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.

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YAKIMA RIVER RADIO-TELEMETRY STUDY: SPRING CHINOOK SALMON, 1991-1992

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Project Number 89-089
Contract Number DE-AI79-89BP00276

September 1994

CONTENTS

INTRODUCTION

The Northwest Power Planning Council Master Plan for the Yakima/Klickitat Fisheries Project was developed in 1987 to test the assumptions that artificial production can be used to 1) increase harvest opportunities, 2) enhance the natural production of depleted stocks in the Yakima and Klickitat Basins, and 3) maintain genetic resources (Clune and Dauble 1991). In addition, the plan proposed the development and implementation of a program to monitor the status and productivity of salmon and steelhead in the Yakima and Klickitat Basins.

As part of the presupplementation planning, baseline data on the productivity of spring chinook salmon (*Oncorhynchus tshawytscha*) in the Yakima River have been collected (Fast et al. 1991). However, for adult salmonids, data on habitat use, delays in passage at irrigation diversions, migration rates, and substock separation have not been collected.

In 1991, the National Marine Fisheries Service (NMFS) began a 2-year radio-telemetry study of adult spring chinook salmon in the Yakima River Basin.

Specific objectives of the study were to:

1) Determine spawning populations' run timing, passage patterns at irrigation diversion dams, and morphometric characteristics.to determine where and when substocks become separated.
2) Evaluate fish passage at Yakima River Basin diversion dams including Prosser, Sunnyside, Wapato, Roza, Town Diversion, Easton, Cowiche, and Wapatox Dams.

3) Determine spring chinook salmon migration rates between Yakima River Basin dams, prespawning behavior, temporal distribution, and habitat utilization.

4) Identify spawning distribution and timing of spring chinook salmon.

5) Determine the amount and cause of prespawning mortality of spring chinook salmon.

6) Evaluate adult fish-handling procedures for the right-bank, adult-trapping facility at Prosser Dam.

MATERIALS AND METHODS

Study Area

The Yakima River flows 349 km southeast from its headwaters in the Cascade Range (elevation 746 m) to its confluence with the Columbia River (elevation 91 m) near Richland, Washington, draining an area of 15,941 km² (Fig. 1). Its major tributaries, with the exception of Satus and Toppenish Creeks, join the river upstream from Yakima, Washington. The largest tributary to the Yakima River is the Naches River, which drains an area of 2,865 km² and enters the Yakima River 0.5 km upstream from the city of Yakima. Major tributaries to the Naches River include the Little Naches, Bumping, and American Rivers, which form its headwaters, and the Tieton River and Rattlesnake Creek. Major tributaries to the upper Yakima River include the Teanaway and Cle Elum Rivers.

Nine major diversion dams control water flow in the basin and provide irrigation to over 200,000 cultivated hectares. On the Yakima River these dams are Horn Rapids (River Kilometer (RKm) 29), Prosser (RKm 75.8), Sunnyside (RKm 167.1), Wapato (RKm 171.6), Roza (RKm 205.9), Town Diversion (RKm 258.6), and Easton (RKm 326) Dams. The major diversion dams on the Naches River are Cowiche (RKm 5.8) and Wapatox (RKm 27.5) Dams. All of these dams have adult fish-passage facilities.

In addition to the irrigation diversion dams, reservoirs on the Yakima and Naches Rivers regulate flows and store water during the winter to supplement irrigation from March through

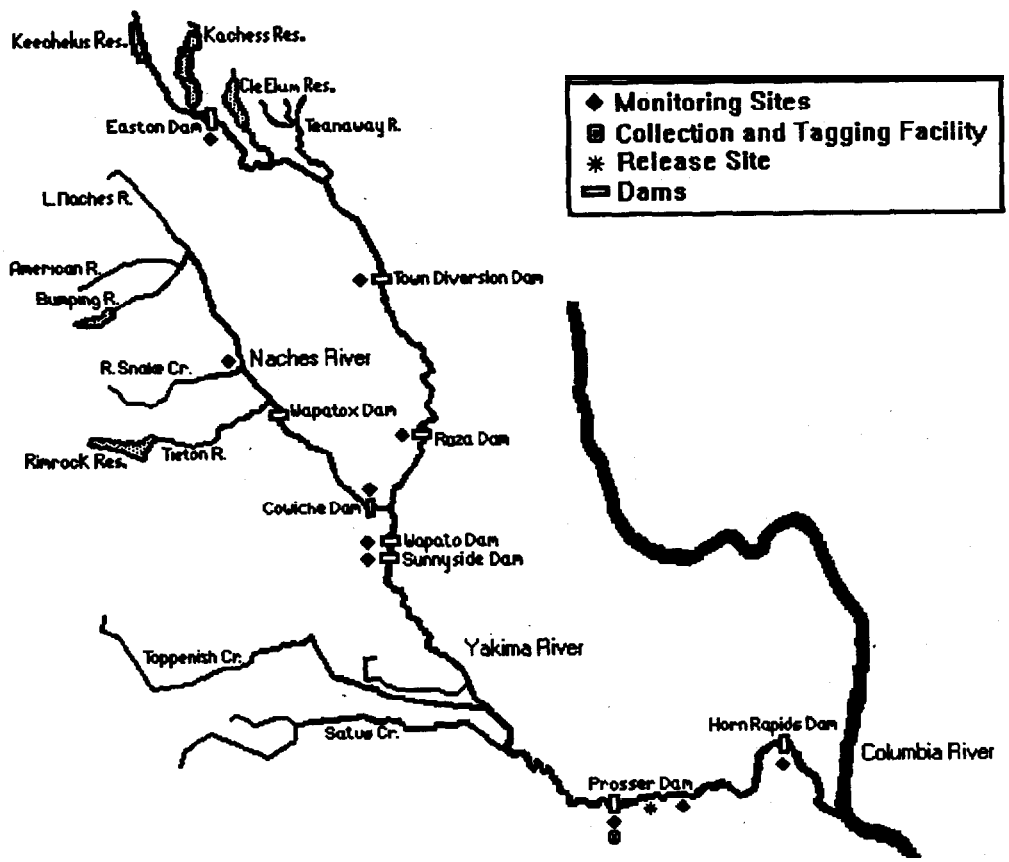


Figure 1.--Map of the Yakima River Basin showing irrigation diversion dams, monitoring sites, collection and tagging **location,** and release site.

October. These reservoirs include Keechelus and Kachess on the Yakima River, Cle Elum on the Cle Elum River, and Rimrock and Bumping Reservoirs in the Naches River Basin. None of the dams associated with the reservoir system have adult fish-passage facilities. Johnson (1964) and Fast et al. (1991) provide additional descriptions of the Yakima River Basin.

Trapping and Tagging

Spring chinook salmon were collected and tagged at Prosser Dam by NMFS and Yakama Indian Nation personnel. Tagging procedures were developed and modified throughout the study. Fish were tagged and released in proportion to temporal abundance based on passage information from McNary and Prosser Dams. We collected spring chinook salmon by blocking upstream movement with a lead gate in the right-bank fish ladder at Prosser Dam. We inserted a steep-pass denil into the pool below the lead gate. Fish ascended the denil to a flume that then diverted them into an anesthesia tank containing a solution of tricaine methanesulfonate (MS-222).

After examination for marks, tags, or injuries, fish were weighed, measured, and had scale samples taken. Each fish was then placed in a tagging cradle, and a radio transmitter was inserted through its mouth and into its stomach (Mellas and Haynes 1985). To minimize tag regurgitation, we radio-tagged only fish larger than 60-cm fork length. Tagged fish were also marked with two external anchor tags for later identification in the tribal subsistence harvest. The entire tagging procedure

took 2-5 minutes per fish. Following tagging, fish were allowed to recover for up to 4 hours in a transport truck with circulating river water. During the recovery period, a receiver was used to monitor transmitters for frequency drift. After recovery, tagged fish were released 0.5 km downstream from Prosser Dam. Nontarget species and target species in poor condition or of insufficient size were released into the fish ladder upstream from the lead gate after recovering from anesthesia.

Age determination from scale samples was conducted by Columbia River Inter-Tribal Fish Commission personnel.

Radio Tags

Radio tags were purchased from Advanced Telemetry Systems', Inc.[1] Each tag was powered by one 3.7-V lithium battery and had a life span of at least 7 months.

The transmitter and battery were sealed in a 6.0-cm length X 1.6-cm diameter epoxy capsule and weighed 26 g in air. Each transmitter had a 12.0-cm flexible external whip antenna attached to one end. The tags transmitted on one of nine frequencies spaced 10 kHz apart (30.17 MHz to 30.25 MHz). The bandwidth of each pulse provided individual identification codes for each tag. Each tag also contained a motion sensor which added extra pulses to the base rate when activated by movement.

'Reference to trade names does not imply endorsement by National Marine Fisheries Service.

Surveillance Equipment and Procedures

Two types of telemetry receivers were used for locating tagged fish during the study. Both types operated on 12-V DC and consisted of a radio receiver, data processor, internal clock, and data logger. Data loggers recorded month, day, hour, minute, tag code, and receiving antenna number. The first type of receiver (Model SRX-400) was purchased from Lotek Engineering Inc., Newmarket, Ontario, Canada. These units were used in vehicles, boats, and as fixed-site general location monitors. The second type of receiver was developed and manufactured by NMFS electronics shop personnel and had a higher scanning rate than Lotek receivers (1.5 vs. 13.5 seconds). These units were used in vehicles, boats, airplanes, and as fixed-site general location and fish-ladder passage monitors.

Self-contained fixed-site monitors were installed to record the presence and activities of radio-tagged fish in specific areas. Fixed-site monitors (Fig. 1) collected run-timing information at potential broodstock removal sites and passage information at irrigation diversion dams. A fixed-site monitor consisted of a receiver system, power supply, antenna switching box, and either a single antenna or series of antennae. Fixed-site surveillance data were downloaded and processed at least once per week.

Two types of antennae were used. Underwater antennae consisted of coaxial cable suspended in fish ladders, with 10 cm of shielding stripped from the distal end. Tuned-loop antennae

were used to monitor fish in a general area or to monitor fish-passage by the combination of two antennae (one upstream and one downstream). Locations and antennae configuration for fixed-site telemetry monitors are summarized in Table 1.

In 1991, only the entrances to the right-bank fish ladder at Prosser dam were monitored. Problems with electronic equipment resulted in limited data to evaluate the rejection of or withdrawal from the fish ladders. In 1992, monitoring of all fish-ladder entrances and exits at Prosser Dam and improvements to electronic equipment provided data to.evaluate avoidance of the denil fishway or withdrawal from fish ladders.

Aerial surveillance of the Yakima River and its major tributaries was conducted once per week, weather permitting. Locations of radio-tagged individuals were determined from latitude and longitude coordinates provided by a global positioning system.

Mobile telemetry receivers were used once per week, and more frequently when personnel were available, to collect more-precise information on fish locations. This information was used to develop data on habitat utilization and fish behavior. Activity in the radio-tag motion switch and upstream movement were used as indicators of live fish. In addition, attempts were made to recover carcasses of, stationary individuals.

In 1992, tests were conducted comparing "V" and flash-board type weirs in the right-bank fish ladder at Prosser Dam for the entrance into a proposed off-ladder holding pool. Fish movements

Table 1.--Locations and antennae configuration for fixed-site telemetry monitors.

Monitor number	Monitor location	Monitor type	River	River Km	Antenna number	Antenna location
72	Horn Rapids Dam	Lotek	Yakima	28.8	1	Downstream
72	Horn Rapids Dam	Lotek	Yakima	28.8	2	Upstream
1	Chandler Juvenile Facility	NMFS	Yakima	74.1	1	Across
2	Prosser Dam Right-Bank	NMFS	Yakima	15.4	1	Denil pool
2	Prosser Dam Right-Bank	NMFS	Yakima	15.4	2	Ladder exit
70	Prosser Dam Right-Bank	NMFS	Yakima	75.4	1	Ladder entrance
3	Prosser Dam Center	NMFS	Yakima	75.4	1	Ladder entrance
3	Prosser Dam Center	NMFS	Yakima	15.4	2	Ladder exit
4	Prosser Dam Left-Bank	NMFS	Yakima	15.4	1	Ladder entrance
4	Prosser Dam Left-Bank	NMFS	Yakima	75.4	2	Ladder exit
71	Prosser Dam Left-Bank	Lotek	Yakima	75.4	1	Downstream
5	Sunnyside Dam Right-Bank	NMFS	Yakima	166.1	1	Ladder exit
6	Sunnyside Dam Center	NMFS	Yakima	166.1	1	Ladder exit
7	Sunnyside Dam Left-Bank	NMFS	Yakima	166.1	1	Ladder exit
7	Sunnyside Dam Left-Bank	NMFS	Yakima	166.1	2	Downstream
8	Wapato Dam Left-Bank	NMFS	Yakima	170.6	1	Ladder exit
9	Wapato Dam Center	NMFS	Yakima	170.6	1	Ladder exit
9	Wapato Dam Center	NMFS	Yakima	170.6	2	Downstream
10	Wapato Dam Right-Bank	NMFS	Yakima	170.6	1	Ladder exit
10	Wapato Dam Right-Bank	NMFS	Yakima	170.6	2	Downstream
11	Rosa Dam Left-Bank	NMFS	Yakima	204.6	1	Ladder exit
11	Roza Dam Left-Bank	NMFS	Yakima	204.6	2	Downstream
12	Roza Dam Right-Bank	NMFS	Yakima	204.6	1	Gallery inside
12	Roza Dam Right-Bank	NMFS	Yakima	204.6	2	Gallery outside
13	Town Diversion Dam	Lotek	Yakima	257.0	1	Downstream
13	Town Diversion Dam	Lotek	Yakima	257.0	2	Upstream
14	Easton Dam	Lotek	Yakima	324.0	1	Ladder exit
14	Easton Dam	Lotek	Yakima	324.0	2	Downstream
40	Cowiche Dam Left-Bank	NMFS	Naches	5.8	1	Ladder entrance
40	Cowiche Dam Left-Bank	NMFS	Naches	5.8	2	Ladder exit
43	Cowiche Dam Left-Bank	Lotek	Naches	5.8	1	Downstream
41	Wapatox Dam Left-Bank	Lotek	Naches	27.4	1	Downstream
41	Wapatox Dam Left-Bank	Lotek	Naches	21.4	2	Upstream
42	Rattlesnake Creek	NMFS	Rattlesnake	0.8	1	Across

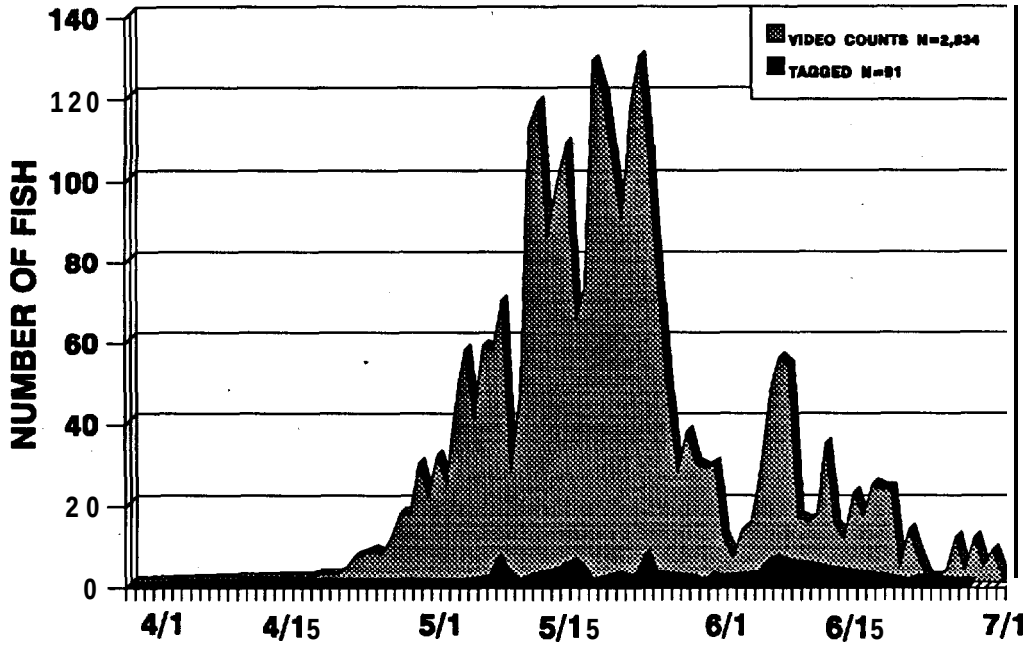
in the right-bank fish ladder were videotaped, to compare the numbers of fish that passed vs. those that rejected the entrance.

RESULTS

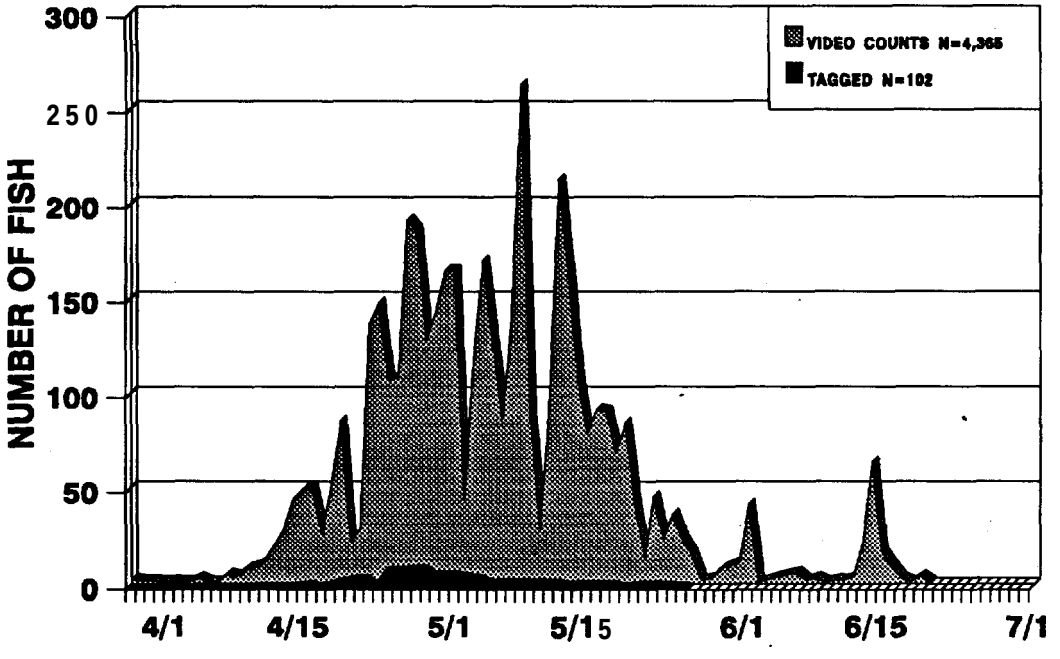
Spawning Population Segregation

In 1991 and 1992, respectively, 63 and 92 spring chinook salmon were radio tagged at Prosser Dam and tracked through spawning. Spring chinook salmon migrated into the Yakima River from early April through June (Fig. 2). Returning adult spring chinook salmon exhibited three behavioral phases similar to those described for Atlantic salmon (*Salmo salar*) by Baglinière et al. (1991). These phases consisted of a migratory phase, a prespawning holding phase, and a spawning phase. The following substocks or spawning populations of spring chinook salmon were identified in the Yakima River Basin: American River; Bumping River; Little Naches River; Naches River; Rattlesnake Creek; the upper Yakima River above Ellensburg, Washington; Cle Elum River; and Roza Dam tailrace.

Analysis of 1991 and 1992 passage data indicated that all substocks were mixed and could not be segregated based on time of passage at Pros‘ser, Sunnyside, and Wapato Dams (Figs. 3-5). In addition, spawning populations could not be segregated on the basis of fish-ladder selection at Yakima River diversion dams with multiple fish ladders (Prosser, Sunnyside, and Wapato Dams) (Figs. 6-8). Segregation of substocks did not occur until fish reached the confluence of the Naches and Yakima Rivers.

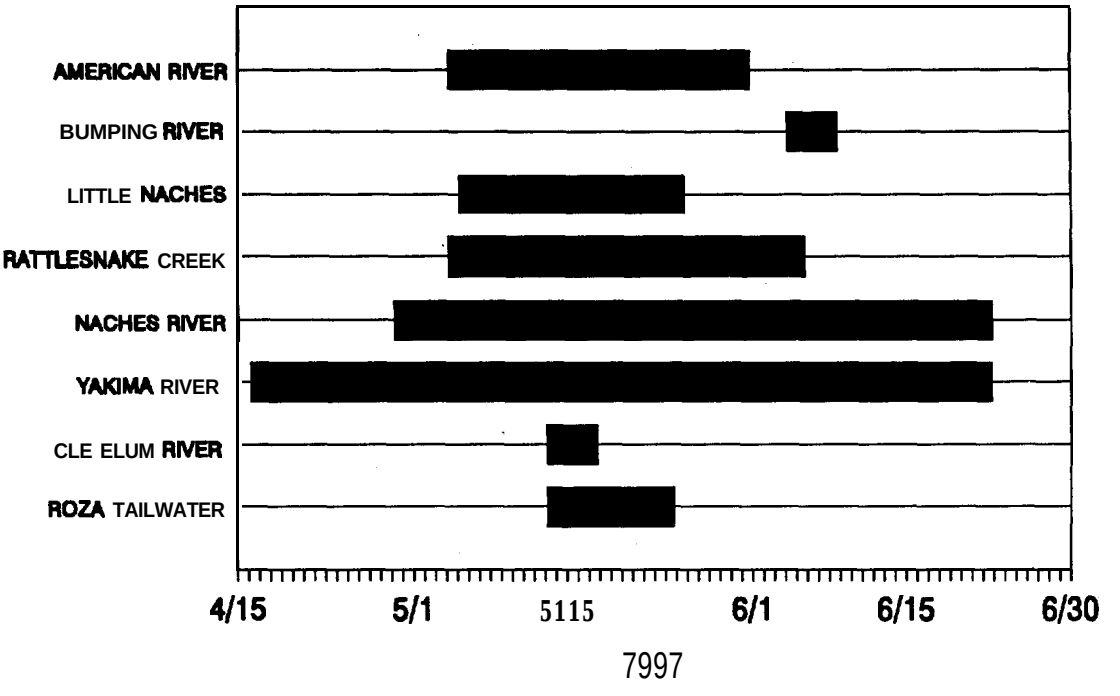


1991



1992

Figure 2.--Spring chinook salmon migration past Prosser Dam and number radio tagged, 1991-92.



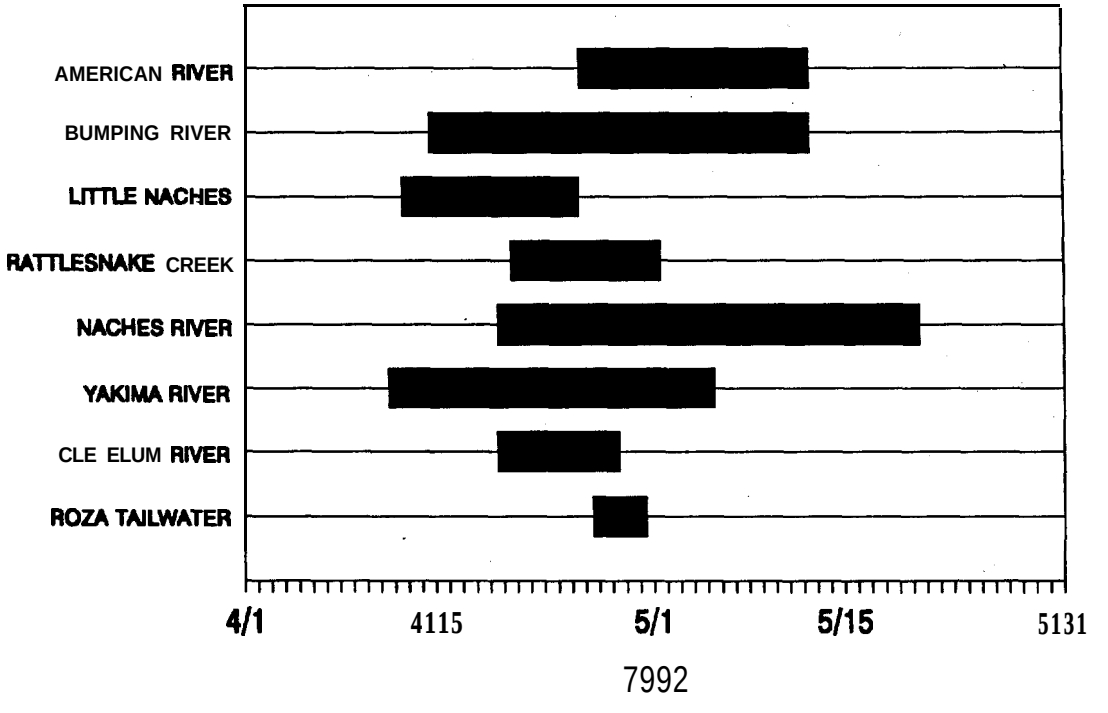


Figure 3.--Tagging dates of spring chinook salmon substocks at Prosser Dam, 1991-92.

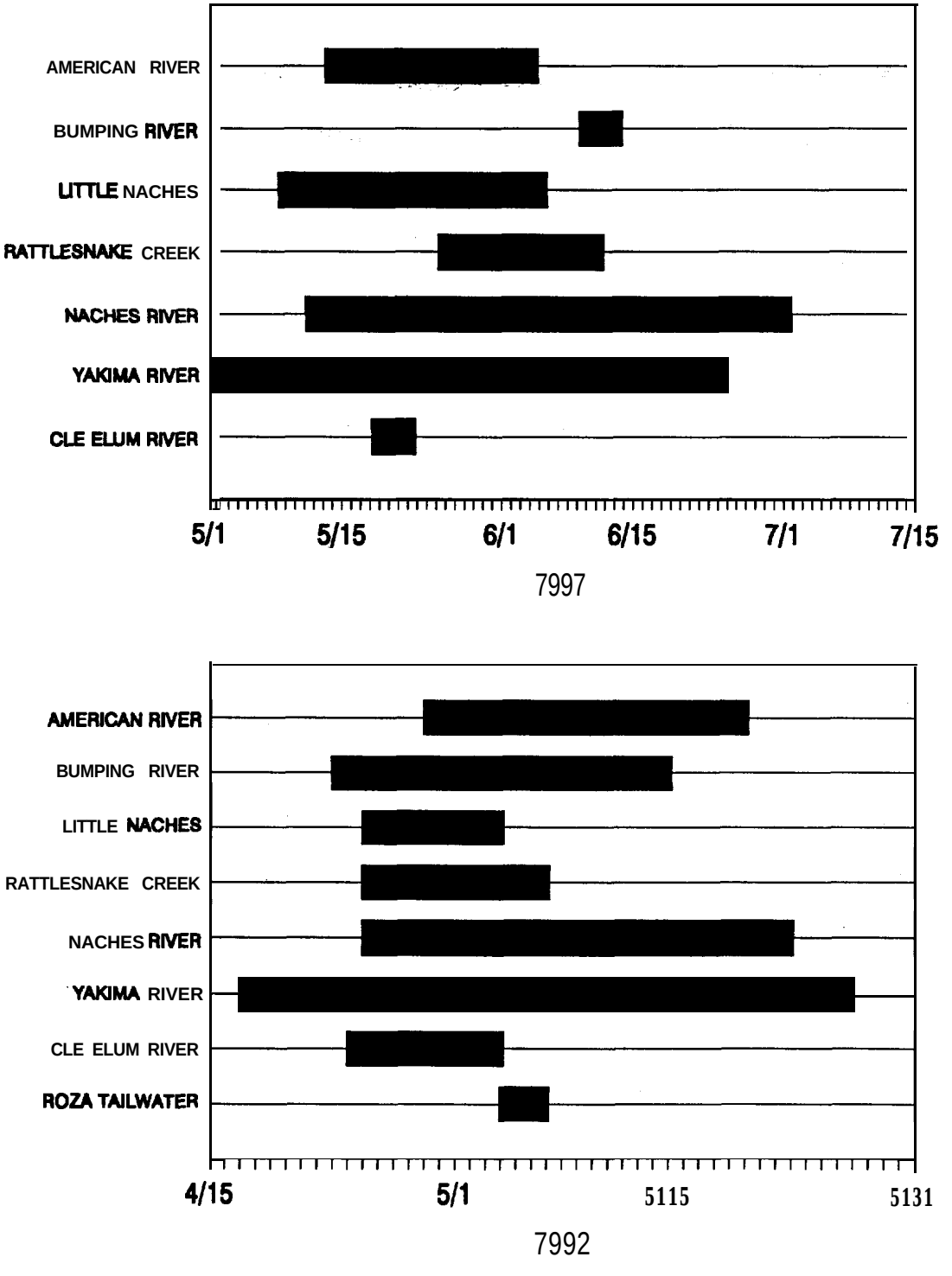


Figure 4.--Passage dates of radio-tagged spring chinook salmon substocks at Sunnyside Dam, 1991-92.

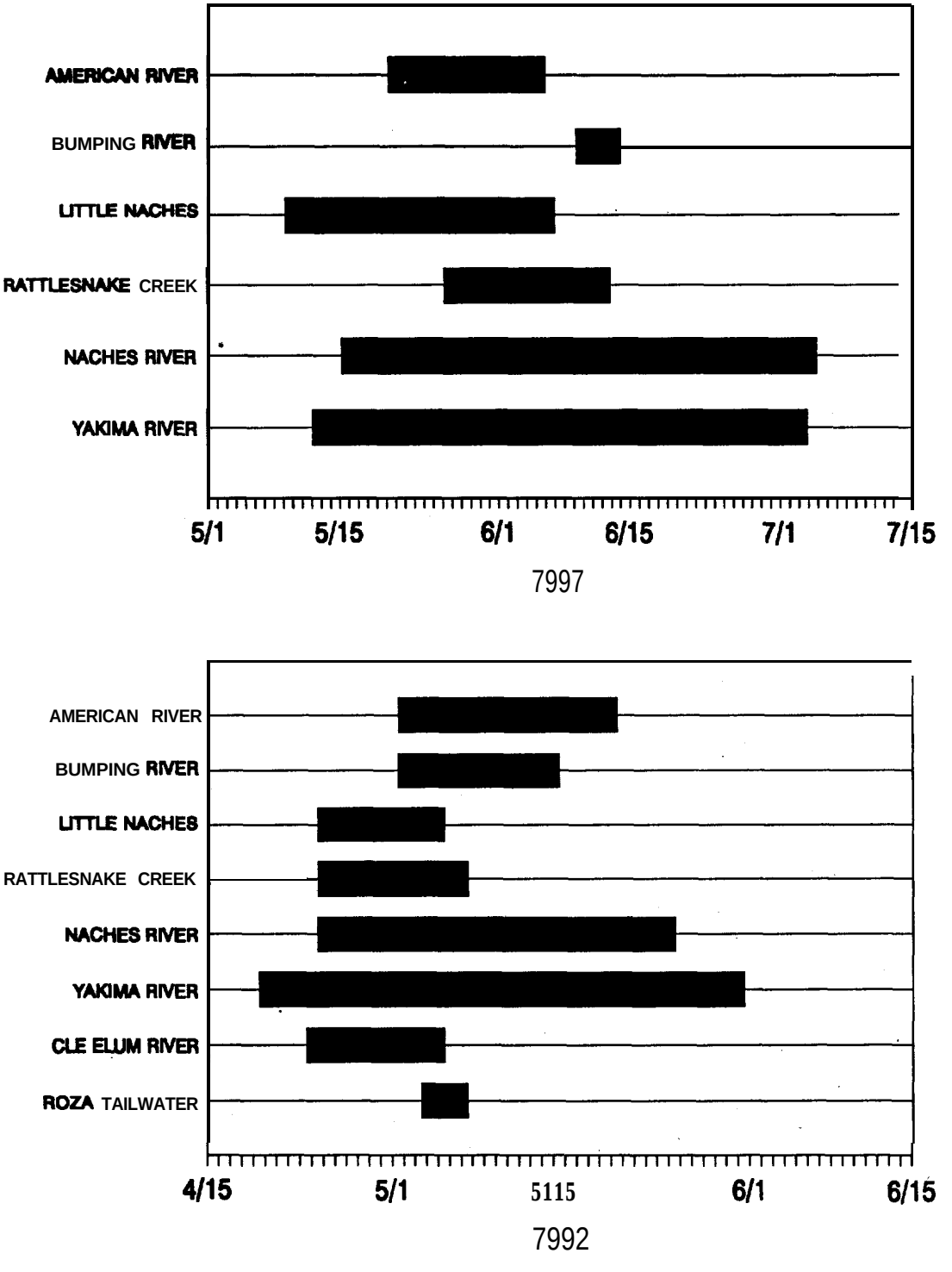


Figure 5.--Passage dates of radio-tagged spring chinook salmon substocks at Wapato Dam, 1991-92.

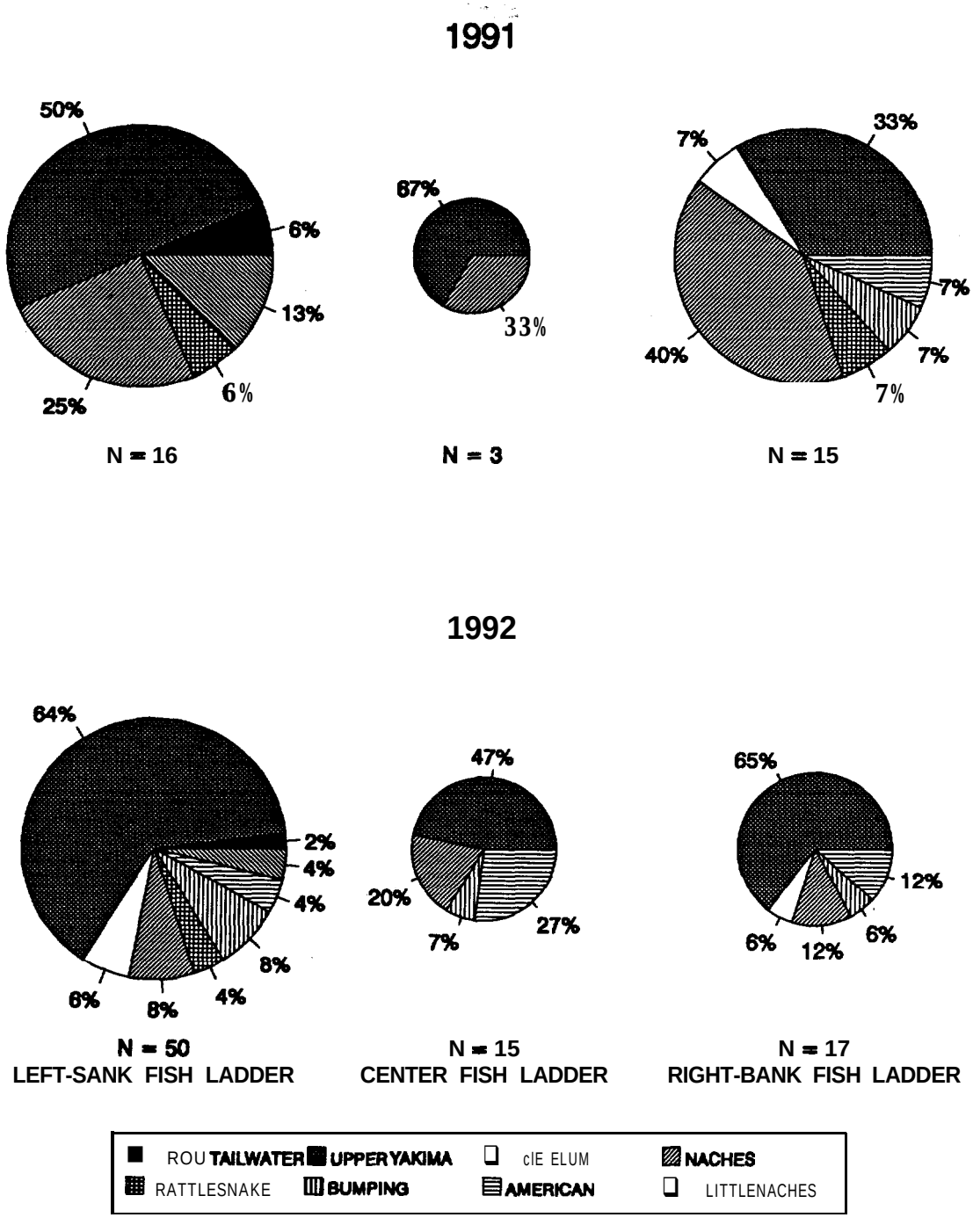


Figure 6.--Fish-ladder selection by radio-tagged spring chinook salmon substocks at Prosser Dam, 1991-92.

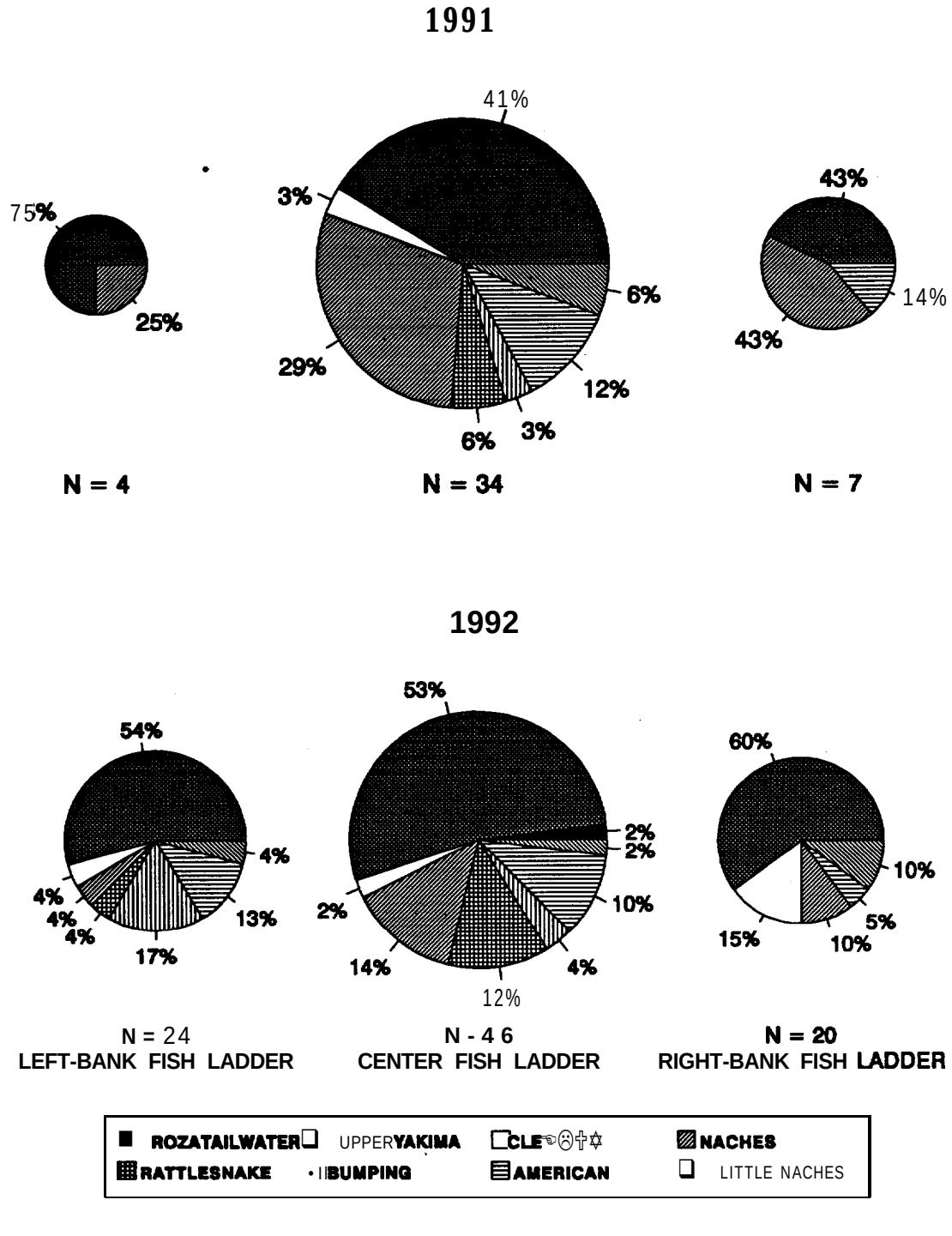


Figure 7. --Fish-ladder selection by radio-tagged spring chinook salmon substocks at Sunnyside Dam, 1991-92.

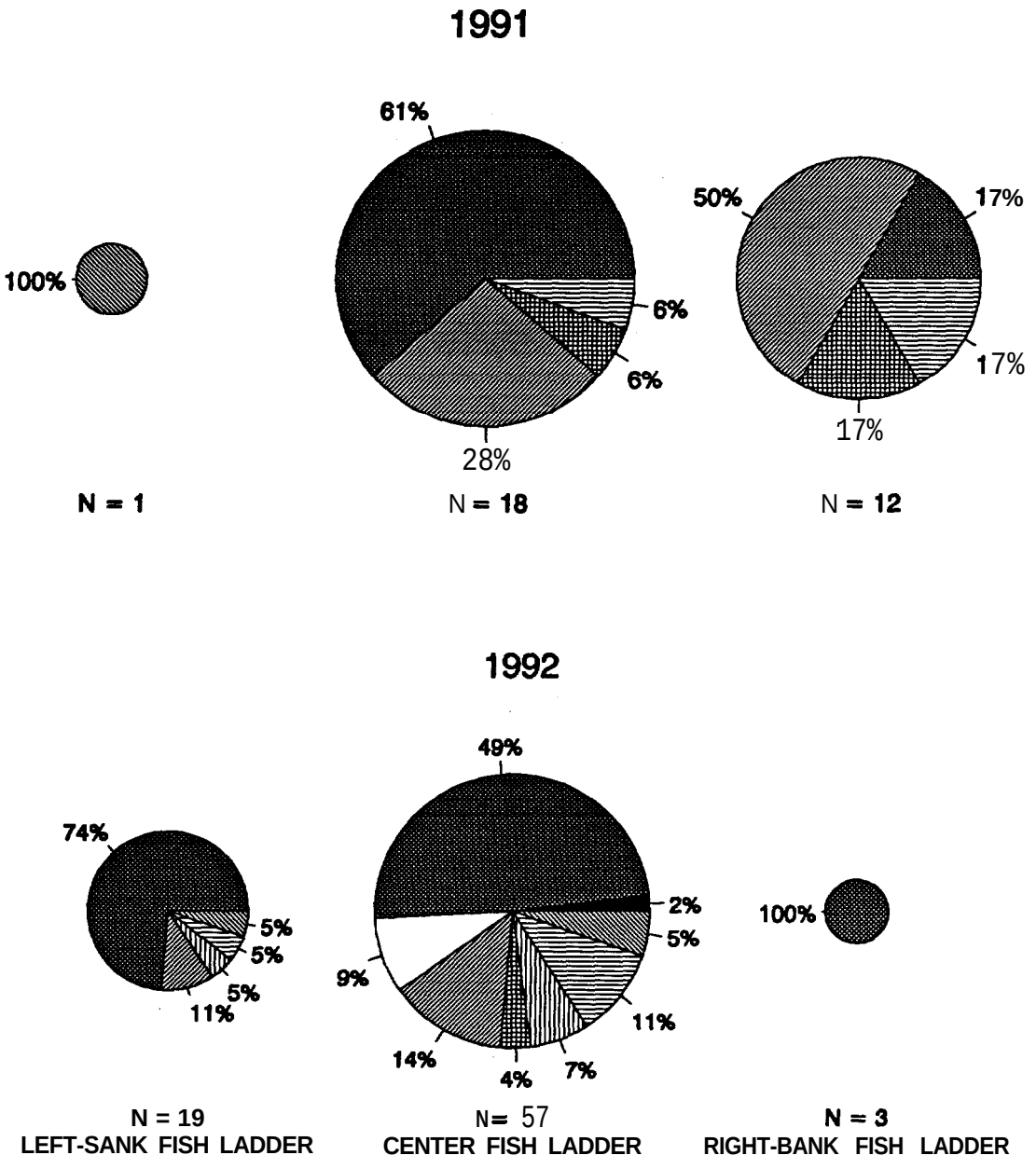


Figure 8. --Fish-ladder selection by radio-tagged spring chinook salmon substocks at Wapato Dam, 1991-92.

At that point, spring chinook salmon that spawned in the mainstem Yakima River or Cle Elum River continued up the Yakima River, and those that spawned in the Naches River Basin migrated up the Naches River. Only two radio-tagged spring chinook salmon deviated'from this behavior, both in 1991. These two individuals eventually spawned in the mainstem Naches River after straying past the Naches River to the base of Roza Dam. Neither fish exited the fish ladder at Roza Dam: one remained in the tailrace at Roza Dam for 1.8 days, while the other remained for 36.9 days before moving back downstream and migrating up the Naches River. Only upper Yakima River and Cle Elum River spawners exited the fish ladder at Roza Dam during both years. No Naches River substocks strayed to Roza Dam in 1992.

Naches River Basin spawning populations were mixed during passage at Cowiche Dam on the Naches River (Fig. 9). These populations did not become segregated until completing their migration phase and settling into the prespawning holding phase.'

Straying of upper Yakima River spawners into the Naches River below Cowiche Dam could not be assessed, since the area was not monitored by fixed-site equipment. Similarly, straying of Naches River Basin spawning populations into the Yakima River above the Naches River confluence and downstream from Roza Dam could not be assessed since this area also was not monitored by fixed-site equipment. In addition, since the entrance of the Roza Dam fish ladder was not monitored, entrance into the fish ladder by the two Naches River fish that strayed to the base of

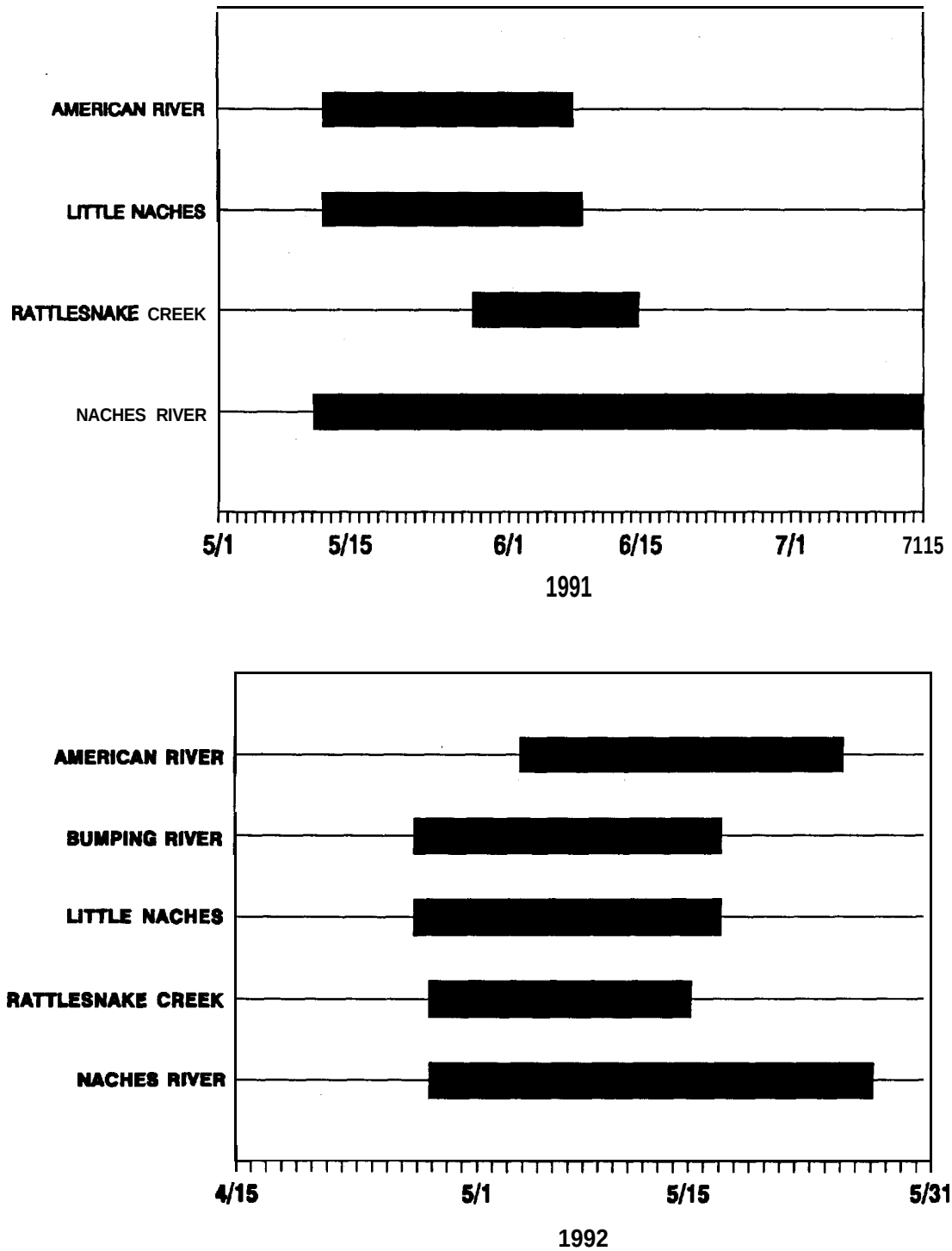


Figure 9. --Passage dates of radio-tagged Naches River spring chinook salmon substocks at Cowiche Dam, 1991-92.

Roza Dam in 1991, or by the Roza Dam tailrace spawners during both years, could not be assessed.

Length and age characteristics of radio-tagged spring chinook salmon were analyzed to determine if substocks could be separated based on those characteristics. Length, age, and last observations of individual radio-tagged fish are indicated in Appendix Tables A.1 and A.2. Spawning populations were predominantly 4-year-old in both years, but in 1991, there was a higher proportion of 5-year-old fish in the Naches River drainage (Table 2).

Lengths of fish from individual substocks overlapped considerably (Figs. 10-11). The largest radio-tagged fish were part of the American River population. Large fish (fork length >90 cm) also spawned in the Bumping River, Rattlesnake Creek, and Naches River. Fish from the Yakima River were generally smaller.

Passage Evaluation

Individual radio-tagged spring chinook salmon passage times and ladder use at Yakima River irrigation diversion dams are indicated in Appendix Tables B.l and B.2.

Prosser Dam

Passage times at Prosser Dam in 1991 ranged from 0.1 to 9.8 days for 57 fish (median 1.0 day) and in 1992 ranged from 0.1 to 6.0 days for 94 fish (median 0.5 days) (Fig. 12). Migration delay at Prosser Dam was less in low-flow conditions (1992) than normal-flow conditions (1991) (Figs. 12-13).

Table 2.--Age composition of radio-tagged spring chinook salmon substocks, 1991-92.

Substock	1991		1992	
	4-year old	5-year old	4-year old	5-year old
American River	0	6	5	3
Bumping River	0	1	4	2
Little Naches River	0	2	3	1
Naches River	9	12	9	1
Rattlesnake Creek	2	1	4	0
Roza Dam tailrace	2	0	1	0
Cle Elum River	1	0	4	0
Upper Yakima River	22	5	44	6

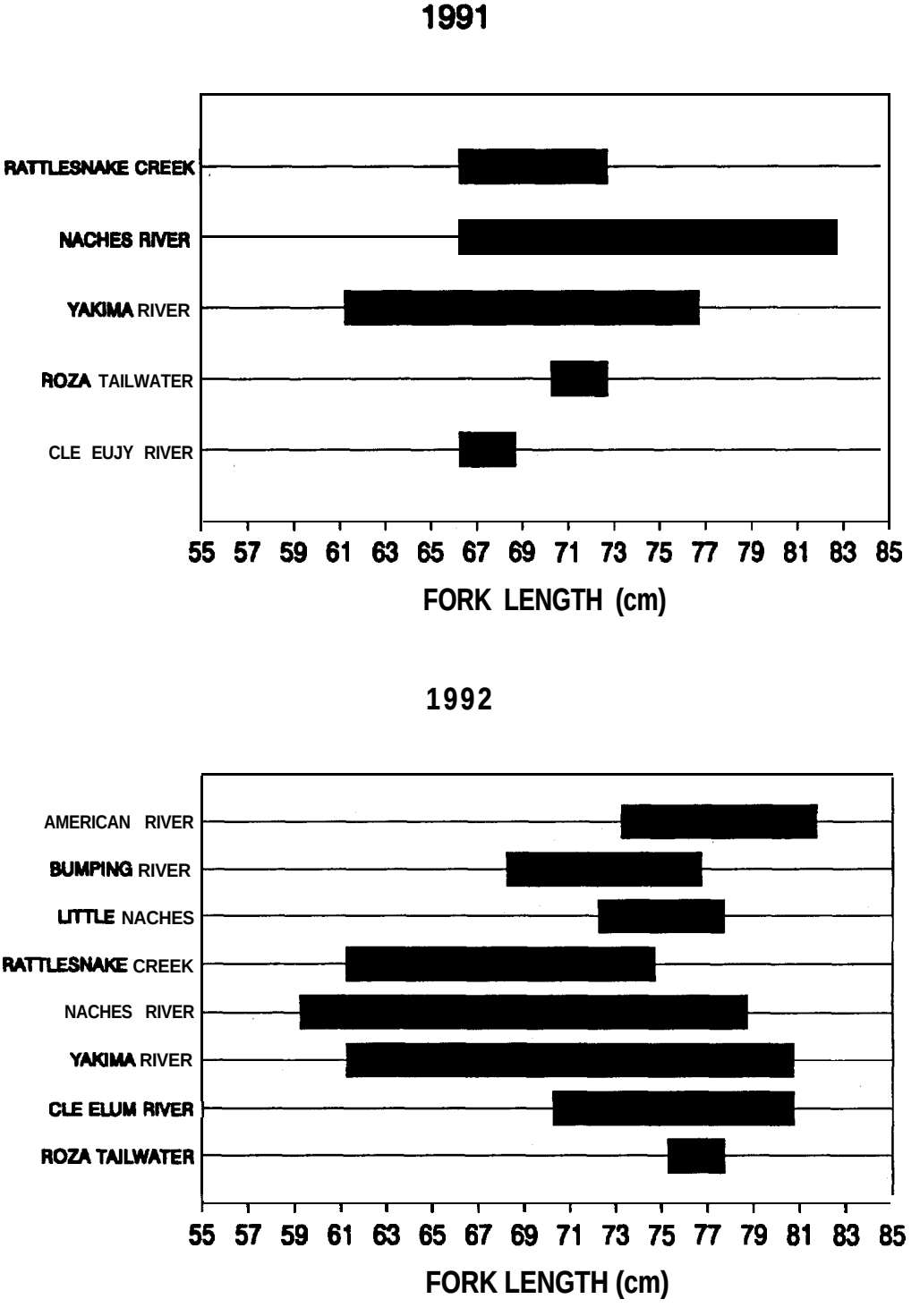
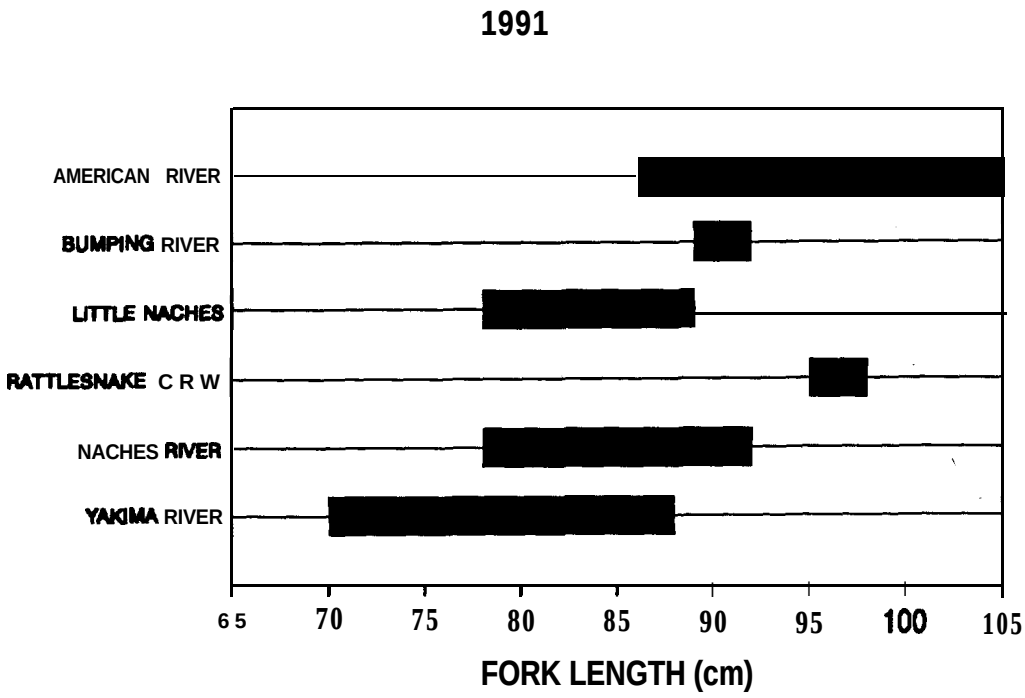


Figure 10.--Fork lengths (cm) of 4-year-old radio-tagged spring chinook salmon by substock, 1991-92.



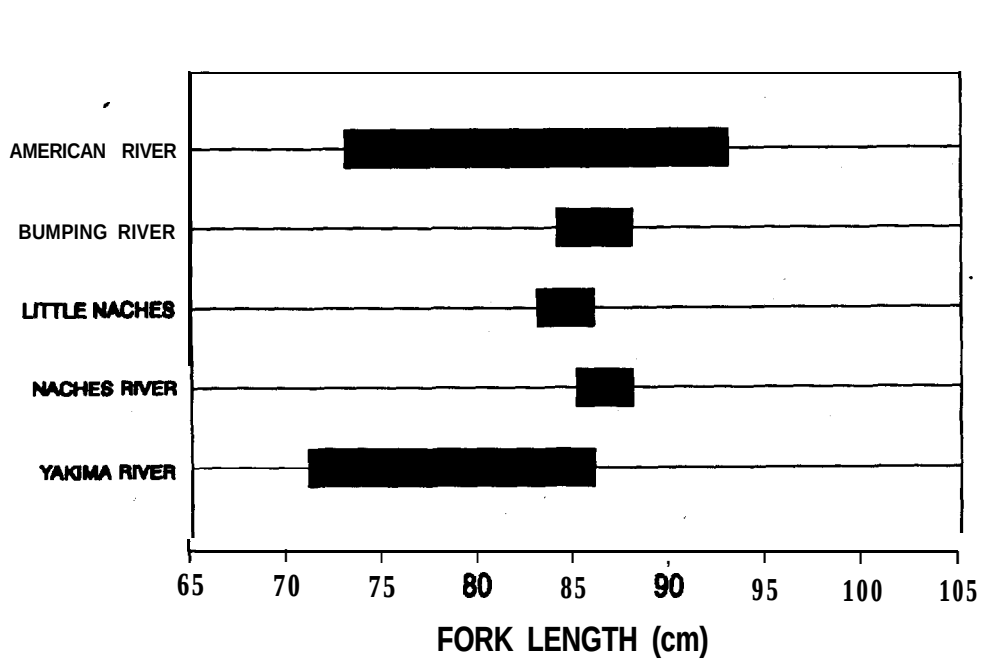


Figure 11.--Fork lengths (cm) of 5-year-old radio-tagged spring chinook salmon by substock, 1991-92.

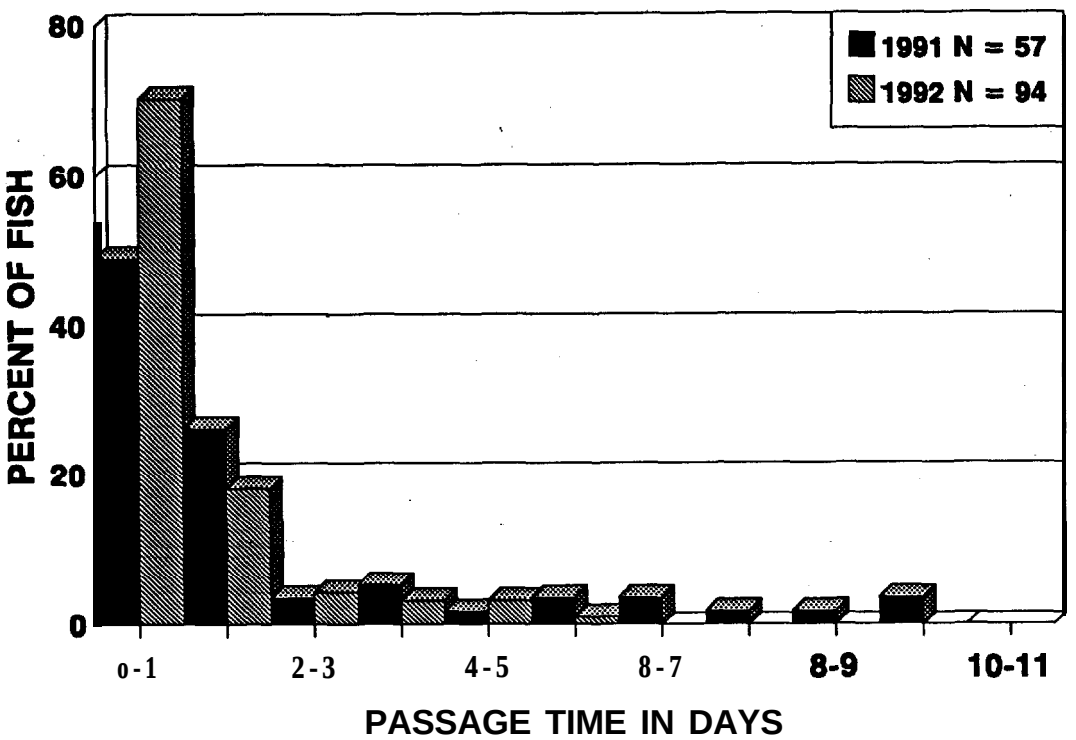


Figure 12. --Passage times of radio-tagged spring chinook salmon at Prosser Dam, 1991-92.

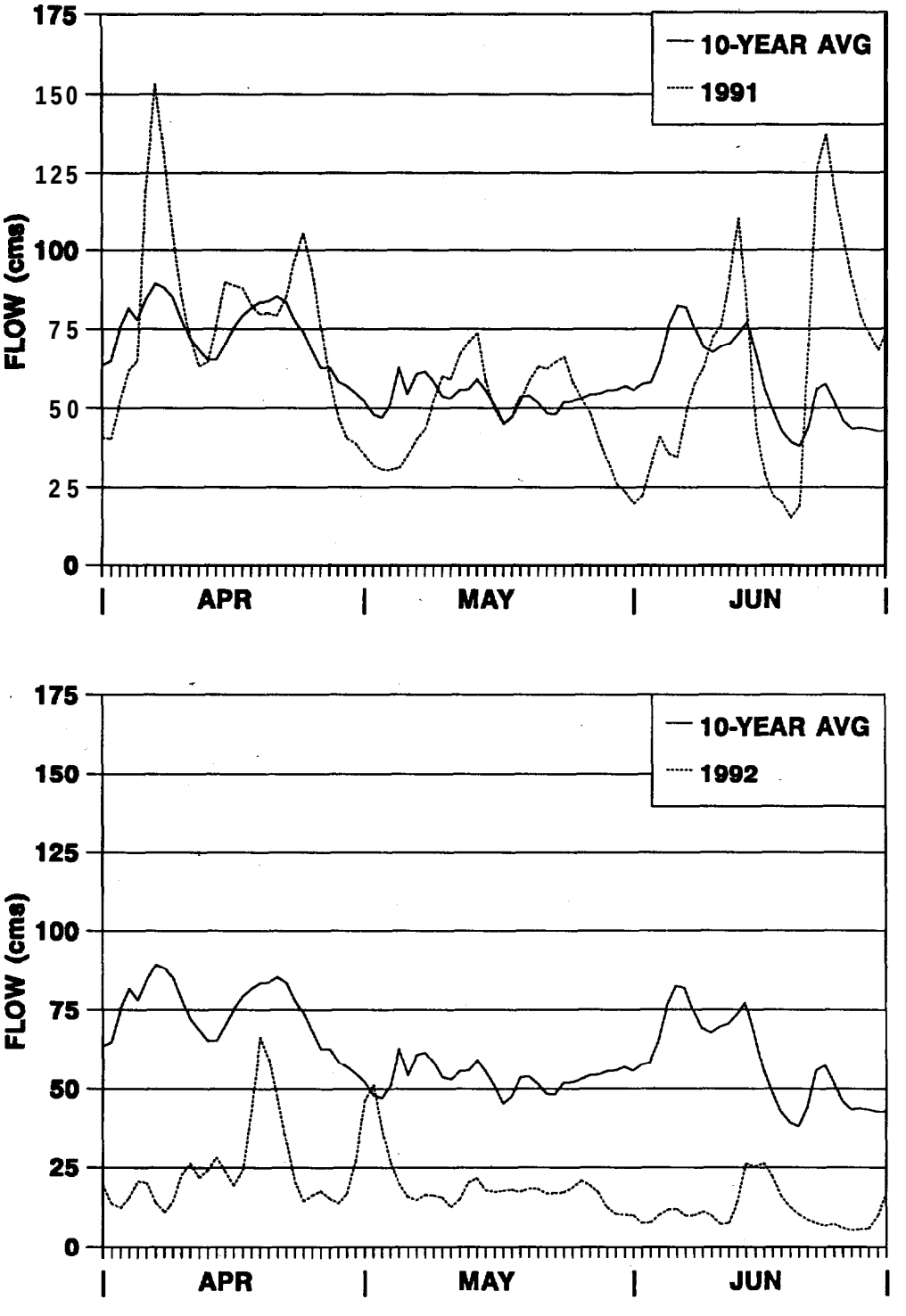


Figure 13. --Yakima River flow (cubic meters per second, cms) at Prosser Dam compared to the lo-year average.

Fish-ladder selection by radio-tagged fish was compared with overall ladder distribution from videotape monitoring to determine if ladder selection may have been biased by collecting all fish from the right-bank fish ladder (Fig. 14). In 1991, the portion of radio-tagged fish using the right-bank fish ladder was greater than, and the portion using the left-bank and center fish ladders was less than, in the total run. However, in 1992, the radio-tagged portion using the right-bank and center fish ladders was less than, and the portion using the left-bank fish ladder greater than, in the total run.

No conclusions regarding fish-ladder selection in relation to flow were possible due to variability in discharge below the dam, ladder operations, environmental conditions, and fluctuations in run composition.

During 1991, 51% of the radio-tagged fish passing Prosser dam were monitored for fish-ladder selection. Four fish withdrew from the right-bank fish ladder: two while the denil was operating and two while the denil was not operating (Table 3). Of the four fish that withdrew from the right-bank fish ladder, three subsequently passed Prosser Dam via the left-bank fish ladder and one passed via the right-bank fish ladder when the denil was not operating. Withdrawal from the center and left-bank fish ladders was not evaluated in 1991.

During 1992, 91% of the radio-tagged fish passing Prosser Dam were monitored for fish-ladder selection. Only three fish withdrew after entering the right-bank fish ladder. Two fish

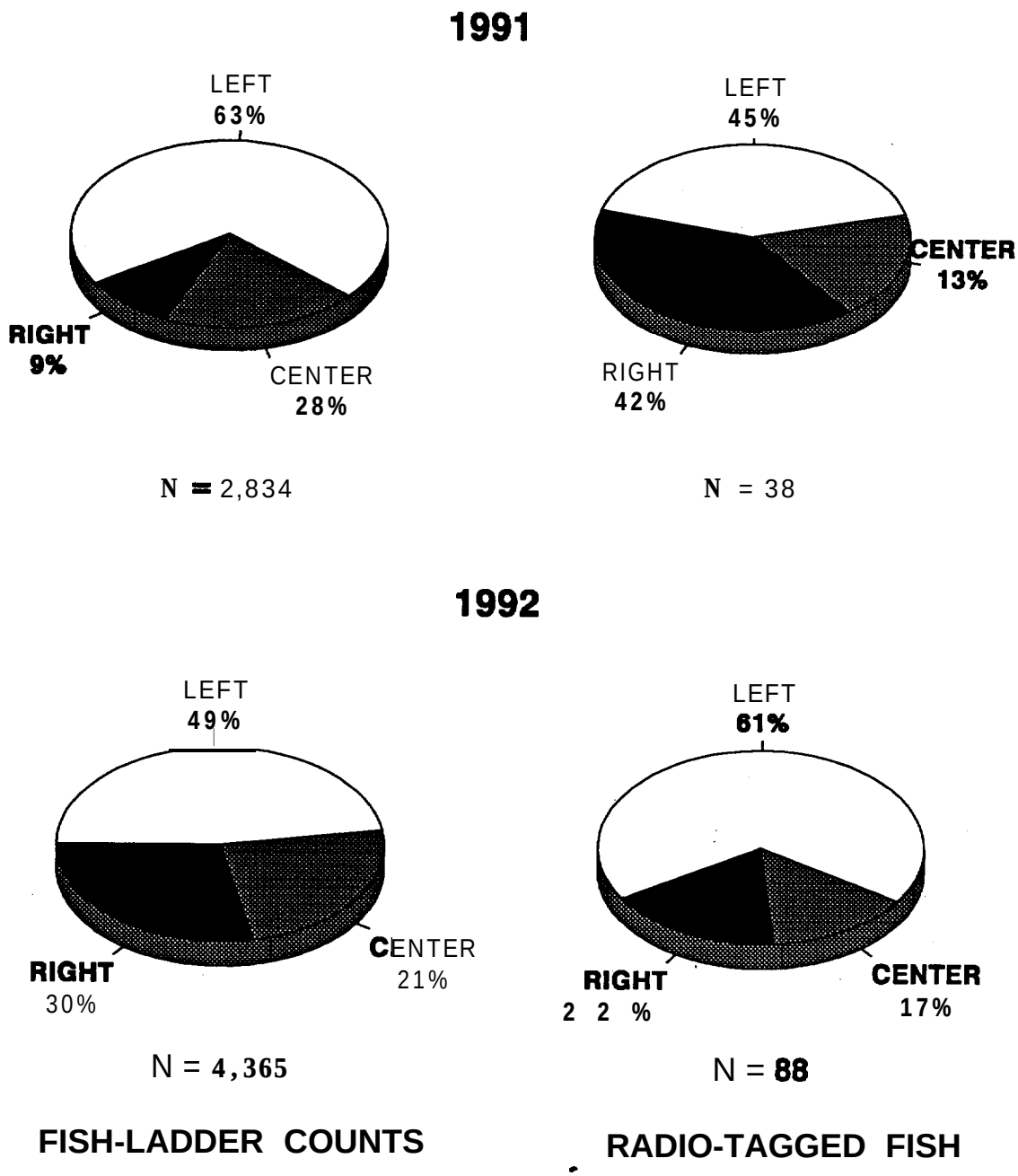


Figure 14. --Comparison between fish-ladder counts and radio-tracking monitoring of spring chinook salmon fish-ladder use at Prosser Dam, 1991-92.

Table 3.--Radio-tagged spring chinook salmon passage at Prosser Dam, 1991-92.

	1991	1992
Tagged	91	102
Passed Prosser Dam	74	97
Fish-ladder passage recorded	38	88
Recaptured in denil	1	1
Withdrawal from:		
Right-bank fish ladder	4	3
Center fish ladder	0	1
Left-bank fish ladder	0	0

withdrew during operation of the denil, and one withdrew when the denil was not operating. Of the three fish that withdrew from the right-bank fish ladder, two subsequently passed Prosser Dam via the left-bank fish ladder and one via the center fish ladder. In addition, one fish withdrew after entering the center fish ladder and subsequently passed Prosser Dam via the left-bank fish ladder. No withdrawal from the left-bank fish ladder was observed in 1992. During both years, only two (one in each year) radio-tagged spring chinook salmon were recaptured in the denil after being tagged and released downstream.

Sunnyside Dam

Passage times and fish-ladder selections of radio-tagged spring chinook salmon were analyzed for 54 and 95 fish in 1991 and 1992, respectively (Fig. 15). Passage times at Sunnyside Dam ranged from CO.1 to 4.0 days in 1991 (median 0.2 days) and from <0.1 to 1.8 days in 1992 (median CO.1 days). Passage delay was less in 1992. A majority of the fish (74% in 1991 and 53% in 1992) preferred the center fish ladder (Fig. 16).

Wapato Dam

Passage times and fish-ladder selections of radio-tagged spring chinook salmon at Wapato Dam were analyzed for 35 and 78 fish in 1991 and 1992, respectively (Fig. 17). Passage times at Wapato Dam ranged from <0.1 to 6.1 days in 1991 (median 0.2 days) and from CO.1 to 6.7 days in 1992 (median 0.2 days). Migration delays were similar in both 1991 and 1992. More fish preferred

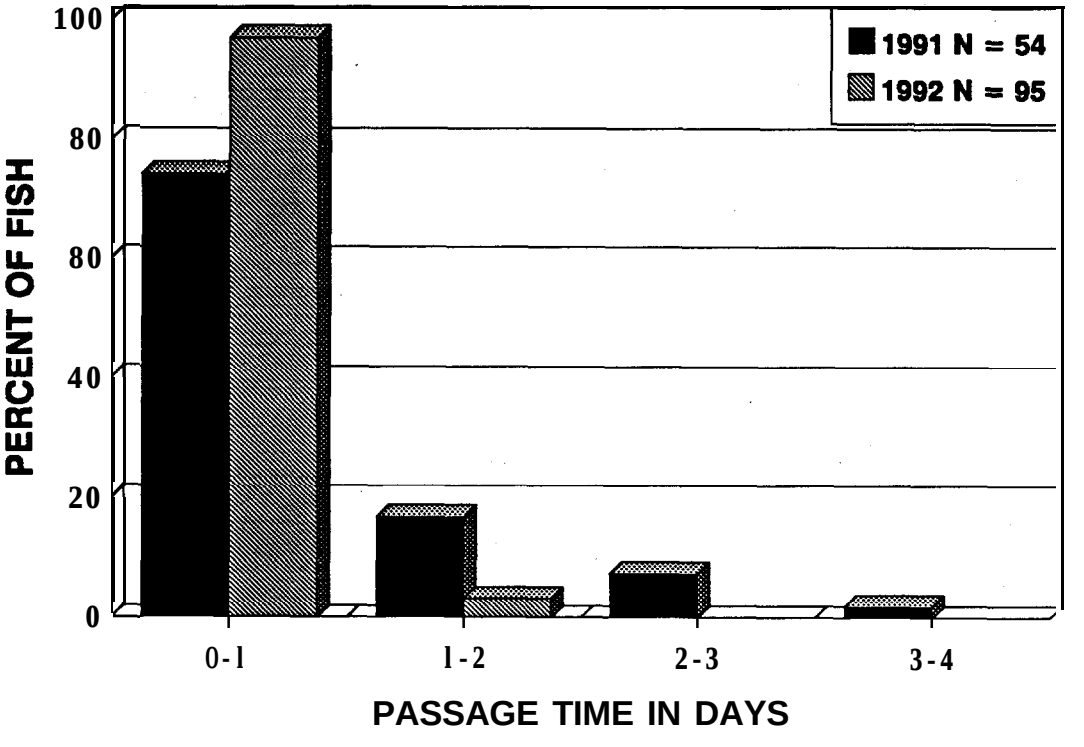


Figure 15.--Passage times of radio-tagged spring chinook salmon at Sunnyside Dam, 1991-92.

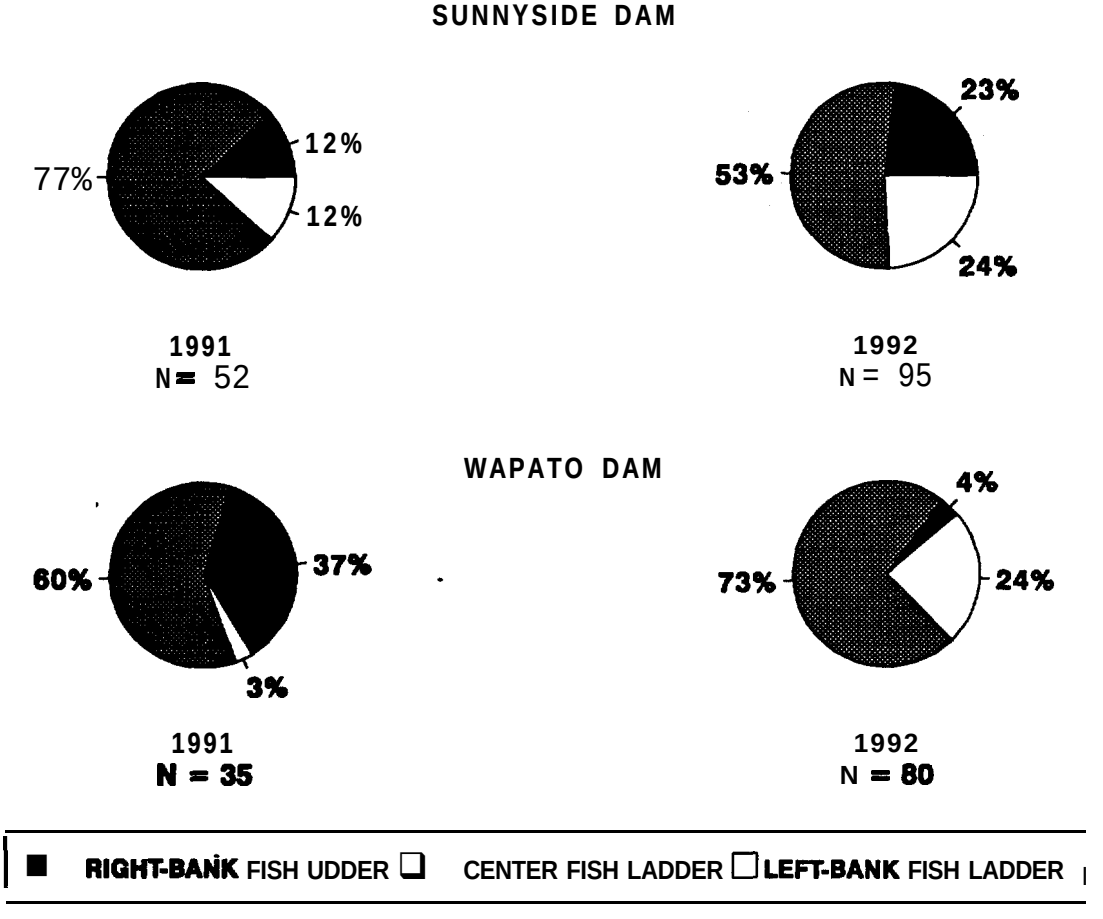


Figure 16.--Fish-ladder selection by radio-tagged spring chinook salmon at Sunnyside and Wapato Dams, 1991-92.

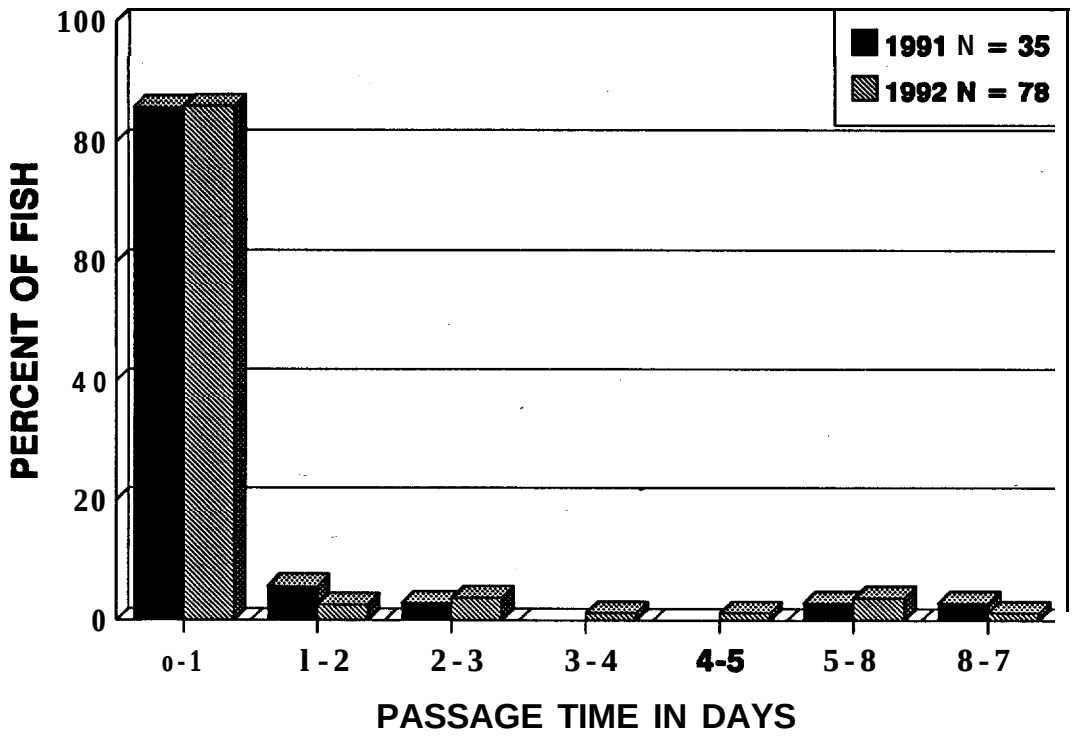


Figure 17. --Passage times of radio-tagged spring chinook salmon at Wapato Dam, 1991-92.

the center fish ladder (60% in 1991 and 74% in 1992) (Fig. 16).

Roza Dam

Passage times at Roza Dam were analyzed for 26 and 59 fish in 1991 and 1992, respectively (Fig. 18). Passage times at Roza Dam ranged from 0.1 to 22.1 days in 1991 (median 1.4 days) and from 0.1 to 8.7 days in 1992 (median 0.8 days). No fall-backs were observed in either 1991 or 1992.

A total of 10 (38%) and 32 (54%) radio-tagged spring chinook salmon used the gallery at Roza Dam in 1991 and 1992, respectively (Table 4). Only 5% (two fish, both in 1992) of the fish using the gallery passed upstream through the gallery into the fish ladder and continued up the fish ladder past Roza Dam. The remaining fish dipped into the gallery entrance but did not pass though the gallery, passed downstream through the gallery (from the fish ladder into the gallery and exited into the tailrace on the right-bank shoreline), or passed upstream through the gallery into the fish ladder and traveled back down the ladder into the tailrace on the left-bank shoreline.

Thirty and 38% of the fish associated with the gallery in 1991 and 1992, respectively, only dipped into the gallery entrance. The number of radio-tagged spring chinook salmon that passed through the gallery downstream only, upstream only, and both upstream and downstream were similar during both years (Table 4).

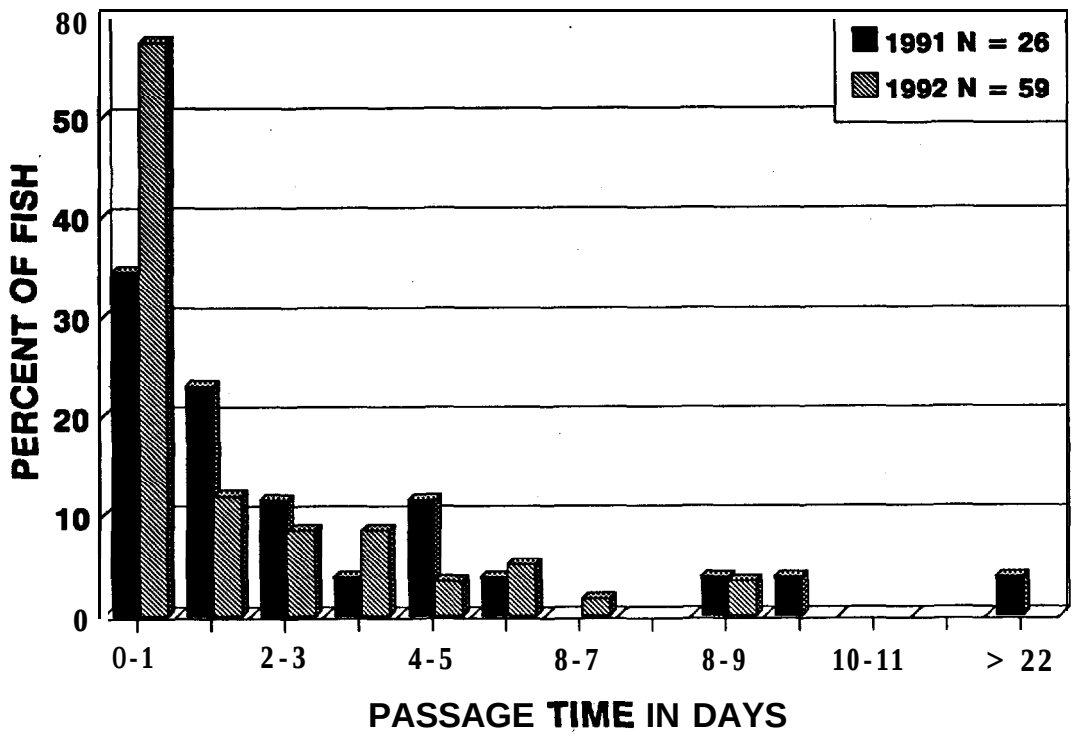


Figure 18.--Passage times of radio-tagged spring chinook salmon at Roza Dam, 1991–92.

Table 4.--Fish passage and gallery use at Roza Dam by radio-tagged spring chinook salmon, 1991-92.

	1991	1992
Did not use the gallery	16	27
Used the gallery for passage	0	2
Entered the gallery	10	30
Gallery behavior and movement		
Dipped into entrance only	3	12
Passed downstream only	2	6
Passed upstream only	2	8
Passed both upstream and downstream	3	6

Migrational delays at Roza Dam were mainly associated with the use of the gallery (Table 5). Median passage times for fish that used the gallery were more than twice as long in 1991 and four times as long in 1992 than median passage times for fish that did not use the gallery.

Town Diversion Dam

Passage times at Town Diversion Dam ranged from <0.1 to 1.4 days (median 0.2 days) for 14 fish in 1991 and from <0.1 to 1.8 days (median 0.3 days) for 52 in 1992 (Fig. 19). Delays in migration at Town Diversion Dam were minimal, with similar passage times during both years. Passage routes and use of the' baffle-chute fishway at Town Diversion Dam were not determined.

Easton Dam

Only two radio-tagged spring chinook salmon passed Easton Dam, one each in 1991 and 1992. Passage times at Easton Dam were 34.6 days in 1991 and 74.8 days in 1992. In 1992, the fish remained in the Easton Dam tailrace area during the prespawning holding period and passed Easton Dam on 16 August to spawn. In 1991, the fish passed Easton Dam on 3 July at least 52 days prior to spawning.

Cowiche Dam

Passage times for radio-tagged spring chinook salmon at Cowiche Dam were analyzed for 25 and 33 fish in 1991 and 1992, respectively (Fig. 20). Passage times at Cowiche Dam ranged from

Table 5.--Median passage delay (days) for radio-tagged spring chinook salmon at Roza Dam, 1991-1992.

	1991	1992
Overall	1.4	0.8
Fish that did not use the gallery	1.1	0.5
Fish that used the gallery	2.7	2.0

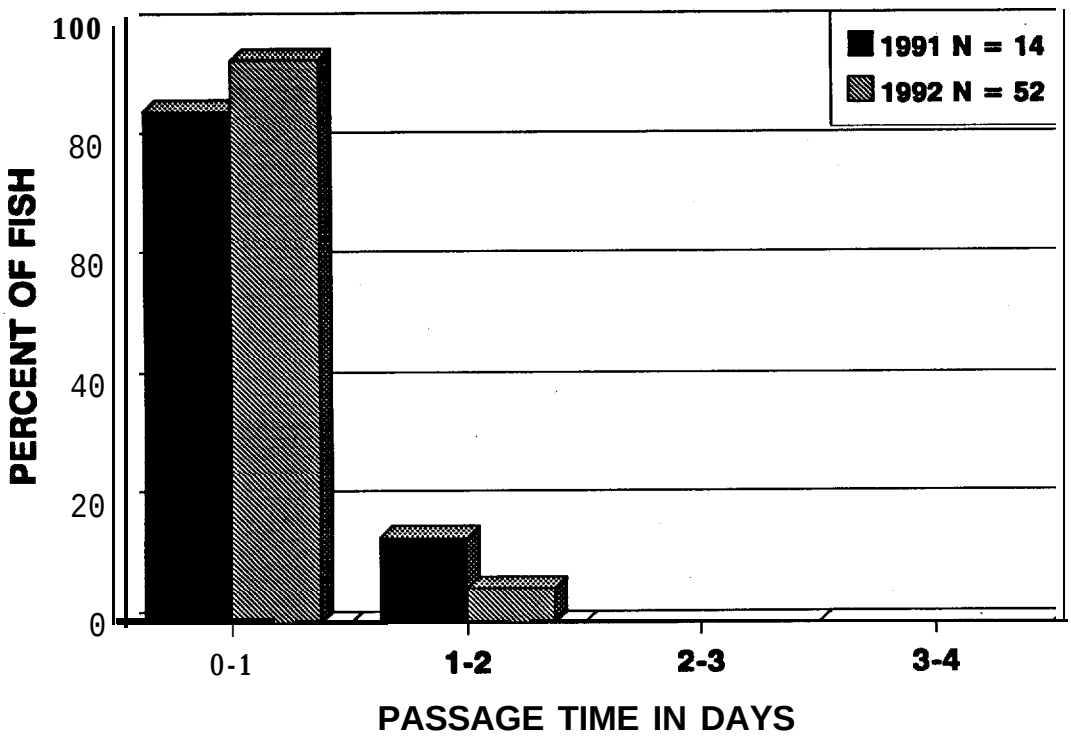


Figure 19. --Passage times of radio-tagged spring chinook salmbn at Town Diversion Dam, 1991-92.

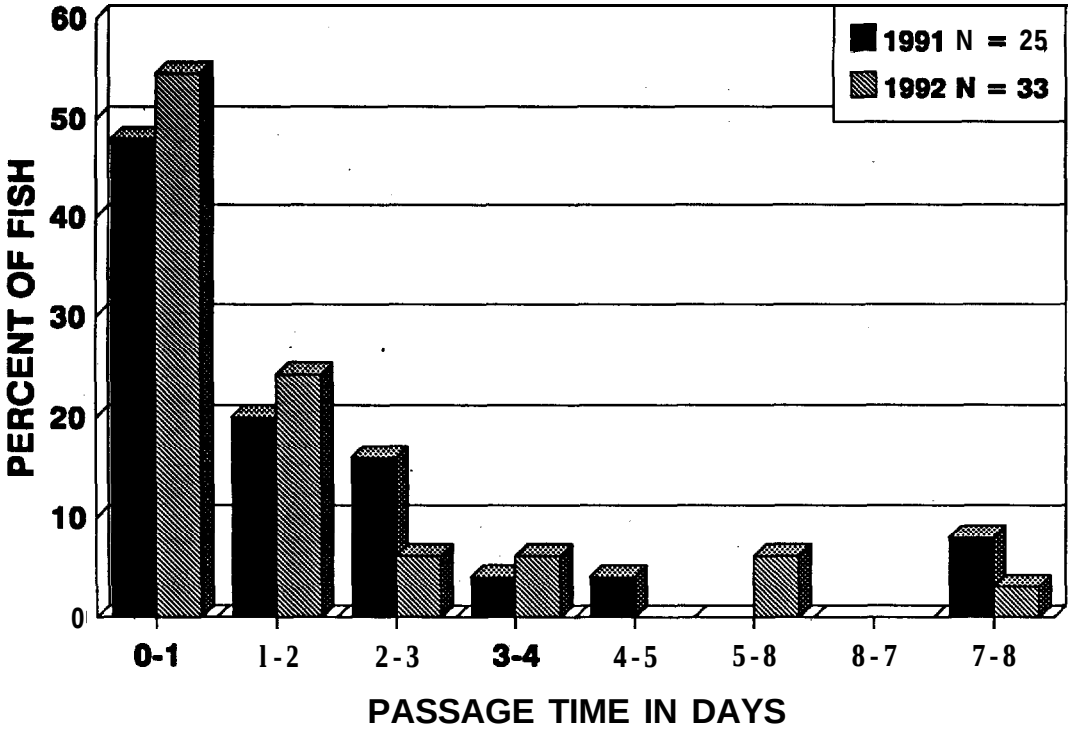


Figure 20. --Passage times of radio-tagged spring chinook salmon at Cowiche Dam, 1991-92.

0.1 to 7.8 days in 1991 (median 1.0 day) and from <0.1 to 7.4 days in 1992 (median 0.9 days). Migrational delays at Cowiche Dam were similar for both years. Ladder passage was minimal (12 and 33% in 1991 and 1992, respectively) with most fish jumping over the dam instead (Fig. 21).

Wapatox Dam

Wapatox Dam on the Naches River has a pool- and weir-type fishway. Because of the location of the Wapatox Dam fishway weirs, it was not possible to determine if fish were using the weirs or jumping between pools.

Passage times for radio-tagged spring chinook salmon at Wapatox Dam ranged from 0.1 to 9.7 days (median 3.5 days) for 30 fish and from <0.1 to 44.9 days (median 4.2 days) for 33 fish in 1991 and 1992, respectively (Fig. 22).

Migration Behavior

Individual migration times for radio-tagged spring chinook salmon between Yakima River Basin irrigation diversion dams in 1991 and 1992 are indicated in Appendix Table C.l and C.2. Median migration rates decreased in both years as fish moved upstream (Fig. 23). In general, migration rates were higher in 1992 than 1991, probably due to decreased flow. The migration period from tagging until arrival at prespawning holding areas ranged from 10 to 100 days and averaged 35.3 days.

Upon arrival at prespawning holding areas, spring chinook salmon remained stationary from June through August (40 to

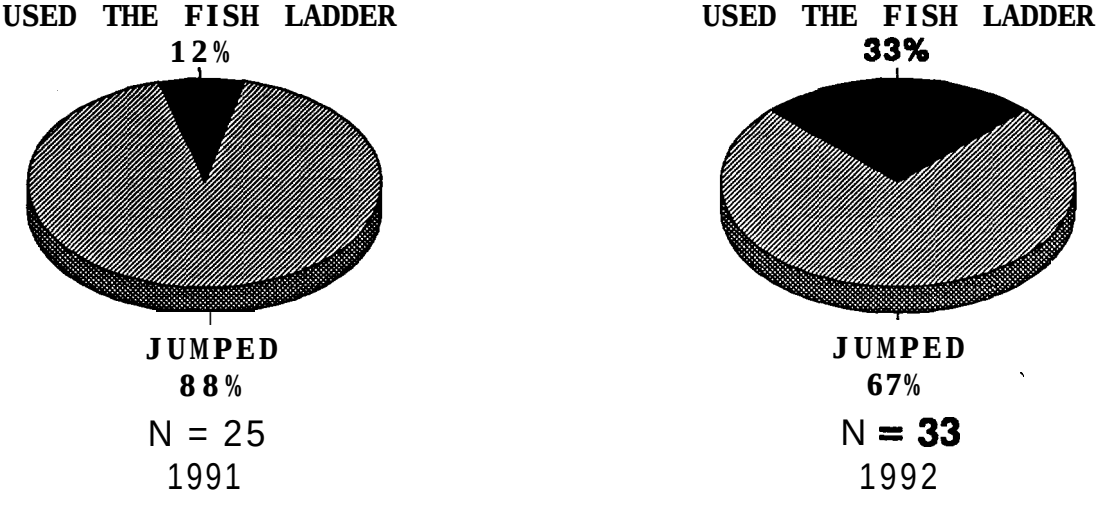


Figure 21.--Fish-ladder use at Cowiche Dam by radio-tagged spring chinook salmon, 1991-92.

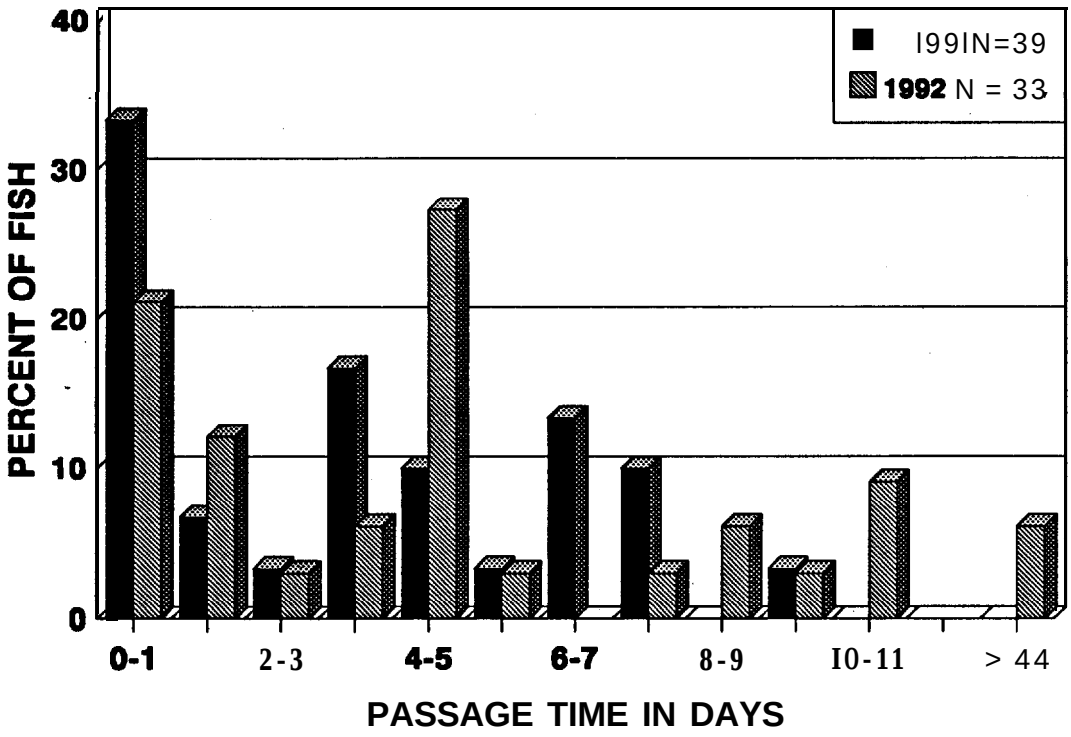


Figure 22. --Passage times of radio-tagged spring chinook salmon at Wapatox Dam, 1991-92.

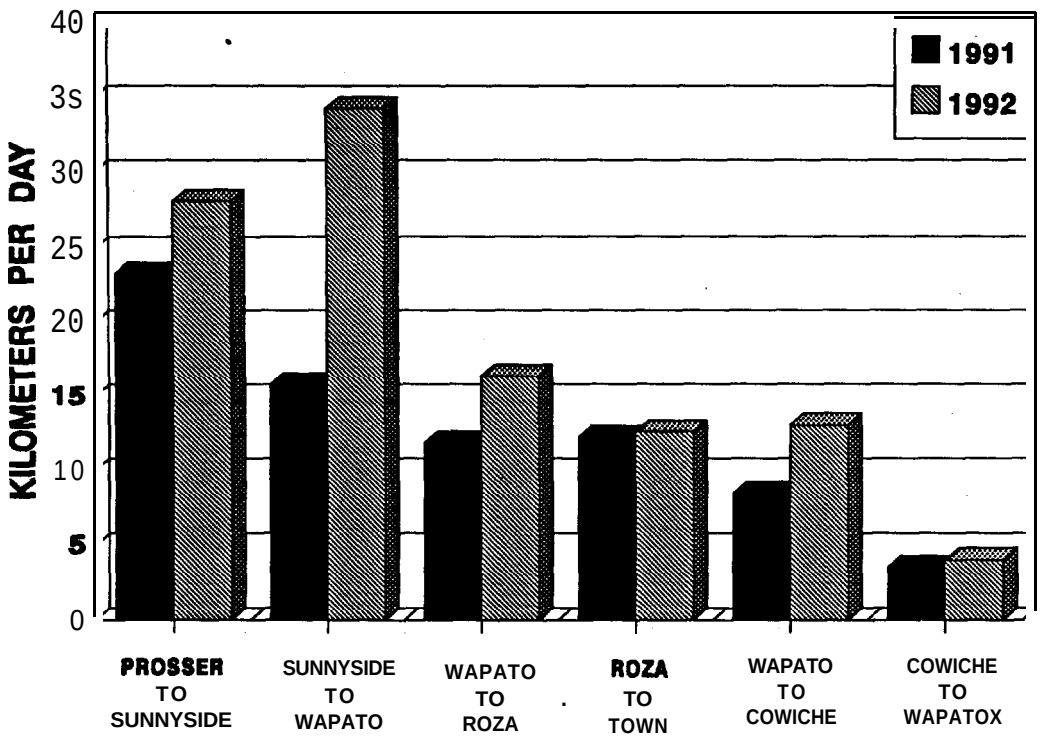
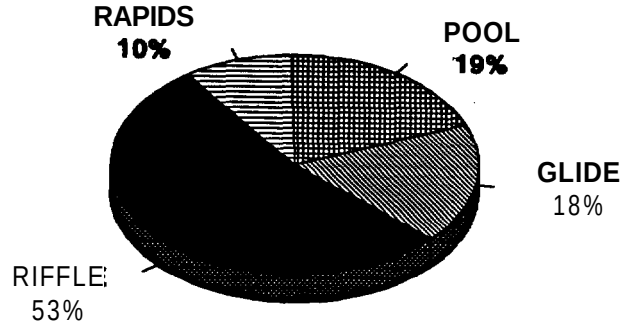


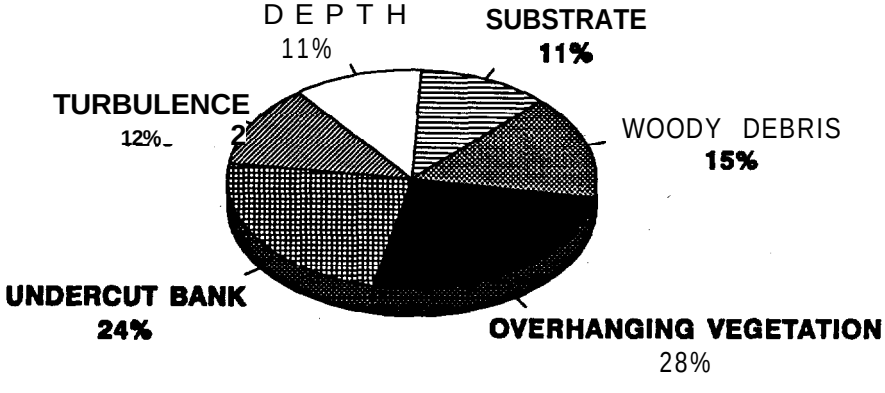
Figure 23. --Median migration rates of radio-tagged spring chinook salmon between Yakima River irrigation diversion dams, 1991-92.

141 days). Habitat utilization and behavior during prespawning holding periods were investigated only in 1992. Prespawning behavior, spawning behavior, and habitat utilization for individual radio-tagged spring chinook salmon are indicated in Appendix D. Of 94 radio-tagged spring chinook salmon, 91% (86 fish) held in only one location during the prespawning holding period; the remaining 9% (8 fish) continually migrated upstream or held in multiple locations for short durations.

Habitat utilization while holding was limited to areas with nonlethal water temperatures, turbulence, large substrate material, and high-quality overhead cover such as woody debris, undercut banks, and overhanging vegetation. During 1992, 83% (76 fish) of the radio-tagged spring chinook salmon spent holding periods in areas with overhead cover. Spring chinook salmon preferred riffle habitat associated with overhanging vegetation or undercut banks (Fig. 24). No aggressive behavior was observed during the prespawning holding period. A log jam on the American River was utilized by one radio-tagged and three nontagged spring chinook salmon throughout the summer in 1992. These four fish spent holding periods in close proximity (<2 m) and did not appear affected by the presence of each other. Beginning in August and continuing through October, territorial behavior began, and radio-tagged fish moved onto adjacent spawning grounds.



HABITAT TYPE



COVER TYPE

Figure 24. --Prespawning habitat and cover used by radio-tagged spring chinook salmon in the Yakima River Basin, 1992.

Spawning Behavior

Spawning areas were close (<16 km) to prespawning holding areas, with 45% of the tagged fish moving less than 1 km to spawn and 80% moving 4 km or less (Fig. 25). Spawning occurred earlier in areas of higher elevation and where water was cooler (e.g., American River) than in areas of lower elevation and warmer water (e.g., Roza Dam tailrace) (Fig. 26).

The spawning areas were determined for 63 and 91% of the radio-tagged fish in 1991 and 1992, respectively (Fig. 27). Eight spawning areas (American River, Bumping River, Little Naches River, Naches River, Rattlesnake Creek, the upper Yakima River above Ellensburg, Cle Elum River, and Roza Dam tailrace) were identified by radio telemetry. Radio-tagged spring chinook salmon utilized spawning grounds in a pattern similar to that identified during spawning ground surveys of the distribution of redds conducted by the Yakama Indian Nation during both years (Hubble et al. 1991, 1992). Only one radio-tagged spring chinook salmon spawned outside historical spawning locations during this study (Fast et al. 1991). During 1992, this fish ended its spawning migration in Crow Creek, a tributary to the Little Naches River. No spawning was observed in the Tieton or Teanaway Rivers, downstream from Cowiche Dam on the Naches River, or in the Yakima River downstream from the Naches River confluence.

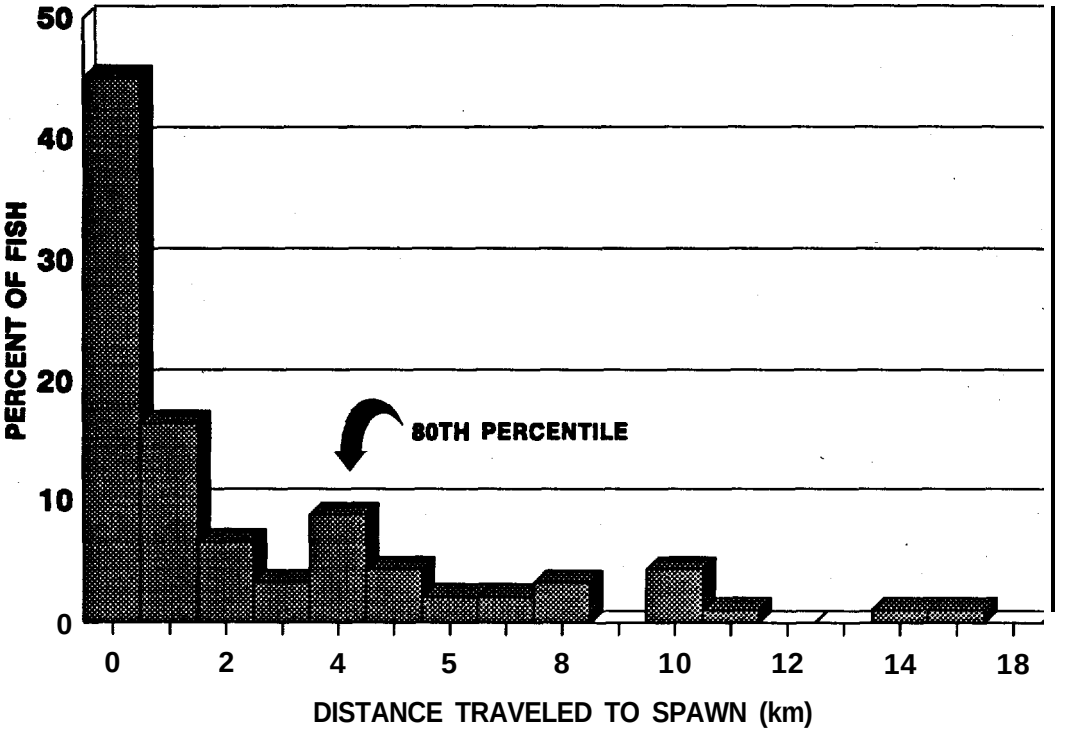


Figure 25.--Migration distance from pre-spawning holding areas to spawning locations for radio-tagged spring chinook salmon in the Yakima River Basin, 1992.

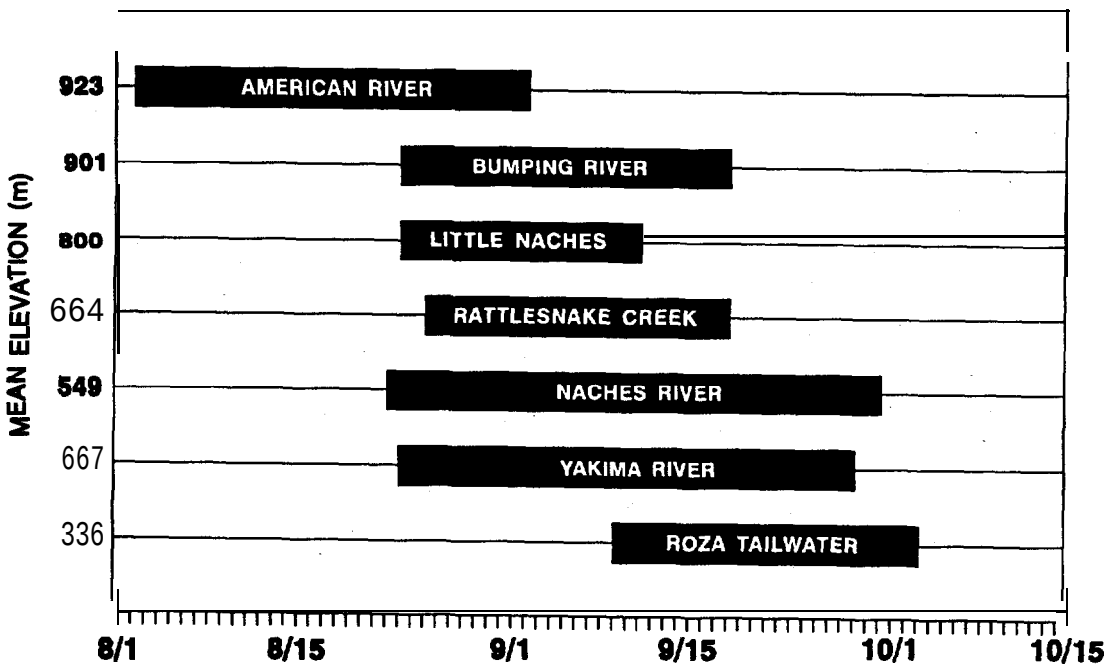


Figure 26.--Mean elevation of spawning areas compared to time of spawning by substock for radio-tagged spring chinook salmon in the Yakima River Basin, 1992.

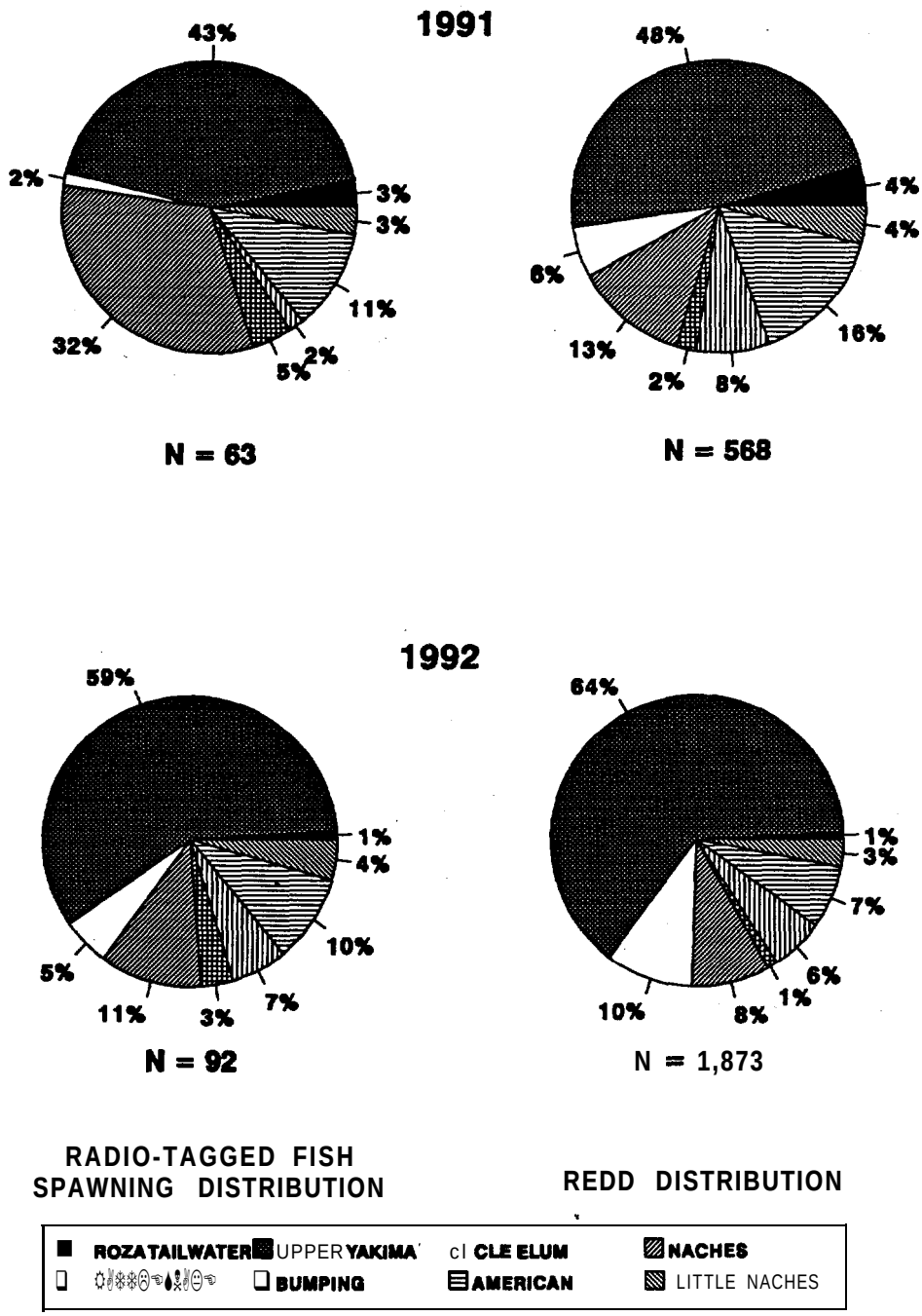


Figure 27. --Spawning distribution of spring chinook salmon in the Yakima River Basin, 1991-92, as determined by radio telemetry and Yakama Indian Nation redd survey data.

Mortality

Observed mortality of radio-tagged spring chinook salmon was 14 and 10% in 1991 and 1992, respectively (Table 6). The tribal subsistence fishery on the Yakima River harvested 1 and 2% of the tagged fish in 1991 and 1992, respectively. Tagging accounted for 3 and 1% of mortality in 1991 and 1992, respectively. The remaining 10% mortality observed in 1991 consisted of fish that died during migration (7%), and fish surviving the prespawning holding period but whose carcasses were found unspent during spawning-ground surveys (3%). The remaining 7% mortality observed in 1992 consisted of fish that died during migration (3%), fish that died from predation (2%), and fish surviving the prespawning holding period but whose carcasses were found unspent during spawning-ground surveys (2%).

Evaluation of *Prosser* Dam Adult Collection Facility

Daily fish-ladder counts of spring chinook salmon passing Prosser Dam are indicated in Appendix Tables E.l and E.2. Denil operations at Prosser Dam to collect spring chinook salmon at Prosser Dam for radio-tagging are indicated in Appendix Table F.l and F.2. Collection and handling of salmonids at the right-bank fish ladder of the adult collection facility at Prosser Dam was difficult; run numbers were low, and most of the run used the left-bank ladder (Fig. 14). To collect significant numbers of fish, the trap was operated frequently, resulting in the capture of large numbers of nontarget species. When fish were collected in the handling room, it required immediate staff attention to

Table 6.--Observed mortality of radio-tagged spring chinook salmon, 1991-92.

	1991	1992
Number tagged	91	102
Tagging mortality	3	1
Migration mortality	6	3
Harvest mortality	1	2
Pre-spawning holding mortality	3	2
Predation mortality	0	2

handle fish. If fish accumulated in the crowder area, they required dipnetting before anesthetization.

Collection of fish in the hopper and transfer to the flume near the denil for further transfer to the tagging room was viable only when nontarget species were absent. These handling procedures confined large numbers of target and nontarget fish in the hopper and thus may have caused additional stress or injury.

Pass to rejection ratios were 1.0 and 0.7 for "V" and flash-board weirs, respectively. These ratios measured the entrance of a proposed off-ladder holding pool weir in the right-bank fish ladder at Prosser Dam, with the "V" weir having slightly less rejection (Table 7).

From 24 April through 1 May 1992, attraction flows were turned off in the left-bank fish ladder and reduced in the center fish ladder under operational criteria for low-flow conditions. During this time, the majority of attraction water passed through the right-bank fish ladder. The change in attraction flow did not affect fish-ladder passage distribution (Fig. 28). The dominant use of the left-bank fish ladder for passage at Prosser Dam was probably due more to the orientation of the dam to tailrace flow than to environmental factors. Because Prosser Dam is oriented at an angle to the downstream flow, the right-bank fish ladder is downstream from the left-bank fish ladder (Fig. 29). Fish migrating upstream at Prosser Dam are funneled into a corner at the left-bank fish-ladder entrance due to the combined orientation of the dam and a diversion wall below the dam.

Table 7.--Passage by adult spring chinook salmon through "V" and flash-board weirs.

Weir type	Passed	Rejected	Ratio
"V"	453	451	1.00
Flash-board	639	924	0.69.

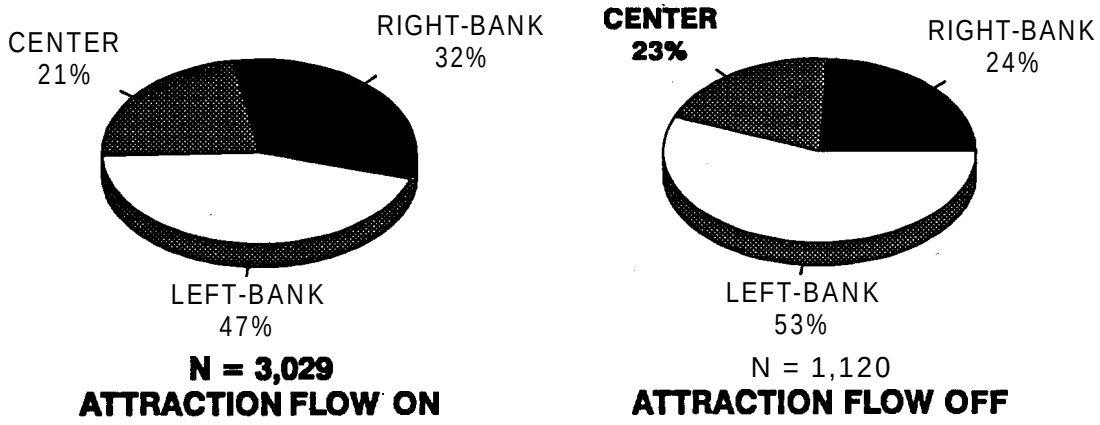


Figure 28.--Fish-ladder selection by spring chinook salmon with and without attraction flow in the left-bank fish ladder at Prosser Dam, 1992.

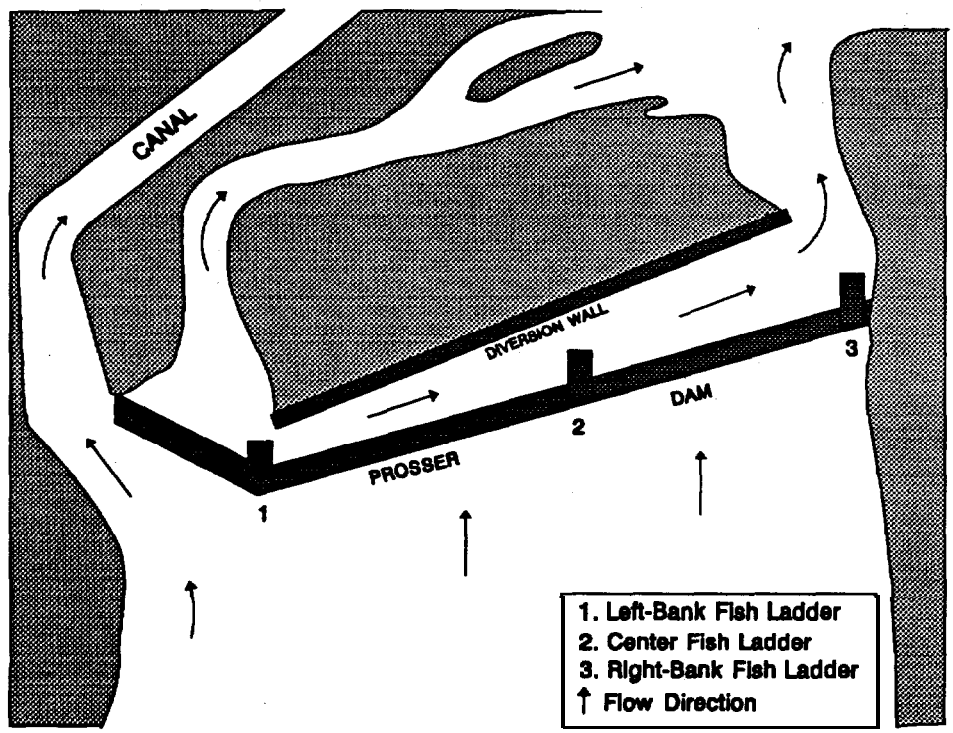


Figure 29.--Yakima River flow pattern at Prosser Dam.

DISCUSSION

Eight substocks or spawning populations (American River, Bumping River, Little Naches River, Naches River, Rattlesnake Creek, the upper Yakima River above Ellensburg, Cle Elum River, and Roza Dam tailrace) of spring chinook-salmon were observed in the Yakima River Basin. The fish exhibited three behavioral phases (migratory period, prespawning holding period, and spawning period).

Prosser Dam, Roza Dam, and Cowiche Dam have been selected as possible broodstock collection sites for spring chinook salmon in the Yakima River. Although Prosser Dam was selected because it is downstream from all spawning areas, based on our radio-tagged spring chinook salmon, separation of substocks there would not be possible either by size, age, run timing, or ladder selection. In both 1991 and 1992, the run timing of all substocks occurred simultaneously below the confluence of the Naches and Yakima Rivers and throughout the migration period in the Naches River.

If upper Yakima River and Cle Elum River spawners are genetically simiiar, broodstock from these populations could be collected at the exit of the Roza Dam fish ladder. However, this study could not determine if spawning fish in a given location were part of the population or strays from other populations. Nonetheless, straying during migration was observed for only two fish that eventually spawned in the mainstem Naches River after spending time below Roza Dam. Some level of straying probably occurs naturally in wild populations and should be accounted for

in the plan for the Yakima/Klickitat Fisheries Project (Quinn and Fresh 1984, Quinn and Nemeth 1991).

Radio-telemetry data from 1991 and 1992 identified problems with broodstock collection and substock separation at Cowiche Dam. Seventy-five percent of the radio-tagged fish jumped Cowiche Dam rather than using the fish ladder, thereby avoiding the locations of the proposed fish-ladder trapping or monitoring facilities. The fish-ladder entrance at Cowiche Dam opens into the spill basin and may account for the low percentage of fish using the fish ladder. Broodstock collection would be affected by fish jumping the dam, and operation of a trap in the fish ladder may delay passage or increase the portion of the run jumping the dam. In addition, radio-tagged Naches River substocks were mixed while passing Cowiche Dam. Naches River Basin substocks were mixed until arrival at prespawning holding areas.

Separation of substocks based on age or length was not possible due to the overlap of length and age classes between most spawning populations.

Migration delays for radio-tagged spring chinook salmon at Yakima River Basin dams were similar or less than passage times at Columbia and Snake River dams (Bjorn and Perry 1992).

Although fall-back at Roza Dam was not observed for normal (1991) and below-normal (1992) flows, fall-back may occur under high flow conditions (during spill), at Roza Dam. Berman and Quinn (1991) reported that 8 of 19 radio-tagged adult spring

chinook salmon collected and tagged at Roza Dam in 1989 subsequently fell back downstream over Roza Dam to spawn.

Passage delay at Roza Dam was two to four times longer for fish using the gallery. Radio-tagged fish traveled upstream and downstream through the gallery. After passing through the gallery, most fish returned to the Roza Dam tailrace before passing Roza Dam.

Delays to migration at Wapatox Dam were the longest delays observed for radio-tagged spring chinook salmon, with the exception of passage delays at Easton Dam. Passage conditions at Wapatox Dam or its proximity to spawning grounds may have been responsible for these delays.

Long passage delays at Easton Dam may have been due to passage conditions or its proximity to spawning grounds. A large population holds and spawns below Easton Dam, and this may affect passage times for individuals spawning above the dam.

Migration rates of radio-tagged spring chinook salmon decreased as fish migrated upstream, and long delays in passage at dams close to spawning areas may be a function of decreased migration rates. In general, passage times at dams were lower and migration rates between dams were higher in 1992 during lower flow conditions. Bjorn and Perry (I992) also found that migration rates were higher and passage times were lower at dams on the Snake and Columbia Rivers during lower flow conditions.

After migrating upriver, adult spring chinook salmon settled into prespawning holding areas near spawning areas. Habitat

utilization while holding was limited to areas with nonlethal water temperatures, turbulence, large substrate material, and high-quality overhead cover such as woody debris, undercut banks, or overhanging vegetation. Riffle habitat with either overhanging vegetation or undercut banks was preferred. The availability of holding areas did not appear to be limiting.

Spawning occurred near prespawning holding areas from August through September in the Yakima River Basin. The time of spawning was tributary-specific, with spawning occurring earlier in areas of higher elevation than in areas of lower elevation. Differences in spawning time due to water temperature associated with elevation for chinook salmon have been described by Miller and Brannon (1982) and Mullan (1987).

No spawning was observed in the Yakima River below its confluence with the Naches River in 1991 or 1992. However, Berman and Quinn (1991) reported that four radio-tagged spring chinook salmon spawned in this area in 1989.

Most of the mortality observed during the study occurred with equal frequency during the migration period and during the prespawning holding period.

Behavior of radio-tagged spring chinook salmon at Prosser Dam may have been biased by collecting all fish from the right-bank fish ladder and then subjecting them to a second passage to evaluate ladder selection and rejection. Only 1 year of reliable data were analyzed for fish-ladder rejection and subsequent selection at Prosser Dam, during a low-flow year when passage was

faster. In addition, it was not possible to monitor movements around Prosser Dam tailrace to determine where and how migrating salmon select a fish ladder for passage or how flows affected fish-ladder selection. The operation of the denil in the right-bank fish ladder at Prosser Dam had a limited effect on fish passage.

Most adult spring chinook salmon pass Prosser Dam via the left-bank fish ladder; changes in attraction flow did not influence ladder selection. The dominant use of the left-bank fish ladder for passage at Prosser Dam is probably due to the orientation of the dam to tailrace flow rather than to environmental factors.

RECOMMENDATIONS

Based on results of the 1991-92 radio-telemetry studies, we developed the following recommendations:

1) Construction of the off-ladder holding pool on the right-bank at Prosser Dam should proceed only if significantly more fish use the right-bank fish ladder. Passage times at Prosser Dam may increase if use of the right-bank fish ladder is increased by blocking the left-bank fish ladder. Development of fish-handling facilities at the left-bank fish ladder would be preferable to attempts to alter passage behavior at Prosser Dam.

2) Broodstock collection for upper Yakima River and Cle Elum River spawning populations appears feasible at Roza Dam. However, the effects of broodstock collection on fish passage should be evaluated. Structural modifications or changes in attraction flows for the gallery at Roza Dam should be considered to reduce passage delay associated with use of the gallery.

3) Broodstock collection of Naches River substocks should be conducted either during the prespawning holding period or on the spawning grounds. If broodstock collection is to occur at Cowiche Dam, the fish-ladder entrance should be moved to the downstream face of the fish ladder. Also, the height of Cowiche Dam may need to be raised during migration periods to increase the

numbers of fish using the fish ladder.

4) Unspent fish should be counted during spawning ground surveys to further quantify prespawning mortality of fish reaching the spawning grounds.

5) When numbers increase from supplementation, prespawning holding areas may provide an opportunity to assess interactions of resident and anadromous populations.

6) Radio-telemetry studies should be conducted on adults from supplementation programs to evaluate straying, intra-specific competition, mortality rates, and the overall effects supplementation programs have on wild populations.-

ACKNOWLEDGMENTS

Support for this research came from the region's electrical rate payers through the Bonneville Power Administration.

The following staff members of the National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington, participated directly in the study: Charles Bartlett, Byron Iverson, Mark Kaminski, Bryan Sheckler, and Brad Peterson. The following staff of the Yakama Indian Nation, Toppenish, Washington, assisted with collection, tagging, and tracking fish: Joe Jay Pinkham-, Thomas Morrison, Paul Wahpat and Virgil Lewis.

Jeffrey Fryer, Columbia River Inter-Tribal Fish Commission, aged scale samples from radio-tagged spring chinook salmon.

The help and cooperation of personnel from the Bureau of Reclamation were instrumental to completion of the project.

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APPENDIX TABLES

Appendix Table A.1.--Tagging data and last observations of radio-tagged spring chinook salmon, 1991.

Serial number	Tagging date	Length (cm)	Weight (kg)	Sex	Age	Last observation
A002	6 May	67	3.8	F	4	Rattlesnake Creek spawner
A003	22 May	76	4.5	F		Upper Yakima River spawner
A005	16 May	71	3.8	M	4	Upper Yakima River spawner
A008	13 May	67	3.4	F	4	Naches River spawner
A009	30 May	a9	7.9	F	5	Naches River spawner
A012	4 Jun	72	4.0	a	4	Rattlesnake Creek spawner
A014	6 Jun	90	7.9	F	5	Bumping River spawner
A016	6 Jun	88	7.6	F	5	Disappear below Prosser Dam
A026	8 May	71	4.4	F	4	Disappear below Prosser Dam
A033	21 May	89	6.6	M	5	American River spawner
A034	23 May	66	2.8	M	4	Migration mortality
A037	6 May	87	8.4	F	5	American River spawner
A040	16 May	95	9.1	F	5	America" River spawner
A041	4 Jun	62	2.6	F	4	Tagging mortality
A044	6 Jun	69	3.9	M	4	Disappear below Prosser Dam
A045	8 May	74	4.3	F	4	Upper Yakima River spawner
A048	18 Apr	87	6.9	F	5	Upper Yakima River spawner
A049	20 Jun	85	6.8	M	5	Naches River spawner
A053	15 May	88	7.7	F	5	Naches River spawner
A066	7 May	62	2.7	F	4	Upper Yakima River spawner
A068	23 Way	68	3.6	F	4	Migration mortality
A070	16 May	a9	7.3	F	5	Naches River spawner
A072	28 nay	73	4.2	F	4	Upper Yakima River spawner
A075	5 J""	69	4.1	F	4	Upper Yakima River spawner
A077	6 J""	83	0.0	M	5	Disappear below Prosser Dam
A079	7 Jun	72	4.8	F	4	Prespawning mortality
A081	7 Jun	77	5.4	F	4	Disappear below Prosser Dam
A083	21 Jun	85	6.6	F	5	Prespawning mortality
A090	8 May	69	3.3	F	4	Upper Yakima River spawner
A093	15 May	69	3.6	F	4	Upper Yakima River spawner
A097	7 m y	79	7.7	F	5	Little Naches River spawner
A099	23 May	69	3.5	F	4	Upper Yakima River spawner
A100	15 May	71	4.2	F	4	Cle Elum River spawner
A.101	23 May	88	7.7	F	5	Naches River spawner
A104	16 May	72	4.3	M	4	Naches River spawner
A106	9 May	73	4.6	F	4	Upper Yakima River spawner
A107	31 May	93	8.8	F	5	American River spawner
A111	5 Jun	86	6.6	M	5	Naches River spawner
All3	6 Jun	69	3.6	F	4	Migration mortality
All7	7 J""	66	3.9	F	4	Disappear below Prosser Dam
A118	21 Jun	79	7.2	F	5	Upper Yakima River spawner
A125	13 Hay	67	3.5	M	4	Upper Yakima River spawner
A131	21 May	80	5.0	F	5	Upper Yakima River spawner

Appendix Table A.l.--Continued.

Serial number	Tagging date	Length (cm)	Weight (kg)	Sex	Age	Last observation
Al34	23 May	71	3.9	F	4	Naches River spawner
A136	23 May	79	5.0	M	5	Naches River spawner
Al37	7 May	73	4.5	F	4	Naches River spawner
A139	28 May	87	7.3	F	5	Naches River spawner
Al41	15 nay	67	3.6	F	4	Upper Yakima River spawner
A142	5 Jun	71	3.9	F	4	Disappear below Prosser Dam
A144	6 Jun	68	3.7	F	4	Naches River spawner
A145	7 Jun	a9	7.5	F	5	Tagging mortality
Al.50	27 Jun	83	5.0	M	5	Migration mortality
A158	10 nay	64	3.1	M	4	Tag regurgitation
A160	17 May	91	5.7	F	5	Naches River spawner
A162	29 Apr	72	3.7	F	4	Upper Yakima River spawner
A163	15 nay	79	5.4	M	5	Prespawning mortality
A165	24 May	69	3.7	M	4	Upper Yakima River spawner
A167	29 nay	68	4.1	M	4	Tagging mortality
Al69	20 May	72	4.8	M		American River spawner
A172	5 Jun	94	10.0	M	5	Disappear below Prosser Dam
A174	7 May	103	13.0	M	5	American River spawner
A175	7 Jun	71	5.0	F	4	Upper Yakima River spawner
A176	18 Jun	79	4.5	F	5	Tag regurgitation
A184	10 May	72	4.5		4	Upper Yakima River spawner
A186	7 May	76	5.2	F	4	Upper Yakima River spawner
A190	3 May	80	6.0	F	5	Tribal harvest
Al94	22 May	67	3.4	F	4	Naches River spawner
Al97	23 May	97	9.3	F	5	Rattlesnake Creek spawner
Al99	24 May	91	8.2	F	5	Naches River spawner
A202	30 May	64	3.1	M	4	Upper Yakima River spawner
A204	31 May	69	3.6	M	4	Migration mortality
A205	5 Jun	93	8.6	a	5	Disappear below Prosser Dam
A207	6 Jun	71	4.4	F	4	Disappear below Prosser Dam
A208	1 May	80	5.7	F	5	Naches River spawner
A210	14 Jun	71	4.1	a	4	Disappear below Prosser Dam
A215	15 May	68	3.6	F	4	Roza Dam tailrace spawner
A217	13 May	75	4.8	M	4	Naches River spawner
A220	20 May	68	3.5	F	4	Disappear below Prosser Dam
A224	7 May	71	3.9	F	5	Upper Yakima River spawner
A226	22 May	89	7.5	M	5	American River spawner
A228	23 May	67	3.1	F	4	Roza Dam tailrace spawner
A230	24 May	88	6.6	F	5	Little Naches River spawner
A233	30 May	70	3.9	F	4	Upper Yakima River spawner
A235	4 Jun	95	9.0	F	5	Migration mortality
A236	5 Jun	68	3.6	F	4	Disappear below Prosser Dam
A237	2 May	65	3.3	F	4	Upper Yakima River ‘pawner
A238	7 Jun	62	2.9	F	4	Disappear below Prosser Dam

Appendix Table A.l.--Continued.

Serial number	Tagging date	Length (cm)	Weight (kg)	Sex	Age	Last observation
A239	13 nay	71	4.4	M	4	Upper Yakima River spawner
A242	16 May	71	4.3	M	4	Naches River spawner
A244	7 May	82	6.8	F	4	Naches River spawner
A247	20 May	66	3.2	M	4	Upper Yakima River spawner

Appendix Table A.2. --Tagging data and last observations of radio-tagged spring chinook salmon, 1992.

Serial number	Tagging date	Length (cm)	Weight (kg)	Sex	Age	Last observation
C003	4 Apr	71	3.6	F	4	Cle Elum River spawner
C008	21 Apr	80	5.6	F	4	Cle Elum River spawner
C010	5 May	66	3.1	F	4	Disappear below Prosser Dam
C011	22 Apr	72	4.1	M	4	Cle Elum River spawner
co14	29 Apr	69	3.6	M	4	Upper Yakima River spawner
CO16	1 May	88	4.4	F	5	American River spawner
C018	8 May	68	3.5	F	4	Upper Yakima River spawner
co22	24 Apr	76	5.4	M		Cle Elum Rive? spawner
CO23	30 Apf	65	2.7	M	4	Rattlesnake Creek spawner
CO25	1 May	87	7.0	F	5	Bumping River spawner
CO26	18 May	77	5.1	F		Upper Yakima River spawner
CO27	29 Apr	76	5.4	F	4	Naches River spawner
co30	28 Apr	67	3.3	F	4	Sport fishing harvest
co31	12 May	85	6.4	M	5	Upper Yakima River spawner
C040	4 May	75	5.0	F	4	upper Yakima River spawner
CO42	29 Apr	72	4.3	F		Upper Yakima River spawner
co49	17 Apr	72	3.4	F	4	Upper Yakima River spawner
CO52	27 Apr	79	5.3	F	4	Cle Elum River spawner
co57	30 Apr	88	7.7	F	5	Predation mortality
co54	07 nay	78	5.4	M	4	American River spawner
CO60	28 Apr	69	3.6	M	4	Upper Yakima River spawner
CO61	22 May	75	4.5	M	4	Migration mortality
CO63	15 May	74	5.1	F	4	Upper Yakima River spawner
CO65	24 Apr	86	6.9	F	5	Naches River Spawner
CO66	27 Apr	92	9.3	F	5	American River spawner
co70	23 Apr	68	3.7	M	4	Upper Yakima River spawner
C080	13 Apr	78	5.4	F		"pper Yakina River spawner
C081	4 nay	67	3.2	F		Upper Yakima River spawner
C085	28 Apr	78	5.e	F	4	Upper Yakima River spawner
C088	6 May	72	4.2	F	4	Upper Yakima River spawner
co91	8 May	76	5.1	M	4	Upper Yakima River spawner
CO96	12 May	73	4.3	M	4	Naches River spawner
C098	12 May	68	3.8	M	4	Naches River spawner
co99	23 Apr	67	3.0	F	4	Upper Yakina River spawner
C100	24 Apr	69	3.8	F	4	Bumping River spawner
Cl03	22 May	78	5.9	F	4	Upper Yakima River spawner
C105	21 Apr	74	5.4	F	4	Upper Yakima River spawner
C111	30 Apr	76	5.0	F	4	Naches River spawner
C114	27 Apr	63	2.9	F	4	Upper Yakima River spawner
C117	7 May	75	5.0	F		American River spawner
C120	24 Apr	71	4.1	F	4	Upper Yakima River spawner
Cl22	4 May	75	5.3	M	4	Upper Yakima River spawner
Cl24	24 Apr	81	5.4	M	5	Upper Yakima River spawner

Appendix Table A.2.--Continued.

Serial number	Tagging date	Length (cm)	Weight (kg)	Sex	Age	Last observation
Cl27	29 Apr	74	5.0	M	4	upper Yakima River spawner
C132	1 May	79	5.2	F	5	upper Yakima River spawner
C133	21 Apr	70	4.1	M	4	Naches River spawner
C134	29 Apr	67	3.6	M	4	Tagging mortality
Cl40	15 May	79	5.4	F	4	Upper Yakima River spawner
Cl42	21 Apr	76	5.4	F	4	Upper Yakima River spawner
C151	4 May	72	4.5	M	4	Bumping River spawner
C159	29 Apr	91	6.4	F	4	American River spawner
Cl62	24 Apr	70	4.2	F	4	Upper Yakima River spawner
Cl65	24 Apr	64	4.1	M	4	Upper Yakima River spawner
Cl66	26 May	77	5.0	F	4	Upper Yakima River spawner
Cl67	12 May	70	4.1	F	4	Upper Yakima River spawner
Cl69	19 May	69	3.6	F	4	Upper Yakima River spawner
Cl70	14 Apr	77	5.4	M	4	Little Naches River spawner
C171	6 Way	67	3.4	M	4	Upper Yakiaa Rive? spawner
Cl72	11 May	74	9.5	M	5	American River spawner
C173	30 Apr	76	5.2	M	4	Bumping River spawner
C175	27 Apr	72	4.5	F	4	Migration mortality
C218	27 Apr	76	5.0	M	4	American River spawner
C220	11 May	60	4.8	F	4	Naches River spawner
C222	22 Apr	70	4.1	M	4	Rattlesnake Creek spawner
C225	6 May	73	4.9	F	4	Upper Yakima River spawner
C227	13 May	75	4.5	F	4	Naches River spawner
C228	30 Apr	69	3.6	F	4	Upper Yakima River spawner
C229	16 Apr	66	3.6	M	4	Prespawning mortality
C230	5 May	69	3.6	F	4	Upper Yakima Rive? spawner
C231	27 Apr	62	2.7	F	4	Rattlesnake Creek spawner
C237	1 May	80	5.9	F	4	Upper Yakima River spawner
C238	1 May	67	3.4	F	4	Upper Yakima River spawner
c239	29 Apr	73	4.9	F	4	Little Naches River spawner
C240	24 Apr	69	3.7	F	4	Upper Yakima River spawner
C241	21 May	68	3.6	F	4	Upper Yakima River spawner
C242	29 Apr	71	4.1	M	4	Upper Yakima River spawner
C245	1 May	62	2.6	F	4	Predation mortality
C257	29 Apr	74	4.8	F	4	Rattlesnake Creek spawner
C261	29 Apr	76	5.4	F	4	Roza Dam tailrace spawner
C263	21 Apr	72	4.1	F	5	Upper Yakima River spawner
C266	22 Apr	68	4.1	F	4	Upper Yakima River spawner
C267	4 May	74	4.1	F	4	upper Yakiaa River spawner
C268	24 Apr	84	6.4	F	5	Crow Creek spawner
C269	27 Apr	75	4.8	F	4	Upper Yakima River spawner
C271	29 Apr	74	4.9	F	4	American River spawner
C272	18 nay	71	5.1	F	4	upper Yakima River spawner
C273	30 Apr	73	4.1	F	4	Upper Yakima River spawner

Appendix Table A.2.--Continued.

Serial number	Tagging date	Length (cm)	Weight (kg)	Sex	Age	Last observation
C275	8 May	73	4.5	M	4	Migration mortality
C282	30 Apr	71	3.6	M	4	Upper Yakima River spawner
C286	22 Apr	77	5.0	F	4	Upper Yakima River spawner
C288	5 May	72	4.6	F	4	Upper Yakima River spawner
C289	16 Apr	69	4.1	F	4	Bumping River spawner
C290	13 nay	65	3.2	M	4	Prespawning mortality
C292	29 Apr	76	5.2	M	4	American River spawner
C296	21 May	76	4.8	F	4	Upper Yakima River spawner
C300	7 May	64	3.1	F	4	Tribal harvest
C303	24 Apr	69	3.4	M	4	Upper Yakima River spawner
C304	11 May	85	6.8	F	5	Bumping River spawner
C306	1 May	68	3.3		4	Tag regurgitation
C309	27 Apr	78	5.4	F	4	Naches River spawner
C311	27 Apr	74	5.4	M	4	Naches River spawner
c314	28 Apr	68	3.6	F	4	Upper Yakima River spawner

Appendix Table B.1.--Passage times (days) for and fish-ladder use by radio-tagged spring chinook salmon at Yakima River Basin irrigation diversion dams, 1991.

Serial number	Prosser Dam		Sunnyside Dam		Wapato Dam		Roza Dam	Tom Diversion Dam	Cowiche Dam		Wapatox Dun
	Fish ladder	Passage time	Fish ladder	Passage time	Fish ladder	Passage time	Passage time	Passage time	Fish ladder	Passage time	Passage time
A002	Left	0.8	Center	0.7	Right	0.5					1.2
A003		2.7	Center	<0.1	Center	1.0	0.1	1.4			
A005	Right	0.3	Center	2.1	Center	0.6		<0.1			
A008		1.4	Center	co.1	Right	0.9			No	0.6	6.3
A009	Right	3.0	Center	co.1	Center	<0.1			Yes	2.0	3.0
A012	Right	1.3	Center	0.3	Center	0.8			NO	4.7	6.9
A014	Right	0.1	Center	0.2							9.6
A016											
A026											
A033		1.9	Center	0.9							4.8
A034	Center	0.2									
A037		0.9	Center	0.9							7.2
A040			Center	1.3	Center	(0.1			No	0.1	0.7
A041											
A044			Center	0.4							
A043		1.2	Center	0.7			1.2				
A048	Left	3.6	Left	<0.1			1.0				
A049	Left	2.4	Center	<0.1	Center	0.4			No	0.6	
ADS3									WO	2.1	0.6
A066	Left	0 . 7	Right	0.1							
A068		0.2	Riqht	0.1	Right	0.1					1.7
A070		0.2	Left	1.1					Yea	1.4	1.0
A072	Left	1.3	Center	0.1	Center	0.1	2.9				
A075	Right	1.3	Center	<0.1	Center	1.4	3.5	0.4			
A077											
A079			Center	1.0			0.1	0.1			

Appendix Table B.1.--Continued.

Serial number	Prosser Dam Fish ladder	Prosser Dam Passage time	Sunnyside Dam Fish ladder	Sunnyside Dam Passage time	Wapato Dam Fish ladder	Wapato Dam Passage time	Roza Dam Passage time	Town Diversion De Passage time	Cowiche Dam Fish ladder	Cowiche Dam Passage time	Wapatox Dam Passage time
A081											
A083	Left	0.2	Left	0.3	Center	6.1			Yea	3.7	
A090			Center	1.1	Center	0.1					
A093	Riqht	0.2					1.1				
A097	Left	0.1	Center	<0.1	Left	co.1			No	1.3	3 . 7
A099		0.2	Center	0.2			0.8	0.6			
A100	Right	0.4	Center	<0.1			<0.1				
A101									No	1.1	0.3
A104	Riqht	1.2	Center	1.9					No	1.1	0.1
A106		0.9	Center	0.9	Center	<0.1	0.2				
A107	Riqht	0.6	Center	0.1	Right	0.3			No	0.3	1.0
A111	Right	1.3	Center	2.1	Riqht	<0.1					4.7
A113			Center	0.8	Center	0.1					
A117			Center	2.0	Center	0.2	0.3				
A118	Left	5.3	Center	2.0	Center	2.7	4.8	1.8			
A125	Left	1.4									
A131	Center	0.2	Center	0.1			1.6	0.2			
A134	Left	1.2	Center	0.6	Right	0.4			WO	2.3	4.2
A136	Riqht	3.1	Riqht	<0.1							6.1
A137	Left	0.2	Center	0.1					No	7.1)	0.1
A139	Riqht	3.7	Center	1.5	Right	0.2			No	0.4	0.7
A141	Right	0.2	Center	0.2			1.1				
A142	Center	1.0	Center	1.8	Center	0.2	9.8				
A144			Left	2.0	Center	0.1			No	0.7	3.6
A145											
A150	Riqht	0.2	Center	<0.1							
A158											

Appendix Table B.1.--Continued.

Serial number	Prosser Dam Fish ladder	Prosser Dam Passage time	Sunnyside Dam Fish ladder	Sunnyside Dam Passage time	Wapato Dam Fish ladder	Wapato Dam Passage time	Roza Dam Passage time	Town Diversion Dam Passage time	Cowiche Den Fish ladder	Cowiche Den Passage time	Wapatox Dam Passage time
A160			Center	1.0	Center	<0.1			No	0.4	
A162	Left	0.3	Left	<0.1			0.2				
A163			Right	CO.1	Center	<0.1	2 . 6	<0.1			
A165	Left	9.6	Center	0.1	Center	0.7	8.9				
A167											
A169			Right	<0.1	Right	1.9					5.7
A112											
A174		u.2							No	0.3	2.7
A175			Left	<0.1			1.4	0.3			
A176	Left	0.2									
A184			Right	<0.1	Center	5.2					
A186		0.6	Center	<0.1			0.8	<0.1			
A190											
A194	Right	1.1	Left	<0.1					No	0.7	
A197		0.9			Center	0.2			No	1.0	0.8
A199		0.2							No	0.7 .	3.1
A202	Riqht	1.6			Center	0.6	1.0	0.3			
A204											
A205											
A207											
A208		1.4							No	1.0	7.0
A210											
A215	left	0.9									
A217			Center	0.1	Right				No	2.5	
A220											
A224		0.4			Right	1.0	2.6				
A226		2.0							No	7.5	12.4

Appendix Table B , 1 . --Continued.

Serial number	Prosser Dam Fish ladder	Prosser Dam Passage time	Sunnyside Dan Fish ladder	Sunnyside Dan Passage tine	Wapato Dam Fish ladder	Wapato Dam Peeeaqe tine	Roza Da Passage tine	Tom Diversion Den Passage the	Cowiche Dam Fish ladder	Cowiche Dam Peeeaqe time	Wepator Dem Passage time
A226		4.1					4.1	0.1			
A230	Left	6.6	Center	<0.1					No	0.4	1.0
A233	Center	6.7	Center	<0.1			4.6	0.1			
A233											
A236											
A237		1.1					4.1	0.1			
A236											
A239							5.1				
A242	Center	0.6	Left	4.0	Right	0.3					0.5
A244		1.1									3.3
A247	left	1.6			Right		22.1	0.6			

Appendix Table B&-Passage times (days) for and fish-ladder use by radio-tagged spring chinook salmon at Yakima River Basin irrigation diversion dams, 1992.

Serial number	Prosser Dam Fish ladder	Prosser Dam Passage tine	Sunnyside Dam Fish lrdder	Sunnyside Dam Passage time	Wapato Dam Fish ladder	Wapato Dam Passage time	Roza Dam Passage tine	Town Diversion Dam Passage time	Cowiche Dam Fish ladder	Cowiche Dam Passage time	Wapatox Dam Passage time
C003	Riqht	0.3	Left	<0.1	Center	0.1	1.8				
C008	Left	0.2	Riqht	<0.1	Center	0.1	0.8	0.3			
C010											
C011		0.3	Riqht	0.1	Center	0.1	0.3	(0.1			
C014	Left	4.9	Riqht	<0.1	Left	0.2	1.0	0.9			
C016	center	1.2	Riqht	<0.1	Left	0.1			No	5.5	0.9
C018	Left	0.1	Right	<0.1	Center	0.7	4.2	0.3			
CD22	Left	0.6	Right	<0.1	Center	<0.1	0.2	0.9			
co23	Left	0.2	Center	0.3					No	3.1	8.8
C025	Left	0.2	Center	<0.1	Center	0.4			No	3.3	0.1
C026	Right	0.4	Left	<0.1	Left	<0.1	1.1	<0.1			
C027	Left	0.5	Center	<0.1	Center	2.3			Yes	5.5	9.1
co30											
C031	Left	0.1	Center	to.1	Left	0.1	0.5	0.2			
C040	Left	0.2	Right	<0.1	Center	0.4	0.8	0.3			
C042			Right	0.1	Center	1.3	1.0	0.1			
co49	Left	1.0	Right	<0.1	Center	<0.1	1.7	0.9			
co52	Left	0.4	Center	<0.1	Center	0.4	0.5	1.1			
C057		0.2	Center	<0.1	Center	0.1					
C058	Center	0.9	Center	<0.1	Center	0.2			No	2.2	0.2
C060	Left	0.2	Center	<0.1	Center	0.9	0.3	0.1			
C061	Left	0.3	Center	<0.1							
C063	Riqht	1.6	Center	<0.1			0.7	0.3			
C065	Center	3.2	Center	0.1	Center	0.1			Yes	1.3	2.4
C066		1.0	Center	<0.1	Center	1.1			No	0.4	1.5
C070	Center	4.1	Riqht	(0.1	Center	0.3	3.4	0.8			

Appendix Table B.2.--Continued

Serial number	Prosser Dam Fish ladder	Prosser Dam Passage time	Sunnyside Dam Fish ladder	Sunnyside Dam Passage time	Wapato Dam Fish ladder	Wapato Dam Passage time	Roza Dan Passage time	Town Diversion Dam Passage time	Cowiche Dam Fish ladder	Cowiche Dam Passage time	Wapatox Dam Passage time
C080	Riqht	0.3	Left	0.1	Center	2.4	0.5	0.4			
C081	Left	0.2	Center	to.1			0.1	0.6			
C085	Right	1.0	Center	<0.1	Center	0.3	1.9	0.8			
C088	Center	0.5	Center	<0.1	teft	2.0	0.1	0.3			
co91	Center	0.3	Canter	<0.1	Left	5.7	1.5	0.4			
C096		0.1	Center	<0.1	Left	<0.1			NO	1.4	0.9
C098	Center	1.4	Rlqht	<0.1	Center	<0.1			No	0.8	4.1
co99	Left	0.4	Right	0.1	Center	0.4	8.6	0.2			
C100	Center	0.5	Left	1.8	center	0.5			N0	0.2	0.2
C103		0.1	Left	<0.1	Riqht	<0.1	0.2	0.1			
C105			Left	<0.1	Center	6.0	5.7				
Cl11	Right	0.4	Center	<0.1	center	0.2			Yes	0.5	1.7
C114	Right	0.5	Center	<0.1	Center	0.1	0.9	0.1			
C117	Right	0.5	Center	(0.1	Center	0.1			Yes	0.2	3.1
C120	Left	0.1	Center	<0.1	Center	0.1	0.1	0.5			
C122	Left	1.0	Riqht	<0.1	Center	4.9	3.2	0.6			
Cl24	Right	0.3	Left	<0.1	Center	1.0	0.1	0.4			
C127	Left	0.8	Left	<0.1	center	0.2	2.6	0.8			
C132	Right	1.2	Center	<0.1			0.7				
C133	Left	1.0	Center	<0.1	Center	<0.1			RR	0.9	0.0
C134											
Cl40	Left	0.7	Left	0.1	Left	0.9	4.6	0.2			
C142	Left	1.9	Left	<0.1			0.1	<0.1			
Cl51	Left	0.3	Center	<0.1	Center	0.1			Yes	2.0	10.4
C159	Left	0.2	Right	0.1					Yer	1.3	5.2
Cl62	Center	0.2	Left	0.1	Center	<0.1	0.4	1.3			
Cl65	Left	1.3	Left	1.3	Center	<0.1	0.1	0.2			

Appendix Table B.2.--Continued

Serial number	Prosser Dam Pith ladder	Prosser Dam Passage time	Sunnyside Dam Fish ladder	Sunnyside Dam Passage time	Wapato Dam Fish ladder	Wapato Dam Passage time	Roza Dam Passage time	TownDiver&an Dam Passage time	Cowiche Dam Fish ladder	Cowiche Dam Passage time	Wapatox Dam Passage time
Cl66	Right	4.4	Center	<0.1	Left	<0.1	4.7				
Cl67	Left	0.2	Center	0.6	Left	<0.1	0.5	0.1			
C169	Center	0.3	Center	0.3	Riqht	6.7	1.6	0.1			
C170	Left	2.3	Right	0.1					Yea	0.8	10.3
C171	Riqht	1.5	Riqht	0.6	Left	0.9	6.1	0.3			
Cl72	Left	1.6	Center	0.1					No	0.3	0.6
C173	Left	0.2	Left	<0.1	Center	<0.1			Yea	1.1	4.6
C175	Left	0.3									
C218	Riqht	0.9	Riqht	0.1	Center	3.5			NO	0.1	4.5
C220	Right	0.2	Left	<0.1	Left	0.3			NO	0.1	4.2
c222	Left	0.2	Center	<0.1	Center	0.1			Yes	0.9	10.4
C225	Left	0.6	Center	<0.1	Left	0.1	1.5	<0.1			
c227	center	0.4	Center	0.1	Center	5.7			NO	0.1	7.1
C228	Left	0.2	Center	<0.1	Center	<0.1	0.3				
C229	Left	0.4	Center	<0.1	Canter	<0.1			No	0.9	14.2
C230	Right	2.5	Center	to.1	Center	0.1	4.1	0.2			
C231	Right	1.3	Left	<0.1					No	2.0	3.0
C231	Center	2.1	Center	<0.1			0.3	0.2			
C238	Left	3.5	Center	1.6	Center	0.3	1.2	0.3			
c239	Left	0.2	Right	0.4	Center	0.5			NO	0.2	4.1
C240	Left	0.2	Left	(0.1			0.1	0.2			
t241	Right	1.0	Center	<0.1	Left	0.1	0.3	<0.1			
C242	Left	1.2	Center	<0.1			0.4	0.4			
C245	Left	6.0	Center	<0.1	Center	0.1	2.6	0.1			
c257		0.9	Center	<0.1	Center	<0.1			No	7.4	0.2

Appendix Table B.2. --Continued

Serial number	Prosser Duo Fish ladder	Prosser Duo Passage time	Sunnyside Dam Fish lrdder	Sunnyside Dam Passage time	Wapato Dam Fish ladder	Wapato Dam Passage time	Roza Dam Passage time	Town Diversion Dam Passage time	Coviche Dam Fish ladder	Coviche Dam Passage time	Wapatox Dam Passage time
C261	Left	0.9	Center	<0.1	Center	<0.1					
C263	Left	2.1	Center	<0.1	Center	0.1	2.6	0.5			
C266	Center	3.6	Right	<0.1	Center	0.2	0.1	1.5			
C267	Left	1.8	Center	<0.1	Left	0.2	0.1	0.6			
C268			Left	<0.1	Center	0.1			NO	2.8	44.9
C269	Right	0.4	Left	<0.1	Center	<0.1	0.7	0.1			
C271	Center	0.4	Center	<0.1	Center	0.1			Yes	0.5	5.0
C272	Left	0.8	Center	<0.1	Left	<0.1	3.1	<0.1			
C273	Left	0.1	Center	(0.1	Center	0.1	0.1	0.1			
C275	Left	0.2	Center	<0.1							
C282	Left	0.3	Right	<0.1			0.5	0.1			
C286	Left	1.5	Left	(0.1			1.7	0.4			
C288	Left	1.5	Center	<0.1	Center	0.3	2.9	<0.1			
C289	Left	0.6	Left	<0.1					No	0.3	4.0
C290	Left	0.6	Canter	<0.1	Center	0.3	3.5				
C292	Center	0.6	Left	0.1	Center	0.3			No	1.3	1.2
C296	Left	0.7	Left	<0.1	Right	0.3	1.2	0.3			
C300											
C303	Left	0.2	Center	<0.1			1.0	0.6			
C304	Right	0.3	Left	0.2	Left	0.1			No	1.0	5.0
C306											
C309	Left	0.2	Center	<0.1	Center	0.7			NO	0.8	4.6
C311	Left	0.3	Right	0.1	Center	0.4			Yes	1.8	1.4
c314	Left	0.1			Center	0.1	0.1	1.0			

Appendix Table C.1.--Migration times (days) between dams for radio-tagged spring chinook salmon in the Yakima River Basin, 1991.

Serial number	Prosser Dam to Sunnyside Dam	Sunnyside Dam to Wapato Dam	Wapato Dam to Roza Dam	Roza Dam to Town Diversion Dam	Wapato Dam to Cowiche Dam	Cowiche Dam to Wapatox Dam
A002	5.6	0.2				
A003	1.7	0.4	2.2	2.5		
A005	4.0	0.2				
A008	4.5	0.1			3.0	5.0
A009	3.2	0.1			3.0	13.9
A012	4.1	0.5			2.6	6.3
A014	3.7					
A016						
A026						
A033	4.2					
A034						
A037	6.1					
A040		0.2			1.8	6.2
A041						
A044						
A045	3.4					
A048	8.8					
A049	3.9	0.4			1.6	
A053						6.2
A066	5.0					
A068	5.4	0.2				
A070	2.7					8.0
A072	5.5	0.2	2.9			
A075	3.0	0.1	1.5	4.6		
A077						
A079				3.3		
A081						
A083	5.7	0.2			16.2	
A090		0.7				
A093						
A097	3.3	0.4			1.7	6.6
A099	4.7			3.1		
A100	4.9					
A101						9.7
A104	1.7					7.0
A106	4.1	0.2	4.8			
A107	2.7	0.2			2.4	4.0
Al11	1.7	0.4				
A113		1.0				
A117		0.3	0.7			

Appendix Table C.1.--Continued.

Serial number	Prosser Dam to Sunnyside Dam	Sunnyside Dam to Wapato Dam	Wapato Dam to Roza Dam	Roza Dam to Town Diversion Dam	Wapato Dam to Cowiche Dam	Cowiche Dam to Wapatox Dam
A118	0.7	0.3	2.4	4.2		
A125						
A131	5.4			6.2		
A134	3.3	0.4			1.3	4.9
A136	4.4					
A137	5.5					1.1
A139	2.5	0.6			3.2	8.6
A141	3.1					
A142	1.9	0.1	1.9			
A144		0.9			8.3	10.3
A145						
A150	0.9					
A158						
A160		3.0			2.5	
A162	6.8					
A163		0.7	2.9	5.0		
A165	4.6	0.3	2.2			
A167						
A169		0.8				
A172						
A174						4.6
A175				3.2		
A176	3.5					
A184		0.2				
A186	6.4			10.6		
A190						
A194	7.3					
A197					1.4	3.2
A199						8.1
A202			3.2	8.0		
A204						
A205						
A207						
A208						8.1
A210						
A215						
A217		0.3			4.7	
A220						
A224			5.7			
A226						4.6
A228						

Appendix Table C.1.--Continued.

Serial number	Prosser Dam to Sunnyside Dan	Sunnyside Dam to Wapato Dam	Wapato Dam to Roza Dam	Roza Dam to Diversion Dam	Wapato Dam to Cowiche Dam	Cowiche Dam to Wapatox Dar
A230	2.6			4.2		
A233	3.0			4.2		
A235						
A236						
A237				7.3		
A239						
A239						
A242	1.3	0.7				
A244						
A247			4.2	4.3		

Appendix Table C.2.--Migration times (days) between dams for radio-tagged spring chinook salmon in the Yakima River Basin, 1992.

Serial number	Prosser Dam to Sunnyside Dam	Sunnyside Dam to Wapato Dan	Wapato Dam to Roza Dam	Roza Dam to Town Diversion Dam	Wapato Dam to Cowiche dam	Cowichc Dar to Wapatox Dam
coo3	5.4	0.3	2.3			
C008	4.3	0.1	1.5	5.3		
C010						
co11	3.2	0.4	1.9	5.5		
C014	2.3	0.1	1.4	5.2		
C016	3.9	0.1			1.7	4.1
C018	2.4	co.1	2.9	6.1		
co22	2.9	0.3	7.2	3.1		
C023	5.6					3.1
C025	2.6	0.7			2.9	19.5
C026	2.0	0.2	2.9	2.9		
C027	5.0	0.1			0.9	3.4
co30						
co31	2.0	0.1	1.5	4.4		
C040	2.5	0.1	2.7	4.0		
C042		0.2	2.6	5.6		
co49	9.2	0.1	2.0	5.2		
C052	6.2	0.2	1.9	2.1		
co57	3.1	0.1	1.6			
co59	2.2	0.2			2.6	2.6
C060	4.6	0.2	1.3	2.3		
C061	2.7	0.1				
C063	2.6			3.9		
C065	2.5	0.4			5.7	9.7
C066	4.2	to.1			1.1	7.0
co70	6.3	0.4	3.0	5.3		
C080	4.9	1.1	5.2	7.4		
C081	3.0			3.5		
co95	3.4	0.1	1.9	5.1		
co**	2.4	0.3	1.6	4.1		
co91	3.0	0.1	1.5	4.3		
C096	2.6	0.1			1.5	7.9
C098	1.9	0.1			1.1	5.4
co99	4.3	0.3	7.0	4.3		
Cl00	3.6	3.1			1.3	8.7
C103	2.5	0.4	0.9	3.1		
C105		0.6	3.4			
Cl11	4.2	0.1			1.5	9.e
C114	6.6	0.3	2.5	6.4		
C117	2.2	0.3			1.7	2.3
Cl20	5.4	0.2	1.9	2.3		
Cl22	2.2	0.1	3.1	6.4		

Appendix Table C.2.--Continued.

serial number	Prosser Dam to Sunnyside Dam	Sunnyside Dam to Wapato Dam	Wapato Dam to Roza Dam	Roza Dam to Town Diversion Dan	Wapato Dam to Cowiche dam	Cowiche Dam to Wapatox Dam
Cl24	3.3	0.1	9.7	5.7		
Cl27	3.4	0.3	1.7	3.4		
Cl32	2.9					
C133	3.6	0.4			1.7	6.6
C134						
C140	2.4	0.1	2.5	2.9		
Cl42	3.3			6.1		
C151	2.5	0.1			1.4	5.5
C159	3.1					2.0
Cl62	2.5	0.9	1.1	3.7		
Cl65	2.9	<0.1	0.4	6.2		
Cl66	2.2	0.2	1.6			
Cl67	2.4	0.1	2.1	3.5		
Cl69	2.9	0.1	1.3	14.7		
Cl70	'5.3	0.1				0.7
C171	7.0	0.2	3.9	3.9		
Cl72	6.0					7.0
C173	3.0	0.1			1.1	5.5
C175						
C218	1.7	0.2			1.7	4.6
C220	3.4	0.1			0.7	3.0
C222	3.5	0.2			2.5	3.5
C225	2.2	0.1	2.9	4.0		
C227	4.3	0.2			1.9	5.6
c229	4.5	0.2	2.2			
C229	7.1	2.3			1.7	4.8
C230	2.8	0.1	4.1	3.7		
C231	6.2					8.1
C237	2.7			5.9		
C238	1.3	0.1	2.9	3.3		
C239	4.3	1.0			1.9	1.9
C240	3.4			4.7		
C241	3.1	0.1	1.7	3.3		
C242	4.6			7.3		
C245	6.5	0.4	2.1	5.0		
C257	5.4	0.1			2.5	3.0
C261	4.9	1.2	3.1			
C263	3.2	0.1	0.8	3.5		
C266	2.9	0.1	1.4	1.8		
C267	2.2	0.1	3.7	3.6		
C268		0.2			6.4	6.3
C269	1.1	0.1	5.0	2.4		
C271	4.7	0.1			1.5	2.9

Appendix Table C.2.--Continued.

Serial number	Prosser Dam to Sunnyside Dam	Sunnyside Dam to Wapato Dam	Wapato Dam to Roza Dam	Roza Dam to Town Diversion Dan	Wapato Dam to Cowiche dam	Cowiche Dam to Wapatox Dam
c272	2.4	0.1	1.6	2.1		
c273	4.4	0.1	2.3	5.2		
c275	2.0	0.1				
C282	5.1			6.1		
C286	3.9			22.7		
C288	2.2	0.4	1.9	3.1		
C289	6.9					3.6
C290	4.9	0.2	5.6	2.2		
C292	3.7	0.2			2.0	5.7
C296	2.4	0.2	1.2	1.5		
C300						
C303	3.9	0.1		12.2		
C304	2.5	0.1			1.3	3.1
C306						
C309	5.9	0.1			0.5	9.4
c311	5.3	0.3			1.1	7.4
C314			1.6	0.7		

Appendix Table D.--Prespawning and spawning behavior, and habitat utilization, of radio-tagged spring chinook salmon in the Yakima River Basin, 1992.

Serial number	Days migrating	Holding dates	Prespawning behavior	Holding cover[b]	Holding habitat	Holding location River name	Holding location RKm	Spawning location River name	Spawning location RKm	Spawning dates
coo3	34	6/1-10/2	Stationary	dep/turb	Rapids	Cl. Elum River	8.0	Cle Elm River	8.0	8/11-10/2
C008	40	6/1-8/11	Stationary	ub	Riffle	Cle Elw River	11.0	Cle Elum River	12.9	8/11-9/8
co11	100	6/27-10/3	Stationary	ov	Riffle	Cle Elum River	9.7	Cle Elum River	9.7	
C014	51	6/19-8/25	Stationary	ov/ub	Riffle	Yakima River	299.7	Yakima River	209.7	8/25-9/25
C016	32	6/2-8/19	Stationary	wm/ub	Pool	American River	9.7	American River	9.7	8/4-8/19
C018	53	6/30-9/17	Stationary	ub	Riffle	Yakima River	280.1	Yakima River	288.1	
co22	40	6/3-9/8	Stationary	ov	Riffle	Cle Elum River	6.4	Cle Elum River	8.0	9/8-10/2
C023	34	6/3-8/27	Stationary	ov/ub/wm	Glide	Naches River	46.7	Rattlesnake Creek	1.6	e/27-9/17
C025	41	6/10-9/1	Stationary	dep	Glide	Bumping River	2.7	Bumping River	2.7	8/25-9/9
C026	59	7/16-8/5	Stationary			Yakima River	297.7	Yakima River	307.4	9/23
C027	86	7/24-9/15	Stationary	ub	Glide	Naches River	56.3	Naches River	69.2	8/25-9/15
co31	14	5/26-9/25	Stationary	ov	Riffle	Yakima River	294.4	Yakima River	294.4	8/25-9/25
C040	22	5/26-9/17	Stationary	ov/ub	Riffle	Yakima River	286.4	Yakima River	291.3	9/25
C042	41	6/9-9/21	Stationary	dep	Pool	Yakima River	323.5	Yakima River	323.5	9/21
co49	29	5/26-9/3	Stationary		Riffle	Yakima River	294.5	Yakima River	310.6	9/3-9/29
C052	37	6/3-9/17	Stationary	turb/dep/sub	Pool	Cle Elum River	12.9	Cle Elum River	12.9	
C058	22	5/29-8/11	Stationary	sub/turb	Rapids	American River	8.0	American River	10.1	8/11-8/22
C060	48	6/15-9/15	Stationary	dep	Pool	Yakima River	321.9	Yakima River	323.5	9/15-10/02
C063	19	6/3-10/1	Stationary	ov/ub	Riffle	Yakima River	289.7	Yakima River	190.0	9/25
C065	35	5/29-9/17	Stationary	ub	Glide	Naches River	54.7	Naches River	54.7	
C066	36	6/2-8/5	Stationary	ub/wm	Glide	American River	12.9	American River	14.5	8/5-8/11
co70	61	6/23-9/29	Stationary	wm	Riffle	Yakima River	317.q	Yakima River	317.0	
C080	35	5/18-9/15	Stationary	wm/ov/dep/ub	Riffle	Yakima River	315.4	Yakima River	323.5	9/21
C081	14	5/18-9/11	Stationary	wm/dep	Riffle	Yakima River	297.7	Yakima River	305.8	9/16-9/22
C085	20	5/18-9/16	Stationary	ub/ov	Glide	Yakima River	297.7	Yakima River	313.8	9/16
C088	79	7/24-9/3	Stationary	ub/ov	Riffle	Yakima River	288.1	Yakima River	304.2	9/17-9/22
co91	26	6/3-8/14	Stationary	turb/ub	Rapids	Cle Elum River	1.6	Yakima River	299.3	8/27-9/17

Appendix Table D , --Cont inued.

Serial number	Days migrating	Holding dates	&spawning behavior	Holding cover[b]	Holding habitat	Holding location River name	RKm	Spawning location River name	RKm	Spawning dates
C096			Gradual migration					Naches River	36.6	9/14
co91	20	6/1-8/9	Stationary			Rattlesnake Creek	3.2			
co99	47	6/9-9/17	Stationary	dep/turb	Riffle	Yakima River	320.3	Yakima River	320.2	
C100	35	5/29-8/14	Strtionrry	ov/ub	Glide	Bumping River	3.2	Bumping River	19.3	1126-W
C103	16	6/9-9/3	Stationary	dep/turb	Rapids	Yakima River	291.7	Yakima River	304.2	9/22-9/23
C105	43	6/3-9/28	Strtionrry	ub/wm	Riffle	Yakima River	254.3			
Cl11	34	6/3-9/14	Stationary	dep	Pool	Naches River	40.2	Naches River	39.4	9/14
Cl14	31	6/3-9/27	Stationary	ub/wm/ov	Riffle	Yakima River	289.7	Yakima River	289.7	9117
C117	22	5/29-8/26	Stationary	wm	Pool	American River	8.7	American River	9.0	8/19
C120	20	5/18-9/3	Stationary		Glide	Yakima River	297.7	Yakima River	304.2	9/21
C122	22	5/26-10/9	Stationary			Yakima River	272.0	Yakima River	272.0	
Cl24	24	5/18-9/25	Stationary	ub	Riffle	Yakima River	294.4	Yakima River	284.8	
C127	35	6/3-9/17	Stationary	wm	Riffle	Cle Elum River	3.2	Cle Elum River	3.2	9/17
C132	25	5/26-9/21	Strtionrry	ub/wm	Pool	Yakima River	315.4	Yakima River	313.4	9/21
C133	27	5/18-10/6	Strtionrry		Riffle	Naches River	27.4			
C140	25	6/9-9/16	Stationary	ov/ub/sub	Pool	Yakima River	312.2	Yakima River	312.2	9/16
Cl42	23	5/14-9/10	Stationary	sub/dep	Pool	Yakima River	325.1	Yakima River	323.5	9/15
C151	51	6/24-9/3	Stationery	sub/turb/ov	Riffle	Bumping River	3.2	Bumping River	3.2	8/25-9/1
C159	31	5/29-8/19	Stationary	wm/ub	Glide	American River	12.1	American River	12.9	a/19
C162	24	5/18-9/25	Stationary	ub/wm/ov	Riffle	Yakima River	216.4	Yakima River	246.4	9/25
C165	31	5/25-9/21	Stationary	wm/ov	Riffle	Yakima River	324.3	Yakima River	323.1	9/21
C166	59	7/24-9/17	Stationary			Yakima River	254.3			
C167	16	5/26-9/23	Stationary	ub	Riffle	Yakima River	297.1	Yakima River	299.3	9/23
C169	58	7/16-9/25	Stationary	ub/wm/ov	Riffle	Yakima River	288.1	Yakima River	294.5	9/25
C170	34	5/18-8/4	Stationary	turb/sub	Riffle	Naches River	61.2	Little Naches River	6.4	9/10
C171	55	6/30-9/3	stationary	turb/ov	Riffle	Yakima River	305.8	Yakima River	313,s	9/3-9/30
C172			Gradual migration					American River	4.6	911
C173			Gradual migration					Bumping River	16.0	9/9-9/17

Appendix Table D.--Continued.

Serial number	Days migrating[a]	Holding dates	Prespawning behavior	Holding cover[b]	Holding habitat	Holding location River name	Holding location RKm	Spawning location River name	Spawning location RKm	Spawning Dates
C218	32	5/29-8/19	stationary	ub/ov	Glide	American River	11.3	American River	11.3	8/4-8/11
C220			Gradual migration					Naches River	54.7	8/24-9/17
C222	34	5/26-9/23	stationary	sub	Rapids	Rattlesnake Creek	2.9	Rattlesnake Creek	3.2	8/27-9/17
c225	28	6/3-8/21	stationary	turb/sub	Rapids	Cle Elum River	6.4	Yakima River	300.9	9/3
C227	20	6/10-9/29	stationary		Pool	Naches River	53.1	Naches River	54.2	9/29
C228	34	6/3-9/17	stationary	turb/ub/ov	Riffle	Yakima River	229.3	Yakima River	229.3	9/17
C229			Gradual migration					Little Naches River	9.6	9/1
C230	45	6/19-8/26	stationary	sub	Rapids	Yakima River	209.7	Yakima River	229.3	8/27-9/3
c231	32	5/29-9/3	stationary	turb/sub	Riffle	Naches River	40.3	Rattlesnake Creek	0.0	9/17
C237	25	5/26-8/26	Stationary	turb	Riffle	Yakima River	296.1	Yakima River	309.0	9/16
C238			Gradual migration					Yakima River	305.0	8/25-9/10
c239	31	5/29-9/3	stationary	ov/ub/turb/sub	Riffle	Little Naches River	3.2	Little Naches River	3.2	9/25-9/1
C240	18	5/13-8/26	stationary	wm/ov	Riffle	Yakima River	297.7	Yakima River	323.5	9/17-9/21
C241	40	6/30-9/10	stationary			Yakima River	297.7	Yakima River	297.7	9/17
C242	27	5/26-9/21	stationary			Yakima River	321.9	Yakima River	321.9	9/21
C245	90	7/30-8/27	stationary	ov	Riffle	Yakima River	305.0			
C257	31	5/29-8/27	Stationary	ub	Pool	Rattlesnake Creek	4.0	Rattlesnake Creek	4.6	9/11
C261	10	5/9-9/2	stationary			Yakima River	202.8			
C263	46	6/9-8/20	stationary	wm/ov	Pool	Yakima River	317.0	Yakima River	323.5	9/14-9/17
C266	54	6/15-9/16	stationary	wm/ov	Pool	Yakima River	317.0	Yakima River	312.2	9/16
C267	22	5/26-9/10	stationary			Yakima River	320.7	Yakima River	323.5	9/15
C268			Gradual migration					Crow Creek	1.6	
C269	36	6/2-8/16	stationary	dep	Pool	Yakima River	325.1			
C271	31	5/29-8/14	stationary	ov	Riffle	American River	11.3	American River	11.3	8/4-8/21
C272	16	6/3-9/29	stationary	ub/ov	Riffle	Yakima River	310.6	Yakima River	315.4	9/10-9/27
c273	19	5/18-9/25	stationary	ov/ub/wm	Riffle	Yakima River	209.6	Yakima River	209.7	9/25
C282	35	6/3-9/25	Stationary		Riffle	Yakima River	209.6	Yakima River	209.6	8/11-9/25
C286	42	6/3-7/31	stationary			Yakima River	265.5	Yakima River	283.2	

Appendix Table D ,--Continued,

Serial number	Days migrating[a]	Holding dates	Prespawning behavior	Holding cover[b]	Holding habitat	Holding location. River name	RKm	Spawning location River name	RKm	Spanning Dates
C288	29	6/3-9/17	Stationary			YakimaRiver	296.4	Yakima River	294.5	9/17
C289	55	6/10-8/26	Stationary			American River	0.8	American River	0.8	
C290	21	6/3-8/14	Stationary		Riffle	YakimaRiver	266.4			
C292	42	6/10-8/4	stationary	ov/turb	Rapids	American River	3.2	AmericanRiver	4.8	8/4-9/1
C296	19	6/9-9/17	Stationary	ub/ov	Riffle	YakimaRiver	288.1			
C303	24	5/18-9/17	Stationary			Yakima River	268.8			
C304	23	6/3-9/9	Stationary	ov/turb/sub	Riffle	Bumping River	3.2	Bumping River	6.4	9/9
C309	31	6/3-9/28	stationary		Glide	Nachos River	48.3	NachesRiver	46.3	9/14
C311			Gradual migration					NachesRiver	69.2	9/1
C314	28	5/26-9/21	Stationary	ov	Riffle	Yakima River	323.5	Yakima River	323.5	9/21

[a] Days Migrating = travel tine from release to arrival at prespawning holding area.
[b] Holding Cover: dop = depth
ov = overhanging vegetation
rub = substrate
turb = turbulence
ub = undercut bank
wm. woody material

Appendix Table E.1.--Daily fish-ladder counts of spring chinook salmon passing Prosser Dam, Yakima River, 1991.

Date	Right Bank	Center	Left Bank	Denil	Total
13 Apr		1			1
14 Apr	1				1
15 Apr			1		1
16 Apr			1		1
17 Apr	2				2
18 Apr			1	1	2
19 Apr	1		1		2
20 Apr		1	2		3
21 Apr	1		5		6
22 Apr	2	1	4		7
23 Apr			8		8
24 Apr	1		6		7
25 Apr	1	3	7		11
26 Apr	1	8	8		17
27 Apr	1	7	9		17
28 Apr	3	10	16		29
29 Apr		5	15	1	21
30 Apr	4	6	21		31
01 May		12	11	1	24
02 May	2	8	32	1	43
03 May	3	17	36	1	57
04 May	7	6	27		40
05 May	8	18	32		58
06 May	2	14	40	1	57
07 May	6	18	36	9	69
08 May	2	12	10	3	27
09 May	3	19	24	1	47
10 May	3	41	66	2	112
11 May	2	32	84		118
12 May	4	22	59		85
13 May	1	20	75	2	98
14 May	1	25	81	1	108
15 May	1	20	36	8	65
16 May	3	18	50	1	72
17 May	7	32	88	1	128
18 May	10	37	73		120
19 May	2	47	56		105
20 May		24	60	5	89
21 May	2	28	85	2	117
22 May	1	32	92	4	129
23 May	1	29	65	8	103
24 May		13	53	5	71
25 May		11	35		46
26 May		11	16		27
27 May	3	19	15		37
28 May	2	7	18	2	29

Appendix Table E.1.--Continued.

Date	Right Bank	Center	Left Bank	Denil	Total
29 May	3	4	20	1	28
30 May	3	9	11	6	29
31 May	3	2	4	2	11
01 Jun	1	2	3		6
02 Jun	1	4	8		13
03 Jun	1	6	8		15
04 Jun		11	12	5	28
05 Jun	2	11	23	10	46
06 Jun		18	28	9	55
07 Jun	2	13	30	8	53
08 Jun	1	3	12		16
09 Jun		6	9		15
10 Jun		5	11		16
11 Jun	1	8	24		34
12 Jun	2	2	10		14
13 Jun	2	2	6	1	11
14 Jun	5	3	14		22
15 Jun	6	3	7		16
16 Jun	9	2	13		24
17 Jun	8	5	10		23
18 Jun	4	7	10	2	23
19 Jun	1	2	1		4
20 Jun	2	10		1	13
21 Jun		1	2	3	6
22 Jun					1
23 Jun			1		1
24 Jun			3		3
25 Jun			10	1	11
26 Jun		1	2		3
27 Jun	1	3	7		11
28 Jun		1	3		4
29 Jun		2	6		8
30 Jun			1		2
01 Jul			3		3
02 Jul			1		1
03 Jul		1	2		3
04 Jul	1		2		3
05 Jul					
06 Jul					
07 Jul					
08 Jul					
09 Jul					
10 Jul					
11 Jul					
12 Jul					
13 Jul					

Appendix Table E.l.--Continued.

Date	Right Bank	Center	Left Bank	Denil	Total
14 Jul					
15 Jul					
16 Jul			1		1
17 Jul					
18 Jul		1			1
19 Jul		1	4		5
20 Jul			2		2
21 Jul					
22 Jul					
23 Jul					
24 Jul					
25 Jul					
26 Jul					
27 Jul					
28 Jul					
29 Jul					
30 Jul					
31 Jul					
01 Aug					
02 Aug					
03 Aug					
04 Aug					
05 Aug					
06 Aug					
07 Aug					
08 Aug					
09 Aug					
10 Aug					
11 Aug					
12 Aug		1			1
13 Aug					
14 Aug					
15 Aug					
16 Aug					
17 Aug					
18 Aug					
19 Aug					
20 Aug					
21 Aug					
22 Aug					
Total	154	785	1,785	110	2,834

Appendix Table E.2.--Daily fish-ladder counts of spring chinook salmon passing Prosser Dam, Yakima River, 1992.

Date	Right Bank	Center	Left Bank	Denil	Total
29 Mar	1				2
30 Mar					
31 Mar					
01 Apr					
02 Apr					
03 Apr					
04 Apr					3
05 Apr		1			1
06 Apr					
07 Apr		5			5
08 Apr		4			4
09 Apr	5	2			8
10 Apr	3	6			9
11 Apr	8	3			12
12 Apr	9	8	3		20
13 Apr	10	13	5	1	29
14 Apr	22	11	10	1	44
15 Apr	23	20	6		49
16 Apr	29	7	11	2	49
17 Apr	16	9			26
18 Apr	34	13	3		50
19 Apr	62	15	8		85
20 Apr	16	2	4		22
21 Apr	12	8	4	5	29
22 Apr	89	37	8	2	136
23 Apr	75	34	36	2	147
24 Apr	43	19	36	9	107
25 Apr	55	24	29		108
26 Apr	95	56	40		191
27 Apr	89	38	48	10	185
28 Apr	58	20	40	10	128
29 Apr	83	14	37	8	142
30 Apr	96	28	33		164
01 May	80	54	23	7	164
02 May	18	15	11		44
03 May	67	37	13		117
04 May	107	25	32		169
05 May	81	17	27		128
06 May	32	16	35		86
07 May	45	32	56		136
08 May	129	50	79		262
09 May	39	23	24		86
10 May	16	3	10		29
11 May	18	16	57		94
12 May	87	37	85		212
13 May	74	22	65		163

Appendix Table E.2.--Continued.

Date	Right Bank	Center	Left Bank	Denil	Total
14 May	48	21	36	1	106
15 May	23	8	46	2	79
16 May	23	20	48		91
17 May	20	19	51		90
18 May	23	11	32	2	68
19 May	32	15	35	2	84
20 May	7	6	29		42
21 May	5	2	7		14
22 May	11	9	25		45
23 May	8	4	12		24
24 May	6	3	27		36
25 May	6	6	11		23
26 May	6	5	4		15
27 May		1			2
28 May		1	2		3
29 May	2		5		8
30 May		1	9		10
31 May		1	10		11
01 Jun			4		4
02 Jun		1			1
03 Jun					
04 Jun					
05 Jun	4		1		5
06 Jun	2		4		6
07 Jun			2		2
08 Jun			3		3
09 Jun			1		
10 Jun			2		2
11 Jun			2		2
12 Jun			4		4
13 Jun	6		15		21
14 Jun	38		25		63
15 Jun	6		10		16
16 Jun	6		3		9
17 Jun	2		1		3
18 Jun	1				1
19 Jun			4		4
20 Jun			1		
21 Jun					
22 Jun					
23 Jun					
24 Jun					
25 Jun					
26 Jun					
27 Jun					
28 Jun					
29 Jun					

Appendix Table E.2.--Continued.

Date	Right Bank	Center	Left Bank	Denil	Total
30 Jun					
01 Jul					
02 Jul					
03 Jul					
04 Jul					1
05 Jul					
06 Jul					
07 Jul	3				3
08 Jul	2				2
09 Jul					1
10 Jul					
11 Jul					
12 Jul					
13 Jul	1				
14 Jul					
15 Jul					
16 Jul					
17 Jul					1
18 Jul					
19 Jul					
20 Jul					
21 Jul					
22 Jul					
23 Jul					
24 Jul					
25 Jul					3
26 Jul					
27 Jul					
28 Jul					
29 Jul					
07 Aug					
31 Jul					
01 Aug					
02 Aug					
03 Aug					
04 Aug					
05 Aug					
06 Aug					
07 Aug					
08 Aug			1		1
09 Aug					
10 Aug		1	3		4
11 Aug		1			1
12 Aug		1			1
Total	2,022	1,087	1,361	98	4,568

Appendix Table F.l.--Denil operation at Prosser Dam to collect spring chinook salmon, 1991.

Date	Start time	stop time	Total time (hours)	Date	Start time	stop time	Total time (hours)
29 Apr	05:30	14:oo	6.5	29 nay	05:00	19:oo	17.0
30 Apr	05:15	14:oo	a.0	30 May	05:00	19:oo	17.0
01 nay	00:30	16:30	16.0	31 May	05:00	19:oo	17.0
02 May	00:30	15:00	14.5	01 Jun			
03 May	00:30	08:00	7.5	02 Jun			
04 nay				03 Jun	05:00	19:oo	17.0
05 May				04 J""	07:00	18:30	11.5
06 May	00:30	16:00	15.5	05 Jun	05:00	20:oo	16.0
07 nay	00:15	16:00	15.6	06 Jun	05:00	20:oo	16.0
08 May	00:30	14:oo	13.5	07 Jun	05:30	20:00	17.5
09 nay	05:00	20:oo	15.0	08 Jun			
10 May	04:00	20:oo	16.0	09 Jun			
11 nay				10 Jun	05:00	20:oo	16.0
12 nay				11 Jun	05:00	18:00	16.0
13 nay	05:00	19:oo	12.0	12 Jun	05:00	12:oo	7.0
14 nay	05:00	19:oo	12.0	13 Jun	05:00	11:30	6.5
15 nay	05:00	20:oo	15.0	14 Jun			
16 May	05:00	19:oo	12.0	15 Jun			
17 May	05:00	16:00	11.0	16 Jun			
19 nay				17 Jun	05:00	11:oo	6.0
19 nay				18 Jun	05:00	11:oo	6.0
20 nay	05:00	16:00	11.0	19 Jun	05:00	12:oo	7.0
21 nay	13:30	19:oo	5.5	20 Jun	05:00	12:oo	7.0
22 nay	07:00	19:oo	12.0	21 Jun	05:00	14:00	9.0
23 nay				22 Jun			
24 May	05:30	15:00	9.5	23 Jun			
25 nay				24 Jun	05:00	12:oo	7.0
26 May				25 Jun	05:00	12:oo	7.0
27 Way				26 Jun	05:00	12:30	7.5
26 May	05:00	19:oo	17.0	27 Jun	05:30	12:oo	6.5

Appendix Table F.2.--Denil operation at Prosser Dam to collect spring chinook salmon, 1992. ,

Date	Start Time 1	stop Time 1	Start Time 2	stop Time 2	Total time (hours)
13 Apr	07:17	13:oo			5.7
14 Apr	07:35	10:30			2.9
15 Apr	08:00	13:00			5.0
16 Apr	08:30	12:45			4.2
17 Apr	07:30	15:00			7.5
20 Apr	07:05	12:30			5.4
21 Apr	06:00	18:00			12.0
22 Apr	06100	15:35			9.6
23 Apr	06:00	11:30			5.5
24 Apr	06:05	08:10	12:10	17:oo	6.9
27 Apr	06:00	08:45	10:55	12:30	4.3
28 Apr	06:00	09:52			3.9
29 Apr	06:15	15:25			9.2
30 Apr	06:00	09:23			3.4
01 May	06:05	09:47			3.7
04 nay	06:07	07:12			2.1
05 nay	11:30	12:55			1.4
06 May	09:05	14:05			5.0
07 May	09100	12:30			3.5
08 May	10:45	16:05			5.3
11 May	09:03	09:58			0.9
12 May	09:30	11:21			1.9
13 May	09:25	09:42			0.3
14 May	09:30	15:oo			5.5
15 May	10:40	13:08			2.5
18 nay	08:57	lo:oo			1.0
19 nay	09:18	11:50			2.6
21 nay	09:12	12:15			3.0
22 nay	09:20	12:20			3.0
26 May	11:07	14:35			3.5
26 May	04:47	10:15			5.5
02 Jun	01:50	06:40			4.0
03 Jun	10:11	13:27			2.3