	120	141	5	26.04	2.134	20.2	30.3
23	2	120.0	1.00	119	121	2	22.06	2.200	20.4	24.8

Table 12. Fork lengths (mm) and weights (g) of juvenile spring chinook salmon captured by a rotary screw trap at rkm 3 of the Lostine River, weeks 43 to 52, 1996 and weeks 1 to 19, 1997.

Year,	Length					Weight				
week	*N*	Mean	SE	Min.	Max.	*N*	Mean	SE	Min.	Max.
1996:										
43	70	106.7	0.93	90	125	70	14.40	0.415	8.5	24.3
44	90	104.5	0.94	86	128	90	13.60	0.379	7.2	26.6
45	32	98.6	1.86	81	126	32	11.19	0.625	5.9	22.2
46	17	98.8	1.36	90	110	17	10.97	0.498	8.1	15.1
47	228	98.8	0.55	78	124	228	11.17	0.194	5.1	21.5
48	89	98.7	0.84	80	120	89	10.82	0.289	5.2	20.1
49	118	97.1	0.84	79	123	118	10.29	0.289	5.6	19.9
50	72	96.3	0.97	78	121	72	9.92	0.326	4.8	18.3
51	26	97.5	1.61	87	118	26	10.36	0.590	7.0	18.3
52	54	95.7	1.14	82	114	54	9.78	0.386	6.3	17.2
1997										
1	38	96.6	1.53	75	117	38	10.33	0.489	4.3	17.9
2	22	93.5	1.99	75	112	22	8.90	0.561	4.5	15.2
3	34	96.9	1.43	79	110	34	10.37	0.462	5.2	14.7
4	10	93.0	3.07	74	112	10	9.10	0.831	4.3	14.6
5	24	95.3	1.28	82	107	24	9.56	0.433	6.0	13.9
6	3	94.0	4.93	85	102	3	8.83	1.202	6.5	10.5
7	17	95.3	2.36	80	122	17	9.91	0.909	5.6	21.5
8	9	94.0	2.71	84	105	9	9.74	0.847	6.5	13.6
9	7	100.9	2.10	92	108	7	10.99	0.773	8.3	13.6
10	51	104.1	1.85	81	137	51	13.10	0.696	6.1	28.1
11	76	102.8	1.36	82	133	76	12.41	0.484	5.9	25.7
12	112	99.5	1.05	79	125	112	11.64	0.388	5.2	23.4
13	119	98.2	0.92	80	132	119	11.14	0.350	6.2	26.0
14	128	99.1	1.02	80	132	128	11.65	0.389	5.7	26.7
15	83	104.3	1.30	84	131	83	13.58	0.559	7.1	27.2
16	148	102.4	0.90	81	134	148	13.13	0.389	6.4	29.5
17	73	107.2	1.52	87	137	73	14.78	0.667	8.0	31.4
18	45	110.4	2.07	88	141	45	16.64	0.946	8.2	34.2
19	1	100.0				1	12.10			

PIT tags allow us to identify individual fish, and thus assess growth of individuals as fish are recaptured. We recaptured only nine PIT-tagged fish from Catherine Creek as they left the Grande Ronde Valley during the spring, and as in previous years, these data indicate that juvenile spring chinook salmon significantly increase in length (paired t test, $P \leq 0.05$) before leaving the Grande Ronde Valley in the spring (Table 13). The Grande Ronde Valley provides more than a migration corridor for juvenile spring chinook salmon, as a portion of both the Grande Ronde River and Catherine Creek populations leave upper rearing areas during the fall to overwinter in the Grande Ronde Valley. Before leaving the valley in the spring, juvenile spring chinook salmon put on significant growth before they pass our trap at rkm 164 to leave the Grande Ronde Valley.

Table 13. Mean fork lengths (mm) of juvenile spring chinook salmon PIT-tagged in Catherine Creek and recaptured by a rotary screw trap on the Grande Ronde River at rkm 164 during spring 1997. Standard errors are in parentheses.

		Mean length	
Group	*N*	Tagging	Recapture
Summer	5	88.6 (2.87)	121.0 (3.75)
Fall	3	86.0 (7.00)	122.0 (2.52)
Spring	1	98.0	135.0

Migration Timing and Survival to Mainstem Dams

At the upper Grande Ronde River trap, we PIT-tagged 27 fall and one spring migrating spring chinook salmon juveniles that were not previously tagged. At the Catherine Creek trap, we PIT-tagged 403 fall and 78 spring migrating spring chinook salmon juveniles that were not previously tagged. In addition, we captured and PIT-tagged 102 parr from rearing areas above the Catherine Creek trap during winter. At the Lostine River trap, we PIT-tagged 519 fall, and 476 spring migrating juvenile chinook salmon that were not previously tagged. In addition, we dipnetted and PIT-tagged 390 parr from winter rearing areas above the Lostine River trap during winter.

PIT-tagged fish from the upper Grande Ronde River ($N = 3$) were detected at Lower Granite Dam from 22 April 1997 to 14 May 1996, with 50% of the Grande Ronde River fish passing Lower Granite Dam by 24 April 1997 (Figure 4). PIT-tagged fish from Catherine Creek ($N = 129$) were detected at Lower Granite Dam from 17 April 1997 to 15 June 1997, with 50% of the Catherine Creek fish passing Lower Granite Dam by 14 May 1997 (Figure 5). PIT-tagged fish from the Lostine River ($N = 265$) were detected at Lower Granite Dam from 2 April through 27 May 1997, with 50% of the Lostine River fish passing Lower Granite Dam by 24 April 1997 (Figure 6).

Travel times to Lower Granite Dam for fish tagged during the spring migration from Catherine Creek ranged from 17 to 91 days with a mean of 61.0 days (*N* = 22). The one fish tagged during the spring migration from the upper Grande Ronde River arrived at Lower Granite Dam 57 days after it was tagged. Travel times for fish tagged during the spring migration at the Lostine River trap ranged from 5 to 51 days with a mean of 23.3 days (*N* = 109).

In Catherine Creek, the median arrival dates to Lower Granite Dam by tag group was 14 May for summer, 12 May for fall, 17 May for winter, and 26 May for spring (Figure 5). The median arrival date to Lower Granite Dam by tag group for fish PIT-tagged on the Lostine River was 23 April for summer, 22 April for fall, 2 May for winter, and 25 April for spring (Figure 6). The earliest fish detected at Lower Granite Dam from Catherine Creek and the Lostine River were tagged during fall and had moved into lower river rearing areas to overwinter.

Juvenile spring chinook salmon PIT-tagged during the fall at our upper Grande Ronde River trap were detected at Snake and Columbia river dams at a rate of 14.8% (Table 14). We were unable to compare detection rates by tag groups in the upper Grande Ronde River because only one fish was tagged during spring, and none were tagged during the winter. The one fish tagged during the spring was detected at Lower Granite Dam on 14 May 1997.

Detection rates by tag group for Catherine Creek PIT-tagged fish ranged from 6.9% for fish tagged during the winter in upstream rearing areas, to 37.2% for fish tagged during the spring migration at our trap (Table 15). Spring-tagged fish had the highest detection rate. This is the only group tagged after overwinter mortality had occurred. Fall-tagged fish from Catherine Creek were detected at higher rates in 1997 than winter-tagged fish, suggesting better overwinter survival for fish that left the upper rearing areas of Catherine Creek and overwintered in the Grande Ronde Valley. We found similar results in 1996; however, in 1995, we found that fish tagged during winter had higher detection rates than fish tagged during fall, suggesting better overwinter survival for fish remaining in the upper rearing areas of Catherine Creek. 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 approximate 19% in 1997, whereas data from 1996 indicated that overwinter survival in the upper rearing areas was approximately 32% (Jonasson et al. 1996), and in 1995 it was approximately 53% (Keefe et al. 1995).

Detection rates by tag group for Lostine River PIT-tagged fish ranged from 15.7% for fish tagged in upstream rearing areas (rkm 16-21) in the summer to 51.7% for fish tagged at the trap (rkm 3) during the spring migration (Table 16). Fish tagged during the fall migration overwinter in lower rearing areas and experienced similar survival to fish tagged in the winter, 26.0% to 27.2%. Fish were not tagged in upper rearing areas for the winter group until mid-January to mid-February and the spring-tagged fish were tagged beginning in mid-March. Comparing detection rates of winter-tagged fish to spring-tagged fish from the Lostine River suggests that overwinter survival, specifically late February to early March, of fish remaining in the upper rearing areas may be approximately 53%.

In conclusion, spring chinook salmon that leave the upper rearing areas of Catherine Creek and the Lostine River during the fall and overwinter in lower rearing areas arrive at Lower Granite Dam earlier in the spring than fish that overwinter in the upper rearing areas. As spring flow patterns change in the Snake and Columbia rivers from year to year, survival rates may vary for fish arriving at the dams during different periods of the migration season.

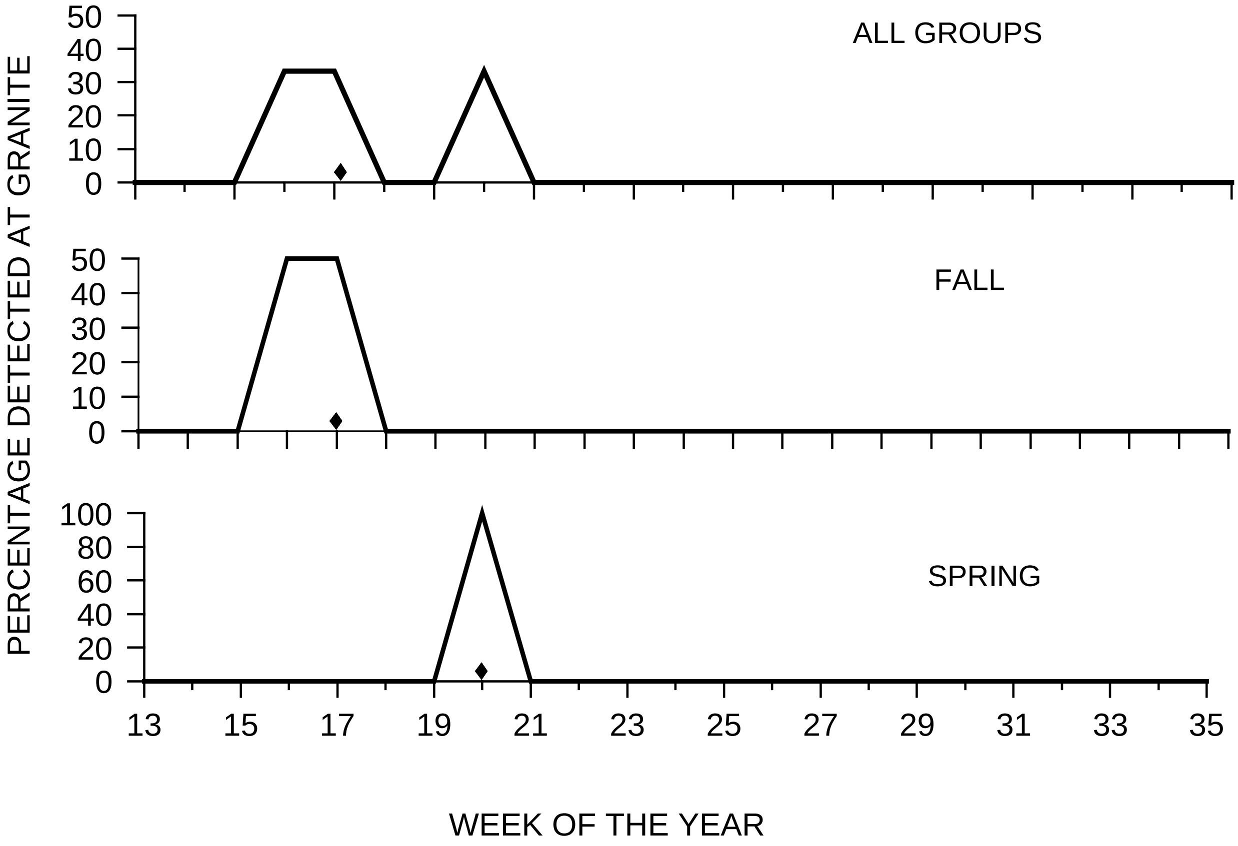

Figure 4. Migration timing at Lower Granite Dam for juvenile spring chinook salmon from the Grande Ronde River, by tag group, 1997 migration year. ♦ = median arrival date. Data were expanded for spillway flow.

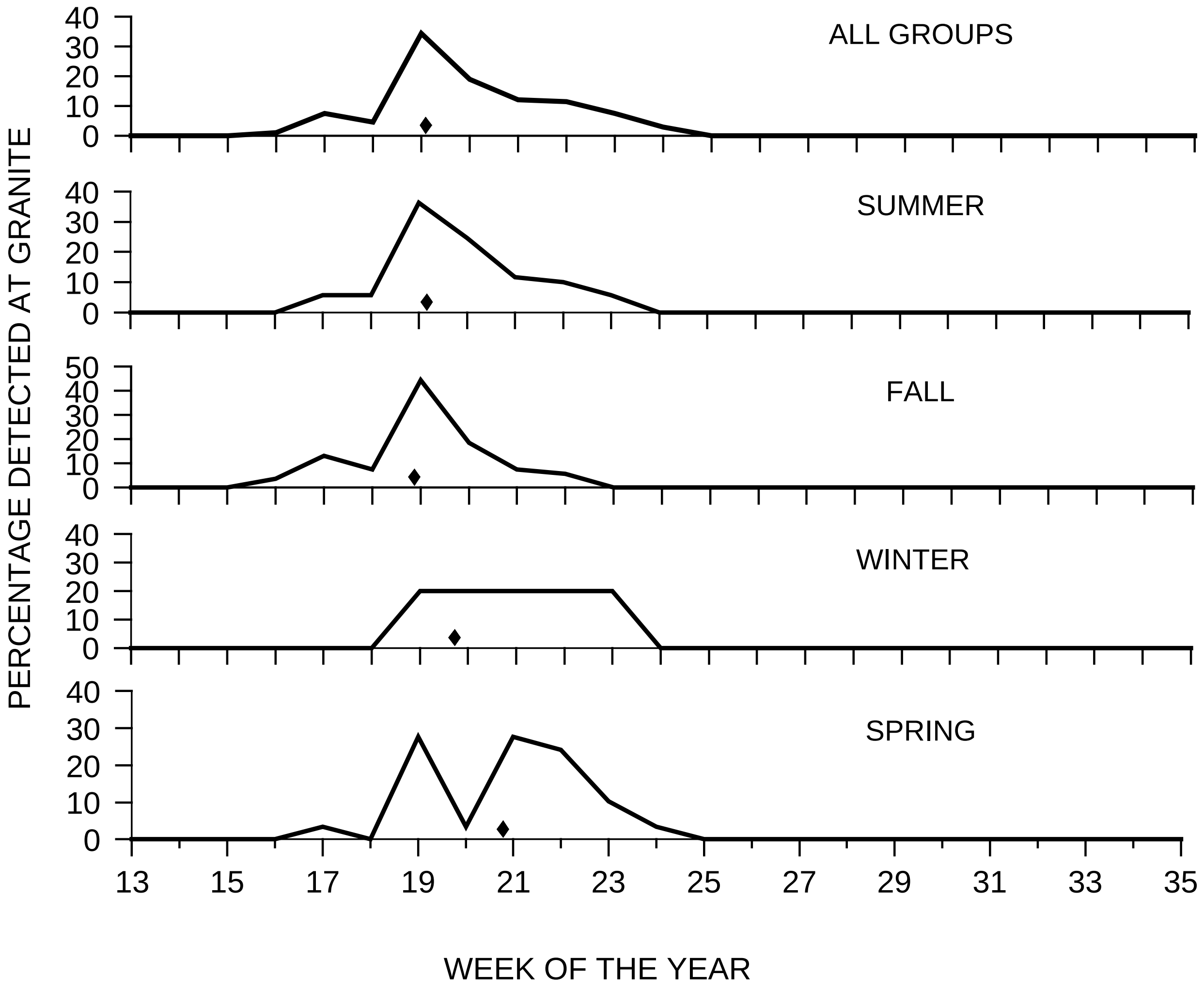

Figure 5. Migration timing at Lower Granite Dam for juvenile spring chinook salmon from Catherine Creek, by tag group, 1997 migration year. ♦ = median arrival date. Data were expanded for spillway flow.

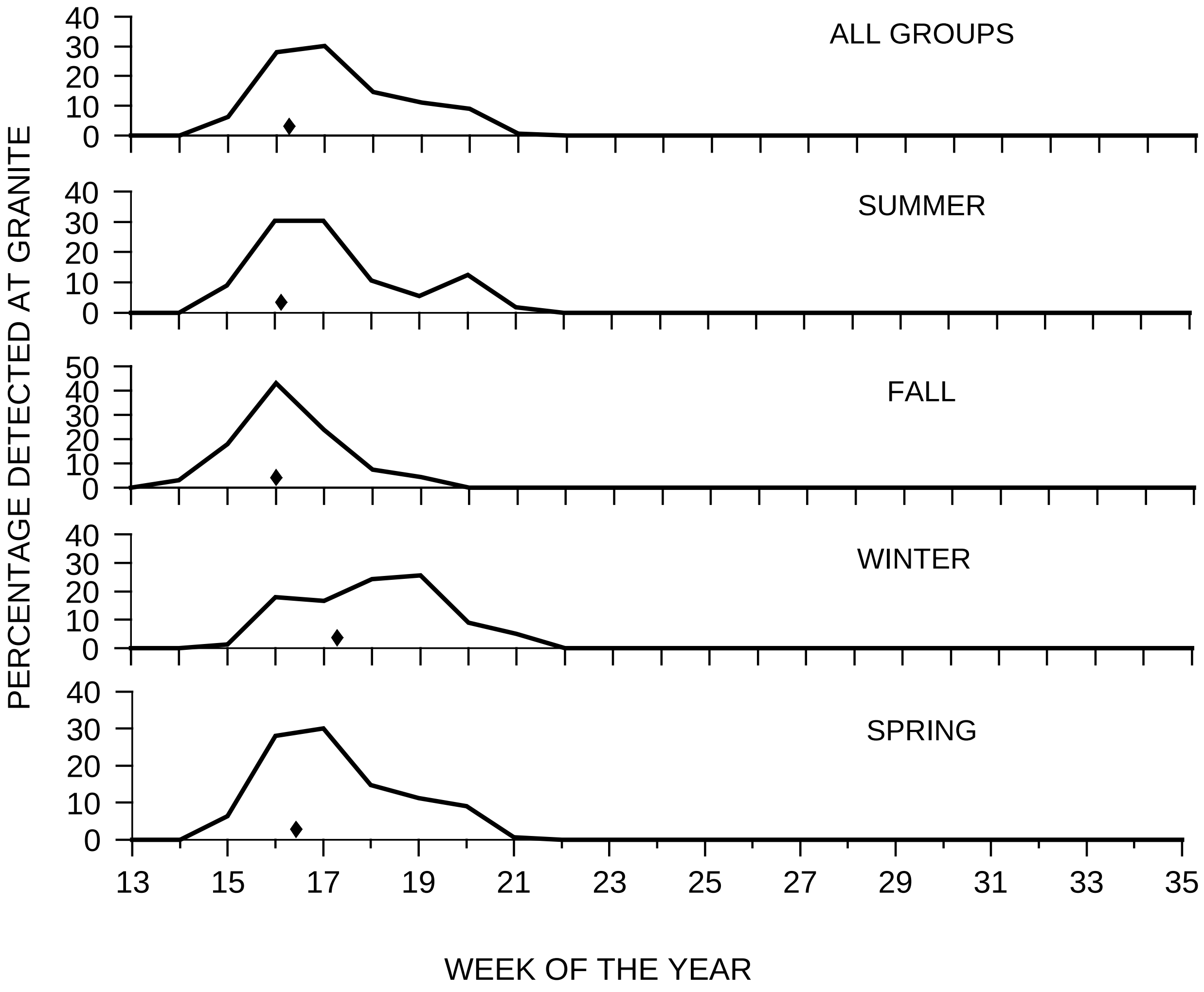

Figure 6. Migration timing at Lower Granite Dam for juvenile spring chinook salmon from the Lostine River, by tag group, 1997 migration year. ♦ = median arrival date. Data were expanded for spillway flow.

Table 14. First-time detections of Grande Ronde River spring chinook salmon, by dam site, during the 1997 migration year. Chinook salmon were PIT-tagged on the Grande Ronde River during the previous seasons as indicated. Detections are presented as a percentage of the total fish released. Lower Mon. = Lower Monumental Dam, Bonn. = Bonneville Dam.

Group	Number released	Lower Granite	Little Goose	Lower Mon.	McNary	John Day	Bonn.	Total
Fall	27	7.4	0.0	7.4	0.0	0.0	0.0	14.8
Spring	1	100.0	0.0	0.0	0.0	0.0	0.0	100.0
Total	28	10.7	0.0	7.1	0.0	0.0	0.0	17.9

Table 15. First-time detections of Catherine Creek spring chinook salmon, by dam site, during the 1997 migration year. Chinook salmon were PIT-tagged on Catherine Creek during the previous seasons as indicated. Detections are presented as a percentage of the total fish released.

Group	Number released	Lower Granite	Little Goose	Lower Mon.	McNary	John Day	Bonn.	Total
Summer[a]	586	8.7	3.4	2.2	0.0	0.2	0.2	14.7
Fall	403	9.9	4.7	4.7	0.3	0.0	0.7	20.3
Winter	102	4.9	2.0	0.0	0.0	0.0	0.0	6.9
Spring	78	28.2	2.6	3.9	2.6	0.0	0.0	37.2
Total	1169	10.1	3.7	3.0	0.3	0.1	0.3	17.5

[a] *From Sankovich, et al., 1996.*

Table 16. First-time detections of Lostine River spring chinook salmon, by dam site, during the 1997 migration year. Chinook salmon were PIT-tagged on the Lostine River during the previous seasons as indicated. Detections are presented as a percentage of the total fish released.

Group	Number released	Lower Granite	Little Goose	Lower Mon.	McNary	John Day	Bonn.	Total
Summer[a]	527	8.2	4.9	2.7	0.0	0.0	0.0	15.7
Fall	519	10.4	7.9	6.2	1.0	0.0	0.6	26.0
Winter	390	15.4	7.2	3.8	0.3	0.0	0.5	27.2
Spring	476	22.9	14.5	12.0	1.5	0.0	0.8	51.7
Total	1,912	13.9	8.6	6.2	0.7	0.0	0.5	29.8

[a] *From Sankovich, et al., 1996.*

Habitat Utilization

We surveyed 42 habitat units in 29 km of Catherine Creek during the winter and observed 187 spring chinook salmon parr. Chinook salmon were observed in all habitat types sampled in winter, and were most abundant in backwater pools (Table 17). We surveyed 57 habitat units in 5 km of the Lostine River during the winter and observed 233 spring chinook salmon parr. Chinook salmon parr were most abundant in backwater pools and were generally associated with low velocity habitat types (Table 18).

We surveyed 106 habitat units during the summer in 26 km of the upper Grande Ronde River and 1 km of the lower ends of several tributaries and observed 1,440 age-0 chinook salmon. Chinook salmon were observed in all habitat types except rapids ($N = 2$) and were most abundant in alcoves (*N* = 2, Table 19). We observed spring chinook salmon from rkm 288 to 304 and from rkm 317 to 325 in the Grande Ronde River, the lower 0.8 km of Fly Creek, and the lower 0.1 km of Clear Creek. We surveyed 137 habitat units in 21 km of Catherine Creek and 4.5 km of the lower ends of several tributaries during summer and observed 1,705 age-0 and 40 age 1 spring chinook salmon. Chinook salmon were observed in all habitat types except alcoves (*N* = 1), and were most abundant in backwater pools (Table 20). We observed chinook salmon parr from rkm 30 to 51 in Catherine Creek and in the lower 1.5 km of Little Catherine, North Fork Catherine and South Fork Catherine creeks. We surveyed 118 habitat units in 22 km of the Lostine River during the summer and found spring chinook salmon parr rearing below Walla Walla Campground to Williamson Campground (rkm 32-33) and from Six-mile bridge to the mouth (21 rkm). We observed 1,438 spring chinook salmon parr. Spring chinook salmon parr were observed in all habitat types and were most abundant in alcoves, backwater and dammed pools (Table 21). Spring chinook salmon parr were generally associated with low velocity habitat types.

The protection of tributaries to spawning streams is important as spring chinook salmon parr use the lower reaches of non-natal tributaries for rearing in both the Grande Ronde River and Catherine Creek. Habitat protection or enhancement efforts in spring chinook salmon rearing areas should emphasize pool-type habitat as the parr are more abundant in pools than glides or riffles in the summer and winter.

Table 17. Density (fish/100 m^2) of spring chinook salmon parr in Catherine Creek (rkm 18 - 19 and rkm 27 - 46) and mean water velocity (m/s) by habitat type during winter 1997.

Habitat type	*N*	Density	Water velocity
Pools:			
Backwater pool	5	7.87	0.025
Lateral scour pool	17	2.13	0.465
Plunge pool	5	1.74	0.156
Straight scour pool	2	10.00	0.157
Glide	6	0.04	0.347
Riffle	7	0.46	0.337

Table 18. Density (fish/100 m^2) of spring chinook salmon parr in the Lostine River (rkm 16 to rkm 21) and mean water velocity (m/s) by habitat type during winter 1997.

Habitat type	*N*	Density	Water velocity
Pools:			
Backwater pool	12	17.50	0.053
Dammed pool	2	5.90	0.093
Lateral scour pool	16	2.64	0.213
Plunge pool	2	0.75	0.148
Straight scour pool	6	1.15	0.305
Glide	10	0.27	0.320
Riffle	9	0.37	0.676
Riffle with pockets	1	0.00	1.070

Table 19. Density (fish/100 m^2) of spring chinook salmon parr in the Grande Ronde River (rkm 288 - 306 and rkm 318 - 325) and tributaries and mean water velocity (m/s) by habitat type during summer 1997.

Habitat type	*N*	Density	Water velocity
Pools:			
Alcove	2	231.64	0.025
Backwater pool	6	14.37	0.071
Dammed pool	5	50.60	0.245
Lateral scour pool	28	17.24	0.369
Plunge pool	21	25.16	0.335
Straight scour pool	21	5.83	0.419
Rapid with boulders	2	0.00	0.487
Riffle	12	1.83	0.633
Riffle with pockets	8	5.03	0.409

Table 20. Density (fish/100 m^2) of spring chinook salmon parr in Catherine Creek (rkm 30 to rkm 52) and tributaries and mean water velocity (m/s) by habitat type during summer 1997.

		Density		
Habitat type	*N*	age 0	age 1	Water velocity
Pools:				
Alcove	1	0.00	0.00	0.007
Backwater pool	3	39.92	0.00	0.085
Lateral scour pool	51	14.53	0.53	0.369
Plunge pool	10	8.33	0.00	0.399
Straight scour pool	21	8.68	0.07	0.368
Glide	3	28.38	0.00	0.169
Rapid with boulders	8	1.23	0.00	0.906
Riffle	19	5.05	0.00	0.601
Riffle with pockets	22	6.93	0.03	0.561

Table 21. Density (fish/100 m^2) of spring chinook salmon parr in the Lostine River (rkm 0-21 and rkm 32-33) and mean water velocity (m/s) by habitat type during summer 1997.

Habitat type	*N*	Density	Water velocity
Pools:			
Alcove	2	29.06	0.093
Backwater pool	27	23.89	0.073
Dammed pool	4	13.95	0.227
Isolated pool	5	4.08	0.000
Lateral scour pool	23	9.84	0.526
Plunge pool	2	1.67	0.390
Straight scour pool	9	5.81	0.327
Glide	14	3.54	0.482
Riffle with pockets	7	3.18	0.701
Riffle	14	0.77	0.914
Rapid with boulders	11	0.44	1.112

FUTURE DIRECTIONS

We will continue this early life history study of spring chinook salmon in Catherine Creek, and the upper Grande Ronde, Lostine, and Wallowa rivers. We will add objectives to the study to determine survival to the parr stage for spring chinook salmon and to investigate the significance of precocious males and two-year smolts in Catherine Creek and the Lostine River populations.

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