ESCAPEMENT MONITORING OF SOME NATURALLY SPAWNING COLUMBIA RIVER BASIN CHINOOK SALMON STOCKS, 1987

Technical Report 89-5

Alex L. Heindl
Roy E. Beaty

December 1989

YAKIMA NEZ PERCE WARM SPRINGS UMATILLA

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
975 S.E. Sandy, #202, Portland, OR 97214, (503) 238-0667

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ACKNOWLEDGEMENTS

This report, and much of the work it describes, was funded by U.S. Government (Bureau of Indian Affairs, Department of the Interior) Contract Number P00C1409445 for implementation of the United States-Canada Pacific Salmon Treaty of 1985, Public Law 99-5. It was compiled from reports submitted to the Columbia River Inter-Tribal Fish Commission (CRITFC) by the tribal and agency biologists who conducted the field studies. Portions of the text and several tables and figures were taken intact or adapted from material contained within those reports.

Phillip B. Roger, Phillip R. Mundy, Alex L. Heindl, and Roy E. Beaty of the CRITFC staff provided project planning and liaison. Matthew Schwartzberg, CRITFC, provided sound critical comments on the draft manuscript; CRITFC's Public Information Office provided editorial review; and administrative staff typed sections of this report. However, it is the tribal and agency personnel to whom credit is mainly due. Noted below are the primary biologists who planned, conducted, and reported the field work; it is their efforts that are reflected here. We acknowledge: **Don Sampson**, Senior Fisheries Scientist, Confederated Tribes of the Umatilla Indian Reservation (Grande Ronde, Imnaha, and John Day river spring chinook); **Paul A. Kucera**, Acting Director, Department of Fisheries Management, Nez Perce Tribe (Salmon River spring chinook); **Patrick K. Murphy**, Habitat Management Biologist, Department of Fisheries Management, Nez Perce Tribe (Selway River spring chinook); **Dr. David E. Fast**, Fisheries Research Director, Yakima Indian Nation (Yakima and Wenatchee river spring chinook and Wenatchee River summer chinook); **Terry A. Luther**, Fish and Wildlife Biologist, and **Mark Fritsch**, Fishery Biologist, Department of Natural Resources, Confederated Tribes of the Warm Springs Reservation of Oregon (Deschutes River fall chinook); and **Brian C. Jonasson**, Fisheries Research Biologist, Oregon Department of Fish and Wildlife (Deschutes River fall chinook).

Considerable thanks are also owed to the numerous other biologists and technicians who worked alongside them.

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SUMMARY

As part of ongoing efforts to implement the 1985 United States-Canada Pacific Salmon Treaty, the four tribes[1] of the Columbia River Inter-Tribal Fish Commission (CRITFC) in 1987 monitored nine substocks of naturally reproducing upper Columbia River chinook salmon (Oncorhynchus tshawytscha) for purposes of estimating their spawning escapements. Monitoring was done in eight Columbia River tributary systems in Idaho, Oregon, and Washington.

The Pacific Salmon Commission's Chinook Technical Committee (CTC) has identified naturally reproducing upriver spring, summer, and fall chinook (races recognized by Columbia River fishery managers) as "indicator" stocks, or groups of fish that may reflect the success or failure of treaty-mandated efforts to rebuild Columbia River fisheries (CTC 1987). Fish populations monitored during the projects described here are representative components of those indicator stocks.

Various types of foot surveys were used to index spring and summer chinook escapements and spawning success. Live fish, redds (spawning nests), and spawner carcasses were enumerated during one or more surveys of each inventoried area. While we attempted to obtain a total redd count as our escapement index, in some areas this was not possible. Where it was not, we timed our surveys to occur at or near the peak of spawning activity to collect as near a total count as possible under the circumstances. Fall chinook escapement was estimated via mark-recapture (Ricker 1975). A portion of the upstream migration was tagged below the spawning grounds and tags were subsequently collected during spawner carcass recovery operations conducted from boats.

The general results of the 1987 efforts are summarized below.

SPRING CHINOOK

Grande Ronde River

We surveyed 13 Grande Ronde Basin streams. Total redds counted in all streams during the assumed peak of spawning (531) were 64% more numerous than in 1986, and approximately twice recent 5- and 10-year averages. Lookingglass Hatchery, a spring chinook production facility located on Lookingglass Creek (a Grande Ronde tributary), removed broodstock from the Creek in the early 1980s and outplanted 1,498 excess spawners to three Grande Ronde Basin streams in 1987. Juveniles from non-native

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[1]Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes of the Warm Springs Reservation of Oregon, the Nez Perce Tribe, and the Confederated Tribes and Bands of the Yakima Indian Nation.

broodstock were also outplanted in the system from the Lookingglass and Carson National fish hatcheries between 1982 and 1985 (0.1-1.0 million per year).

Imnaha River

Three Imnaha River Basin streams were surveyed. At peak spawning, their combined redd counts (115) were only 63% of 1986 results and similarly less than recent 5- and 10-year average counts. Broodstock for Lookingglass Hatchery has been trapped on the Imnaha since 1982, but the same number of spawners (340) was removed in 1986 and 1987. Yearling fish from Lookingglass Hatchery were released into the Imnaha Basin in 1984 (85,400), 1985 (59,600), and 1986 (35,300). Some summer chinook redds may have inadvertently been included in Imnaha spring chinook spawning counts in 1987.

John Day River

The Oregon Department of Fish and Wildlife manages John Day spring chinook as a wild run -- no hatchery supplementation is now permitted. The combined redd count (1,109) from seven Basin areas in 1987 was 67% higher than in 1986, but one surveyed area had been substantially enlarged since 1986. Redd counts in 1987 were nearly three times higher than recent 5- and 10-year averages.

Salmon River

We conducted multiple surveys in Big Creek, Johnson Creek, and the Secesh River subsystems of the Salmon River system. Redds were scarce in Big Creek (53), even below 1986 levels in some areas. Fifty-nine redds were found in Johnson Creek, and 113 were located in the Secesh system. Differences in counting methodology make it difficult to directly compare our 1986 and 1987 counts to those conducted here prior to 1986 by the Idaho Department of Fish and Game (IDFG). The later spawn-timing of chinook in lower Big Creek has led some observers to classify these fish as a summer run, but all Big Creek chinook were considered part of the spring run during our surveys.

Selway River

We completed multiple surveys of four upper mainstem Selway areas and Bear Creek, a lower river tributary. The redd count was very low (39), even less than in 1986. Historical escapement data for this system consists primarily of one-time aerial counts by IDFG. But as demonstrated by the different results achieved by conducting both ground and aerial surveys of common areas in 1987, the one-time aerial surveys are probably less accurate than and not comparable to the multiple counts conducted on the ground in 1986 and 1987 by the Nez Perce Tribe.

Wenatchee River

We conducted multiple surveys for the first time on four upper Basin tributaries in 1987, but our results (569 redds) are difficult to compare to the single-pass counts made in five streams by a host of agencies between the early 1950s and 1986. Washington Department of Fisheries (WDF) counts from 1976-86 peaked in 1985 (673 redds), then declined by 44% in 1986. Additional multiple survey data will have to be collected before trends in escapement can be clearly established.

Yakima River

Comprehensive multiple surveys were conducted throughout the Basin in 1987 as they have been since 1981. Counts from 1981-87 peaked in 1986 (3,106) at a level four to six times higher than counts in 1981-83, then declined to 1,740 in 1987. Although size of spawners is similar throughout the Yakima Basin, significantly earlier (about one month) peak spawning in part of the American River (Naches River subsystem) suggests that American River fish may be genetically distinct from others in the Yakima system.

SUMMER CHINOOK

Wenatchee River

We surveyed the lower 58 km of the mainstem Wenatchee on three occasions, locating a total of 2,955 redds. Historical counts by WDF and the Chelan Public Utility District (PUD) are single-pass efforts made during the peak of spawning and are, therefore, not directly comparable to our 1987 counts (1987 PUD count was 2,052). PUD redd counts, which since 1974 have closely paralleled escapement expectations based on mainstem Columbia River dam counts, were higher in 1987 than in any year since 1976, although their 1980 count was of similar magnitude. PUD counts from 1981-86 averaged 1,196.

FALL CHINOOK

Deschutes River

Since 1977, Deschutes River run size estimates have been calculated by summing statistically-based harvest and escapement estimates. Deschutes fisheries are sampled with a modified, two-stage, stratified random creel census, and the escapement estimate is based on mark-recapture techniques applied to the run above Sherars Falls, which is the trapping and tagging point. Although the estimated 1987 jack (precocious male fish) run (1,184) was the lowest in 11 years, the estimated adult run (3,201) was the highest since 1982 and the third highest in 11 years.

INTRODUCTION

A principal goal of the 1985 Pacific Salmon Treaty (PST) between the United States and Canada is to increase salmon production through conservation and enhancement (PST 1985). Toward this end, both countries are presently investigating the status and productivity of fish species of common concern, including chinook salmon (Oncorhynchus tshawytscha) originating in the Columbia River system. Columbia River chinook contribute to ocean fisheries from northern California to British Columbia and Alaska (Howell et al. 1985), and escapements of many of the system's discrete groups or "stocks" have declined in recent years (Howell et al. 1985, PST 1985). This document reports the results of 1987 efforts to monitor escapement of nine naturally spawning mid- and upper- Columbia River chinook stock components.

Basin Description

The Columbia River drains 671,000 km^2 of land, including large areas of Idaho, Oregon, Washington, and British Columbia, and smaller sections of Montana, Nevada, Utah, and Wyoming (HoR 1938). About 90% of the Columbia basin is upstream of Bonneville Dam, which, at river kilometer (RKm) 235, is the farthest downstream of the Columbia mainstem impoundments (Figure 1, Chaney 1978). From Columbia Lake in British Columbia, the river traces a serpentine but generally southwesterly route of about 1,960 km to enter the Pacific Ocean between the states of Oregon and Washington. The longest of the Columbia's numerous major tributaries, the Snake River, rises in Wyoming and flows through southern Idaho and southeastern Washington before joining the Columbia at RKm 523.

The Columbia system has been extensively dammed to produce hydropower and provide other regional developments. The upstream passage of migrating fish is blocked at Chief Joseph Dam (RKm 877) on the Columbia, and Hells Canyon Dam (RKm 396 above the Columbia/Snake confluence) on the Snake (Figure 1). The passable dams below Chief Joseph and Hells Canyon are equipped with fish ladders to facilitate upstream movement by adult salmon; various means (with widely ranging effectiveness) are employed to bypass downstream migrating juvenile fish around dam turbines (Table 1) (Figure 2). Adult and juvenile chinook monitored under PST programs must contend with up to eight mainstem dams during their migration.

Regulated total river discharges measured at Bonneville Dam from 1983 to 1987 averaged 5,430 m^3/s [191.8 thousand cubic feet per second (kcfs)] with a minimum of 2,250 m^3/s (79.4 kcfs) during July 1985, and a maximum of 11,560 m^3/s (408.2 kcfs) during June 1983.

Lowest average monthly flows occurred from July through October; highest flows occurred from March through June (Dave

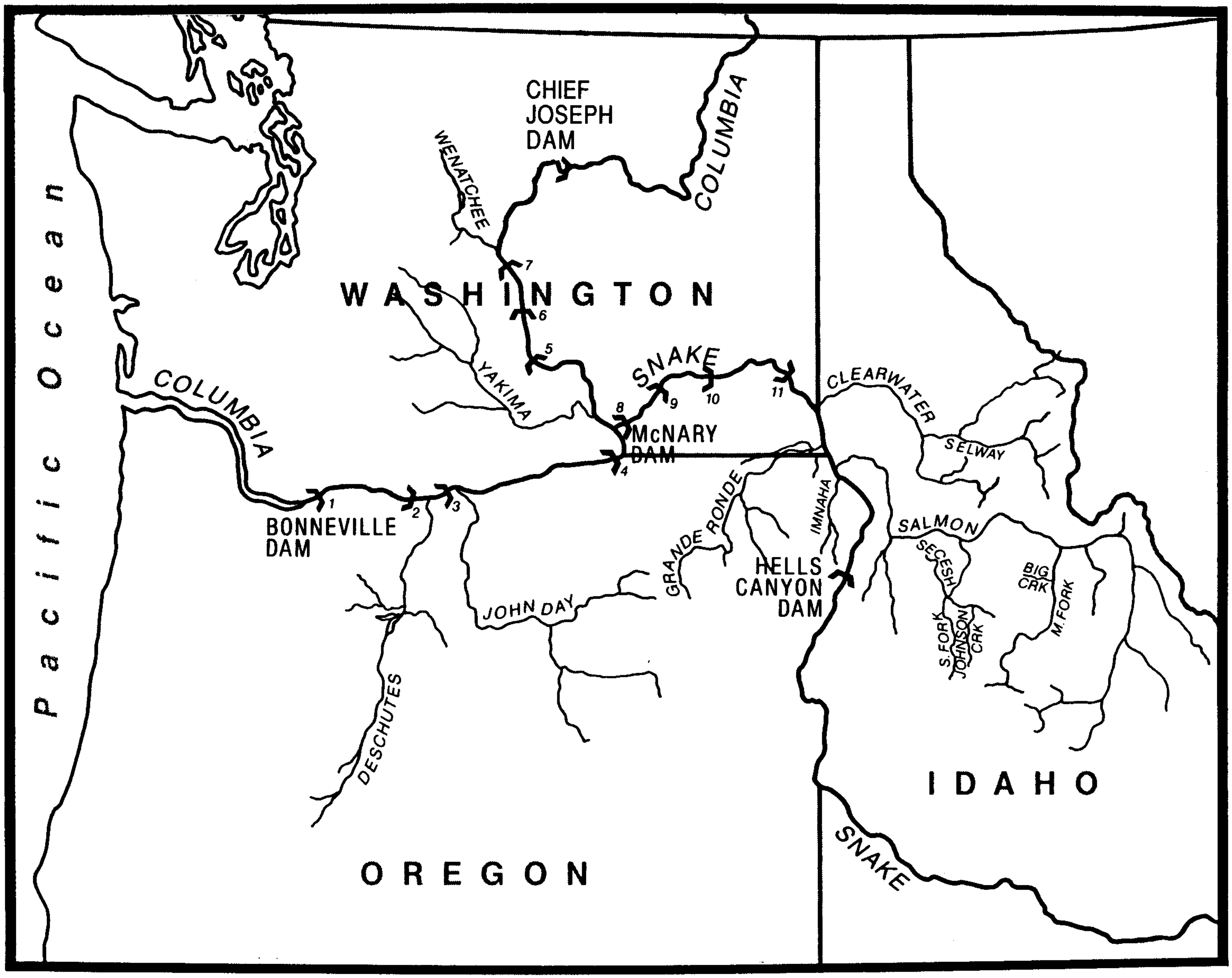

Figure 1. Columbia River tributary streams monitored for escapement of naturally reproducing chinook stock components, and Columbia and Snake river dams affecting upstream and downstream fish migration.

Marvin, Fish Passage Center, Portland, Oregon, personal communication).

Description of Fish Runs

Columbia River fishery managers recognize **spring**, **summer**, and **fall** chinook races or "runs," distinguishing them by time of spawning migration (Howell et al. 1985, Schreck et al. 1986, NPPC 1987). Runs bound for the middle and upper Columbia Basin tributaries are initially counted at Bonneville. Spring chinook pass the project from March through May with a peak occurring between the middle and end of April. Summer chinook pass during June and July; the fall run typically crosses from late August through September, with peak passage in early to mid-September [unpublished 10-year run summaries compiled by Columbia River Inter-Tribal Fish Commission (CRITFC) from U.S. Army Corps of Engineers (CoE) daily fish counts].

The Pacific Salmon Commission's Chinook Technical Team (CTC) has labeled these fish as "indicator" stocks because they are believed capable of reflecting results of treaty implementation through changes in their escapements (CTC 1987). In 1987, CRITFC coordinated the efforts of biologists from five organizations to estimate the escapement of nine representative stock components to eight Columbia subbasins above Bonneville Dam. The organizations, stocks, and areas surveyed are listed in Table 2.

Survey Methodologies

In past years stock abundance has typically been estimated through use of "peak index surveys," annual inspections of selected or "index" areas within the spawning grounds at the assumed time of peak spawning. Consequently, peak counts of spawning nests or "redds" are commonly the best available measure of historical escapement levels, and they continue to form the basis of much contemporary monitoring. For our projects, however, more precise measurements were desired. Where we employed redd counts, we used a multiple survey approach in most instances, surveying all known or suspected spawning areas at about weekly intervals throughout the spawning season. This strategy permitted us to collect a more complete redd count than was possible with just a single survey; it also provided spawn-timing information and increased opportunity to examine spawner carcasses and collect bio-samples. However, on those streams, where virtually all spawning is believed to occur within traditionally recognized index areas, we employed "multiple index surveys," repeatedly counting all redds within the index until spawning ceased. In systems for which good spawn-timing information was already available, and in some where manpower or time constraints permitted only a single survey of the recognized index area, only one survey was made -- a "single index survey." When a single index survey was employed, it was timed to occur during or just after the period of peak spawning. Finally, to substantiate our assumption that most spawning occurred within index areas, we also surveyed spawning habitat adjacent to some

Table 1. Mainstem Columbia and Snake river dams affecting Pacific Salmon Treaty chinook indicator stocks.

Project	Owner/ Operator	Purpose	Juv. Bypass Facilities[a]
Bonneville (1)[b]	US Army Corps of Engineers (CoE)	1-4	1,2,4,6,8
The Dalles (2)	CoE	1-4	4,5
John Day (3)	CoE	1-4	1,2,4,8
McNary (4)	CoE	1-4	1-4,8[c]
Priest Rapids (5)	Grant County Public Utility Dist. (PUD)	1,2,4	4,7
Wanapum (6)	Grant PUD	1,2,4	4
Rock Island (7)	Chelan PUD	1,2,4	2,4
Ice Harbor (8)	CoE	1-4	4,5
Lower Monumental (9)	CoE	1-4	2,4
Little Goose (10)	CoE	1-4	1-4,8[c]
Lower Granite (11)	CoE	1-4	1-4,8[c]

[a] Listed facilities function with varying effectiveness. Most are either being upgraded or are under consideration for redesign and expansion.

[b] Project number on Figure 1 (page 2).

[c] CoE Fish Transportation Program collector project.

Purpose Key:
1. Hydropower generation
2. Flood control
3. Slack water navigation
4. Irrigation storage

Bypass Facility Key:
1. Submersible traveling screens
2. Gatewell orifices and fish collection channel
3. Juvenile fish collection system[b]
4. Spill
5. Gatewell orifices and ice-trash sluiceway
6. Special powerhouse operation criteria
7. Gatewell dipping
8. Juvenile fish sampling capability

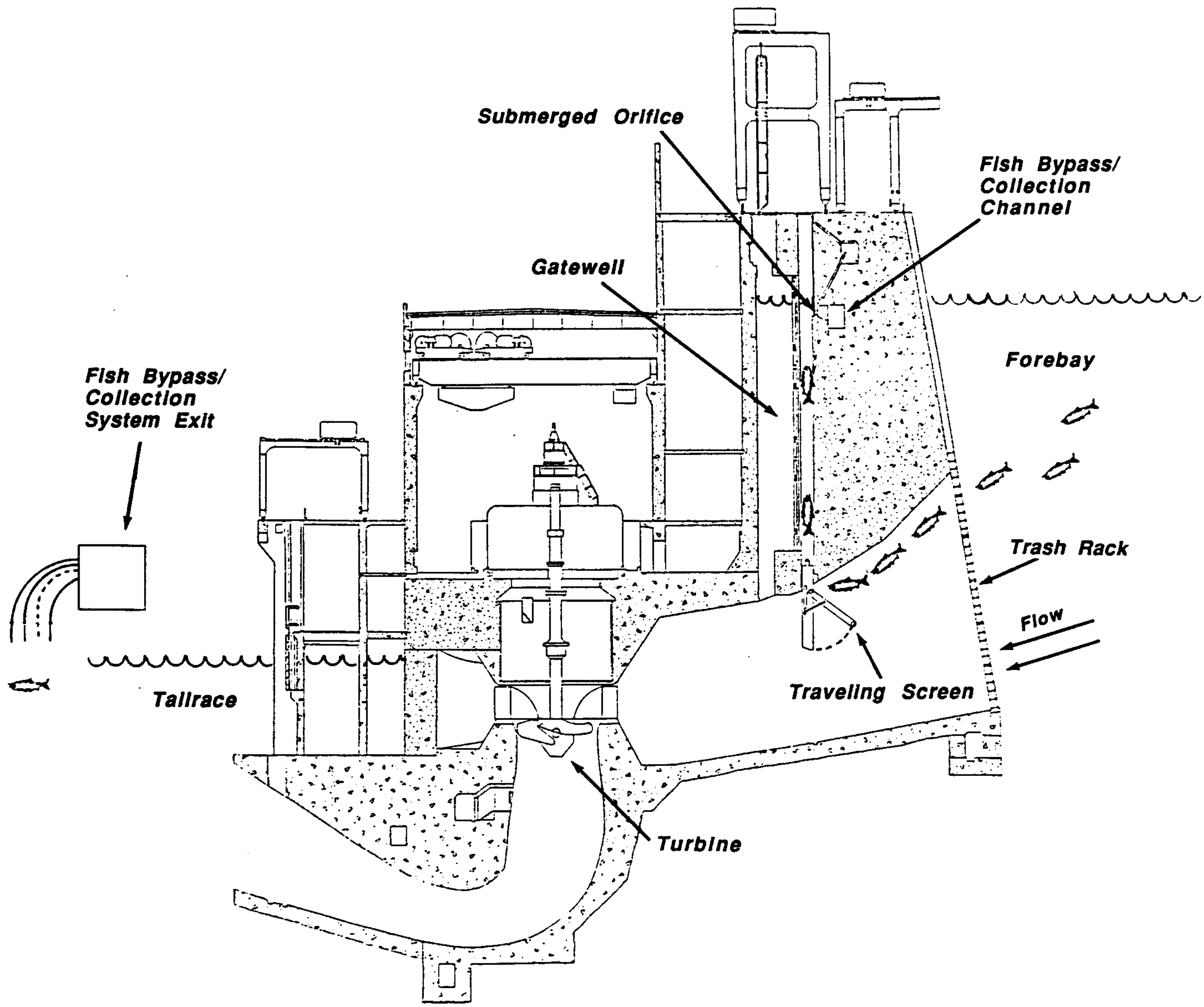

Figure 2. Traveling screen-based juvenile fish bypass system typical of some Columbia and Snake river mainstem dams (Adapted from Koski et al. 1986).

Table 2. Columbia River chinook runs, indicator stock components and locations, and organizations active in PST escapement monitoring efforts coordinated by CRITFC, 1987.

Run	Stock (by stream)	Location	Monitoring Organization(s)
Spring	Grande Ronde	NE Oregon	CTUIR[a/], ODFW[b/], NPT[c/]
Spring	Imnaha	NE Oregon	CTUIR, ODFW, NPT
Spring	John Day	N Central-NE Oregon	CTUIR, ODFW
Spring	Salmon	Central Idaho	NPT
Spring	Selway	N Idaho	NPT
Spring	Wenatchee	Central Washington	YIN[d/]
Spring	Yakima	S Central Washington	YIN
Summer	Wenatchee	Central Washington	YIN
Fall	Deschutes	N Central Oregon	ODFW, CTWS[e/]

a/ Confederated Tribes of the Umatilla Indian Reservation.

b/ Oregon Department of Fish and Wildlife.

c/ Nez Perce Tribe.

d/ Confederated Tribes and Bands of the Yakima Indian Nation.

e/ Confederated Tribes of the Warm Springs Reservation of Oregon.

index areas. These surveys are referred to as "extended area surveys."

While redd counting was the most commonly used monitoring method in 1987, surveyors were also instructed to seek and note locations in the stream system(s) being surveyed where other, potentially more precise, escapement estimation techniques (e.g., weir counts, sonar counts, mark-recapture, etc.) might be employed in future years. Pre-existing fish trapping facilities at a site on Oregon's Deschutes River did allow us to estimate escapement of our lone fall chinook stock component via mark-recapture.

Although at this point in the program we are not able to provide statistically bounded escapement estimates for other than the fall chinook population, and must rely on redd counts as our primary escapement index, we plan to investigate using other, more statistically defensible, methods. It must be recognized, however, that given current technology and existing constraints on permissible activity in some inventory areas (e.g., those wholly or partly within congressionally designated wilderness), redd counting may be the only practical assessment method available. In areas where escapement is recognized to be low or where detailed information about escapement into a particular subdrainage is desired, periodic foot surveys emphasizing redd counting may also be the most cost-effective technique by which to assess changes in fish populations. The same may be true in areas where the adult migration is protracted, as is often the case with spring and summer chinook. Whatever the eventual method, developing a reliable, cost-effective counting process is a priority.

SPRING CHINOOK

GRANDE RONDE RIVER
(Snake River Subbasin)

DESCRIPTION OF STUDY AREA AND STOCK

The Grande Ronde River system drains 10,540 km^2 of northeastern Oregon and southeastern Washington and enters the Snake River at RKm 272 (Figure 3). Spring chinook spawn in approximately 160 km of the system's streams from about mid-August to late-September, with peak activity occurring around the first two weeks of September. Outplants of hatchery-reared spring chinook juveniles were initiated here in 1982 (Table 3). In 1987, adult returns in excess of the 1,500 needed to fulfill facility spawning requirements to Lookingglass Hatchery were also outplanted.

Table 3. Releases of hatchery-reared spring chinook in the Grande Ronde Basin, 1982-85. [Source: R. W. Carmichael, Oregon Department of Fish and Wildlife (ODFW), La Grande, personal communication.]

			Release		
Brood Year	Stock	Hatchery of Rearing	Number (1000's)	Date	Size (no./lb)
1980	Carson	Carson	100.0	4/82	20.0
1982	Carson	Carson	101.9	4/84	16.7
1983	Carson	Lookingglass	502.6	5/84-7/84	85.5-148.0
1983	Carson	Lookingglass	382.5	6/84	187.5
1983	Carson	Carson	100.4	4/85	18.2-20.2

METHODS

ODFW has surveyed the Grande Ronde since 1960, and biologists of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) have participated in the surveys since 1986. Thirteen streams in the system contain index areas that have been used since 1976 (Schwartzberg and Roger 1986).

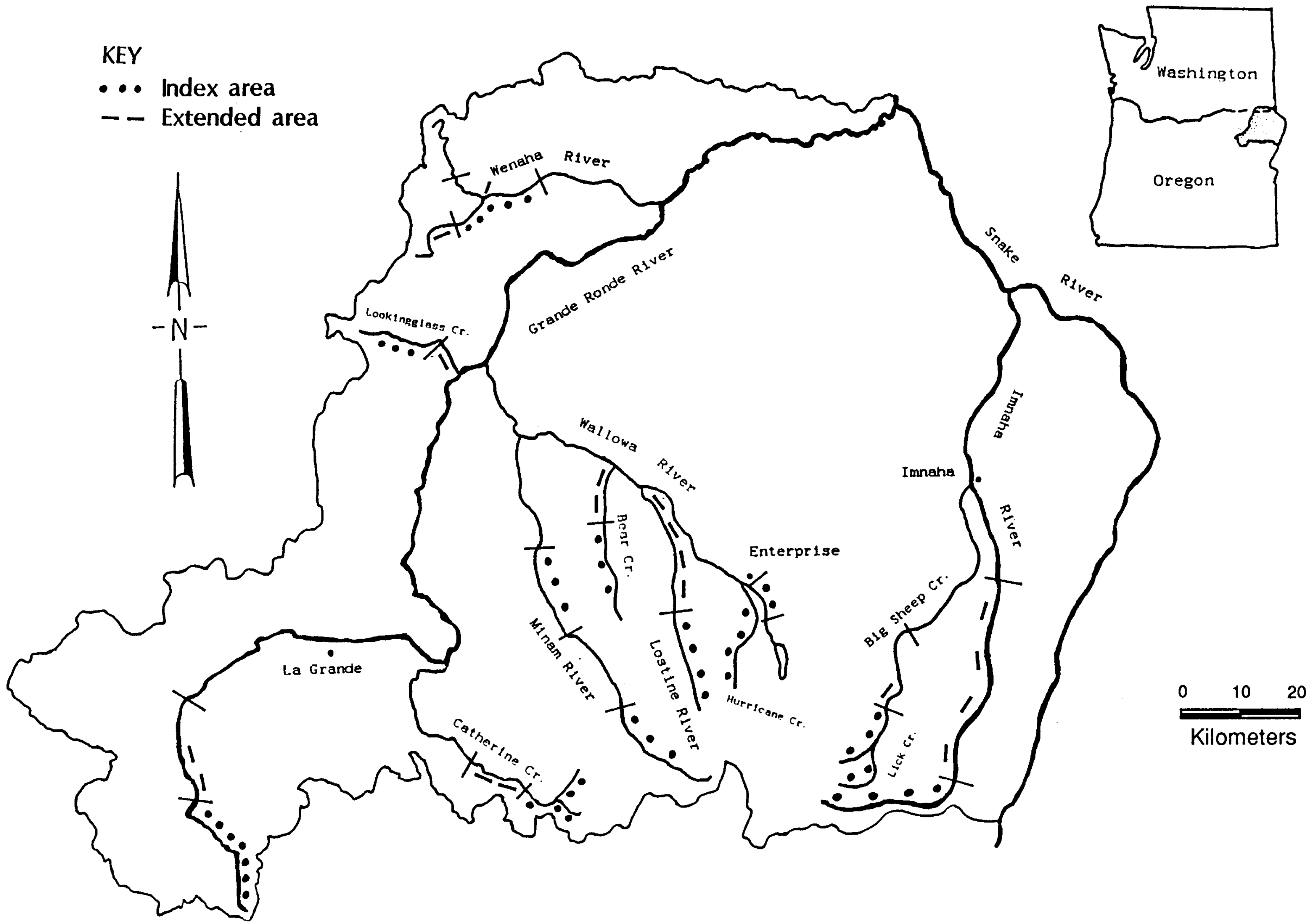

Figure 3. Grande Ronde and Imnaha river basins, Oregon.

In 1987, index areas of four streams (Grande Ronde River, Lostine River, Catherine Creek, and Hurricane Creek) were surveyed three times and the lower Minam River was surveyed twice. Where these multiple index surveys occurred, one was scheduled, based on ODFW data from previous years to coincide with historic peak spawning. The additional surveys were conducted within two weeks before and after the peak survey, except in the Minam River where the second survey was completed about four weeks after the first. The same two persons surveyed a given index area on all occasions and enumerated redds, live fish, and carcasses. Redd locations were marked with dated flagging and noted as being occupied or unoccupied by spawners. Sex of live fish was recorded when discernible; carcasses were sampled for length, age, sex, and marks (Heindl 1987).

Extended surveys, covering all known spawning habitat outside the index area (based on past ODFW observations), were conducted once during the year on five streams, some of which also received multiple index surveys (Table 4). Scheduled to coincide with peak spawning, extended surveys were done in an attempt to establish the relationship between spawning activity levels inside index areas and elsewhere in the stream. The same methods used in index areas were applied on extended surveys, except that redds were not flagged (unnecessary in one-time surveys) and a lone surveyor was often employed.

Table 4. Grande Ronde Basin streams and survey(s), 1987.

Stream	Single Index Without Extended	Single Index With Extended	Multiple Index Without Extended	Multiple Index With Extended
Grande Ronde River				*
Wenaha River		*		
Lookingglass Cr.	*			
Wallowa River	*			
Lower Minam River	*			
Upper Minam River			*	
Catherine Cr.				*
N. Fk. Catherine	*			
S. Fk. Catherine	*			
Sheep Cr.		*		
Bear Cr.	*			
Lostine River				*
Hurricane Cr.			*	

Index areas in the eight streams not subjected to multiple surveys were surveyed only once, at approximately the time of peak spawning.

RESULTS

Reconnaissance surveys from August 6 to August 10 familiarized personnel with survey areas in the upper Grande Ronde (above Starkey) and Wenaha rivers, and Catherine Creek. Many live fish were seen during this time but spawning was observed only in the Wenaha. Reconnaissance survey data are not reported.

Total index area redds in 1987 (531) were 64% more numerous than in 1986 (323). Although counts in both years are generally higher than recent five- and ten-year averages (Table 5), small declines from 1986 levels were seen in the 1987 Wenaha and upper Minam counts and a substantial decrease occurred in North Catherine Creek.

Index areas accounted for 19-66% of the total (index plus extended) stream area surveyed. Within the five streams subjected to extended surveys, original index areas in all but the Wenaha River contained the majority of observed redds (Table 6). In the five streams where multiple index surveys were undertaken, an average of 80% (range: 64-92%) of all observed redds was counted by the second (peak) survey (Table 7).

DISCUSSION

Some of the reported increases in redd counts may be attributable to outplants in 1987 of excess Lookingglass Hatchery spawners. A total of 1,498 adults from that facility were released in the upper Grande Ronde River (498), in Wallowa River (300), and in Catherine Creek (700). Of these, 298 had been tagged at the hatchery. Of the tagged fish, 67 went to the upper Grande Ronde; another 67 were put in the Wallowa; and the remaining 164 were released in Catherine Creek. Nine tagged fish were observed alive on the spawning beds, four in the upper Grande Ronde and five in Catherine Creek, but only eight tag recoveries were made during spawning surveys (three in the upper Grande Ronde, two in the Wallowa, and three in Catherine Creek). A total of 49 tags were eventually recovered, mostly from fish that returned again to the hatchery (18) or were harvested during a Umatilla tribal fishery (19). An additional four tags were returned by anglers (Bruce Miller, ODFW, La Grande, personal communication).

Table 5. Spring chinook peak redd counts and densities for Grande Ronde River system index areas, 1986 and 1987, with averages for recent periods. [Pre-1985 data from Schwartzberg and Roger (1986); 1986 data from CTUIR (1986).]

Stream	Peak Redd Counts 1977-86 Average	1982-86 Average	1986	1987	Km	1987 Redds per km	Peak Survey Date[a]
Grande Ronde R.	42	42	37	**112**[b]	13.7	8.2	9/01
Wenaha River	35	33	68	**62**	9.7	6.4	9/08
Lookingglass Cr.	--[c]	--[c]	5	**18**	10.0	1.8	9/03
Wallowa River	4	3	7	**15**[d]	7.2	2.1	8/25
Lower Minam River	22	24	36	**64**	12.1	5.3	8/28
Upper Minam River	21[e]	18	27	**26**	9.7	2.7	8/27
Catherine Creek	35	35	47	**103**[f]	12.1	8.5	9/02
N. Fk. Catherine	5	8	89	**14**	4.8	2.9	9/02
S. Fk. Catherine	10[e]	9	21	**35**	3.2	10.9	9/02
Sheep Creek	--[g]	--[g]	4	**7**	9.7	0.7	8/31
Bear Creek	11	12	10	**10**	10.5	1.0	8/24
Lostine River	46	54	48	**49**	4.8	10.1	8/27
Hurricane Creek	4	5	5	**16**	4.8	3.3	8/24
Total	**235**[h]	**243**[h]	**323**	**531**	**112.3**	**4.7**	

a/ Date when second of three surveys was conducted on multiple survey streams (Grande Ronde River, Lostine River, Minam River, Hurricane Creek and Catherine Creek) and the date of the single index survey in other areas. Dates correspond approximately to the historical time of peak spawning.

b/ Received 498 spawners from Lookingglass Hatchery in 1987.

c/ Spawners for Lookingglass Hatchery broodstock were removed from Lookingglass Creek from 1981 to 1983. Not surveyed in 1985.

d/ Received 300 spawners from Lookingglass Hatchery in 1987.

e/ Not surveyed in 1977.

f/ Received 700 spawners from Lookingglass Hatchery in 1987.

g/ First surveyed in 1986.

h/ Lookingglass and Sheep creeks excluded.

Table 6. Percent of total area surveyed and redds observed in index areas during peak surveys on the five Grande Ronde Basin streams subjected to extended surveys, 1987.

Stream	Survey Area (km)			Observed Redds		
	Total	Index	% Index	Total	Index	% Index
Grande Ronde River	29.0	13.6	47	154	112	73
Wenaha River	50.1	9.6	19	151	62	41
Catherine Creek	20.1	12.0	60	149	103	69
Sheep Creek	14.5	9.6	66	9	7	78
Lostine River	20.9	4.8	23	68	49	72

Table 7. Results of individual spring chinook spawning surveys on Grande Ronde River Basin index areas receiving multiple index surveys, 1987. [After Carmichael et al. (In prep.)].

Stream	Survey Date	Km Surveyed[a/]	Redds	% of Total
Grande Ronde R.	8/20	8.0	14	22
	9/01[b/]	8.0	47	72
	9/10	8.0	65	100
Lostine River	8/17	4.8	27	51
	8/27[b/]	4.8	49	92
	9/09	4.8	53	100
Catherine Creek	8/21	3.2	15	33
	9/02[b/]	3.2	40	89
	9/11	3.2	45	100
Hurricane Creek	8/17	2.1	5	20
	8/24[b/]	2.1	16	64
	9/04	2.1	25	100
Lwr. Minam River	8/28[b/]	6.4	61	82
	9/24	6.4	74	100

a/ Distances surveyed are index areas or within index areas.

b/ Survey conducted at historic peak spawning time.

Based on data collected from streams receiving multiple index surveys, redd counts from index areas receiving only one-time "peak" surveys could be considered to represent about 80% of the total redds deposited in that particular stream in 1987. Whether or not this ratio will be maintained in subsequent years remains to be seen. In previous years, proportional values have not been determined for the number of redds in index areas versus the total number in the stream system (Rich Carmichael, ODFW, La Grande, personal communication).

Redd numbers in a survey area of fixed length could be a good measure of potential egg deposition in a larger area (assuming knowledge of average number of eggs per female), if the survey area continued to receive a constant fraction of total spawners. If the fraction varied, however, the redd counts would not accurately reflect total potential egg deposition.

Hatchery influences in the Grande Ronde Basin confuse our ability to interpret changes in spawner populations and make assessment of Pacific Salmon Treaty programs in that locale more difficult.

IMNAHA RIVER
(Snake River Subbasin)

DESCRIPTION OF STUDY AREA AND STOCK

The Imnaha River (Figure 3) drains 2,460 km^2 of northeastern Oregon and enters the Snake River at RKm 309. A major portion of the Imnaha River Basin is contained within the Hells Canyon National Recreation Area and Eagle Cap Wilderness.

The Imnaha supports naturally-reproducing spring chinook and summer chinook. Since 1982, the Imnaha spring chinook run has been a source of broodstock for the Lower Snake River Compensation Program's (LSRCP) Lookingglass Hatchery (Figure 3) (Table 8) and has been supplemented with hatchery production (Table 9). Spring chinook spawn in approximately 100 km of the system from early August to mid-September with a peak near the end of August.

Table 8. Spring chinook trapped in the Imnaha River for use as LSRCP broodstock. [Rich Carmichael, ODFW, La Grande, personal communication.]

Year	Total Fish	Females Trapped	Females Spawned	Males Adults	Males Jacks
1982	28	14	10	14	0
1983	64	35	31	21	8
1984	36	17	11	9	10
1985	165	41	32	78	46
1986	340	120	61	199	21
1987	340	131	--[a]	180	29

[a] Data not available.

Table 9. Hatchery releases of juvenile spring chinook in the Imnaha Basin, 1984-86. [Rich Carmichael, ODFW, La Grande, personal communication.]

Brood Year	Stock	Hatchery of Rearing	Release Number (1000's)	Release Date	Release Size (no./lb)
1982	Imnaha	Lookingglass	24.9	3/84	32.0
1982	Lookingglass	Lookingglass	4.3	3/84	31.0
1983	Imnaha	Lookingglass	56.2	9/84	24.4
1983	Imnaha	Lookingglass	59.6	3/85	17.4
1984	Imnaha	Lookingglass	35.3	3/86	10.8

METHODS

ODFW began surveying spring chinook index areas in the Imnaha system in 1960. Since 1986, the CTUIR and NPT have participated in the surveys. Combinations of single and multiple index and extended area surveys were conducted on three Imnaha streams in 1987. Multiple index and extended surveys were conducted on the Imnaha mainstem. A single index survey was combined with an extended survey on Big Sheep Creek, and a single index survey was conducted on Lick Creek. In keeping with past methods, all chinook and redds were considered part of the spring run.

RESULTS AND DISCUSSION

The total redd count for the three Imnaha Basin index areas was 20% lower in 1987 (115) than in 1986 (143), and counts in each index stream were below recent averages (Table 10). Results of the three individual surveys conducted on the mainstem Imnaha River index area are displayed in Table 11.

LSRCP broodstock removals were similar in 1986 and 1987 (Table 8); although this program's specific effects on subsequent redd numbers is not known, it is probably safe to assume that they are reduced because of it. Even so, the decline of 28 redds from 1986 to 1987 cannot reasonably be seen as the result of the LSRCP-related removal of eleven more females in 1987 than in 1986. Regardless of LSRCP influences, the Imnaha River is the only Imnaha Basin index stream where redd numbers are sufficiently large to indicate escapement trends; thus, its utility for continued use in the PST stock monitoring program remains high.

Table 10. Peak spring chinook index area redd counts and densities for Imnaha Basin streams in 1986, 1987, and recent periods. [Pre-1985 data from Schwartzberg and Roger (1986); 1986 data from CTUIR (1986).]

Stream	Peak Redd Counts 1977-86 Average	1982-86 Average	1986	1987	Km	1987 Redds per km	Peak Survey Date[a/]
Imnaha River	139	123	126	**112**	15.5	7.2	8/26
Big Sheep Creek	7	10	15	**3**	6.4	0.5	8/25
Lick Creek	6	1	2	**0**	6.4	0	8/25
Total	**152**	**134**	**143**	**115**	**28.3**	**4.0**	

a/ Date of second of three index surveys on the Imnaha and date of single index surveys on other streams.

Table 11. Results of individual spring chinook spawning surveys on Imnaha River Basin index areas receiving multiple index surveys, 1987. [After Carmichael et al. (In prep.)].

Stream	Survey Date	Km Surveyed[a/]	Redds	% of Total
Imnaha River	8/18	12.3	27	28
	8/26[b/]	12.3	87	92
	9/04	12.3	95	100

a/ Distances surveyed are index areas or within index areas.

b/ Survey conducted at historic peak spawning time.

Table 12 compares Imnaha River and Big Sheep Creek index and extended index areas and associated numbers of redds. Although the Imnaha index area includes only 30% of the area surveyed in that stream, it accounted for 80% of the redds. Redds were few in Big Sheep Creek, and the index area did not contain redds in proportion to its size (31% of the total area surveyed contained only 19% of the redds).

Table 12. Percent of total area surveyed and redds observed in index areas during peak surveys on two Imnaha Basin streams also subjected to extended surveys, 1987.

	Survey Area (km)			Observed Redds		
Stream	Total	Index	% Index	Total	Index	% Index
Imnaha River	51.5	15.5	30	140	112	80
Big Sheep Cr.	20.8	6.4	31	16	3	19

JOHN DAY RIVER

DESCRIPTION OF STUDY AREA AND STOCK

The John Day River Basin, Oregon's third largest, encompasses approximately 20,750 km^2 in the state's north-central and northeastern regions (Figure 4). The river's spring chinook run is the largest in eastern Oregon and is the largest of all naturally reproducing spring salmon runs in the entire state. Spawning occurs from the end of August to the end of September throughout approximately 225 km of the North Fork, Middle Fork, and mainstem John Day and their tributaries. Spawning peaks in mid-September. Both the CTUIR and ODFW have adopted a "wild management" policy for the John Day stock, emphasizing strict reliance on natural spawning as the production base and disallowing supplementation with releases of any artificially produced salmon.

METHODS

Studies by Knox et al. (1984) closely defined the time of peak spawning, so no multiple index surveys were conducted in 1987. Rather, existing survey areas were extended and new surveys were conducted in tributaries and areas for which little or no information on spawning-use existed. Survey and data collection methods are described under METHODS for Grande Ronde spring chinook (page 9). Table 13 lists John Day system streams and the types of surveys conducted on them.

RESULTS AND DISCUSSION

Reconnaissance surveys, conducted August 11 to August 14 in Granite Creek, Clear Creek, and the upper North Fork John Day River, located 331 live spawners but no redds.

Table 14 gives 1987 index area redd counts and densities, and compares them with counts for 1986 and averages for recent multi-year periods. Total redds counted in all index areas in 1987 (1,109) increased 67% over the 1986 total (665). Granite Creek had the only reduction (31%). Redd counts in all areas, particularly the mainstem, North Fork, and Middle Fork, were substantially improved over recent averages. It must be pointed out, however, that the Middle Fork index area was expanded by 3.2 km in 1986; thus, averages of index area redd counts including data collected there since 1985 are not directly comparable with averages based on data from prior years only. In 1986, eighteen redds(of 76 in the entire index area) were located in the new, 3.2 km reach; in 1987, 103 (of 340) were counted there. Even if redds in the new section are ignored for both years, the Middle Fork's 1987 redd count rose dramatically (from 58 to 237) above its 1986 level.

Index areas contained 34-80% of the total surveyed area and 64-95% of the redds in streams with extended surveys (Table 15).

New surveys were conducted in the South Fork John Day River, Canyon Creek (mainstem tributary), Desolation Creek (N. Fork tributary), and Clear Creek (M. Fork tributary). Spawning was evident only in Canyon Creek, where one live salmon and four redds were counted on September 22.

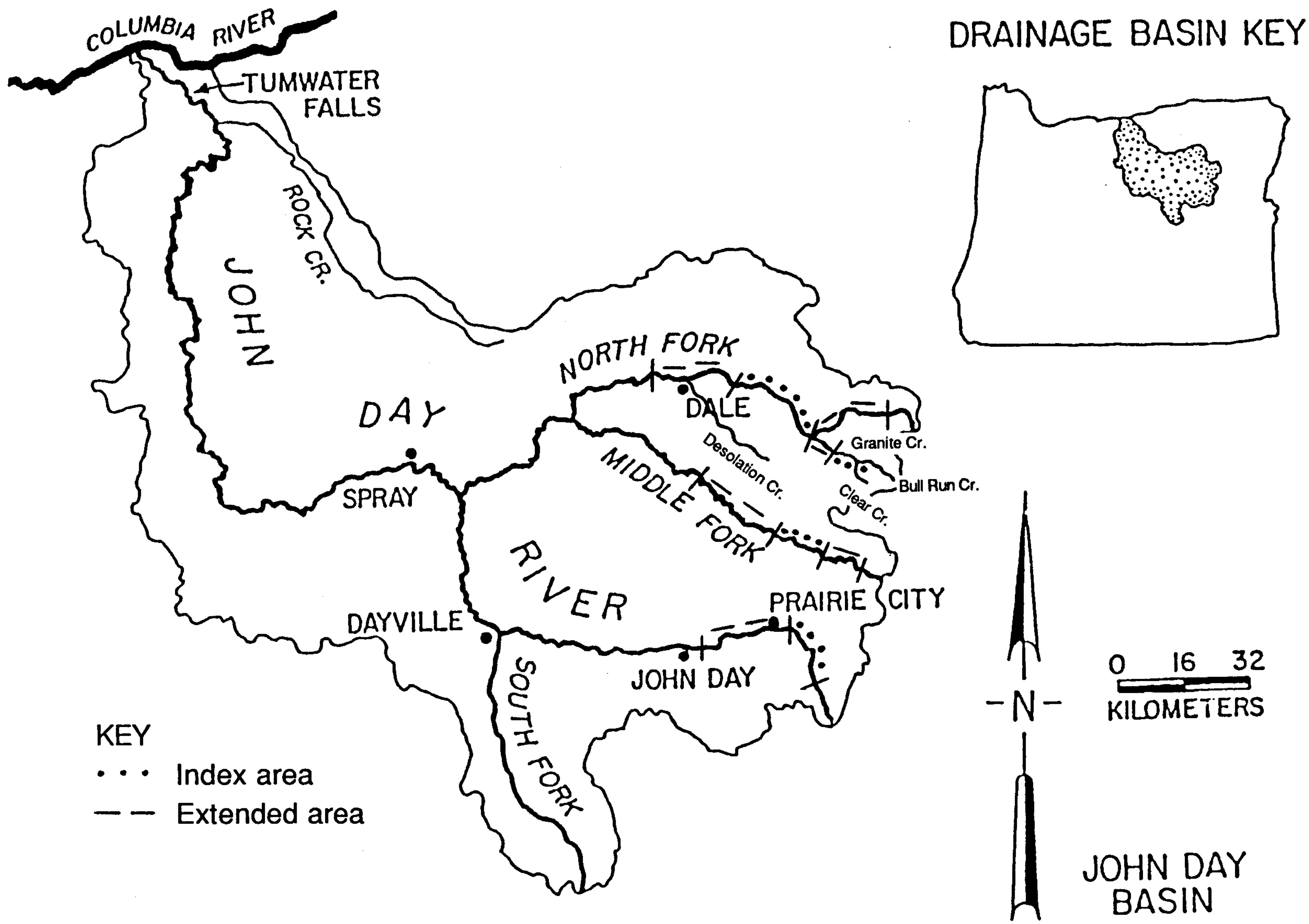

Figure 4. John Day River Basin, Oregon.

Table 13. John Day Basin streams and survey(s), 1987.

Stream	Single Index Survey Only	Single Index Plus Extended Survey
John Day River		*
Middle Fork		*
Upper North Fork		*
Lower North Fork (canyon)	*	
Granite Creek		*
Bull Run Creek	*	
Clear Creek		*

Table 14. Peak spring chinook index area redd counts and densities for John Day River Basin streams in 1986, 1987, and recent periods. [Pre-1985 data from Schwartzberg and Roger (1986); 1986 data from CTUIR (1986).]

Stream	Peak Redd Counts 1977-86 Average	1982-86 Average	1986	1987	Km	1987 Redds per km	Peak Survey Date
John Day River	78	106	159	247	20.9	11.8	9/09
Middle Fork	66	59	76[a/]	340	19.3[a/]	17.6	9/23
Upper North Fork	65	54	150	201	16.1	12.5	9/16
Lower North Fork (canyon)	74	69	107	174	12.9	13.5	9/16
Granite Creek	76	66	111	77	8.9	8.7	9/11
Bull Run Creek	13	9	6	14	6.4	2.2	9/11
Clear Creek	34	33	56	56	4.0	14.0	9/11
Total	**406**	**396**	**665**	**1109**	**88.5**	**12.5**	

a/ Index area expanded by 3.2 km in 1986.

Table 15. Percent of total area surveyed and redds observed in index areas during peak surveys on five John Day Basin streams also subjected to extended surveys, 1987.

Stream	Survey Area (km)			Observed Redds		
	Total	Index	% Index	Total	Index	% Index
John Day River	34.6	20.9	60	259	247	95
Middle Fork	42.6	19.3	45	528	340	64
North Fork[a]	86.6	29.0	34	545	375	69
Granite Cr.	16.1	8.9	55	118	77	65
Clear Cr.	8.0	6.4	80	63	56	89

a/ Index area values are for upper and lower areas combined. No extended survey was conducted on the lower North Fork.

SALMON RIVER
(Snake River Subbasin)

DESCRIPTION OF STUDY AREA AND STOCK

Idaho's Salmon River drains the Snake River's largest (>22,400 km^2) tributary basin (Figure 5). Encompassing much of the state's central region, the Salmon Basin slopes generally northwest in a rough diagonal from the Bitterroot Mountains (Pacific Slope boundary) in the east and the Sawtooth Mountains in the south to the Salmon River's confluence with the Snake at RKm 299 (Parkhurst 1950a). Chinook spawning surveys were conducted on Big Creek (Figure 6) in the Salmon's Middle Fork system, the Secesh River and its headwater tributary Lake Creek (Figure 7) in the South Fork Salmon system, and Johnson Creek (Figure 8) in the East Fork tributary of the South Fork Salmon.

Chinook occupying the Middle Fork Salmon system are generally considered to be a spring run (Howell et al. 1985) that spawns in August and September with peak spawning in late August (Ortmann and Richards 1964). Some authors, however, (e.g., Pollard [1983] and Hall-Griswold and Cochnauer [1986]), cite differences in peak spawn-timing at various locations in the drainage as evidence that both spring and summer chinook salmon inhabit the Middle Fork.

Big Creek is approximately 67 km in length and enters the Middle Fork Salmon River at RKm 29. The drainage covers an area of 1,217 km^2 (Welsch et al. 1965). Major tributaries to Big Creek include Monumental, Beaver, Smith, Logan, Rush, and Cabin creeks. These six tributaries alone contain another 100 km of stream. The majority of mainstem Big Creek is located within the Frank Church-River of No Return Wilderness. Access to the system is by road in the headwaters and by trail at the Smith Creek wilderness boundary trailhead or at the mouth of Big Creek. Several backcountry airstrips are located along the stream.

South Fork Salmon River chinook are considered a summer run fish (Howell et al. 1985). Ortmann and Richards (1964) report typical spawn-timing for this run as August through September with a peak from late August in upper watershed reaches through mid-September in the lower areas.

The Secesh River is roughly 44 km in length and discharges from the west into the South Fork Salmon River at about RKm 59. Access to the Secesh is limited to its lowermost and uppermost reaches.

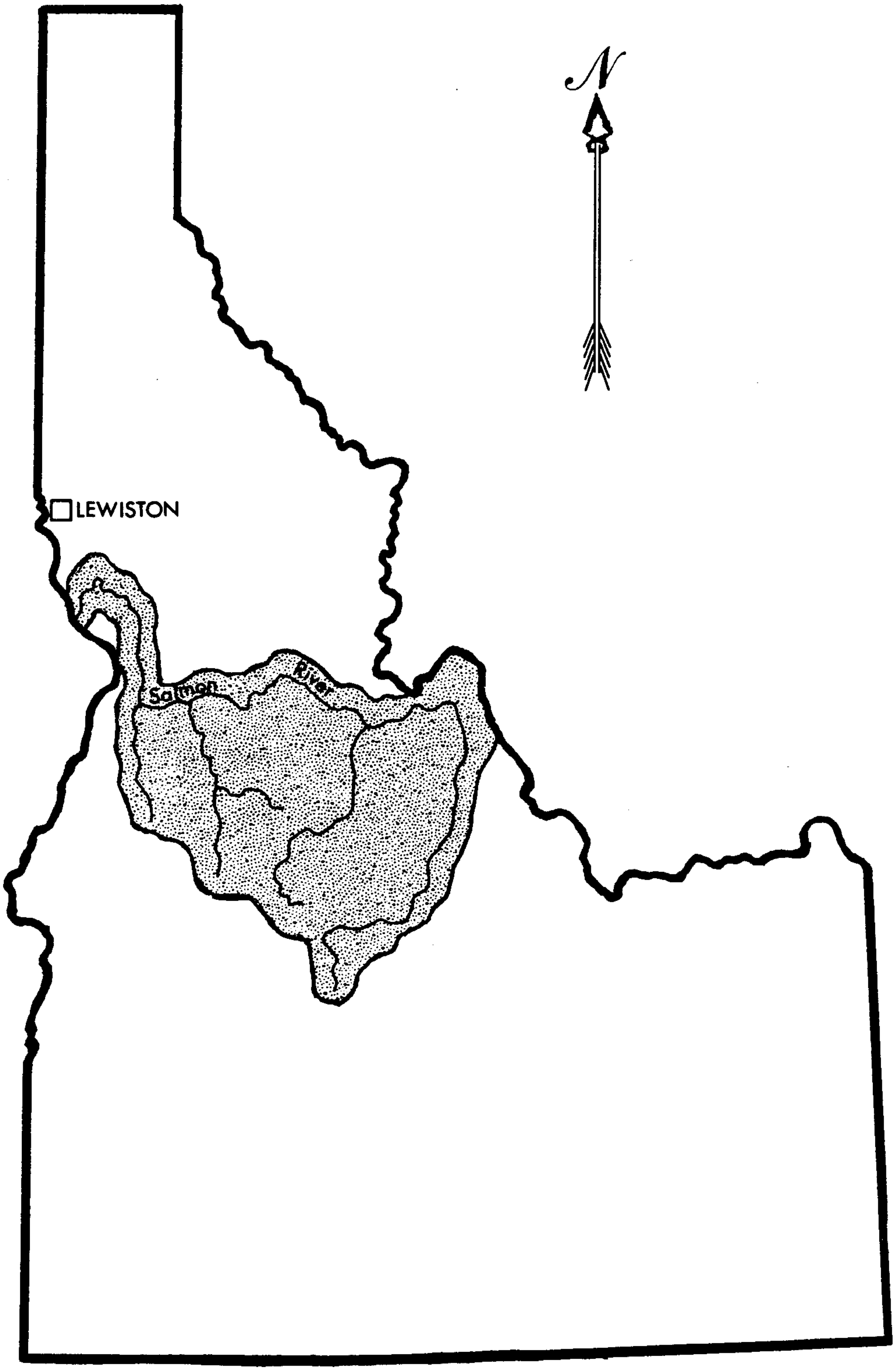

Figure 5. Salmon River Basin, Idaho.

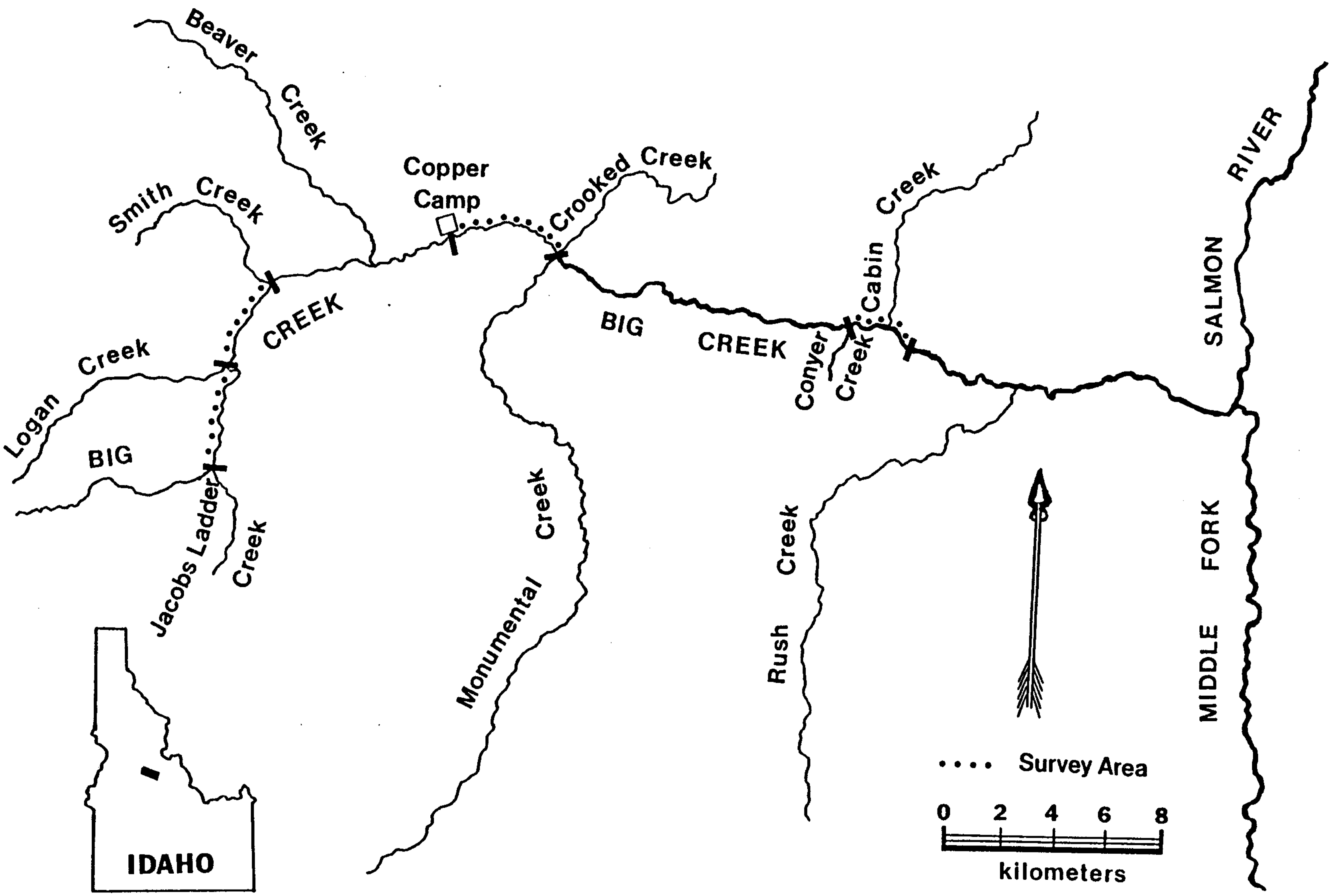

Figure 6. Big Creek (Salmon/Snake) and 1987 survey areas.

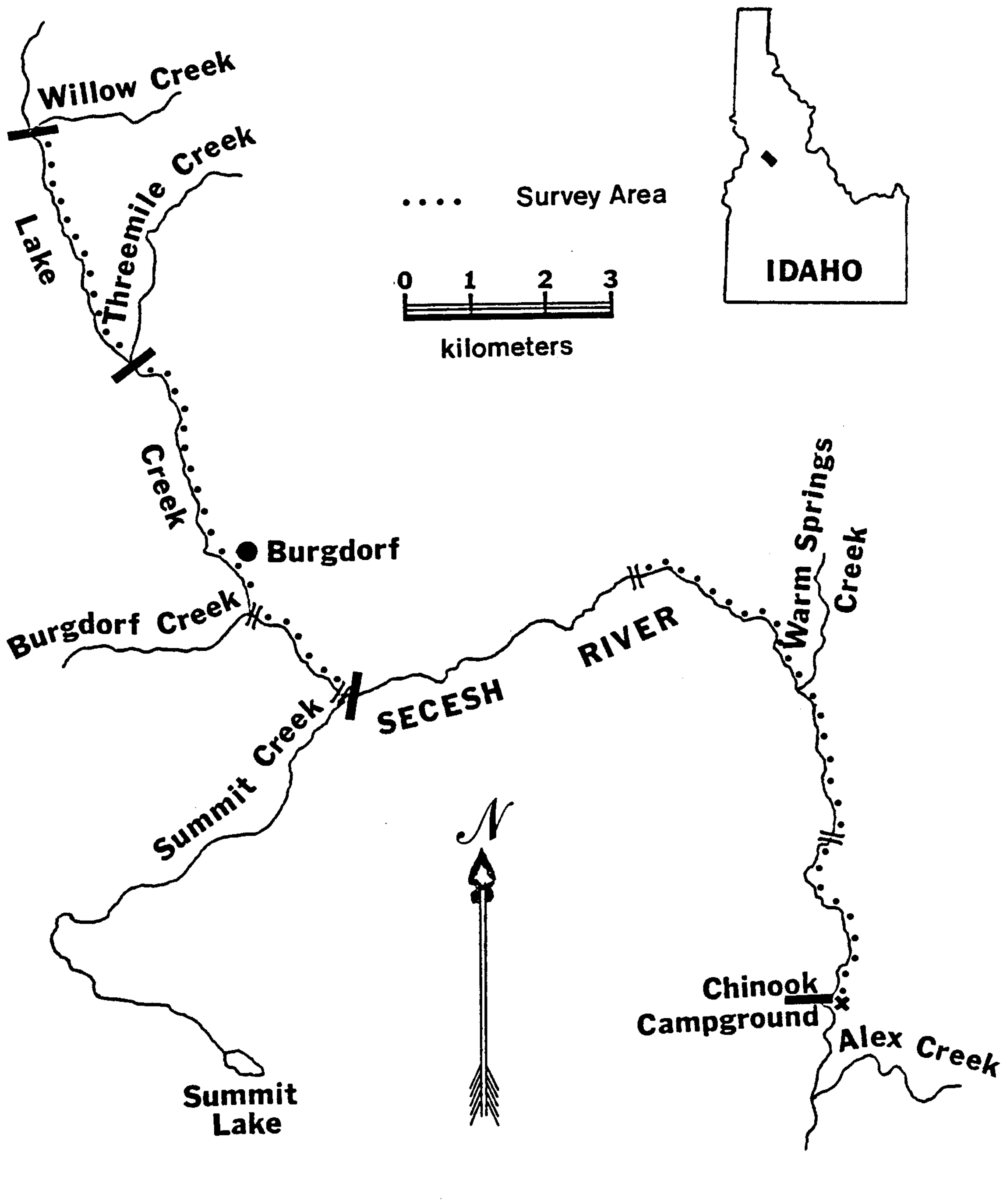

Figure 7. Lake Creek and Secesh River (Salmon/Snake) and 1987 survey areas.

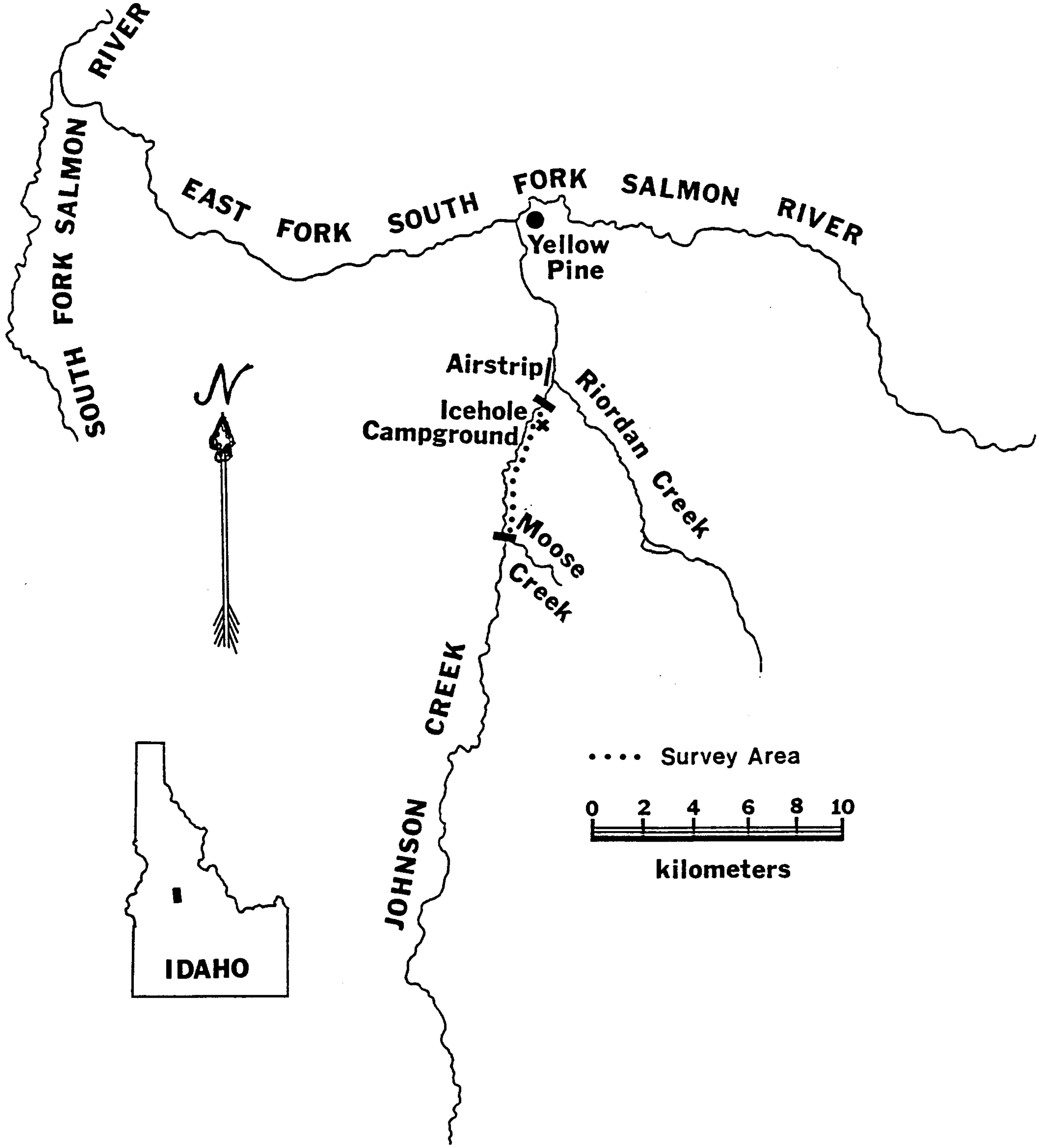

Figure 8. Johnson Creek (Salmon/Snake) and 1987 survey area.

Lake Creek is approximately 20 km in length and, with Summit Creek, forms the headwaters of the Secesh River. Access to Lake Creek is good, with a gravel road paralleling the stream for most of its length.

Johnson Creek flows generally north for 53 km before joining the East Fork tributary of the South Fork Salmon River, at RKm24. Welsch et al. (1965) reported that Johnson Creek drained an area of 552 km^2. Roads access the creek throughout its length.

METHODS

The Big Creek spawning ground survey covered 21.4 km of the mainstem between the Cabin Creek meadow and Jacobs Ladder Creek (Figure 6). Four survey areas were established within this reach: Logan Creek to Jacobs Ladder Creek (5.6 km), Smith Creek to Logan Creek (5.2 km), Monumental Creek to Copper Camp (7.2 km), and 3.4 km between the Cabin Creek meadow and Conyer Creek. These areas were surveyed on July 6, July 27-28, August 11-12, August 24-25, and September 8-9, 1987.

Surveys on the Secesh River covered 9 km from the bridge to the U.S. Forest Service's Chinook Campground in the Secesh Meadow area (Figure 7). The 1.3-km reach from Chinook Campground to Alex Creek was also surveyed. Censuses occurred on July 29, August 13 and 27, and September 10.

Two contiguous survey areas were established on Lake Creek, and included a 4-km reach between Willow and Threemile creeks and a 7.5-km section from Threemile Creek to the mouth of Lake Creek. Lake Creek was surveyed on July 30, August 14, and September 11.

On Johnson Creek, a 4.8-km stretch extending from roughly 300 meters below the Ice Hole Campground upstream to Moose Creek (Figure 8) was surveyed on July 27, August 12 and 26, and September 9.

Numbers of redds, live fish (adults and jacks), and carcasses were recorded. Redds in non-wilderness stream sections were marked with a flag displaying an assigned redd number and the date the redd was first observed. Redds in wilderness stream reaches were not flagged, but were enumerated during each survey period. The previous survey's count within the same wilderness reach was subtracted from the current survey total to obtain the number of new redds constructed since the previous survey.

Carcasses were examined for marks and tags and measured to the nearest 0.1-cm. Lengths were taken from the middle of the eye to the hypural plate and from the tip of the snout to the fork of the tail. Scale samples were taken (Heindl, 1987) for later aging, and fish were opened to determine their sex and estimate the percent of gametes spent in spawning. Carcass data collected by IDFG personnel on their Secesh River and Lake Creek surveys were pooled with those collected in the same areas by Nez Perce Tribe (NPT) personnel.

Initial age assignments were based on carcass length (Hall-Griswold and Cochnauer 1986). Age verification through scale analysis will be subsequently performed by Columbia River Inter-Tribal Fish Commission personnel.

RESULTS

Chinook spawning in upper Big Creek (Logan Creek to Jacobs Ladder Creek) peaked by August 11 and was completed by August 23. Spawning in the lower area, between Copper Camp and Monumental Creek, peaked up to four weeks later. Of the 53 redds located in Big Creek in 1987 (Table 16), 24 were in the Logan Creek to Jacobs Ladder Creek reach, three between Smith and Logan creeks, 21 in the Monumental Creek to Copper Camp stretch, and one between Cabin Creek Flat and Conyer Creek. A total of 72 live fish were observed during these surveys. Nine carcasses were sampled and later aged by length. Mid-eye-to-hypural plate lengths ranged from 52 cm to 83 cm (n=7) for males and 66 cm to 79 cm (n=2) for females (Kucera 1987). Six of the seven males and one of the two females were classified as age IV. The other two fish (one male, one female) were classified as age V.

Spawning activity in the Secesh River peaked by August 27 and was apparently completed by September 10 when twelve new redds were counted but no live fish were observed (Table 17). The mainstem Secesh River surveys revealed a total of 74 redds; 81 live fish were reported; and 51 carcasses were examined, but one was too decomposed to sample. Upstream, in Lake Creek, another 39 redds were found -- five from Willow to Threemile Creek and 34 between Willow Creek and the Lake Creek mouth; 35 live fish were noted; and four carcasses were retrieved. In total, the Secesh River system revealed 113 redds, 116 live fish, and 55 carcasses.

Carcasses of 33 male and 17 female Secesh River salmon were examined for length and sex on August 27 and September 10 (Kucera 1987). Lengths of adult males ranged from 54 cm to 81 cm; one subadult male (jack) carcass measured 39 cm.

Table 16. New redds, live fish, and carcasses observed during the Big Creek spawning ground survey, Middle Fork Salmon River system, 1987.

Stream Section	Survey Date	New Redds	Live Fish	Carcasses
Logan Creek to Jacobs Ladder Cr.	7/06	1	0	0
	7/27	2	0	0
	8/11	18	25	0
	8/24	3	3	3
	9/08	0	0	0
Smith Creek to Logan Creek	7/27	0	1	0
	8/11	2	2	0
	9/08	1	0	0
Monumental Cr. to Copper Camp	7/28	0	0	0
	8/12	4	11	0
	8/25	8	24	6
	9/09	9	3	0
Cabin Creek Flat to Conyer Creek	8/25	5	3	0
TOTAL		53	72	9

Lengths of females ranged from 61 to 81 cm. The jack was later determined to be age III; 22 males and 5 females were age IV; and 10 males and 12 females were age V.

The three male carcasses recovered by tribal biologists in Lake Creek were 43 cm, 62 cm, and 69 cm long (Kucera 1987). The lone female measured 76 cm. The smallest male, a jack, was age III. The other males were age IV, the female -- age V.

In Johnson Creek, 59 redds, 146 live fish, and 32 carcasses were located. Peak spawning occurred by August 26. By September 9, when only three live chinook were observed on redds, spawning was virtually completed.

Mid-eye-to-hypural plate lengths of the seventeen male carcasses ranged from 49 cm to 66 cm (Kucera 1987). Lengths of the fifteen females ranged from 60 cm to 82 cm. Age determinations classified all the males and six females as age IV. The remaining nine females were age V.

Table 17. New redds, live fish, and carcasses observed during the Secesh River, Lake Creek, and Johnson Creek spawning ground surveys, South Fork Salmon River system, 1987.

Stream Section	Survey Date	New Redds	Live Fish	Carcasses
Secesh River	7/29	2	2	0
Meadow Area	8/13	13	31	0
	8/27	47	48	42
	9/10	12	0	9
TOTAL		**74**	**81**	**51**
Lake Creek				
Willow Cr. to	7/30	0	1	0
Threemile Cr.	8/14	1	0	0
	9/11	4	0	0
Threemile Cr.	7/30	11	6	0
to Lake Cr.	8/14	13	26	2
mouth	8/28	10	2	2
	9/11	0	0	0
TOTAL		**39**	**35**	**4**
Johnson Creek	7/28	1	8	0
Moose Creek	8/12	5	35	0
to below	8/26	39	100	12
Ice Hole Camp	9/09	14	3	20
TOTAL		**59**	**146**	**32**

DISCUSSION

Identifying fresh chinook redds in the survey streams was a challenge in 1987 because low spring run-off failed to completely erase some redds constructed in 1986. Steelhead trout (Oncorhynchus mykiss) redds, built in the spring of 1987, were also present in some reaches. Noting locations and appearance of the steelhead and old chinook redds during early-season surveys permitted quick recognition of new chinook redds even after they became obscured by siltation and algae growth later in the season. Numerous old redds were visible in the Secesh River and Johnson Creek. A few were apparent in Big Creek.

Multiple surveys in 1987 helped to define time of spawning commencement, peak, and termination, and aided in distinguishing individual redds in areas where clustering was apparent or suspected. Direct observations of spawning fish and the successive stages of redd construction across the spawning season also facilitated identification and continuous recognition of discrete redds. This was often especially true during later surveys when some early-season redds were partially obscured by subsequent, nearby redd construction, beaver activity, algae growth, etc. In addition, some completed redds that exhibited several upstream "pockets" (created by a fish dislodging gravel to cover its final egg deposit) could still be confidently counted as a single redd because the construction process had been observed and was known to be the work of an individual female salmon. Encountering such a redd only after it is completed can lead to confusion as to the actual number of redds present (Heindl 1987). The number of pockets is used by some observers to indicate number of redds.

Idaho Department of Fish and Game (IDFG) personnel have conducted annual spawning ground surveys on upper Big Creek since 1957 and on Johnson Creek, the Secesh River, and Lake Creek since 1956 (Hall-Griswold and Cochnauer 1986). Intermittent counts have occurred on lower Big Creek since 1957. These surveys have been one-time peak counts intended to closely follow the completion of chinook spawning (Pollard 1983).

Big Creek

Although chinook spawning below the confluence of Logan Creek is reported by some authors (Pollard 1983, Hall-Griswold and Cochnauer 1986) to be summer rather than spring run fish, in this report all chinook in the Big Creek system are considered, in accordance with Howell et al. (1985), to be spring salmon. Aside from their having slightly different peak spawning times, there appears to be little basis on which to segregate upper and lower Big Creek fish into distinct races. Also, unless race-related differences can be shown to affect their utility as indicator stocks, it probably matters little how these fish are labeled. Both summer and fall chinook stocks are currently being used as indicators in other Columbia Basin drainages.

Later spawning in lower Big Creek was also reported during 1986 surveys (Kucera 1986), but no other distinctions were noted. Size of carcasses retrieved in the two areas was similar, with mid-eye-to-hypural plate lengths averaging 70.8 cm in upper Big Creek (n=28) and 74.2 cm in lower Big Creek (n=19) over the two-year period (Kucera 1987).

Redd counts were lower in 1987 than in 1986 in the three areas of Big Creek with comparable data (Table 18). The Logan Creek-Jacobs Ladder Creek section contained 24 redds, fewer than the 41 observed in 1986. By July 27, the upper 0.5 km of this section had no surface water flow and, because of low flows and beaver dams, the upper 0.8 km was probably impassable. Welsch et al. (1965) described the 4-km section downstream from Jacobs Ladder Creek as an exceptionally fine spawning ground. This section is where the majority of redds were located in 1987.

IDFG's survey, conducted August 28 in the Logan Creek-Jacobs Ladder Creek section, counted 36 redds (Don Anderson, IDFG, McCall, personal communication). A plausible explanation for the large difference between the two totals (24 vs. 36) is that IDFG biologists count total number of pockets to establish their redd count whereas Nez Perce tribal biologists, as previously noted, do not.

In contrast to the ample, good quality spawning habitat of the Logan Creek-Jacobs Ladder Creek section, available spawning substrate between Smith and Logan creeks is generally of suboptimum size. This probably contributes to the paucity of redds (three) found there. Little spawning activity (five redds and three live fish) was also found during the one-time, August 25 ground survey between Cabin Creek Flat and Conyer Creek (3.4 km), although habitat appeared both plentiful and suitable.

Redd visibility (redd-life) observations were made in upper Big Creek during the survey. The 18 redds flagged on August 11 were all distinguishable 28 days later. Five of the 24 redds previously flagged between Logan and Jacobs Ladder creeks were difficult to identify by September 8 because of siltation or algae growth. Only one redd out of 37 observed in upper Big Creek in 1986 was not identifiable after a 33-day period (Kucera 1986). Schwartzberg and Roger (1986a) reported about a 40-day redd-life in Washington's Yakima River.

Table 18. Total chinook redd numbers and densities by stream and survey area in monitored Salmon River Subbasin streams, 1987 and (1986).

Stream: Survey Area	Length (km)	Number of Redds	Redds/km
Big Creek:			
Logan Cr. - Jacobs Ladder	5.6	24 (41)	4.3 (7.3)
Smith Cr. - Logan Cr.	5.2	3 (4)	0.6 (0.8)
Monumental Cr. - Copper Camp	7.2	21 (26)	2.9 (3.2)
Cabin Cr. Flat - Conyer Cr.	3.4	5 a/	1.5 b/
Johnson Creek:			
Index Area c/	4.8	59 d/	12.3 d/
Secesh River:			
Bridge - Chinook Campground e/	9.0	74 d/	8.2 d/
Lake Creek (Secesh tributary):			
Willow Cr. - Threemile Cr.	4.0	5 d/	1.2 d/
Threemile Cr. - mouth	7.5	34 d/	4.5 d/

a/ Result of single reconnaissance survey on August 25; no comparable 1986 data.

b/ Not comparable to other areas; result of single reconnaissance survey.

c/ Index area extends from Moose Creek to approximately 300 m below Ice Hole Campground.

d/ No comparable 1986 data.

e/ Section also referred to as Secesh Meadow area.

Secesh River

Spawning in the Secesh River was virtually completed by September 10, by which time tribal biologists had located 74 redds.

Although IDFG's Secesh River survey results (78 redds) appear similar to the Tribe's they are not readily comparable. The state's index area begins within and ends below the Tribe's, and their count is made from a helicopter. The Tribe elected to establish their upstream section boundary (bridge, in Figure 7) above the state's (Secesh River/Warm Springs Creek confluence) so as to include another roughly four kilometers of good spawning habitat. Both agencies originally used the Chinook Campground as the downstream boundary, but IDFG's 1985 change to aerial surveying in the Secesh facilitated moving theirs to the Loon Creek confluence in 1986 (Don Anderson, IDFG, McCall, personal communication).

All redds were still obvious on the final day of sampling. This indicates a visible redd-life of at least 44 days for redds flagged on the first survey (July 29). Redds in place by August 13 (second survey) displayed algae growth on September 10, but were still readily identifiable by the looseness of the gravel covering the eggs.

Lake Creek

The time of peak spawning in Lake Creek was not as clearly defined as in other streams. Surveys conducted July 30 and August 14 and 28 in the Threemile Creek to Lake Creek mouth reach found similar numbers of new redds. Spawning may have peaked as early as August 13. It definitely occurred before August 28, as no new redds were located during the final (September 11) survey, thus indicating that no spawning occurred after August 28. A total of 39 redds was recorded in both index areas (Table 17).

IDFG counted 43 redds in Lake Creek on August 24 (Don Anderson, IDFG, McCall, personal communication).

Of nine redds flagged on July 30, seven were still visible on the last (September 11) survey, 43 days later. Algae growth and siltation were apparent, however, and had totally obscured two redds by this date.

Johnson Creek

The 59 redds counted in the Johnson Creek index area represented the highest redd density (12.3 per km) observed in 1987 (Table 18). Johnson Creek also contained the most fish seen in the four streams surveyed, with 100 live salmon observed on August 26.

IDFG conducted foot counts of redds in this same area on September 8. Their count of 72 (pockets) was 13 higher than the

Nez Perce Tribe's count of 59 redds. Spawning was completed prior to the state's single survey.

Observations of redd-life in Johnson Creek are limited because the majority of redds were constructed during the last two sampling periods. The five redds first noted on August 12 were still visible 28 days later, but two of 39 redds flagged August 26 were barely distinguishable after only 14 days. Stream bank stabilization work near the Ice Hole Campground was conducted by the Boise National Forest during late August and five redds located immediately downstream became heavily silted in as a result. These redds probably would not have been identifiable after that time had they not been previously flagged.

Spring Chinook

SELWAY RIVER

(Clearwater River, Snake River Subbasin)

DESCRIPTION OF STUDY AREA AND STOCK

The Selway and Lochsa rivers combine near the town of Lowell, Idaho, to form the Middle Fork of the Clearwater River. The Clearwater, which drains lands immediately north of the Salmon River Basin, flows generally west through north central Idaho before finally joining the Snake River at Lewiston on the Idaho-Washington border (Figure 9).

The Selway River system drains over 5,000 km^2 of southeast Clearwater Basin landforms characterized by Idaho Batholith in the upper reaches and Columbia Basalt formations in the lower. From its source on the west slope of the Bitterroot Mountains the Selway flows north for more than half its length before turning west and eventually meeting the Lochsa. The river is roughly 150 km long and, except for its lower 34 km, is located entirely within the Selway-Bitterroot Wilderness.

Chinook runs into the Selway system sharply declined as a result of passage problems at the Washington Water Power Company Dam, completed in 1927 about 6 km above the Clearwater River mouth. The dam's original fishway, its sole means of passing migrating fish until 1939, was inaccessible during low flow periods (Parkhurst 1950, Murphy and Metsker 1962). Two new ladders were added in 1939; the dam was dismantled in 1974.

An attempt to reintroduce chinook into the Selway was initiated by IDFG in 1961 with plants of "eyed" eggs at various locations (Lindland and Bowler 1986). Reintroduction efforts have been minimal in recent years, however, and restoration efforts have focused on improving passage and controlling harvest. At present, the Selway River chinook run appears to be small, possibly numbering a few hundred fish. IDFG currently manages the Selway as a wild fish stream and prohibits introduction of hatchery stocks therein (IDFG 1985).

In an attempt to evaluate the potential for monitoring Selway River chinook populations as a Pacific Salmon Treaty indicator stock, ground surveys were initiated by the Nez Perce Tribe in several upper Selway index areas in 1986 (Johnson and Hill 1986). But because low spawner densities were found in the areas surveyed that year, it was decided to concentrate efforts in 1987 on a lower Selway tributary, Bear Creek, where previous surveys by Murphy and Metsker (1962) had identified large accumulations of chinook spawning habitat. Unfortunately, a lightning-caused forest fire within the Bear Creek drainage in 1987 limited access there and caused relocation of some surveys back into the upper Selway (Murphy 1987).

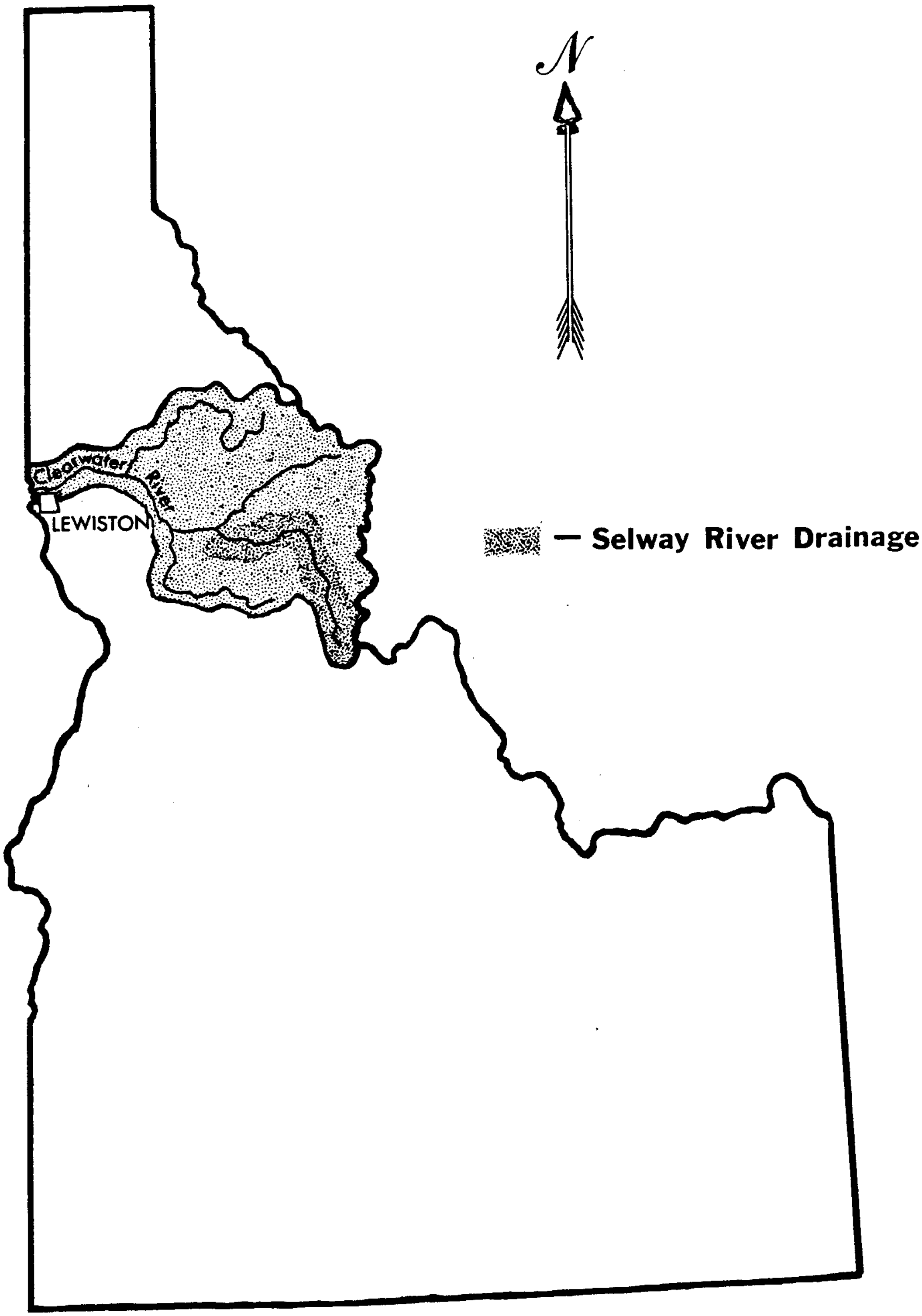

Figure 9. Clearwater and Selway river basins, Idaho.

Although only 35 km in length, Bear Creek provides an estimated 94,500 m^2 of salmon spawning habitat, the most in any Selway tributary (Murphy and Metsker 1962). The Bear Creek drainage lies in the heart of the Selway-Bitterroot Wilderness and is accessible only by foot or packhorse via trailheads at Lost Horse Guard Station in Montana or Paradise Guard Station on the Selway River, 28 km upstream of the Bear Creek-Selway confluence (Figure 10). Since a July 21-25, 1987 reconnaissance of Bear Creek revealed one adult chinook near Bear Creek's confluence with Wahoo Creek (21.8 km from the mouth), passage to that point is possible. Most of Bear Creek's upper reaches are neither readily visible nor easily accessible because of the steep, rugged terrain in which they are located.

The Selway River above White Cap Creek (RKm 112) is paralleled by a road for 26 km to Magruder Guard Station (Figure 10). The additional 13.4 km to Thompson Flat is likewise easily accessible from a well-used trail.

Spring chinook spawn in these areas from mid-August to mid-September, with peak spawning in early September.

METHODS

In past years, IDFG has conducted annual, one-time aerial surveys of ten Selway system index areas (Figure 11). Ground surveys are also done in Index Area 8 only. In 1986, the Nez Perce Tribe initiated multiple ground surveys on index areas in the upper Selway River and, in 1987, added the Bear Creek index lower in the system (Figure 10). The multiple survey approach was adopted to establish time of spawning initiation, peaking, and completion, as well as to collect total redd counts and retrieve samples from a maximum number of spawner carcasses--information not provided by one-time aerial surveys.

A 1.9-km section of Bear Creek, from the Salmon Hole (approximately 6 km above the mouth) to Cub Creek, was selected as that stream's index area because the reconnaissance and first survey revealed that most of the stream's available spawning habitat was concentrated there. The 6 km below the index area contained some small patches of spawning gravel, and even less suitable habitat was noted above the index area. IDFG's aerial survey of Bear Creek (Area 2, Figure 11) covers the entire 8 km from the mouth to Cub Creek.

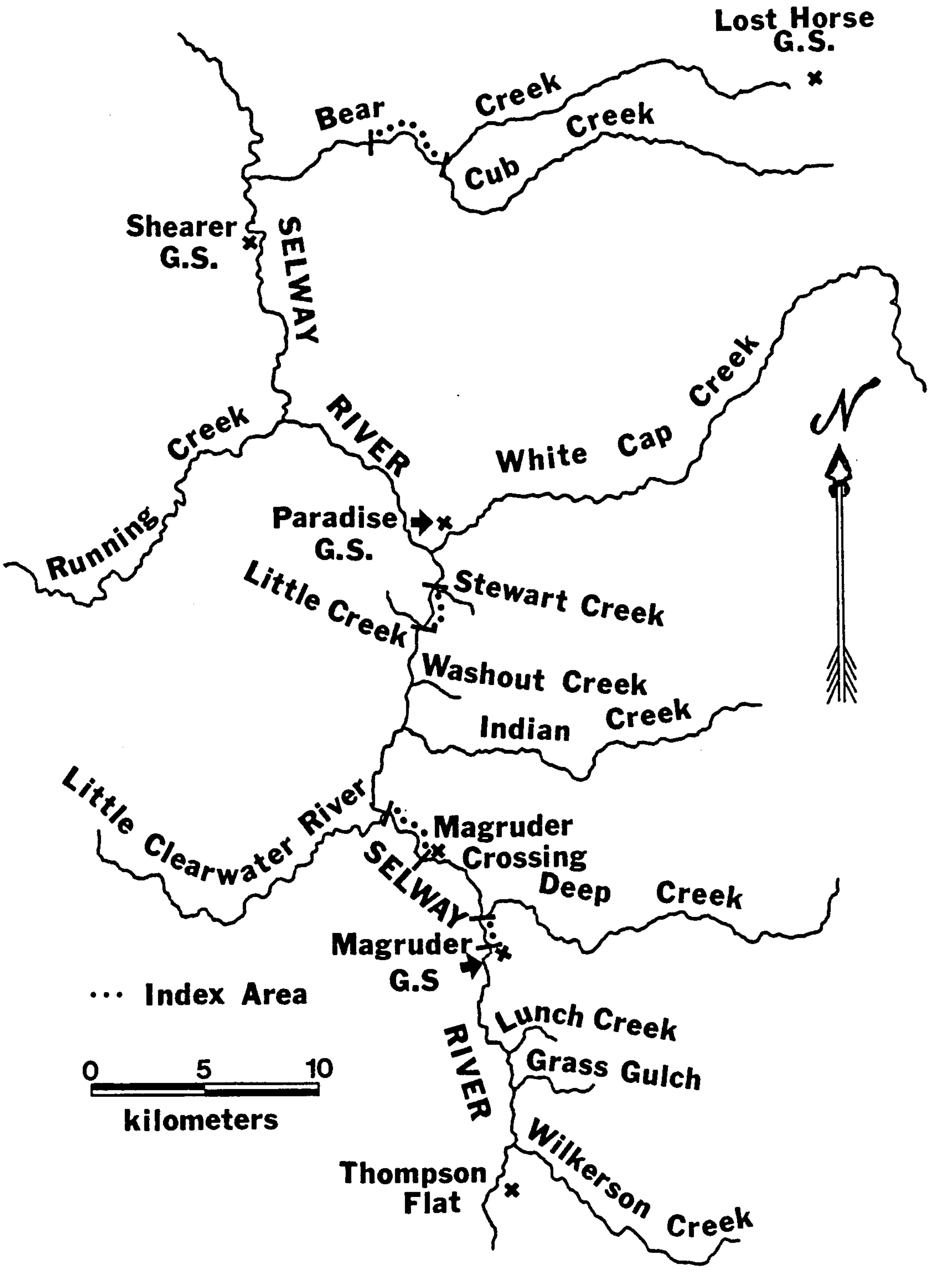

Figure 10. Selway River (Clearwater/Snake) with the Nez Perce Tribe's index areas.

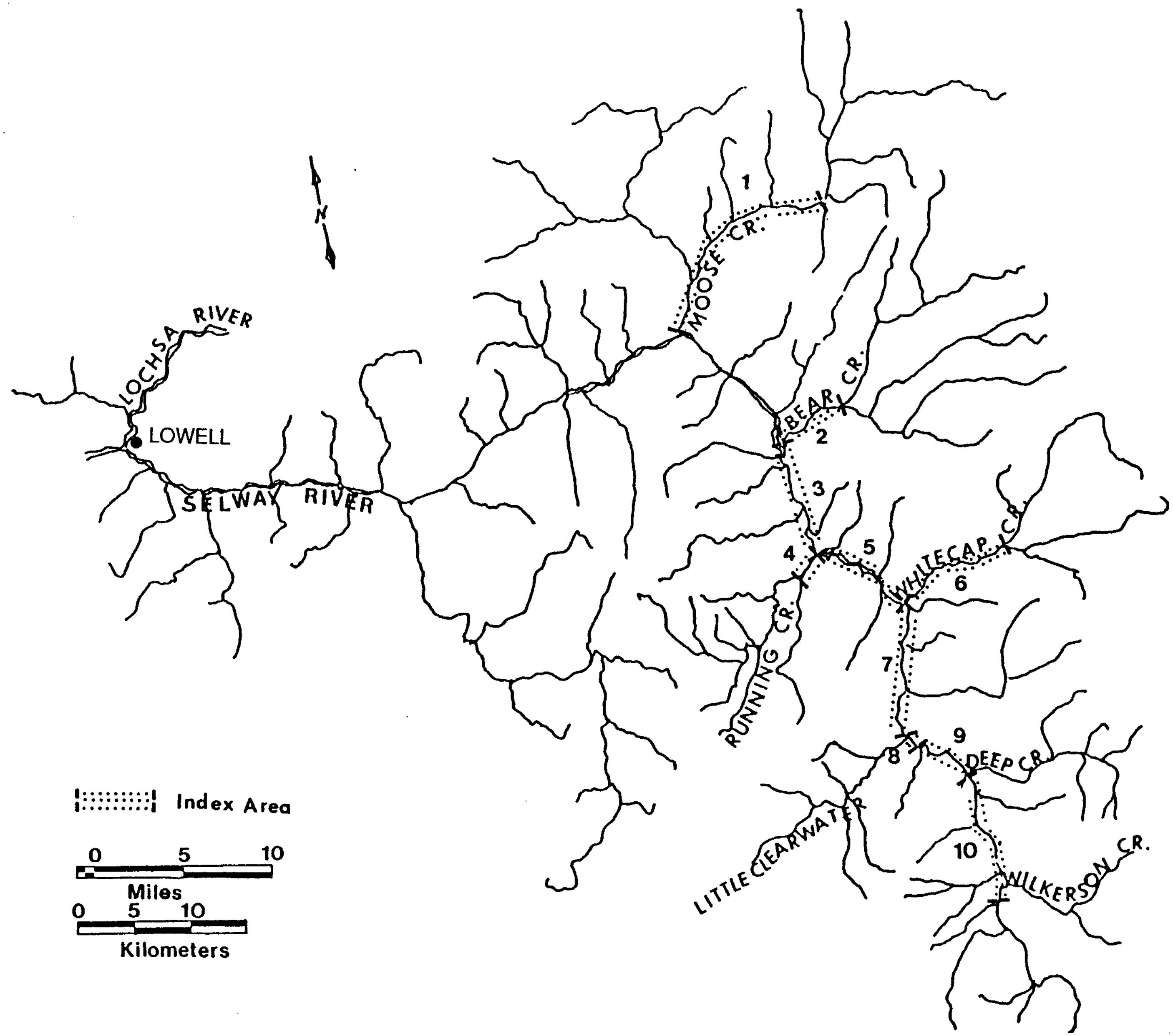

Figure 11. Selway River (Clearwater/Snake) with the Idaho Department of Fish and Game's index areas.

Efforts to survey Bear Creek in 1987 were hampered by a fire that burned from July to October, and only two surveys were completed in the drainage.

As a result of the Bear Creek fire, the Tribe's primary survey effort in 1987 was shifted back into the upper Selway, where four surveys were scheduled. Three study reaches were established, and four index areas--similar to those used in 1986--were selected to represent them (Figure 10). The upper reach, from Thompson Flat to Magruder Guard Station, contains the 1.6 km Grass Gulch-Lunch Creek index area (not used in 1986) and the 0.6 km Magruder Guard Station-Deep Creek area. The middle reach, from Deep Creek downstream to Indian Creek, includes the 3.2 km Magruder Crossing-Little Clearwater River index area, which corresponds to IDFG Index Area 8 (Figure 11). The lower reach, Indian Creek to White Cap Creek, includes the 1.3 km Little Creek-Stewart Creek index area. In 1986, this index area was within a larger one that extended from Washout Creek to Stewart Creek. In 1987, it was shortened because most of its spawning habitat lies inside the 1.3 km between Little and Stewart creeks. All upper Selway reaches are within IDFG Index Areas.

Bear Creek was surveyed twice, on August 26 and September 10. Upper Selway areas were surveyed three or four times during the periods August 11-15 and 23-27, and September 8-12 and 21-24. IDFG aerially surveyed all 10 of its index areas on September 9 (during the NPT's third survey period), and conducted its ground counts in Area 8 on August 26 and September 3.

NPT survey and data collection methodologies are described in detail by Heindl (1987). In each index area, numbers of redds, live fish, and carcasses were recorded. Redd locations were marked with streamside flagging. Different-colored flagging was used on separate surveys to enable recognition of previously observed redds and to afford a means by which to monitor the period of redd visibility.

Carcasses were examined for marks and tags, measured to the nearest 0.5 cm for fork and mid-eye-to-hypural plate lengths, and opened to determine sex and approximate percent of gametes spent. Scale samples were collected to provide verification of initial age determinations made using Hall-Griswold and Cochnauer's (1986) age/length correlation. When available, relevant data were also collected from carcasses located outside the index areas to augment the typically small data sets collected within them. Both data sets are summarized in Murphy (1987).

RESULTS

A total of 39 redds, 34 of which were in index areas, was counted during the Selway River surveys (Tables 19 and 20).

Table 21 compares 1986 and 1987 index area redd counts in the upper Selway. The primary difference between the two counts is a reduction from 17 to 6 in the Magruder Crossing - Little Clearwater River index area. Ground surveys were not conducted on Bear Creek prior to 1987.

Sixteen carcasses were recovered and examined -- four (3 males and 1 female) in the Bear Creek index area and twelve (8 males, 3 females, and 1 unidentified) in upper Selway areas (Murphy 1987). Bear Creek male mid-eye to hypural plate lengths were 54.0, 60.5, and 76.0 cm. Based on the age/length relation developed by Hall-Griswold and Cochnauer (1986), the two smaller fish were classified as age IV, the larger as age V. The female (71 cm) was age V.

Although two carcasses located in the upper Selway were too decomposed to accurately measure, eight males and two females were in sufficiently good condition to examine. The males ranged in length from 56.5 cm to 78.0 cm. Two were classified as age IV; the remaining six were age V. The two measurable females (73.0 and 74.0 cm) were both age V. Although live jacks were seen during the surveys, no jack carcasses were found.

DISCUSSION

Comparison of the results of NPT ground surveys and IDFG ground and aerial surveys reveals some noteworthy differences. Both agencies conducted ground surveys on the Magruder Crossing-Little Clearwater River index area (IDFG Area 8). Early-season surveys (August 13 and 24) allowed NPT to identify and subsequently disregard steelhead or previous years' chinook redds, but later IDFG surveys apparently counted some of them as 1987 chinook redds. The Selway drainage received less than normal snowpack during the winter of 1986-87 (USGS 1987), and the subsequent spring run-off apparently did not produce the substrate scouring and redistribution that normally erases old redds.

Aerial surveys, as might be expected, may overlook some redds that are obscured by trees, instream debris, and shadows. In the Bear Creek index area, IDFG's September 9 aerial survey counted eight redds. A day later the NPT ground survey counted 12 there.

Table 19. New redds, live fish, and carcasses observed in index areas during the Selway River spawning ground survey, Middle Fork Clearwater River system, 1987.

Stream Section	Survey Date	New Redds	Live Fish	Carcasses
Selway River				
Grass Gulch -	8/13	1	2	0
Lunch Creek	8/24	1	1	0
	9/12	*	*	*
	9/22	2	0	1
Total		**4**	**3**	**1**
Magruder G.S -	8/13	0	0	0
Deep Creek	8/24	3	6	0
	9/08	4	5	1
	9/24	0	0	1
Total		**7**	**11**	**2**
Magruder Xing -	8/13	0	0	0
Little Clear-	8/24	3	5	0
water River	9/09	3	4	0
	9/23	0	0	0
Total		**6**	**9**	**0**
Little Creek -	8/14	0	0	0
Stewart Creek	8/27	*	*	*
	9/11	5	10	4
	9/23	0	1	1
Total		**5**	**11**	**5**
Bear Creek				
Salmon Hole -	8/26	4	14	1
Cub Creek	9/10	8	3	3
Total		**12**	**17**	**4**
INDEX AREA TOTAL		**34**	**51**	**12**

*No survey completed.

Table 20. New redds, live fish, and carcasses observed outside of index areas during the Selway River spawning ground survey, Middle Fork Clearwater River system, 1987.

Stream Section	Survey Date	New Redds	Live Fish	Carcasses
Selway River				
Thompson Flat -	8/13	1	0	0
Grass Gulch &	8/24	1	4	0
Lunch Creek -	9/12	*	*	*
Magruder G.S.	9/22	0	0	1
Total		**2**	**4**	**1**
Deep Creek -	8/13	0	0	0
Magruder Xing &	8/24	0	0	0
Little Clear-	9/08	1	1	1
water River -	9/23	1	0	0
Indian Creek				
Total		**2**	**1**	**1**
Indian Creek -	8/14	0	5	0
Little Creek &	8/25	1	3	0
Stewart Creek -	9/11	0	0	1
White Cap Creek	9/23	0	0	1
Total		**1**	**8**	**2**
Bear Creek				
Mouth -	7/23[a]	0	10	0
Salmon Hole	8/26	0	0	0
	9/10	*	*	*
Total		**0**	**10**	**0**
TOTAL OUTSIDE INDEX AREA		**5**	**23**	**4**

* No survey completed.

[a] Reconnaissance trip data.

Table 21. Upper Selway River redd counts by index area and reach, 1986 and 1987. [1986 Data from Johnson and Hill (1986)].

Index Area	Number of Redds 1986	Number of Redds 1987
Grass Gulch - Lunch Cr.	1[a]	4
Magruder G.S. - Deep Cr.	6	7
Magruder Crossing - Little Clearwater River	17	6
Little Cr. - Stewart Cr.	4[b]	5
Reach[c]		
Thompson Flat - Deep Cr. (upper reach)	9[a]	13
Deep Cr. - White Cap Cr. (middle and lower reaches)	24	14

a/ All or part of survey completed from trail; data not directly comparable with the 1987 streamside count.

b/ Does not include counts from the Washout Creek-to-Little Creek portion of the 1986 index area.

c/ Includes data from index areas within reach boundaries.

Discrepant counts may also result from differences of opinion as to whether suspected clustered or overlapping "redds" are actually multiples or just one redd with several upstream pockets. Different methodologies make comparisons of the two agencies' data unappealing. Also, neither data set provides an estimate of escapement that can be statistically bounded. Aerial surveys and one-time "peak" counts may underestimate redd numbers (Schwartzberg and Roger 1986a), and no estimates of spawning in unsurveyed areas can be made.

The 1987 spawning period was consistent with historical timing (mid-August to mid-September), although two completed redds and two live fish were observed in the Thompson Flat - Deep Creek reach on August 13 -- somewhat earlier than might be expected. Redds appeared "weathered" and only one live fish was observed during the entire fourth survey period of September 20-26. The highest number of new redds for all index areas combined was recorded during the third survey period, indicating that peak spawning occurred sometime between August 23 and September 12 (Figure 12).

Redds remained visible for over 40 days, a redd-life similar to that reported in the Yakima River (Schwartzberg and Roger 1986a). Johnson and Hill (1986) reported a redd-life of 20-25 days in the upper Selway River during 1986, and attributed the reduced visibility to increased periphyton growth encouraged by elevated water temperatures associated with that year's hot weather. Similar conditions in 1987 also promoted algae growth, but not to the extent that redds became unrecognizable during the survey season.

Flows in 1987 were exceptionally low, even compared to the drought-year run-off of 1977 (Table 22). Still, plenty of good spawning area was available to the few fish in the streams, and their redds were probably not dewatered. Spawners typically built redds in the faster-flowing waters of riffle areas, and closer to stream banks than to mid-channel.

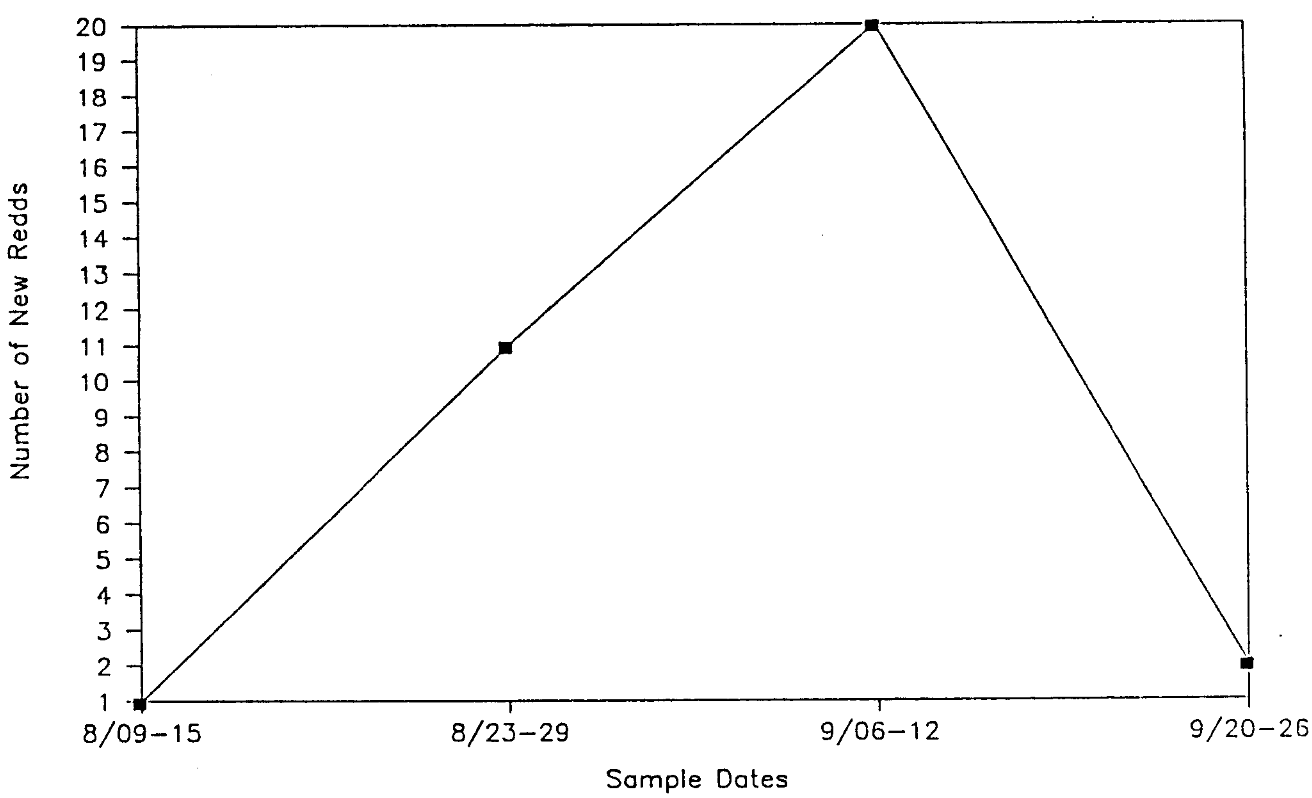

Figure 12. New redds by sampling period in five Selway River chinook spawning areas, 1987.

Table 22. Comparison of stream flow data from Selway River gauging station number 13336500 for selected dates in 1977 (USGS 1979), 1984 (Harper et al. 1985), 1985 (Harenberg et al. 1986), 1986 (USGS 1987), and 1987 (USGS 1987).

	Stream Flow, m^3/s (cfs)			
			Lowest Period Flow	
Year	August 13	September 24	Date	Flow
1977	15.5 (547)	27.8 (982)	8/22	13.8 (486)
1984	32.8 (1,160)	39.9 (1,410)	8/31	19.8 (701)
1985	32.0 (1,130)	34.3 (1,210)	9/01	15.3 (541)
1986	19.7 (694)	21.4 (757)	9/07	15.6 (549)
1987	14.9 (527)	10.2 (359)	-- a/	--

a/ Data not available for the period August 14 - September 23. An October 20 measurement by USGS was 10.3 m^3/s (358 cfs), and flows appeared stable during September at approximately 10 m^3/s.

WENATCHEE RIVER

DESCRIPTION OF STUDY AREA AND STOCK

The Wenatchee River Basin includes approximately 2,130 km^2 of north-central Washington state (USGS 1973) (Figure 13), containing some 370 km of major streams and rivers. The basin is bordered on the north and east by the Entiat Mountains, on the west by the Cascades, and on the south by the Wenatchee Mountains.

Lake Wenatchee, 8 km in length and 990 hectares (ha) in area, is the Basin's principal standing water feature and the Wenatchee River's "source." The lake's average depth is about 55 m. Its water is relatively clear and of low productivity, typical of an oligotrophic lake. The snow-fed White and Little Wenatchee rivers are its principal sources of in-flow.

The Wenatchee River flows for about 87 km from the lake to its confluence with the Columbia River at Wenatchee, Washington. Principal tributaries are Nason Creek, Chiwawa River, Icicle Creek, and Peshastin Creek. The river's average annual discharge, measured from 1962 to 1972 at the USGS gauge at Monitor, was 98.5 m^3/s (3.48 kcfs). Maximum and minimum flows during the same period were 813 m^3/s (28.7 kcfs) and 13 m^3/s (0.46 kcfs), respectively.

There are at least three possible barriers to upstream fish passage within the Wenatchee River: 1) Dryden Dam (2.4 m high) at RKm 27; 2) Tumwater Canyon (particularly the downstream entrance during high flow periods) at RKm 43; and 3) Tumwater Dam (4.6 m high), about 6 km inside Tumwater Canyon (Figure 13). The dams are laddered to permit adult fish passage, but there are no migration aids at potential natural delay areas in Tumwater Canyon.

The Wenatchee is one of three upper Columbia tributaries that continue to support runs of wild spring chinook. Based on fish counts at Rocky Reach and Rock Island dams, located on the Columbia River immediately above and below the Wenatchee-Columbia confluence, the wild spawning run between 1977 and 1986 ranged from about 1,500 to 7,800 fish. Adult spring chinook begin re-entering the Wenatchee in April, with passage at Tumwater Dam extending from early May into July. The fish spawn from about mid-August through September, primarily above the Chiwawa-Wenatchee river confluence (Figure 13). Juvenile spring chinook typically rear in the system for one year before smolting.

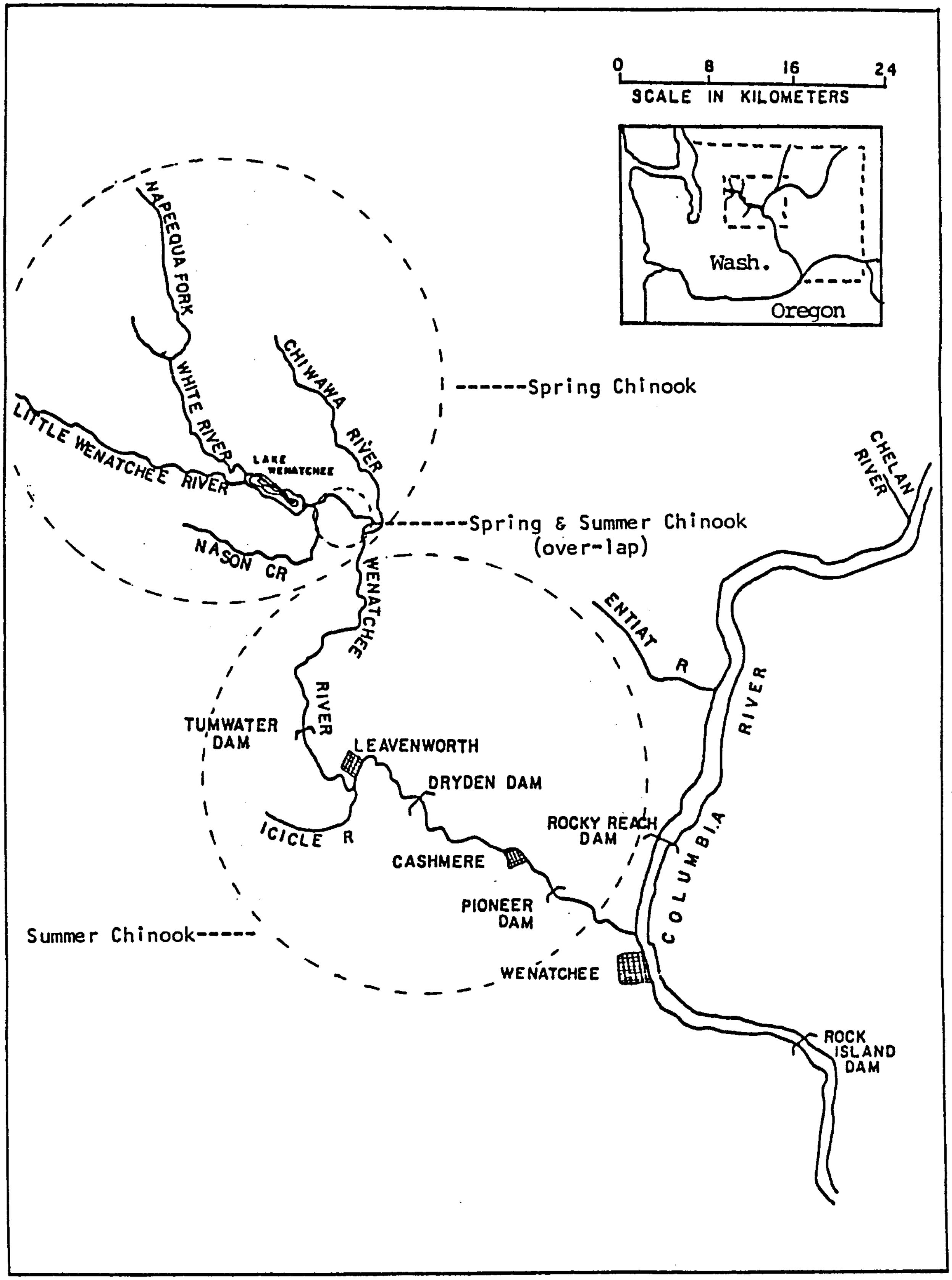

Figure 13. Wenatchee River Basin, Washington.

METHODS

Spring chinook spawning ground surveys have been conducted in the Wenatchee Basin by various agencies, e.g., the National Marine Fisheries Service, United States Fish and Wildlife Service, and Washington Department of Fisheries (WDF), since at least the 1950s and, since 1981, by the Chelan Public Utility District (PUD). The Yakima Indian Nation (YIN) participated in the 1986 surveys and became the lead agency conducting them in 1987.

Redds were counted as surveyors walked or rafted a stream section. To promote familiarity with the reach and accuracy and consistency in the counts, the same two-man teams surveyed the same sections on each occasion. Surveys began around the historical starting date of spawning and were repeated at intervals of approximately two to three weeks. The White River was surveyed twice, on and August 17 and 31. Little Wenatchee River surveys were conducted August 17 and 31, and September 2. The Chiwawa River was also surveyed on three occasions: August 18-20, September 2-3, and September 22-23. Upper sections of Nason Creek (above Kahler Creek) were surveyed August 18, September 1, and September 21; the lower sections were surveyed on only the last two dates.

All new redds were marked with a streamside flag, on which were recorded the redd number, survey date, and redd pocket position relative to the flag. Where new redds were closely spaced, each distinct pocket and associated mound combination was counted as one redd.

Live fish and carcasses were counted. Carcasses were examined for marks and tags, measured for mid-eye-to-hypural plate and fork lengths, and opened to determine sex and the amount of eggs or sperm retained. Scale samples were collected when possible (Heindl 1987). Snouts from adipose-clipped fish were collected for later dissection and recovery of coded wire tags in the laboratory (Fast et al. 1987).

RESULTS AND DISCUSSION

No trends in the number of redds over time are apparent (Tables 23 and 24). The one-time, peak index counts are not directly comparable with the multiple counts from 1987 surveys by the YIN.

Table 23. New redds, live fish, and carcasses observed during the Wenatchee River system spring chinook spawning survey, 1987.

Stream Section and Distance	Survey Date	New Redds	Live Fish	Carcasses
WHITE RIVER				
Grasshopper Meadows - Nepeequa	8/13	16	2	1
(RKm 21.1 - 17.7)	8/31	20	22	10
Nepeequa - Big Bend	8/17	6	1	0
(RKm 17.7 - 11.6)	8/31	2	3	0
Big Bend - Sears Creek	8/17	0	0	0
(RKm 11.6 - 8.7)				
Total		**44**	**28**	**11**
LITTLE WENATCHEE RIVER				
Riverside Campground - Viewpoint	8/17	2	12	2
(RKm 11.9 - 8.4)	8/31[a]	37	23	14
	9/02	42	21	15
Total		**81**	**56**	**31**
CHIWAWA RIVER				
Phelps Creek - Alpine Meadow	8/18	48	14	1
(RKm 48.6 - 45.1)	9/02	0	0	6
	9/22	17	0	1
Alpine Meadow - Atkinsons	8/19	92	51	6
(RKm 45.1 - 40.3)	9/02	24	15	7
	9/22	7	1	1
Atkinsons - Schaefer Creek	8/19	43	33	2
(RKm 40.3 - 35.9)	9/02	48	3	0
	9/22	4	0	0
Schaefer Cr. - Finner Campground	8/20	48	65	3
(RKm 35.9 - 30.8)	9/03	15	3	3
	9/23	11	0	1

- continued -

Table 23. (concluded)

Stream Section and Distance	Survey Date	New Redds	Live Fish	Carcasses
Finner Campground - Grouse Creek (RKm 30.8 - 18.8)	8/20	41	24	0
	9/03	27	17	8
	9/23	7	0	2
Grouse Creek - Plain (RKm 18.8 - 0.0)	9/23	12	--	--
Total		**444**	**226**	**41**

a/ Incomplete survey; entire reach resurveyed 9/02.

Table 24. WDF one-time, "peak" redd counts in Wenatchee Basin spring chinook index streams, 1976-86.[a/]

Stream	Year (19--) 76	77	78	79	80	81	82	83	84	85	86
Upper Nason Creek	103	94	233	70	66	69	93	139	71	162	65
Little Wenatchee R.	19	0	27	0	22	36	40	51	64	55	42
White River	36	39	44	--	--	18	19	89[b/]	49	119	61
Chiwawa R. (index)	220	293	279	59	119	84	97	165	181	320	181
Icicle River	138	15	55	89	91	18	21	15	43	17	26
Total	**516**	**441**	**638**	**—**	**—**	**225**	**270**	**459**	**408**	**673**	**375**

a/ Chelan PUD has duplicated WDF surveys in most areas since 1981. Counts by the two organizations sometimes differ substantially, but neither is consistently higher or lower.

b/ Chelan PUD count substituted for missing WDF data.

Mean lengths of the 121 spring chinook carcasses sampled in Wenatchee Basin surveys are given in Table 25. Scale samples collected from these carcasses are undergoing analysis to establish length-age relationships.

Table 25. Number and mean mid-eye-to-hypural plate length of spring chinook carcasses sampled in Wenatchee River system streams, 1987.

	Males		Females	
Stream	Number Measured	Mean Length (cm)	Number Measured	Mean Length (cm)
Little Wenatchee	6	67.2	16	70.8
Nason Creek	4	75.5	7	69.7
Wenatchee River	38	67.4	19	80.5
Chiwawa River	7	59.2	14	67.7
White River	6	66.2	4	70.2
Total	**61**	**66.9**	**60**	**73.0**

Spring Chinook

YAKIMA RIVER

DESCRIPTION OF STUDY AREA AND STOCK

The Yakima Basin encompasses about 9,850 km^2 of south-central Washington. From its headwaters in the Cascade Mountains, the Yakima River flows generally southeast for 348 km and empties into the Columbia river near the town of Richland (Figure 14). The subalpine region in which the River originates receives abundant precipitation, but for three-fourths of its length the Yakima flows through a semi-arid environment. Yakima waters have been used for agriculture for over a century and, with the aid of five major storage reservoirs, they now irrigate 200,000 ha. The Yakima's largest tributary, the Naches River, drains 2,860 km^2 and enters just above the city of Yakima.

Spring chinook adults normally begin entering the Yakima mainstem about mid-April. Counts at Prosser Dam (RKm 75), the first project on the River where counting occurs, indicate peak passage occurs there about the third week of May and by late July the run has moved upstream. Spawning begins in early August in the American River, a Naches River headwater tributary, and extends through mid-October in the upper Yakima and Cle Elum rivers. Spring chinook spawn in virtually all available, suitable habitat upstream of the city of Yakima. Juvenile fish rear for one year in fresh water before outmigrating. Most adults return in their fourth year, after having spent two full years in salt water. The American River run segment, however, typically contains numerous five-year-old fish, which have spent three years in the ocean.

METHODS

One-time surveys of peak spring chinook spawning have been conducted in the Yakima Basin since at least the 1950s. Multiple ground surveys were initiated there in 1981. The streams, the number of surveys undertaken, and the beginning and ending 1987 survey dates are given in Table 26. Generally, a stream was first examined about the time spawning historically commenced, and investigations ceased after relatively few new redds were observed. The intervals between surveys were approximately one week on the American River, and one to three weeks on other streams. Specific survey methods are the same as those described for Wenatchee spring chinook (page 51).

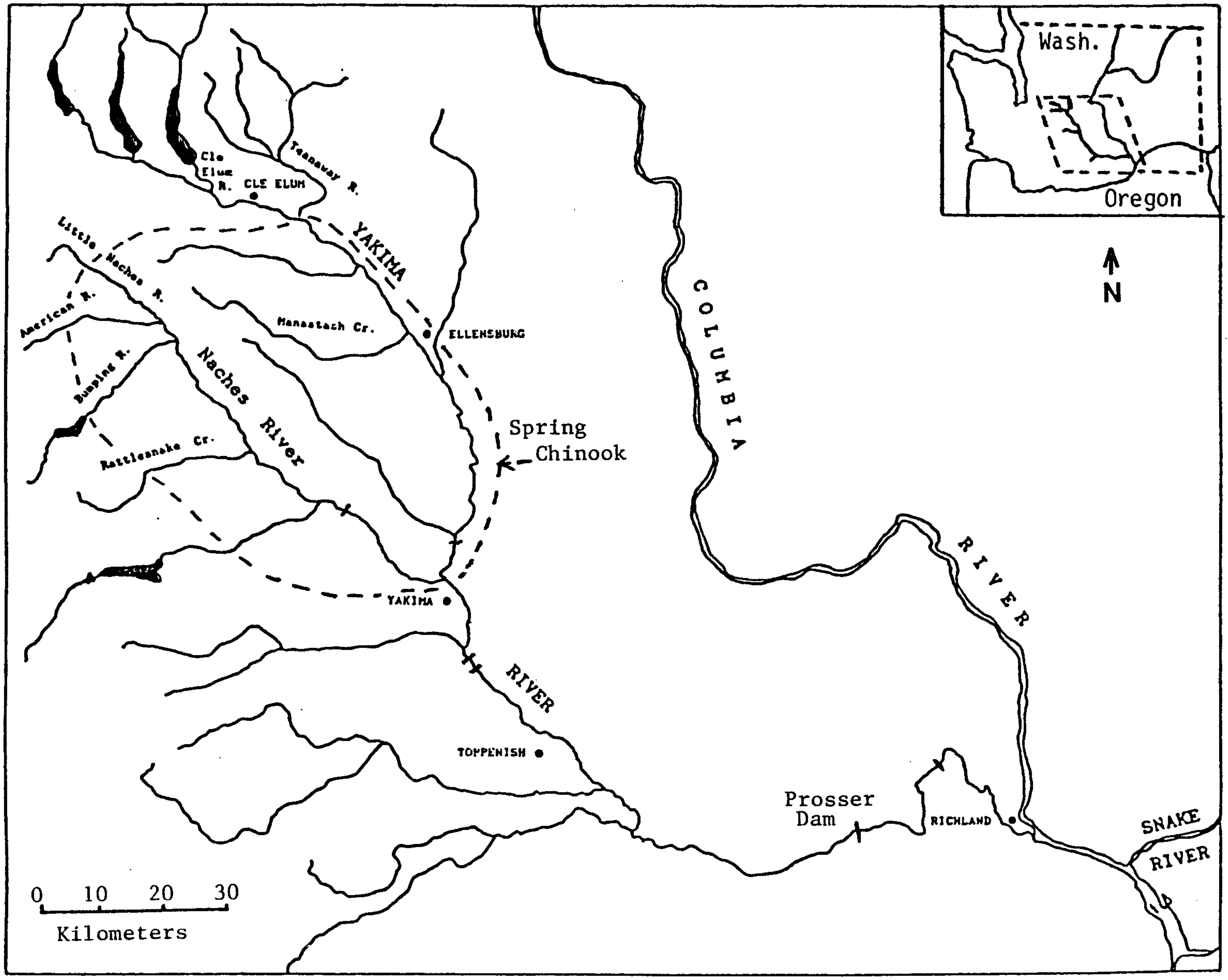

Figure 14. Yakima River Basin, Washington.

Table 26. Summary of spring chinook spawning surveys conducted on Yakima River Basin streams, 1987. (Footnoted survey sections are further described in Table 29.)

Subsystem Stream	Number of Surveys	Survey Dates First	 Last
Naches Subsystem			
American River	4[a/]	8/07	8/27
Bumping River	4	8/24	9/29
Little Naches River	4[b/]	8/26	9/30
Rattlesnake Creek	2[c/]	9/17	10/02
Naches River: (above Horseshoe Bend)[d/]	5	8/25	10/15
(below Horseshoe Bend)	3[e/]	9/30	11/05
Yakima Subsystem			
Cle Elum River	4	9/15	10/25
Manastash Creek	0[f/]		
Teanaway River	0[f/]		
Yakima River: (above Ellensburg)	5[g/]	9/04	10/23
(below Ellensburg)	2[h/]	10/09	11/03

a/ On 9/04, the section from Pleasant Valley to Summer Homes was surveyed a fifth time.

b/ Crow Creek, a Little Naches tributary, was surveyed once on 9/09.

c/ South Fork Rattlesnake Creek was surveyed once on 10/02.

d/ Horseshoe Bend is at RKm 33.8.

e/ The lower 17.1 km below Naches Game Access was surveyed only on 11/06.

f/ Not surveyed because of low water.

g/ The section between So. Cle Elum Bridge and Teanaway River was surveyed only four times between 9/15 and 10/23. The two sections from Teanaway River to KOA were surveyed twice, on 10/08 and 10/26.

h/ The section from Selah Bridge to Ahtanum Creek was surveyed only on 11/12.

RESULTS

Redds were first observed in the American River on August 6, and spawning continued in the Yakima Basin until late October. Spawning peaked in the American River almost a month earlier than in other Yakima Basin streams, suggesting a genetically distinct American River population.

Tables 27-32 detail the 1987 survey data (Fast 1987). Table 33 displays redd count totals from 1981 to 1987, but these yearly summaries are not directly comparable because of changes in survey areas and methods during the seven-year period.

Listed in Table 34 are the streams and stream sections surveyed consistently since 1981, with their respective redd counts. These counts provide a basis for meaningful comparison of yearly data. Data for streams not surveyed consistently (e.g., Naches River below Horseshoe Bend, Manastash Creek, Teanaway River, and all sections of the Yakima River below its confluence with the Teanaway) are omitted.

A total of 372 carcasses were measured during the surveys: 129 in the Naches subsystem and 243 in the Yakima. Table 35 gives the number and mean lengths of carcasses sampled in each Yakima Basin tributary. Sex-specific probabilities for age at a given length (Figure 15) were determined from analysis of scales collected in 1987.

DISCUSSION

Total redds in the consistently surveyed streams were only 60% as numerous in 1987 (1,470) as in 1986 (2,448) (Table 34). But because the 1987 escapement of 4,390 fish at Prosser Dam was considerably lower than the 9,442 counted in 1986 (Fast et al. 1986, 1987), this decrease was expected. Review of available smolt outmigration data (Fast et al. 1986) for 1982-84, years contributing to 1986 and 1987 adult returns, reveals no significant size differences in the outmigrant runs. This suggests that factors other than egg-to-smolt survival contributed to the decreased adult return seen in 1987.

Recent years' redd counts should be viewed with the understanding that newly improved fish passage facilities in the Yakima Basin have contributed to the generally increasing spawning escapements seen there after 1983. Since passage of the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (PL 96-510), and adoption of the Northwest Power Planning Council's (NPPC) Fish and Wildlife Program in 1982, major--improvements--including new fishways and screens--have been made at five major irrigation diversion dams on the Yakima mainstem and at one on the Naches River (NPPC 1987). Chinook must pass these projects to reach their spawning grounds. In past years, passage delays at the diversion structures contributed to pre-spawning mortalities among Yakima River chinook (Bob Tuck, Eco-Northwest Consultants, Granger, WA, personal communication).

passage delays at the diversion structures contributed to pre-spawning mortalities among Yakima River chinook (Bob Tuck, Eco-Northwest Consultants, Granger, WA, personal communication).

Hatchery-reared fish have been planted in the Yakima system since 1958 (Fast et al. 1986). Prior to 1981, most releases were numerically small and probably contributed little to subsequently returning adult runs (Wasserman et al. 1985). Since 1981, these releases have increased in magnitude (180,000 to 500,000 smolts and/or pre-smolts per year). These releases may have played a part in the larger redd counts seen in 1984 and thereafter. The Yakima Indian Nation's Fisheries Resource Management program initiated efforts in 1984 to use indigenous Yakima River fish as a base for a hatchery program designed to further enhance existing in-river production (Wasserman et al. 1985).

Table 27. New redds, live fish, and carcasses observed during the American River spring chinook spawning survey, Yakima River system, 1987.

Stream Section and Distance	Survey Date	New Redds	Live Fish	Carcasses
Lodgepole Campground - Union Cr.	8/07	0	1	0
(RKm 22.4 - 18.5)	8/14	2	4	0
	8/21	3	1	0
	8/27	6	1	1
Union Cr. - Pleasant Valley CG	8/06	5	8	0
(RKm 18.5 - 15.6)	8/13	17	18	4
	8/20	8	10	4
	8/27	5	3	1
Pleasant Valley - Summer Homes	8/06	29	18	1
(RKm 15.6 - 12.9)	8/13	29	53	2
	8/21	7	9	7
	8/27	21	14	5
	9/04	7	0	0
Summer Homes - Hells Crossing CG	8/06	21	13	2
(RKm 12.9 - 9.5)	8/13	17	22	5
	8/21	5	3	6
	8/27	8	2	12
Hells Crossing - Pine Needle CG	8/07	10	4	1
(RKm 9.5 - 4.8)	8/14	10	14	3
	8/21	5	1	4
	8/26	6	1	14
Pine Needle - Bumping River	8/07	0	0	1
(RKm 4.8 - 0.0)	8/14	0	0	0
	8/21	0	1	1
	8/26	1	1	0
Total		222	202	74

Table 28. New redds, live fish, and carcasses observed during the Bumping River, Little Naches River, Crow Creek, and Rattlesnake Creek spring chinoo spawning surveys, Yakima River system, 1987.

Stream Section and Distance	Survey Date	New Redds	Live Fish	Carcasses
BUMPING RIVER				
Bumping Dam - Goose Prairie	8/24	1	0	0
(RKm 27.4 - 23.0)	9/08	5	6	7
	9/16	7	2	3
	9/29	6	3	2
Goose Prairie - Soda Springs	8/24	0	0	0
(RKm 23.0 - 13.7)	9/08	7	2	1
	9/16	13	0	0
	9/29	2	0	0
Soda Springs - American River	8/24	4	2	1
(RKm 13.7 - 5.6)	9/08	25	14	6
	9/16	13	4	1
	9/29	6	0	2
American River - Little Naches R.	8/26	11	8	1
(RKm 5.6 - 0.0)	9/09	15	9	12
	9/17	18	6	4
	9/29	0	0	0
Total		**133**	**56**	**40**
LITTLE NACHES RIVER				
Salmon Falls - Bumping River	8/26	9	8	1
(RKm 7.1 - 0.0)	9/09	20	7	11
	9/17	10	5	5
	9/30	2	0	1
Total		**41**	**20**	**18**
CROW CREEK				
(RKm 0.8 - 0.0)	9/09	1	0	0
Total		**1**	**0**	**0**

- continued -

Table 28. (concluded)

Stream Section and Distance	Survey Date	New Redds	Live Fish	Carcasses
RATTLESNAKE CREEK				
Rattlesnake Forks - Summer Homes (RKm 12.4 - 6.4)	9/17	8	0	2
	10/2	1	0	0
Summer Homes - Naches River (RKm 6.4 - 0.0)	9/17	15	2	3
	10/02	0	0	4
South Fork Rattlesnake Creek (RKm 4.8 - 0.0)	10/02	4	0	2
Total		**28**	**2**	**11**

Table 29. New redds, live fish, and carcasses observed during the Naches River spring chinook spawning survey, Yakima River system, 1987.

Stream Section and Distance	Survey Date	New Redds	Live Fish	Carcasses
Bumping River - Cliffdell	8/25	9	3	1
(RKm 71.8 - 65.8)	9/10	42	27	12
	9/18	20	6	7
	10/01	6	0	0
	10/15	2	0	0
Cliffdell - Upper Nile Bridge	8/25	4	1	0
(RKm 65.8 - 49.9)	9/10	25	19	6
	9/18	45	31	4
	10/01	11	0	0
	10/15	4	0	1
U. Nile Bridge - Horseshoe Bend	8/25	1	7	1
(RKm 49.9 - 33.8)	9/10	4	6	0
	9/18	43	22	6
	10/01	14	3	7
	10/15	1	0	4
H'shoe Bend - Naches Game Access	9/30	5	0	0
(RKm 33.8 - 17.1)	10/16	14	0	0
	11/05	1	0	0
Game Access - Yakima River	11/06	1	0	0
(RKm 17.1 - 0.0)				
Total		**252**	**125**	**49**

Table 30. New redds, live fish, and carcasses observed during the Cle Elum River, Manastash Creek, and Teanaway River spring chinook spawning surveys, Yakima River system, 1987.

Stream Section and Distance	Survey Date	New Redds	Live Fish	Carcasses
CLE ELUM RIVER				
Cle Elum Dam - Yakima River	9/15	9	2	1
(RKm 13.2 - 0.0)	9/25	38	36	1
	10/06	24	18	12
	10/25	4	0	0
Total		**75**	**56**	**14**
MANASTASH CREEK				
Hanson Road - Yakima River (RKm 2.3 - 0.0)	Not surveyed because of low water.			
TEANAWAY RIVER				
US Highway 97 - Yakima River (RKm 6.0 - 0.0)	Not surveyed because of low water.			

Table 31. New redds, live fish, and carcasses observed during the upper (above Ellensburg) Yakima River spring chinook spawning survey, 1987.

Stream Section and Distance	Survey Date	New Redds	Live Fish	Carcasses
Easton Dam - Game Ramp (RKm 325.1 - 314.8)	9/04	4	6	0
	9/14	38	38	5
	9/25	112	55	14
	10/05	51	9	30
	10/22	12	0	2
Game Ramp - Twin Bridges (RKm 314.8 - 307.4)	9/04	0	0	0
	9/14	6	4	1
	9/25	31	24	7
	10/05	7	5	9
	10/22	1	0	4
Twin Bridges - S. Cle Elum Bridge (RKm 307.4 - 294.7)	9/04	0	0	0
	9/14	8	4	2
	9/25	131	108	7
	10/05	48	12	34
	10/22	2	0	3
	10/23	2	0	0
S. Cle Elum Br. - Teanaway River (RKm 294.7 - 283.4)	9/15	7	15	1
	9/25	161	81	16
	10/06	34	5	49
	10/23	4	0	6
Teanaway River - Thorp Bridge (RKm 283.4 - 266.2)	10/08	64	9	10
	10/26	6	0	3
Thorp Bridge - KOA (RKm 266.2 - 250.9)	10/08	21	15	1
	10/26	5	0	3
Total		**755**	**390**	**207**

Table 32. New redds, live fish, and carcasses observed during the lower (below Ellensburg) Yakima River spring chinook spawning survey, 1987.

Stream Section and Distance	Survey Date	New Redds	Live Fish	Carcasses
KOA - Wilson Creek Game Ramp	10/09	9	2	4
(RKm 250.9 - 238.5)	11/02	1	0	0
Wilson Creek Ramp - Roza Creek	10/13	3	3	1
(RKm 236.6 - 210.8)	11/02	0	0	0
Roza Dam - Selah Bridge	10/14	125	69	4
(RKm 205.8 - 187.5)	11/03	15	0	1
Selah Bridge - Ahtanum Creek (RKm 187.5 - 172.0)	11/12	0	0	0
Total		**153**	**74**	**10**

Table 33. Spring chinook redd count totals in the Yakima River Basin, 1981-87.

Subsystem / Stream / Section	Year						
	1981	1982	1983	1984	1985	1986	1987
Naches River Subsystem							
American	72	11	36	72	141	464	222
Bumping	20	6	11	26	74	196	133
Little Naches	16	12	9	41	44	110	42
Rattlesnake Creek	0	2	4	24	11	17	28
Naches[a]	64	23	23	57	157	526	252
Subtotal -- **Naches Subsystem**	**172**	**54**	**83**	**220**	**427**	**1,313**	**677**
Yakima River Subsystem							
Cle Elum River	57	30	15	31	153	77	75
Teanaway River[b]	--	--	--	0	3	0	--
Manastash Creek[b]	--	--	--	3	0	0	--
Yakima River							
Easton Dam - Game Ramp	126	204	104	302	322	352	278
Game Ramp - Twin Bridges	35	92	32	66	77	127	45
Twin Bridges - S. Cle Elum Br.	30	159	87	145	137	352	211
S. Cle Elum Br. - Teanaway R.	39	80	77	67	118	253	205
Teanaway River - Thorp Bridge[c]	2	8	20	9	22	118	70
Thorp Bridge - Ellensburg KOA[d]	--	--	--	11	17	110	26

- continued -

Table 33. (concluded)

Subsystem Stream Section	Year 1981	1982	1983	1984	1985	1986	1987
Yakima River Subsystem (concluded)							
Yakima River (concluded)							
Ellensburg KOA - Roza Dam e/	5	--	25	--	11	82	13
Roza Dam - Selah Bridge f/	--	--	--	--	91	321	140
Selah Bridge - Ahtanum Creek g/	--	--	--	--	--	1	0
Subtotal -- Yakima Subsystem	**294**	**573**	**360**	**634**	**951**	**1,793**	**1,063**
GRAND TOTAL -- YAKIMA BASIN	**466**	**627**	**443**	**854**	**1,378**	**3,106**	**1,740**

a/ First surveyed below Horseshoe Bend (RKm 33.8) in 1985.

b/ First surveyed in 1984; not surveyed in 1987 because of low water.

c/ Teanaway section extended to Ellensburg Town Ditch (RKm 259.6) from 1981 to 1984, thereby including part of the later Thorp Bridge-Ellensburg KOA section (RKm 266.2-250.9).

d/ 1984 count is only for the smaller section from Ellensburg Town Ditch to the Ellensburg KOA (RKm 259.6-250.9). No survey below the KOA in 1984.

e/ 1981 and 1983 counts apply only to the reach between Ellensburg Town Ditch (RKM 259.6) and the Wilson Creek Game Ramp (RKm 238.5). No survey below Ellensburg Town Ditch in 1982. Surveys below Wilson Creek Game Ramp began in 1986.

f/ First surveyed in 1985.

g/ First surveyed in 1986.

Table 34. Comparable spring chinook redd count totals in the Yakima River Basin, 1981-87. (Data from Table 33; exclusions noted in text.)

Subsystem / Stream / Section	Year 1981	1982	1983	1984	1985	1986	1987
Naches River Subsystem							
American	72	11	36	72	141	464	222
Bumping	20	6	11	26	74	196	133
Little Naches	16	12	9	41	44	110	42
Rattlesnake Creek	0	2	4	24	11	17	28
Naches	64	23	23	57	157	500	231
Subtotal -- **Naches Subsystem**	**172**	**54**	**83**	**220**	**427**	**1,287**	**656**
Yakima River Subsystem							
Cle Elum River	57	30	15	31	153	77	75
Yakima River							
Easton Dam - Game Ramp	126	204	104	302	322	352	278
Game Ramp - Twin Bridges	35	92	32	66	77	127	45
Twin Bridges - S. Cle Elum Br.	30	159	87	145	137	352	211
S. Cle Elum Br. - Teanaway R.	39	80	77	67	118	253	205
Subtotal -- **Yakima Subsystem**	**287**	**565**	**315**	**611**	**807**	**1,161**	**814**
GRAND TOTAL -- YAKIMA BASIN	**459**	**619**	**398**	**831**	**1,234**	**2,448**	**1,470**

Table 35. Number and mean mid-eye-to-hypural plate length of spring chinook carcasses sampled in Yakima River Basin streams, 1987.

Subsystem Stream	Males: Number Measured	Males: Mean Length (cm)	Females: Number Measured	Females: Mean Length (cm)
Naches Subsystem				
American River	29	66.8	30	71.5
Bumping River	10	68.4	24	72.7
Little Naches River	4	57.2	10	69.3
Rattlesnake Creek	4	63.5	5	63.8
Naches River	7	70.8	24	72.0
Subtotal -- Naches	**54**	**66.7**	**93**	**71.3**
Yakima Subsystem				
Cle Elum River	2	52.0	11	59.3
Manastash Creek[a]	--	--	--	--
Teanaway River[a]	--	--	--	--
Yakima River	73	63.6	139	61.7
Subtotal -- Yakima	**75**	**63.3**	**150**	**61.5**
GRAND TOTAL -- BASIN	**129**	**64.7**	**243**	**65.3**

[a] Not surveyed because of low water.

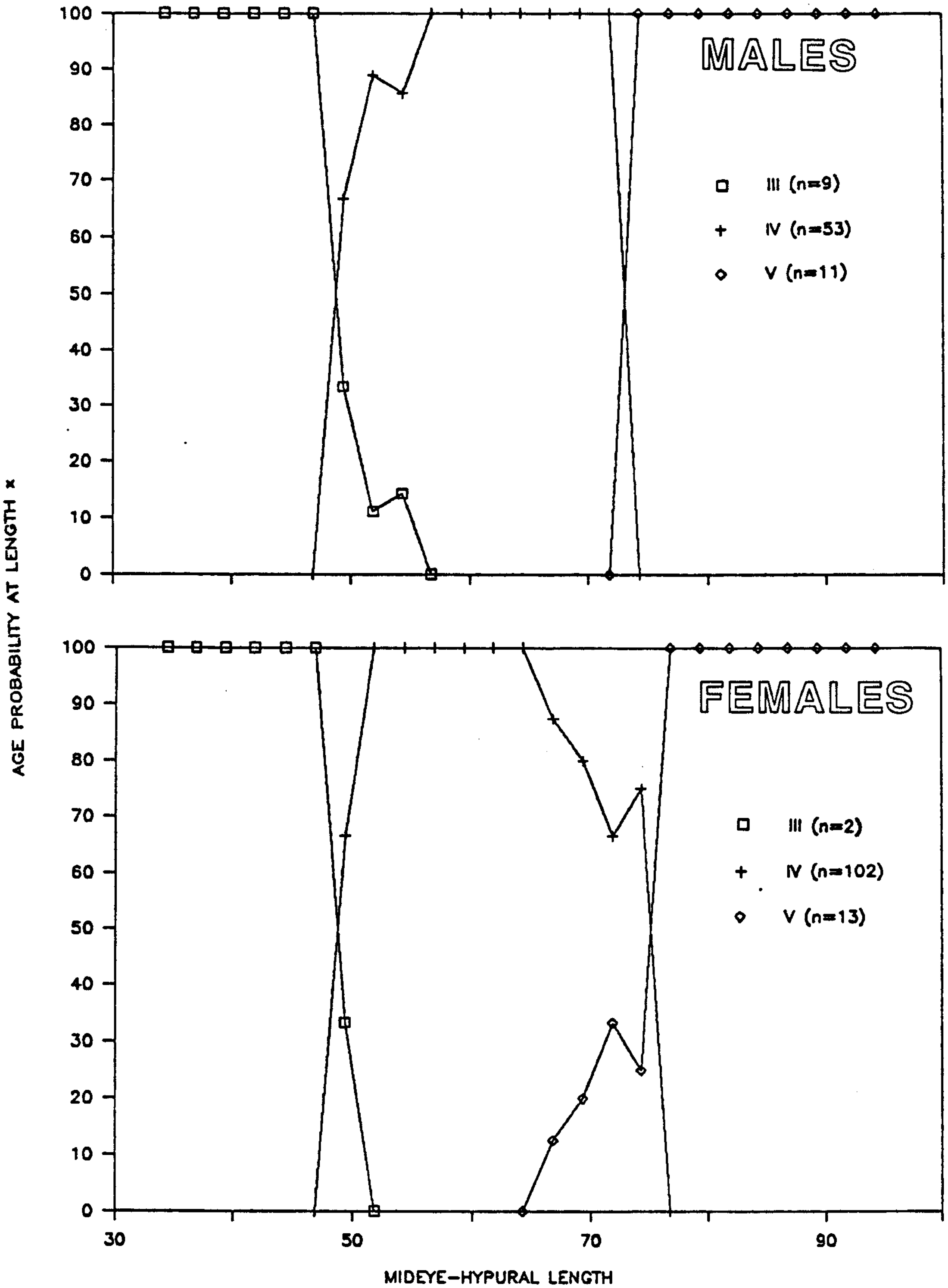

Figure 15. Probability of age at length for Yakima Basin spring chinook spawners, 1987.

SUMMER CHINOOK

Summer Chinook

WENATCHEE RIVER

DESCRIPTION OF STUDY AREA AND STOCK

Summer chinook adults normally return to the Wenatchee River (previously described in this report) during July and August. Most use the lower river (generally below its confluence with the Chiwawa) for spawning, although reproduction may occur as far upstream as Nason Creek (Figure 13). Adult summer chinook are usually somewhat larger than the wild spring chinook which typically spawn in the upper Wenatchee reaches and tributaries. (Note: A hatchery strain of spring chinook returns to the Icicle River and to the Leavenworth Hatchery in the lower Wenatchee.) As juveniles, summer chinook tend to begin outmigrating during their first spring. Unlike spring chinook, they accomplish much of their rearing during their outmigration in the Columbia, rather than spending an entire year in their natal system and outmigrating during their second spring.

METHODS

Multiple summer chinook surveys were conducted in the same fashion as those for spring chinook. On certain gravel bars, however, spawning was so concentrated that specific summer chinook redds could not be readily identified -- even with flagging -- from survey to survey. Therefore, redds were not flagged. Instead, all redds were counted on each survey, three of which were conducted on the entire mainstem below Chiwaukum Campground (RKm 57.8) at 9- to 12-day intervals between October 19 and November 11.

RESULTS AND DISCUSSION

Table 36 summarizes the 1987 summer chinook surveys. The highest redd counts were recorded on the third (final) survey except in the Dryden-to-Cashmere reach, where late-season visibility was poor. For that section, the second survey count (171) is believed to better represent the total number of redds constructed than the third count (143).

Historical one-time peak survey counts by the Chelan PUD and WDF are not in close agreement (Table 37 and Figure 16). Redd counts and escapement estimates suggest that the naturally reproducing summer chinook run in the Wenatchee has increased in strength since a low in the early 1980s. Multiple survey counts by the Yakima Indian Nation in 1987 are not directly comparable to PUD and WDF counts due to differences in methodology and survey area size.

Of the 555 carcasses sexed and measured, 198 were males with a mean mid-eye-to-hypural plate length of 75.2 cm, and 357 were females with a mean mid-eye-to-hypural plate length of 80.0 cm.

Table 36. Total redds, live fish, and carcasses observed during the Wenatchee River summer chinook spawning survey, 1987.

Stream Section and Distance	Survey Date	Total Redds	Live Fish	Carcasse
Chiwaukum CG - Swiftwater CG	10/19	201	261	28
(RKm 57.8 - 54.4)	10/28	218	84	27
	11/09	372	0	10
Swiftwater - Tumwater Dam	10/19	186	177	14
(RKm 54.4 - 52.6)	10/28	262	54	66
	11/09	433	0	54
Tumwater Dam - Golf Course Bridge	10/19	300	425	15
(RKm 52.6 - 42.5)	10/28	392	68	30
	11/09	411	0	67
Golf Course Br. - Dryden	10/20	1058	--	18
2(RKm 42.5 - 27.4)	10/29	1276	--	223
	11/10	1391	38	274
Dryden - Cashmere	10/20	123	218	9
(RKm 27.4 - 15.3)	10/30	171	87	18
	11/11	143	3	30
Cashmere - Columbia River	10/20	83	62	4
(15.3 - 0.0)	10/30	132	31	22
	11/11	177	37	80

Table 37. Wenatchee River peak summer chinook redd counts, 1976-87.

[Includes entire mainstem below Lake Wenatchee (RKm 87.2), and may include some spring chinook redds (see Figure 16).]

	Year											
Organization	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Chelan PUD	1,124	1,411	1,995	1,725	2,040	1,489	1,141	726	1,338	1,121	1,363	2,052
WDF	793	997	1,184	571 a/	1,127	883	553 a/	552	942	-- b/	--	--

a/ Incomplete count; probably excludes area below Leavenworth (RKm 38.5).

b/ Surveys not conducted by WDF after 1984.

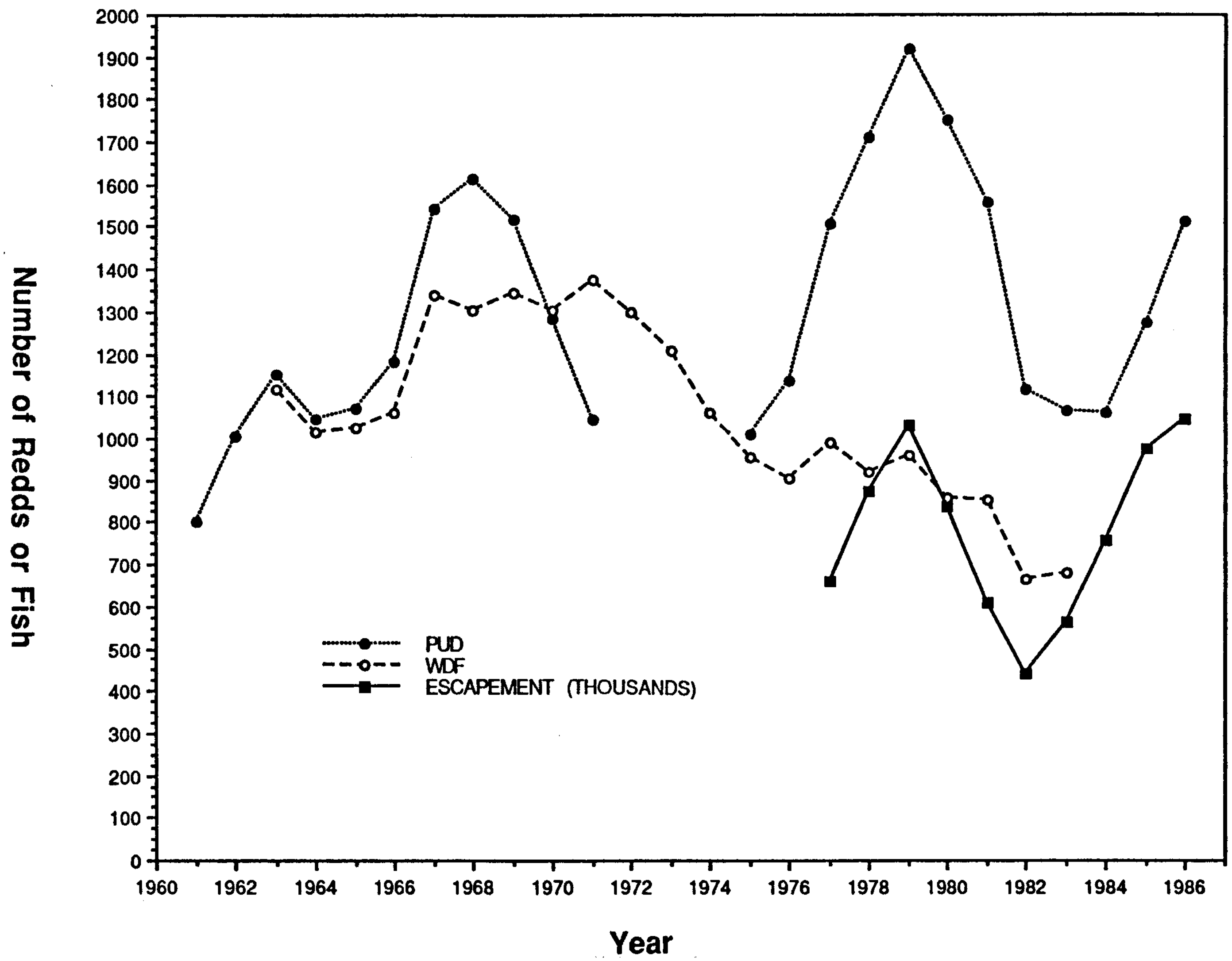

Figure 16. Trends (3-yr smoothing) in Wenatchee River summer chinook peak redd counts (by Chelan PUD and WDF) and escapements, 1961-86. [Escapements are estimated by subtracting counts at Rocky Reach Dam (Columbia RKm 763 about 12km above the confluence of the Wenatchee) from counts at Rock Island Dam (Columbia RKm 729, about 22 km below the Wenatchee). Counts are from one-time surveys near the historical time of peak spawning.]

FALL CHINOOK

Fall Chinook

DESCHUTES RIVER

DESCRIPTION OF STUDY AREA AND STOCK

The Deschutes River Basin covers 27,000 km^2 of central Oregon and is the second largest in the state. Draining the eastern slope of the Cascade Range and portions of the Ochoco Mountains, the river flows northward to enter the Columbia River 330 km from the Pacific Ocean (Figure 17). Flow from 1976 through 1985, regulated by the Portland General Electric Company's (PGE) Pelton-Round Butte hydroelectric project, averaged 138 m^3/s (4.9 kcfs) with a range of 89-419 m^3/s (3.1-14.8 kcfs) at Pelton Reregulating Dam (RKm 161) and 174 m^3/s (6.2 kcfs) with a range of 101-677 m^3/s (3.6-23.9 kcfs) at the river mouth (US Geological Survey, Portland, OR, personal communication).

Upstream fish movement is blocked at Pelton Reregulating Dam, but fall chinook spawn throughout the mainstem up to that point. ODFW began studying chinook in this lower 161 km in 1975, and the run size (harvest and escapement) data set for fall chinook was begun in 1977. Between 1983 and 1985, the Bonneville Power Administration funded a study (Huntington 1985), as part of the Northwest Power Planning Council's Fish and Wildlife Program, to define effects of the PGE hydrocomplex on Deschutes River spawning gravels used by these fish.

There is no hatchery production or release of fall chinook in the system. Spring chinook are reared and released at Round Butte Hatchery and Warm Springs National Fish Hatchery; summer steelhead are also produced at Round Butte.

METHODS

Fall chinook run size in the Deschutes was determined by summing estimates of harvest and spawning escapement. Harvest was estimated using data collected in creel surveys along a 1.6 km reach from Buck Hollow Creek (RKm 69) to Sherars Falls (RKm 70.6) between July 16 and October 31, 1987, a period historically encompassing nearly all angling and fall chinook catch. Most fall chinook harvest in the Deschutes is by recreational anglers and Indian subsistence fishermen and occurs in the vicinity of Sherars Falls. Incidental harvest between the mouth of the Deschutes and Buck Hollow Creek was estimated from data obtained in creel surveys of the summer steelhead fishery in that reach. Based on angler punch card returns and informal interviews with anglers and professional guides, fall chinook harvest above Sherars Falls is negligible, averaging 2.2% of the harvest below the falls in 1984 and 1985 (Don Swartz, Oregon Department of Fish and Wildlife (ODFW), Portland, personal communication).

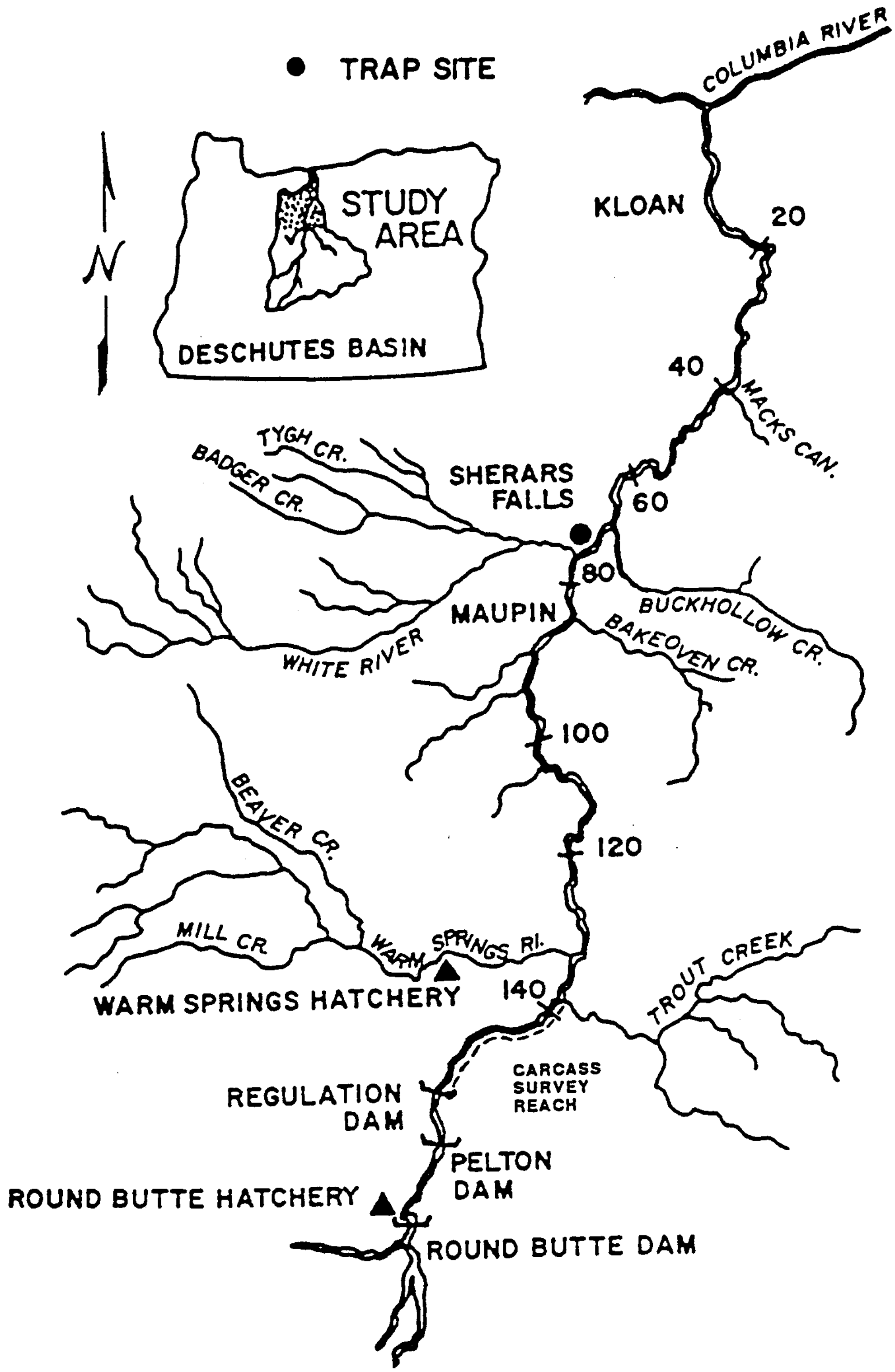

Figure 17. Lower Deschutes River, Oregon.

The creel survey used a "modified" two-stage stratified random sampling design with one **day** representing a sampling unit. Strata depicted in the sampling design included:

1. Season - with each **week** as a stratum; and

2. Week - with **weekday** and **weekend/holiday** strata nested within.

Within each seven-day week, two weekdays and one weekend/holiday day were randomly selected as sample periods. Weekend/holiday sample periods were chosen independent of weekday sample periods.

Because statistical means could not be calculated for data collected during weekend/holiday sample periods (one data point per weekend/holiday period) weekly data for both weekday and weekend/holiday sample periods were pooled by the half-month. For this reason the sampling scheme is described as a "modified" two-stage stratified sampling procedure.

The recreational fishery was sampled from 8:00 a.m. to sunset, and the Indian subsistence fishery was sampled from one hour after sunrise until sunset. Data obtained from anglers included number per party, hours fished, and fish caught by species and fin mark. Data from recreational anglers, Indian net fishermen, and Indian hook and line fishermen at Sherars Falls were recorded separately. Formulas used to estimate fishing effort and harvest appear in the Appendix.

Fall chinook were trapped at the Sherars Falls fish ladder. By closing a weir installed at its top, upstream migrants were diverted into a temporary, steep-pass ladder supplied with pumped water. After ascending the steeppass the fish entered a tank where they were anesthetized with carbon dioxide, measured for fork length to the nearest 0.5 cm, examined for marks, and tagged with a Floy anchor tag. Scale samples were collected from a subsample of trapped fish to determine age at ocean entry and spawning. Fish were then released into a recovery pool above the falls, from which they re-entered the river at will. Generally, the trap was operated from 4:00 p.m. to midnight, five days/week, from August through October.

Fall chinook escapement above Sherars Falls was estimated using Chapman's modification of the Petersen mark-and-recapture method (Ricker 1975). Confidence limits were calculated by assuming a Poisson distribution of mark recoveries and using Appendix II in Ricker (1975). Tagged carcasses were recovered during surveys conducted from a jet sled 1-3 days/week from mid-October to mid-December in the reach between Pelton Reregulating Dam (RKm 161) and Trout Creek (RKm 140). Prior to 1983, the entire reach from Pelton Reregulating Dam to Maupin (RKm 83) was surveyed, but approximately ninety percent of carcass and mark recoveries occurred above Trout Creek. Escapement above Sherars Falls was estimated separately for adults ($\geq$54 cm) and jacks (<54 cm). A 54-cm cut-off was judged appropriate based on age analysis of previous years' scales.

Unfavorable weather and scheduling conflicts prohibited aerial redd counts in 1987. These counts are used to estimate adult escapement below Sherars Falls. Estimated escapement above the Falls is multiplied by the ratio of the number of redds counted in random sample areas below the falls to the number counted in random sample areas above the falls.

$$\text{Adults Below} = \text{Est. Adults Above} \times \frac{\text{Redds Below}}{\text{Redds Above}}$$

For 1987, the average ratio (x=0.28, SD=0.11) of redds counted below Sherars Falls to those counted above, in the years from 1977-86 for which redd count data is available, was used. Jack escapement below Sherars was estimated by the same method:

$$\text{Jacks Below} = \text{Est. Jacks Above} \times \frac{\text{Redds Below}}{\text{Redds Above}}$$

This formula is mathematically identical to that presented in the report by ODFW and CTWS (1987), which initially describes fall chinook monitoring efforts undertaken on the Deschutes in 1987:

$$\text{Jacks Below} = \text{Adults Below} \times \frac{\text{Jacks Above}}{\text{Adults Above}}$$

RESULTS

In 383 hours of trapping at Sherars Falls in 1987, 158 jack and 302 adult fall chinook were captured and tagged. Of the 66 jacks and 485 adults examined during carcass surveys, eight jacks and 45 adults had been tagged at Sherars Falls. Escapement above Sherars Falls was estimated to be 1,184 jacks and 3,201 adults (Table 38).

An estimated total of 277 jacks and 2,117 adult fall chinook were harvested in the Deschutes River in 1987 (Tables 39 and 40, respectively). Total escapement above and below Sherars Falls was estimated at 1,515 jacks and 4,097 adults. Exploitation rates were estimated to be 15% for jacks (Table 41) and 34% for adults (Table 42).

Table 38. Estimated escapement of adult (≥54 cm) and jack (<54-cm) fall chinook in the Deschutes River above Sherars Falls, 1978-87.

Year Age	Population Estimate (95% C.L.)	Tagged	Carcasses Examined for Tags	Recaptured
1978				
Adults	3,564 (3,117-4,076)	992	760	211
Jacks	2,323 (1,462-3,871)	320	122	16
1979				
Adults	2,308 (1,919-2,774)	567	454	111
Jacks	3,042 (2,062-4,680)	489	148	23
1980				
Adults	2,009 (1,640-2,461)	427	431	91
Jacks	1,505 (1,003-2,366)	398	82	21
1981				
Adults	2,495 (2,104-2,959)	542	601	130
Jacks	2,922 (1,812-4,973)	440	105	15
1982				
Adults	3,820 (2,940-4,957)	286	731	54
Jacks	2,625 (1,071-6,563)	99	104	3
1983				
Adults	3,152 (2,265-4,522)	228	467	33
Jacks	738 (301-1,844)	58	49	3
1984				
Adults	1,582 (785-3,460)	48	225	6
Jacks	966 a/	14	43	0
1985				
Adults	1,576 (1,060-2,449)	113	317	22
Jacks	3,208 a/	82	120	2
1986				
Adults	3,137 (2,231-4,563)	197	506	31
Jacks	4,846 a/	66	178	2
1987				
Adults	3,201 (2,406-4,357)	302	485	45
Jacks	1,184 (634-3,133)	158	66	8

a/ Estimated by relationship between number of carcasses examined for tags and escapement, 1977-83. Insufficient number recaptured to use Petersen estimate.

Table 39. Estimated harvest of jack fall chinook (<54-cm) in the Deschutes River, 1971-87.

Year	Indian Subsistence Fishing	Recreational Fishing			
		Sherars Falls	Macks Canyon	Kloan[a]	Mouth
1971	--	--	223	--	--
1972	--	--	177	10	261
1973	1,940	1,308	287	109	564
1974	1,361	1,619	240	84	648
1975[b]	1,750	1,332	183	68	313
1976[b]	789	1,161	143	--	--
1977	723	724	31	5	189
1978[c]	518	1,075	4	--	--
1979	616	1,362	22	--	--
1980	510	910	16	2	69
1981	366	732	29	--	167
1982	366	938	28	--	174
1983	369	290	7	--	12
1984	393	594	--	--	--
1985	789	665	--	--	--
1986	344	1,084	--	--	--
1987	66	205	6	--	0

a/ Located at RKm 10; only point accessible by road between Macks Canyon (RKm 40) and River mouth.

b/ Recreational fall chinook fishery closed until August 1.

c/ Recreational steelhead fishery closed after August 19.

Table 40. Estimated harvest of adult fall chinook (≥54-cm) in the Deschutes River, 1971-87.

Year	Indian Subsistence Fishing	Recreational Fishing: Sherars Falls	Recreational Fishing: Macks Canyon	Recreational Fishing: Kloan[a]	Recreational Fishing: Mouth
1971	--	--	100	--	--
1972	--	--	17	4	84
1973	1,631	340	41	0	27
1974	1,422	339	19	0	7
1975[b]	1,631	474	47	6	194
1976[b]	1,104	333	35	--	--
1977	1,557	247	25	0	32
1978[c]	1,519	442	10	--	--
1979	1,375	217	0	--	--
1980	1,623	291	2	0	35
1981	1,420	380	4	--	33
1982	1,460	489	12	--	55
1983	1,180	278	12	--	26
1984	791	179	--	--	--
1985	660	147	--	--	--
1986	938	215	--	--	--
1987	1,631	457	7	--	22

a/ RKm 10; only road access to the Deschutes between Macks Canyon (RKm 40) and the mouth.

b/ Recreational fall chinook fishery closed until August 1.

c/ Recreational steelhead fishery closed after August 19.

Table 41. Run size and exploitation rate of jack fall chinook in the Deschutes River, 1977-87.

Year	Harvest	Escapement	Run	Exploitation Rate (%)
1977	1,672	2,125	3,797	44
1978	1,597	2,708	4,305	37
1979	2,000	4,338	6,338	32
1980	1,507	1,904	3,411	44
1981	1,294	3,728	5,022	26
1982[a]	1,506	3,360	4,866	31
1983	678	859	1,537	44
1984[a]	987	1,237	2,224	44
1985	1,454	5,384	6,838	21
1986	1,428	5,872	7,300	20
1987[a]	277	1,515	1,792	15

a/ No redd counts. Escapement below Sherars Falls was estimated using the average ratio of redds counted below to those counted above the falls in years with redd counts, 1977-86.

Table 42. Run size and exploitation rate of adult fall chinook in the Deschutes River, 1977-87.

Year	Harvest	Escapement	Run	Exploitation Rate (%)
1977	1,861	5,631	7,492	25
1978	1,971	4,154	6,125	32
1979	1,592	3,291	4,883	33
1980	1,951	2,542	4,493	43
1981	1,837	3,183	5,020	37
1982[a]	2,016	4,890	6,906	29
1983	1,496	3,669	5,165	29
1984[a]	970	2,025	2,995	32
1985	807	2,645	3,452	23
1986	1,153	3,801	4,954	23
1987[a]	2,117	4,097	6,214	34

a/ No redd counts. Escapement below Sherars Falls was estimated using the average ratio of redds counted below to those counted above the falls in years with redd counts, 1977-86.

Table 43. Percent jack and adult composition, Deschutes River fall chinook run, 1987.

Age	Harvest: Indian	Harvest: Recreation (all areas)	Harvest: Total	Tagged	Carcasses Recovered	Total Run Estimate
Jack	4	30	12	34	12	27
Adult	96	70	88	66	88	73
TOTAL	100	100	100	100	100	100

DISCUSSION

The Petersen mark-recapture method is based on assumptions that must be considered when evaluating the population size estimates it renders. Simple tag loss, and/or premature mortality and loss of tagged fish as a result of tagging-related factors, would result in overestimation of population size. Studies conducted in 1979-82 indicated that tag loss averaged 1.5% (range 0 - 4%). This small percentage is disregarded in calculating the escapement above Sherars Falls. The small angling harvest of fish above the falls is assumed to be non-selective for marked fish.

The relative viability of marked and unmarked fish remains in question because the time needed by some tagged fish to recover from the carbon dioxide anesthetic was prolonged (>30 minutes), and the long-term effects of this are unknown. In addition, tagged fish have occasionally been observed below the falls in past years but the extent and effects of this fall-back are also unknown. There is no evidence that tagged and untagged fish distribute differently to spawning areas above the falls. Carcass recoveries in the survey reach from Trout Creek to the Pelton Reregulating Dam are assumed to yield marked/unmarked ratios representative of the Basin.

The trapping operation is also assumed to representatively sample the run ascending the river. However, there is evidence that some adults may leap the 10-to-15-foot height of Sherars Falls (Brian Jonasson, ODFW, Maupin, personal communication), while jacks are more likely to use the ladder and thus be captured (Table 43). This possible behavioral difference, as well as the lower jack carcass recovery rate (5.1% versus 14.9% for adults Table 38), does not bias population estimates as long as separate escapement estimates are made for both groups. Consistent methodology, regardless of assumption-related error, helps insure that trends in estimates reflect actual trends in run size.

The 1987 fall chinook run into the Deschutes River was the largest since 1982 and the third largest in the past 11 years. In general, there was a high harvest of adults in 1987. The adult catch in the recreational fishery more than doubled that of 1986 with only a 1.4% increase in effort. The adult catch in the Indian fishery nearly doubled despite a 15% decrease in effort. The poor jack return resulted in the lowest jack harvest in 11 years of record. The time series of run estimates is not yet adequate to document any changes in escapement of Deschutes fall chinook that may be attributable to Pacific Salmon Treaty implementation.

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APPENDIX

Formulas Used to Estimate Fishing Effort and Harvest of Fall Chinook in the Deschutes River

The creel survey used a "modified" two-stage stratified random sampling design in which one day represented a sampling unit. The sampling design was stratified by:

1. Season - with each week as a stratum; and

2. Week - with weekday and weekend/holiday strata nested within.

Within each seven-day week, two weekdays and one weekend/holiday day were randomly selected as sample periods for each fishery. Weekend/holiday sample periods were selected independent of weekday sample periods. Because statistical means could not be calculated for data collected during weekend/holiday sample periods (one data point per weekend/holiday period), weekly data for both weekday and weekend/holiday periods were pooled by half-month. It is for this reason that the sampling scheme is described as a "modified" two-stage stratified random sampling procedure.

The following formulas are used to estimate fishing effort and harvest:

$\overline{x}_{hk} = (x_{hik})/n_h =$ Sample mean for statistic k in half-month period h for weekdays or weekends-holidays.

$\hat{x}_{hk} = N_h \overline{x}_{hk} =$ Estimated total for statistic k in period h for weekdays or weekends-holidays. Estimates for weekdays and weekends are added to obtain the total estimate for each half-month period.

$\hat{x}_k = \quad \hat{x}_{hk} =$ Estimated season total for statistic k for weekdays and weekends-holidays.

where: N_h = number of weekdays (or weekend days-holidays) in half-month period h.

n_h = number of weekdays (or weekend days-holidays) sampled in half-month period h.

x_{hik} = number of statistic k observed on day i (i = 1, 2, 3, . . ., n_h) in half-month period h.

k = statistic of interest (e.g., angler days, angler hours, catch of a species, catch of a specific fin mark, etc.).

Variances are calculated with the following formulas to determine confidence intervals for the estimates:

$$s^2_{x_{hk}} = \left(\frac{1}{n_h-1}\right) \quad (x_{hik}-\bar{x}_{hk})^2$$

= Sample variance of statistic k in half-month period h for weekdays or weekends-holidays.

$$\hat{Var}\ (\bar{x}_{hk}) = \frac{s^2_{x_{hk}}}{n_h} \quad \frac{N_h-n_h}{N_h}$$

= Estimated variance of mean of statistic k in half-month period h for weekdays or weekends-holidays.

$$\hat{Var}\ (\hat{x}_{hk}) = \hat{Var}\ (\bar{x}_{hk})\ N_h^2$$

= Estimated variance of total for statistic k in half-month period h for weekdays or weekends-holidays.

$$\hat{Var}\ (\hat{x}_k) = \quad \hat{Var}\ (\hat{x}_{hk})$$

= Estimated variance of season total for weekdays and weekends-holidays.

The 95% confidence interval is calculated by

$$\hat{x}_k \pm t_{.05} \quad Var\ (\hat{x}_k)$$

where the degrees of freedom are approximated by (n_h-1).

The **Columbia River Inter-Tribal Fish Commission (CRITFC)** is the coordinating fisheries agency for the Nez Perce, Umatilla, Warm Springs, and Yakima tribes—four Columbia River tribes that reserved fishing rights in 1855 treaties with the United States government.

Since time immemorial, Indian people have lived and fished in the Columbia River's vast basin. Salmon has always been at the center of their diet and their religious lives; as a valued trade item, it has also been of great economic importance to these Native Americans.

Court decisions in the 1960s and 1970s reaffirmed not only the tribes' right to fish, but also their right to co-manage this once plentiful renewable resource. To fulfill their responsibilities as co-managers, the Nez Perce, Umatilla, Warm Springs, and Yakima tribes formed CRITFC in 1977 to be their technical arm on fisheries issues. CRITFC, through its staff of biologists, policy analysts, law enforcement officers, and other specialists, works closely with state and federal agencies, citizen groups, and other tribes to help restore the Columbia Basin's salmon and steelhead runs.

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