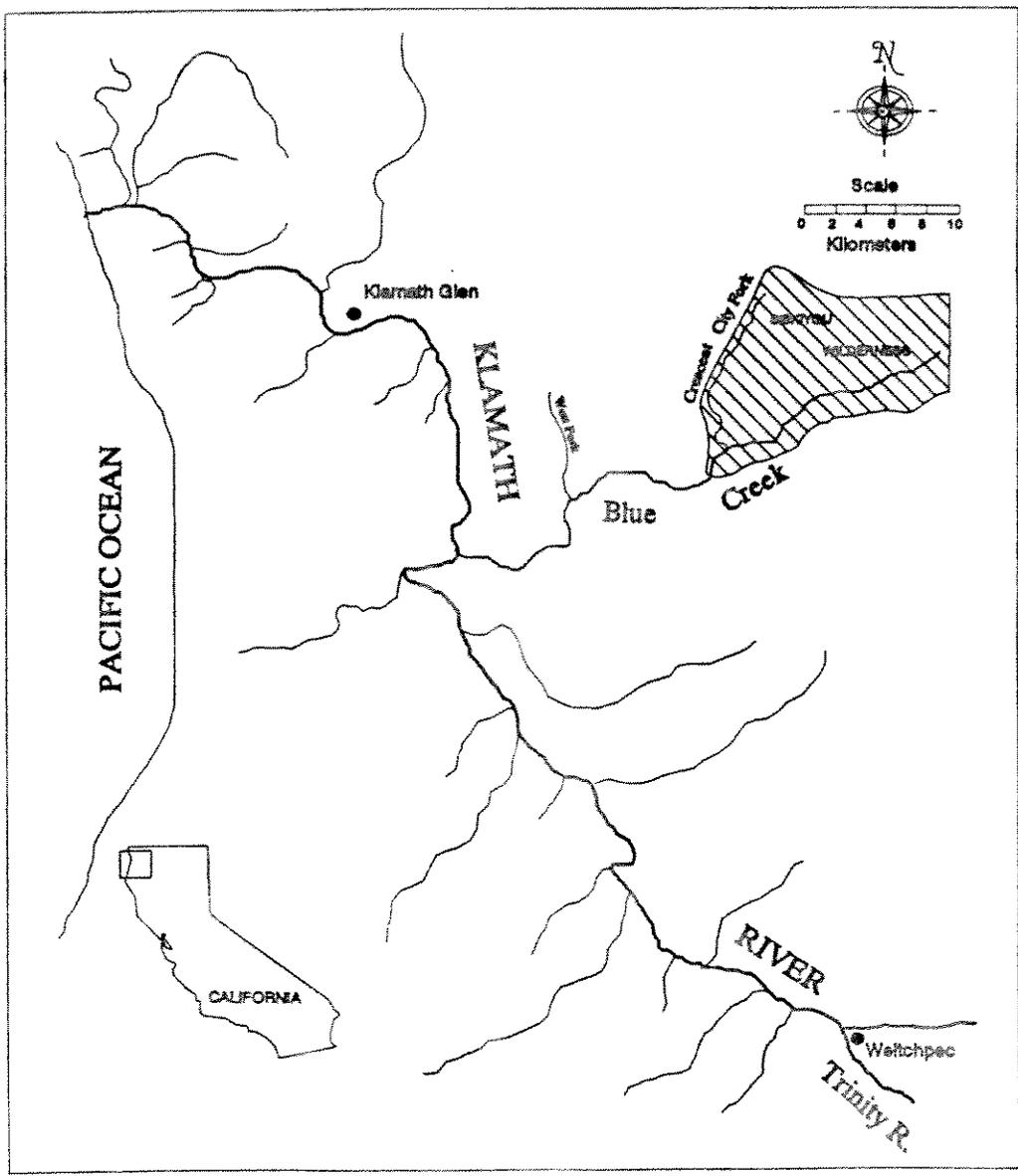


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KLAMATH RIVER FISHERIES ASSESSMENT PROGRAM

INVESTIGATIONS ON BLUE CREEK Annual Progress Report FY 1992

U.S. Fish & Wildlife Service
Coastal California Fishery Resource Office
Arcata, California



PROGRESS REPORT FOR
INVESTIGATIONS ON BLUE CREEK

Fiscal Year 1992

Blue Creek, California

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PROGRESS REPORT FOR
INVESTIGATIONS ON BLUE CREEK
FY 1992

ABSTRACT

The U.S. Fish and Wildlife Service, Coastal California Fishery Resource Office in Arcata, California, was funded to investigate chinook salmon (Oncorhynchus tshawytscha) spawning use, juvenile salmonid emigration, and characterize stream habitats in Blue Creek, a tributary to the Klamath River, California. Investigations began in October 1988, with this reporting period covering October 1991 through September 1992. Adult chinook spawner escapement was addressed by surveys of redds, live fish and carcasses, and by radiotelemetry. Spawner numbers were very low, with only 22 redds observed in fall 1991/winter 1992. The peak count of adult chinook was 97 fish in early November. Radiotelemetry of migrating spawners (n=8) was used to locate remote spawning areas. Emigrating juvenile chinook salmon, steelhead trout (O. mykiss), coho salmon (O. kisutch), and coastal cutthroat trout (O. clarki) were trapped at river kilometer (rkm) 3.35 with a rotary screw trap (screw trap). The trapping period extended from April to July for a total of 75 trapping nights. Screw trap catches totaled 10,688 chinook, 1,388 steelhead, 99 coho and 10 cutthroat. Peak chinook emigration occurred during the week of May 17, which is consistent with the past 3 years of monitoring. A juvenile weir was operated 58 nights, and caught a total of 9,166 chinook, 1,196 steelhead, 127 coho and 1 cutthroat. The index of abundance for emigrating chinook during the 1992 juvenile trapping period was 49,590. Sixty-five percent of the juvenile chinook caught during the trapping season were marked with coded wire tags (n=12,687) and released back into Blue Creek at rkm 3.3. Mean water temperatures varied from 6.3 to 18.6 °C and stream flows ranged from 43 to 2178 cfs (1.3 to 61.7 m³/s) during the Fiscal Year (FY) 1992 study season.

ACKNOWLEDGMENTS

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We wish to thank volunteer Sean Kelly and BIA employee Desma Williams for their assistance in coded wire tagging.

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We also wish to thank the U.S. Coast Guard, McKinleyville Group, for providing helicopter assistance during aerial radiotelemetry.

Thanks especially to Ian Gilroy, who directed project work at Blue Creek in the first part of FY 1992, and to Jim Lintz who assisted with juvenile trapping and coded wire tagging.

Thanks also to Tom Kisanuki and Joseph Polos for editing this report.

INTRODUCTION

The Klamath River Basin, including Blue Creek, a major tributary to the lower Klamath River, has historically supported large runs of chinook salmon (*Oncorhynchus tshawytscha*) and steelhead trout (*O. mykiss*). The watershed has been altered substantially during the past century and particularly during the last four decades. During this period, anadromous salmonid fishery resources have severely declined. Reductions in the quantity and quality of instream habitat, as well as in the population sizes of salmon and steelhead, have coincided with expanded logging and fishing operations, construction of roads and dams, water export, mining, and other development (U.S. Dept. of the Interior, 1985).

In response to problems associated with the anadromous fishery resources of the basin, Congress enacted P.L. 99-552, the Klamath River Fish and Wildlife Restoration Act of 1986. This legislation authorized the Secretary of the Interior to restore anadromous salmonid stocks to historic levels in the Klamath River Basin. In a 1979 report detailing the status of anadromous stocks within the Hoopa Valley Reservation, the U.S. Fish and Wildlife Service (USFWS) found Blue Creek to have "the greatest potential to support anadromous fish of any tributary on the reservation" (USFWS, 1979). Concerns were raised about the restoration program's proposed actions for Blue Creek. Specifically, are there adequate population levels to allow Blue Creek to be considered a broodstock source, and what can be done to restore habitats and rebuild populations to historic levels?

With these questions in mind, the USFWS Coastal California Fisheries Resource Office in Arcata, California (CCFRO Arcata) submitted a five year study proposal in 1989 to the Klamath River Basin Fisheries Task Force to evaluate the status of fall chinook and their habitat in Blue Creek. Work has been ongoing since that time with the final report and recommendations proposed to include data and results from FY 1993. To date the study has gathered information on adult spawner escapement, juvenile emigration characteristics, available spawning habitat, juvenile rearing habitat, general habitat and channel characteristics, stream discharge, and temperature regime.

STUDY AREA

Blue Creek is a fourth-order stream which enters the Klamath River at rkm 26.4 (Figure 1). The stream originates at about 1,500 m elevation and flows south-westerly 37 kilometers (km) to its confluence with the Klamath River. The elevation at the mouth is 12 m. The watershed drains 329 square km (km²) and is the largest tributary to the Klamath River below Weitchpec (rkm 64). It is noted for its clear water, sufficient summer flows, and large chinook salmon (Waterman, 1920). The drainage is steep and mountainous with historically moderate to dense timber growth of coastal redwood (Sequoia sempervirens), incense cedar (Libocedrus decurrens), Port Orford cedar (Chamaecyparis lawsoniana), Douglas fir (Pseudotsuga menziesii), tanoak (Lithocarpus densiflora), and madrone (Arbutus menziesii). Riparian species include alder (Alnus sp.), willow (Salix sp.), California laurel (Umbellularia californica), and big leaf maple (Acer macrophyllum).

The Blue Creek watershed is underlain by four major rock types of the Coastal Range and Klamath Mountains provinces. Proceeding upstream from the mouth, Blue Creek flows through sandstone and shale of the Franciscan Complex; ultramafic rocks (serpentinized peridotite) of the Josephine Ophiolite; slate, metagraywacke, and greenstone of the Galice Formation; and an assemblage of diverse rock types (mostly metasedimentary) of the Western Paleozoic and Triassic Belt (Wagner and Saucedo, 1987). The streambed substrate is generally composed of small and large cobble, with many bedrock controls. Sparsely vegetated flood terraces, dating from the December, 1964 flood, are dominant features below rkm 4.4. Stream gradient averages 1.4% in the lower 23 km (USFWS, 1979).

The watershed is the wettest in the Klamath Basin, with an annual precipitation of approximately 200 cm in the headwaters with about 75% of it occurring during five months of the year (November - March) (U.S. Weather Bureau, 1974). Precipitation runs off quickly, producing rapid fluctuations in discharge and high bedload movement. U.S. Geological Survey (USGS) water discharge records indicate large flow variations ranging from a low of 43 cubic feet per second (cfs) (1.2 m³/s) on November 1, 1965 to 33,000 cfs (934 m³/s) on March 2, 1972 (USFWS, 1979). The extreme flood of December 22, 1964, although outside the period of record (1966-1978), was estimated by USGS at 48,000 cfs (1,360 m³/s).

Three tributaries to Blue Creek have been identified as important to anadromous salmonid spawning and rearing. These include West Fork of Blue Creek, Nickowitz Creek, and Crescent City Fork of Blue Creek, which is the largest and lowest gradient tributary accessible to anadromous fish. These three streams comprise 41% of the area of the entire basin, but only Crescent City Fork of Blue Creek (58.7 km²) is widely used by both salmon and steelhead. A fourth tributary, Slide Creek, has a steep gradient and landslides in the vicinity of the mouth, but may provide access to steelhead during some high flow events. During the summers of 1989 and 1990, the California Department of Fish and Game (CDFG) and California Conservation Corps (CCC) constructed stream habitat enhancement structures on the West Fork of Blue Creek. These log and boulder structures were designed for enhancement of coho salmon and steelhead spawning habitat (C. Harral, personal communication 1990). Additional structures were constructed during the summer of 1992.

A natural barrier to fish movements on the mainstem of Blue Creek is located approximately 1.0 km below the confluence of the East Fork. This barrier consists of a very steep boulder-jammed gorge at rkm 23.6. Below the barrier, four species of anadromous salmonids are present: chinook salmon (O. tshawytscha), coho salmon (O. kisutch), steelhead trout (O. mykiss) and coastal cutthroat trout (O. clarki). The mainstem and East Fork of Blue Creek above the barrier were planted with steelhead, rainbow trout, and eastern

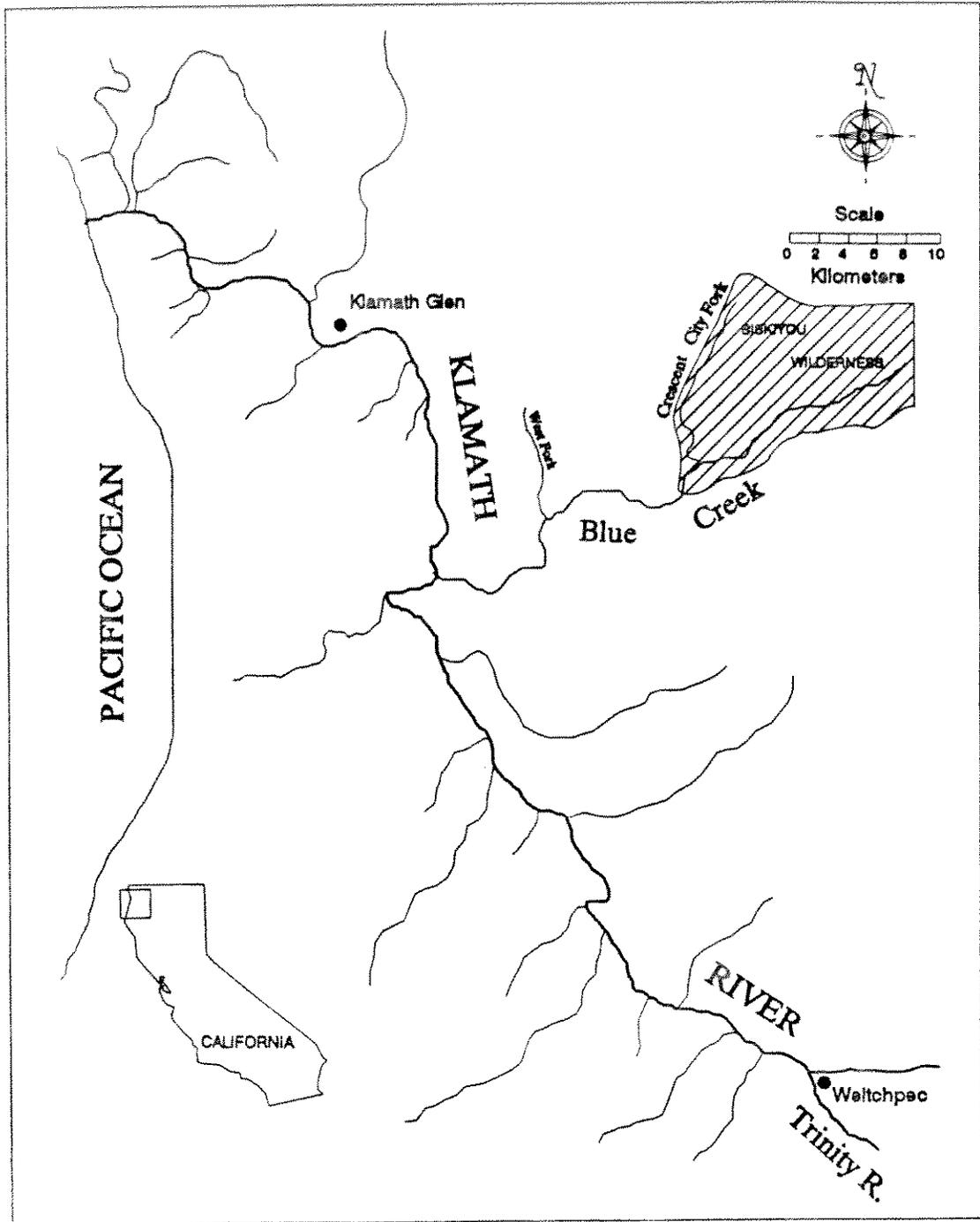


Figure 1. Map of lower Klamath River Basin with Blue Creek and location of Siskiyou Wilderness.

brook trout (Salvelinus fontinalis) during the 1930's and 40's (CDFG files, Eureka). Hereinafter, Blue Creek discussions are restricted to the lower 23 km of stream accessible to anadromous salmonids.

As with many of the tributaries to the lower Klamath River, extensive timber harvesting has occurred along portions of Blue Creek. Since the early 1960's, many areas on the West Fork of Blue Creek and lower 12 km of the mainstem have been clearcut. Timber has been removed from sections adjacent to the stream and along the upper slopes. According to aerial photo interpretation, and recollections of a local resident (F. Erickson, pers. comm. 1991), mature redwoods and hardwood trees provided a dense riparian canopy before the floods in 1955 and 1964. Simpson Timber Company owns the land surrounding the lower 12.8 km of Blue Creek and logging continues in this portion of the watershed. Upstream of Simpson Timber Company property at approximately rkm 12.9, the Creek runs through National Forest lands including the Siskiyou Wilderness of the Six Rivers National Forest above rkm 13.7 (Figure 1). The National Forest lands are mostly forested below elevations of about 1,400 m.

An arterial logging road parallels Blue Creek at an elevation of about 240 m above the Creek, from rkm 3.2 to rkm 9.6. Little used roads branch off this maintained road and provide streamside access at rkms 2.0, 3.2, 8.0, and 12.5. No road access to the watershed above rkm 12.5 is available due to its inclusion in the Siskiyou Wilderness Area. A portion of an old trail cleared by CCC crews in FY 1990, provides access to the confluence of Blue Creek and Crescent City Fork.

MATERIALS AND METHODS

Salmonid Habitat Investigations

Temperature

A Ryan TempMentor thermograph with a remote probe was maintained at rkm 3.2 (Figure 2). Readings were made in degrees centigrade (°C), at two hour intervals and averaged for each 24 hour period. The thermograph was deployed throughout the year and changed at approximately 3 month intervals to recover temperature data. A maximum-minimum thermometer placed on the screw trap was used to monitor water temperature extremes during the juvenile trapping season from late April to mid-July. Air and water temperatures were also monitored with a hand held thermometer at irregular intervals during juvenile trapping and adult surveys.

Stream Discharge

The stream gaging station was established in 1989 at rkm 3.4 (Figure 2), and was described in a previous report (USFWS, 1990). A staff gage and crest gage have been maintained throughout the study. Gage height was read daily during the period of spring and summer juvenile trapping, and the crest gage was read and reset every few weeks (particularly after large flow events) throughout the fall and winter. A top-setting rod and Price AA flow meter were used to measure stream discharge. A discharge rating table was prepared for the site using linear regression analysis to establish a log-log relationship between gage height and discharge.

The former USGS gauge site at rkm 5.0 was not used because the channel there had been greatly changed by deposition of coarse sediments since the gage was removed in September 1978.

Adult Chinook Salmon Investigations

Chinook Salmon Spawning Surveys

Surveys of chinook redds, carcasses, and live adults occurred in fall of 1991 and winter 1992 to determine spawner numbers, spawning areas, and distribution. Due to limited access points, the lower 18.4 km of Blue Creek was broken into six reaches. Reaches 4 and 5 of fall 1988 (FY 1989) surveys were combined to form reach 4 beginning in fall 1989 (Figure 3.a). The lower 3.2 km of Crescent City Fork (Reach 5) and 3.2 km of the main channel above the confluence with Crescent City Fork (Reach 6), were added in fall 1989 to cover additional spawning areas (Figure 3.b). This additional area above the confluence was accessed by wading upstream. Attempts were made to survey the six reaches on a bimonthly basis and the West Fork of Blue Creek on an intermittent basis with a two person crew covering each reach. Crews wore diving suits, snorkeling gear, and carried measuring staffs, a flow meter and top-setting rod.

The location of each chinook redd was indicated on maps. In addition, redd length, width, pit depth and mound depth (to the nearest 0.1 m), pit and mound velocity (feet per second) were recorded and substrate composition was visually estimated. The presence or absence of fish on or near redds was also noted. Habitat units defined by Bisson, *et al.* (1982) and modified by Decker (1986) (Appendix A), were noted for all redd locations.

Salmonid carcasses were classified to species, sexed if possible, and examined for fin clips, animal predation, and percent reproductively spent. Fork length (cm) and scale samples were collected when possible.

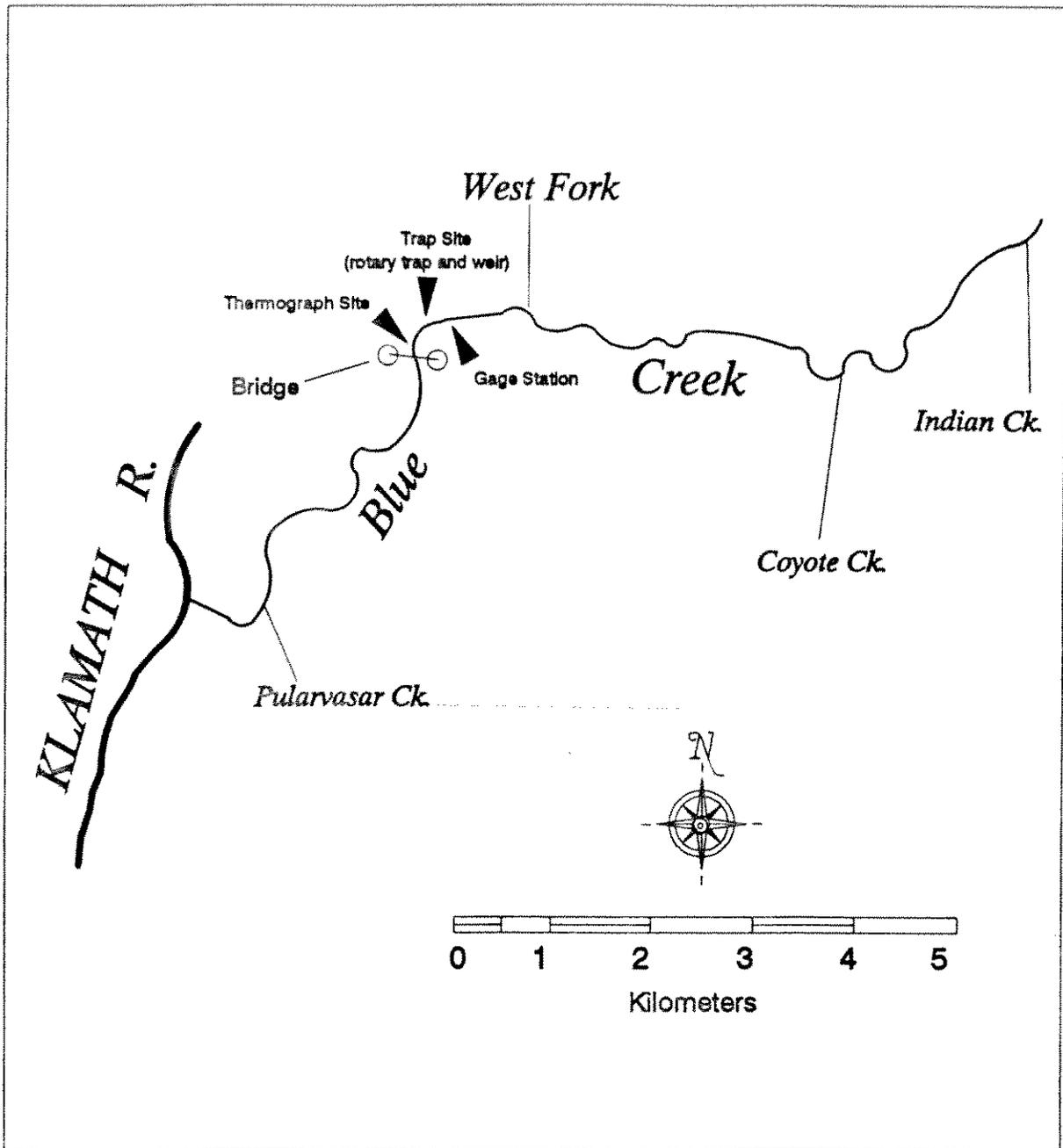


Figure 2. Map of Blue Creek showing location of outmigrant trap site, gage station and thermograph site, during FY 1992.

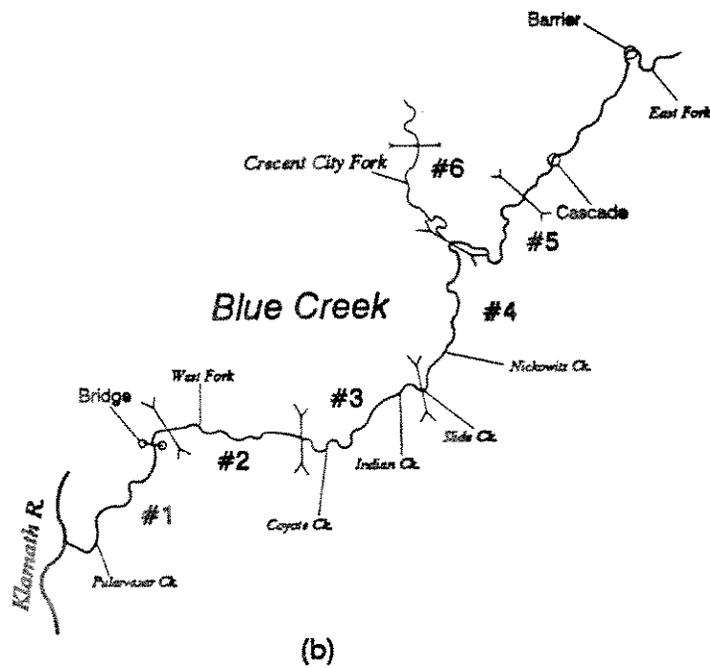
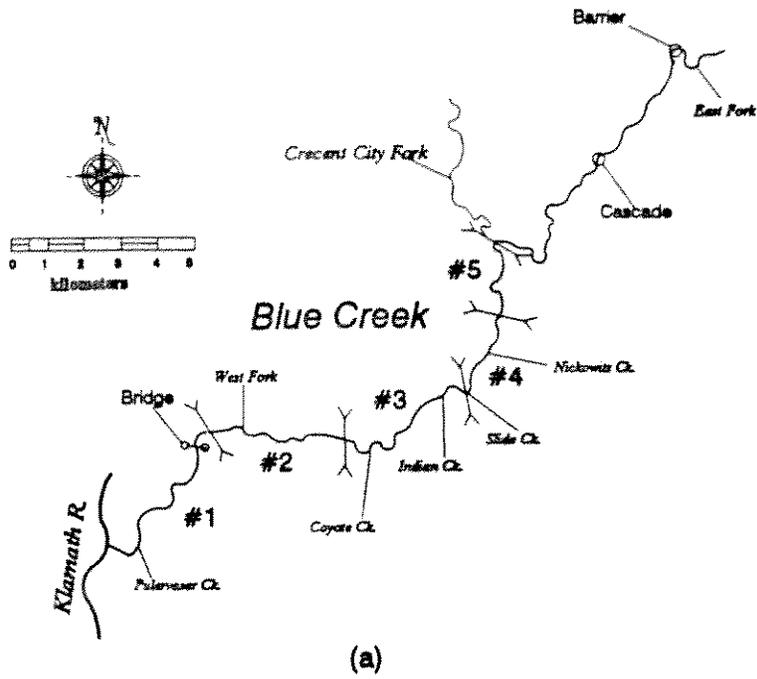


Figure 3. Maps of chinook redd survey reaches in Blue Creek, during (a) fall 1988 and (b) fall 1989-91.

Live counts of adult salmonids were recorded in conjunction with redd and carcass surveys by direct underwater observation through snorkeling. Fish were identified by species and age class (i.e. jack or adult for chinook and coho, half-pounder or adult for steelhead), and sexed when possible. The presence of fin clips on adult fish and stream locations of observed fish were also recorded.

Radiotelemetry

Radiotelemetry was used to gather information on spawning locations and the distribution of fall chinook spawners throughout the watershed. Direct observations of upper spawning areas were difficult due to limited access, while direct observations of all spawning areas were limited in the event of high flows. The use of radiotelemetry allowed the tracking of spawners by road and by air when limiting conditions for spawning surveys occurred. Air tracking was provided by the U.S. Coast Guard helicopter, McKinleyville Group, at the Arcata Airport. The radiotelemetry equipment, two receivers (Model 2000 and 2000B), internal tags and two antenna loops (Air and Ground, <60 Mhz), were purchased from Advanced Telemetry Systems, Inc. (ATS).

Snorkel surveys of the lower 5 km began in October to determine when chinook entered Blue Creek and when there were sufficient concentrations of adults in pools to begin tagging operations. The radio tagging operation used gill nets, (two 30.5 m long, with 0.13 m and 0.18 m stretch mesh sizes), a rubber raft, PVC holding tubes (0.20 diam. x 0.91 m & 0.26 diam. x 1.22 m), and a fish cradle. Holding pools containing adult fish were located, gill nets were stretched across the head and tail-out of the pool, and three or four workers in wet suits would herd the fish toward the upstream net. As fish were caught, they were immediately removed from the net and placed into individual holding tubes. Sex, fork length, scales, physical condition, date of tagging, tagging location and tag number were recorded. Internal tags were inserted down the esophagus into the stomach with the use of a short section of 3/4" PVC tubing (Figure 4). Spaghetti tags were also applied to radio tagged fish for aid in identification during spawning surveys. Tagged fish were released back into the pool.

Radio tracking was conducted weekly, either by driving, walking or by helicopter. Five established roadside overlooks were used to monitor the lower 12.5 km of the creek (Figure 5). Stream tracking, accomplished by walking along the streamside, was used to confirm positions of tagged fish monitored by roadside tracking and to more accurately pinpoint their location within the creek. Helicopter access allowed tracking over the entire Blue Creek watershed, but was limited by weather conditions. The receiver unit was able to detect tags on the average 1 km from roads and 150 m to 300 m above the stream in the helicopter. Bounce of radio signals off and around bedrock often gave confusing directional information when tracking.

Juvenile Salmonid Investigations

Juvenile Trapping

A rotary screw trap (Figure 6) with a 2.44 m diameter cone was used to capture emigrating juvenile salmonids at rkm 3.35 (Figure 2). Operation of the screw trap began on April 7 and continued through July 16. The trap was generally operated at least 5 days (4 nights) per week. A "trapping day" was defined from the time the trap was set or checked, typically morning or early afternoon, to the next morning. Trapping days were set up to encompass the night when salmonids generally emigrate.

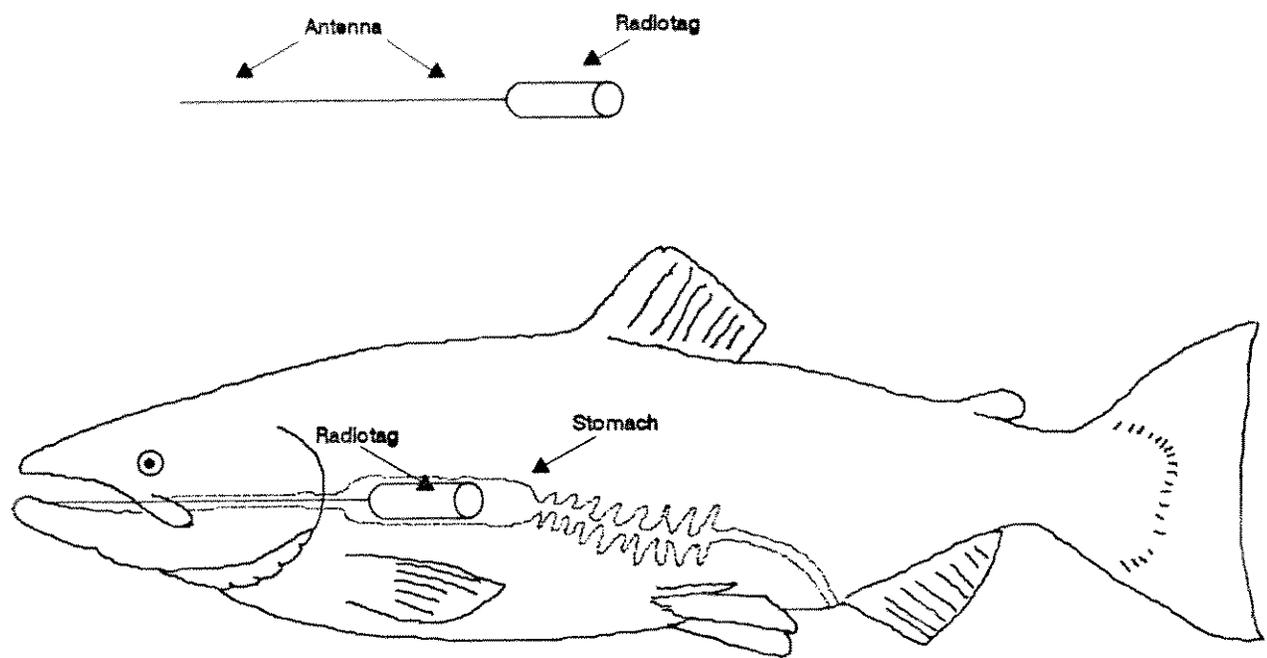


Figure 4. Diagram of a chinook salmon showing placement of internal radiotag.

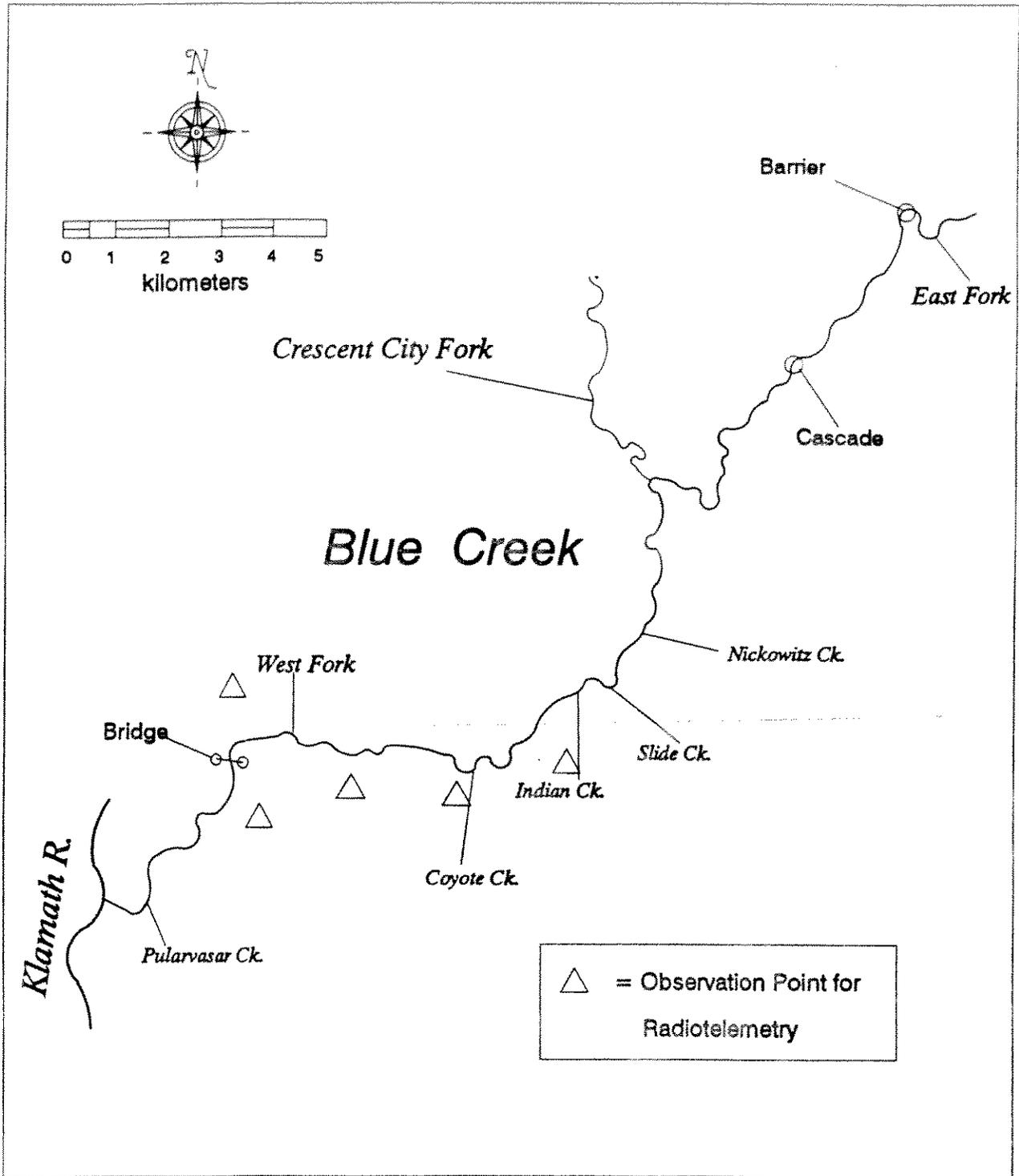


Figure 5. Map of Blue Creek depicting radiotelemetry observation points.

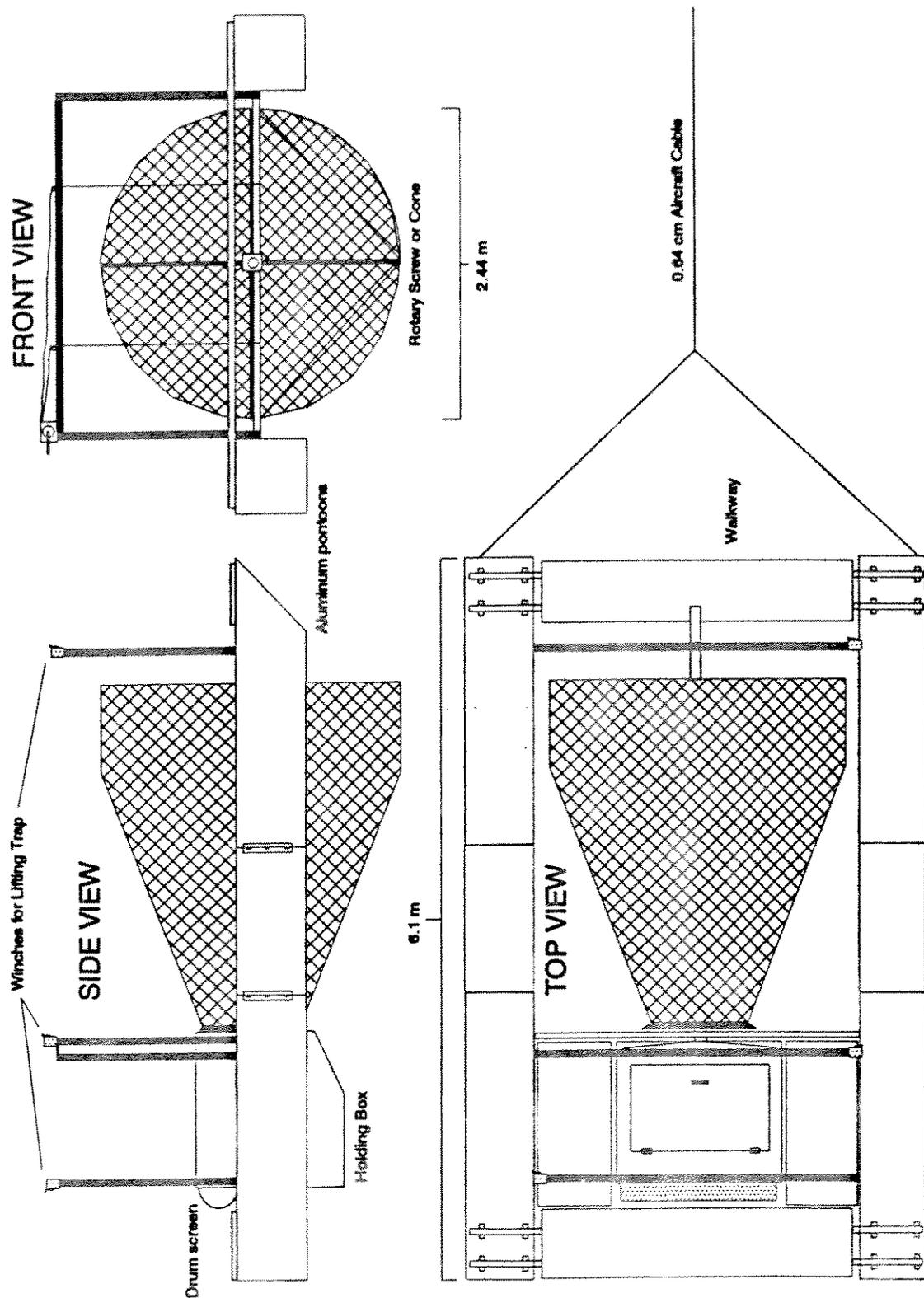


Figure 6. Schematic views of the rotary screw trap used on Blue Creek.

The juvenile salmonid sampling index was determined by dividing the estimated creek discharge by the volume of water sampled by the screw trap. Velocity measurements were measured at the left, center, and right positions immediately in front of the cone with a Price AA current meter and top setting rod. These velocity measurements along with the submerged area of the cone were used to calculate the volume sampled. Daily abundance indices for each species and developmental stage were estimated by multiplying the number of fish captured by the sampling index. Weekly abundance indices were estimated by summing the daily index values for the week and dividing the sum by the proportion of the week that was sampled. Comparisons of magnitude and timing of the juvenile emigration were based on the juvenile indices.

A weir consisting of a frame net (1.5 m x 3 m, 0.48 cm delta mesh) and hardware cloth (0.64 cm width mesh) panels (1.2-1.5 m x 3 m) was installed immediately downstream of the rotary screw trap in the tail-out of the pool. The juvenile weir was operated from May 12 to July 16. The operation of the weir was dependent on flow, so at times only a portion of the stream was trapped. The weir was operated to collect additional chinook for coded-wire tagging.

All salmonids collected were identified to species and enumerated. Steelhead were categorized into three developmental stages: young of year (YOY), parr and smolt. Coho were categorized into two developmental stages, YOY/parr and smolt. Fork length (mm) and displacement (ml) were measured daily on a subsample (up to 30) of all categories of salmonids captured. Scale samples (up to 10 a day) were taken from steelhead parr and smolts randomly selected from the catch. Steelhead age classes were determined by scale analysis in conjunction with length frequency analysis. Volumetric displacement data and complete scale sample data are not presented in this report.

Length comparisons between chinook captured in the screw trap and weir were done using a two-group ANOVA (Statgraphics software). Student's t-tests (n=9), comparing weekly lengths of chinook captured in the weir and screw trap were done at the 99.48% level of significance ($\alpha = 0.0052$) so that an overall 95% level of confidence was maintained. Comparisons of length statistics for steelhead and coho captured in the screw trap and weir were not conducted. Larger steelhead and coho were able to swim out of the frame net leading to a biased sample in the weir.

Coded Wire Tagging

Since 1989, chinook YOY have been coded wire tagged to aid in determining contribution of Blue Creek stock to the Klamath River Basin. Coded wire tags (CWT) were applied to chinook YOY beginning May 15 and continued throughout the emigration season. The field CWT station consisted of a large canvas army tent, a gasoline-powered generator, a gasoline-powered water pump, and a Mark IV tagging machine and quality control device manufactured by Northwest Marine Technology. Chinook YOY were adipose clipped (ad-clipped) and injected with four bit size half-tags. A random sample of 50 CWT fish and 25 untagged fish were held as controls to obtain tag retention and mortality rates for each weeks tagging group. Controls were held for 5 to 6 days and then released, all other tagged fish were released within an hour after tagging at the bottom of a low gradient riffle just downstream of the juvenile weir site.

RESULTS AND DISCUSSIONS

Salmonid Habitat Investigations

Temperature

Water temperature data were collected through FY 1992 using the thermograph placed at rkm 3.2 (Figure 7). Data for most of the month of October 1991, were lost due to a deployment error that was corrected by November. Lowest stream temperatures occurred between January and February with the seasonal low daily mean occurring on January 12 (6.3 °C). July and August temperatures reached over 20 °C during the day, with the seasonal high daily mean occurring on August 14 (18.6 °C). The sharp drops in temperature which occurred intermittently between April and July correspond to storm events which took place between these dates.

Stream Discharge

The stage-discharge relationship prepared for the FY 1992 season has remained similar to the previous two trapping years (Figure 8). Stream discharge fluctuated greatly during the earliest part of the juvenile trapping period, but generally decreased after the week of April 19, with slight increases due to storm events during the weeks of June 14 and June 28 (Figure 9). Drought conditions have occurred in the entire Klamath Basin since about 1986. Measured minimum flow in Blue Creek for FY 1992 was 43 cfs (1.2 m³/s) on September 30, 1992. This minimum flow was equal to the previous low recorded on November 1, 1965. Maximum flow for the season was estimated from crest gage height, and was 2178 cfs (61.6 m³/s) between April 17 and April 19, 1992.

Adult Chinook Salmon Investigations

Radiotelemetry

Eight internal radio tags were applied to chinook salmon on November 5, at rkm 3.5 (Table 1). Progress for five of the tagged fish was able to be followed for at least five subsequent visits. Only one radio tag was physically recovered after spawning. The general locations of two other tags within pools were known, but could not be pinpointed for recovery. Fish were tagged only on one occasion, due to the small concentrations of fish within pools below rkm 5.0 during the FY 1992 season.

One tagged mortality was recovered in the same location of tagging 2 days after implanting, probably the result of stress during the tagging process. All remaining tagged fish migrated upstream, with their progress tracked mainly by ground and once by helicopter (Table 2). After 10 days of deployment, the locations of two tagged fish were unknown due to the limited range of ground tracking. Both of these fish were relocated 10 days later by helicopter. One was 3.2 rkm up the Crescent City Fork and the other was at 14.8 rkm on the mainstem. Distances traveled upstream from the tagging location varied from 2.9 to 15.7 km (average 6.4 km). The location of uppermost movements made by radio tagged chinook indicated the use of various spawning areas previously identified by past redd surveys.

One tagged chinook (frequency 0.250) was tracked to rkm 3.2 of the Crescent City Fork (Table 2). Two adult chinook were also observed during FY 1992 redd surveys conducted on the lower 2.5 rkm of the Crescent City Fork (reach # 6). The fall 1991 spawning use above rkm 2.5 of the Crescent City Fork was not surveyed due to limited accessibility, but greater use of the Crescent City Fork by spawners has been recorded in previous years (USFWS, 1992).

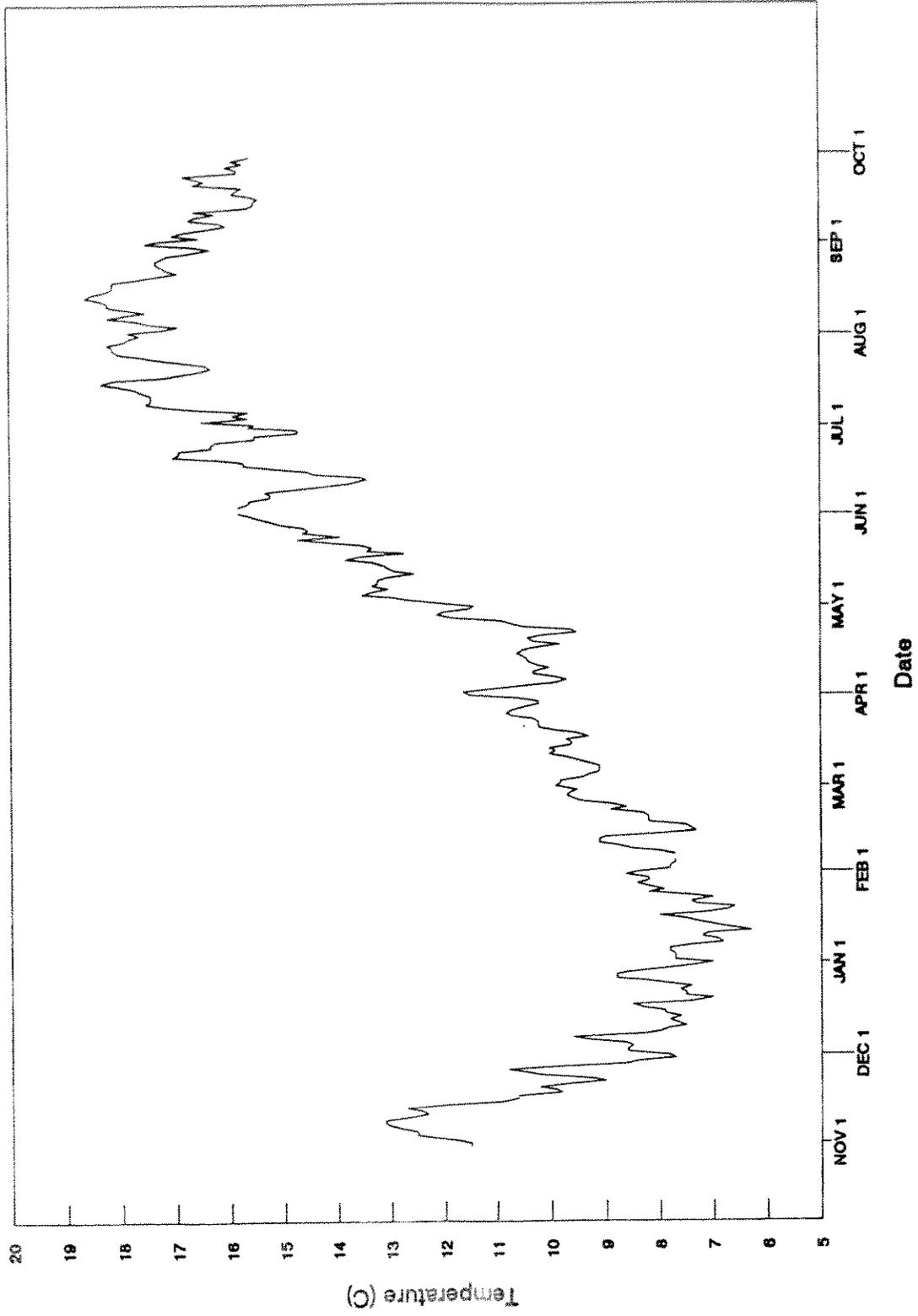


Figure 7. Blue Creek daily average water temperatures, from November 1991 through October 1992.

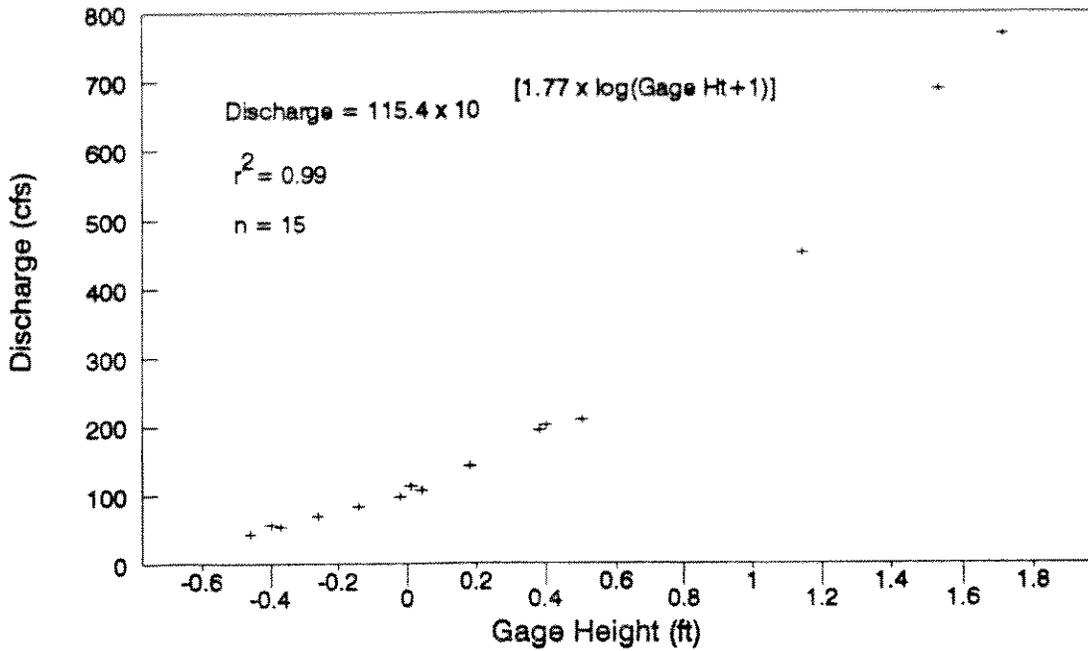


Figure 8. Gage height-discharge relationship recorded in Blue Creek during 1992.

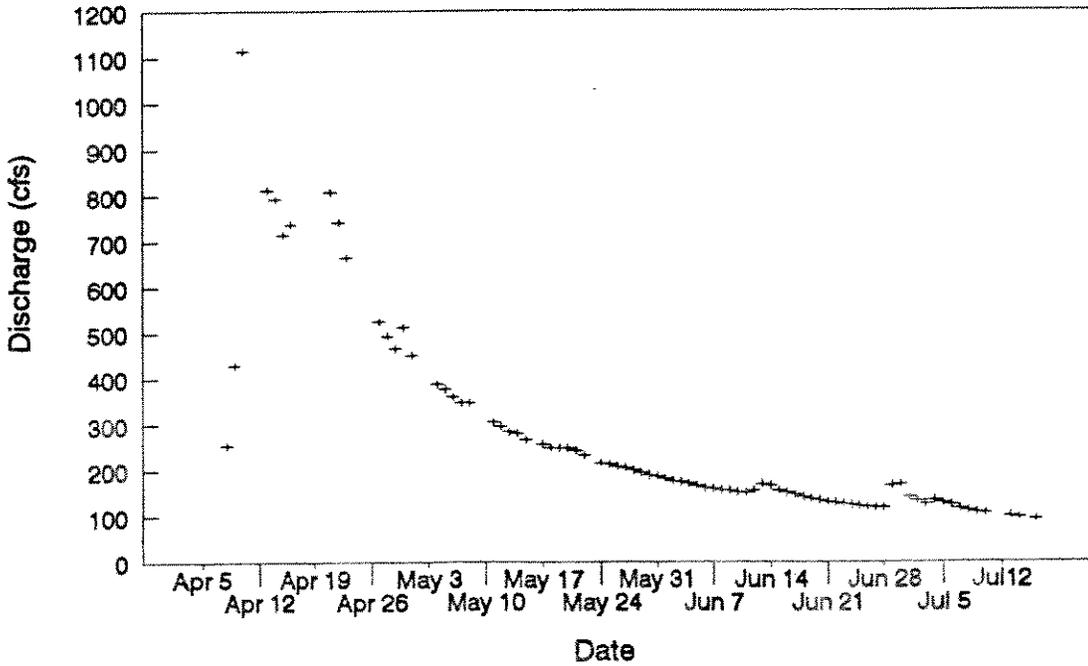


Figure 9. Estimated discharge (cfs) of Blue Creek during 1992 juvenile trapping, by trapping week.

Table 1. Chinook salmon radiotelemetry on Blue Creek, fall 1991. Summary of biodata, tag application, tag recovery, and upper range of migration.

| Radio Frequency (8 tags total) | 0.022 | 0.082 | 0.112 | 0.220 | 0.230 | 0.240 | 0.250 | 0.260 |
|--------------------------------|----------|---------------------|----------|--------------------|----------|------------------------|----------|----------|
| Sex | F | M | M | F | M | M | M | M |
| Fork Length (cm) | 72 | 102 | 67 | 74 | 89 | 83 | 65 | 75 |
| Age | AGE 4 | N/A | N/A | AGE 4 | AGE 5 | N/A | AGE 3 | AGE 3 |
| Date Applied | 11-05-91 | 11-05-91 | 11-05-91 | 11-05-91 | 11-05-91 | 11-05-91 | 11-05-91 | 11-05-91 |
| rkm (Tag Applied) | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 |
| Date Recovered | N/A | 11-21-91 | N/A | N/A | N/A | 11-07-91 | N/A | N/A |
| rkm (Tag Recovered) | N/A | 6.1 | N/A | N/A | N/A | 3.5 | N/A | N/A |
| Date of Upper Most Movement | 11-18-91 | 11-18-91 | 11-25-91 | 11-18-91 | 11-15-91 | N/A | 11-25-91 | 11-27-91 |
| rkm (Furthest Upstream) | 9.5 | 6.6 | 14.8 | 6.4 | 7.2 | N/A | CCF 3.2 | 8.8 |
| Number of Days Deployed | 29 | 16 | 29 | 29 | 29 | 2 | 29 | 29 |
| cm=centimeter | | rkm=river kilometer | | N/A=not applicable | | CCF=Crescent City Fork | | |

Table 2. Locations (rkm) of chinook salmon tracked by ground and helicopter on Blue Creek using radiotelemetry, fall 1991.

| GROUND TRACKING | Radio Frequency | | | | | | | |
|---------------------|-----------------|-------|---------------------------------|-------|------------------------|-------|---------|-------|
| | 0.022 | 0.082 | 0.112 | 0.220 | 0.230 | 0.240 | 0.250 | 0.260 |
| Date | | | | | | | | |
| 11-07-91 | 6.4 | 4.8 | 5.3 | 4.8 | 6.4 | B | 5.3 | 6.4 |
| 11-08-91 | 6.4 | 5.0 | C | 5.0 | 6.4 | B | 7.2 | 6.4 |
| 11-15-91 | 7.6 | 6.3 | C | 5.1 | 7.2 | B | C | N/A |
| 11-18-91 | 9.5 | 6.6 | C | 6.4 | 6.9 | B | C | 6.6 |
| 11-19-91 | 6.9 | 6.1 | C | 6.1 | 6.1 | B | C | 7.6 |
| 11-21-91 | 6.9 | B | C | 5.8 | 6.1 | B | C | 7.6 |
| 11-27-91 | C | B | N/A | 5.3 | 5.6 | B | C | 8.8 |
| 12-04-91 | A | B | A | A | A | B | A | C |
| HELICOPTER TRACKING | | | | | | | | |
| | Radio Frequency | | | | | | | |
| Date | 0.022 | 0.082 | 0.112 | 0.220 | 0.230 | 0.240 | 0.250 | 0.260 |
| 11-25-91 | 6.9 | B | 14.8 | 5.3 | 6.0 | B | CCF 3.2 | 7.2 |
| A=Tag not recovered | B=Tag recovered | | C=Lost signal, unable to locate | | CCF=Crescent City Fork | | | |

Redd, Carcass, and Live Adult Surveys

Redd Counts

Chinook redd surveys conducted between November 12, 1991 and January 9, 1992 identified a total of 22 redds on the mainstem of Blue Creek and no redds on the lower 2.5 rkm of the Crescent City Fork (Figure 10 and Table 3). All 4 surveys covered all 6 sections. In addition to the 22 chinook redds, 1 coho redd was observed. Only one redd appeared to be formed either by several spawning pairs or by multiple spawning attempts by a single pair. Redds were ordered by habitat type in percent. Tail-outs of lateral scour bedrock formed pools were the most commonly used spawning habitat, with low gradient riffles being the next most common area used for spawning. The majority of spawning has occurred in these two habitat types over the period of the study (Figure 11). The average surface area for each of the 22 measured redds on the mainstem of Blue Creek was 10.5 m². Total area of measured redds on Blue Creek was 230.8 m². This is the lowest redd count since the initiation of the Blue Creek study in 1988. In a previous report (USFWS 1992) it was estimated Blue Creek could support at least 1,153 chinook spawning pairs. Based on this estimate, only 2% of the maximum potential number of redds were observed during fall 1991 spawning surveys.

Chinook also spawn in the flatter section of stream located above the confluence with Crescent City Fork and immediately below the anadromous barrier, rkm 18.4 to 22.2 (Figure 10). This section was not routinely surveyed because of the inaccessibility and related budget constraints. The amount of spawning use is unknown.

The majority of spawning activity appeared to occur in two time periods which coincided with two storms that encouraged upstream migration in early November and early December (Table 3).

Carcass Counts

Chinook carcass surveys recovered 16 chinook carcasses, 1 coho carcass, and 3 partial salmonid carcasses whose species could not be determined (Table 4). All but one of the whole chinook carcasses were determined to be at least 95% spent. The single coho carcass appeared to be unspent retaining at least 50% of its eggs. Carcass recovery was poor due to heavy predation by black bears (Ursus americanus), otters (Lutra canadensis), and raccoons (Procyon lotor).

Live Counts

Late October rains provided enough flow to allow entry of fall chinook into Blue Creek. On November 1, 1992 a preliminary survey identified 1 chinook at rkm 7.1 and rkm 7.0, 3 chinook at rkm 6.6, and a school of 22 chinook at rkm 4.7. A complete survey of all six reaches made between November 12 and 14 identified a total of 97 adult chinook, which was the peak count during the FY 1992 fall surveys (Table 5). This minimum estimate for fall 1991 escapement is probably conservative, since later surveys showed continued entry of bright chinook into the month of December. Snorkel surveys also identified the presence of adult coho and steelhead with peak counts in mid-November and early January respectively. No adult salmonids were observed in the West Fork of Blue Creek during the FY 1992 fall surveys.

A total of three ad-clipped chinook were identified during fall surveys. The observed ad-clip rate for the survey period of November 12 to 14 was 2.1% (n=2), and for the survey period of November 25 to 26 3.3% (n=1). No ad-clips were observed during the last two survey periods. Due to the lack of age structure data and the difficulty of identifying ad-clipped fish within large schools, an ad-clip rate for year classes cannot be accurately determined.

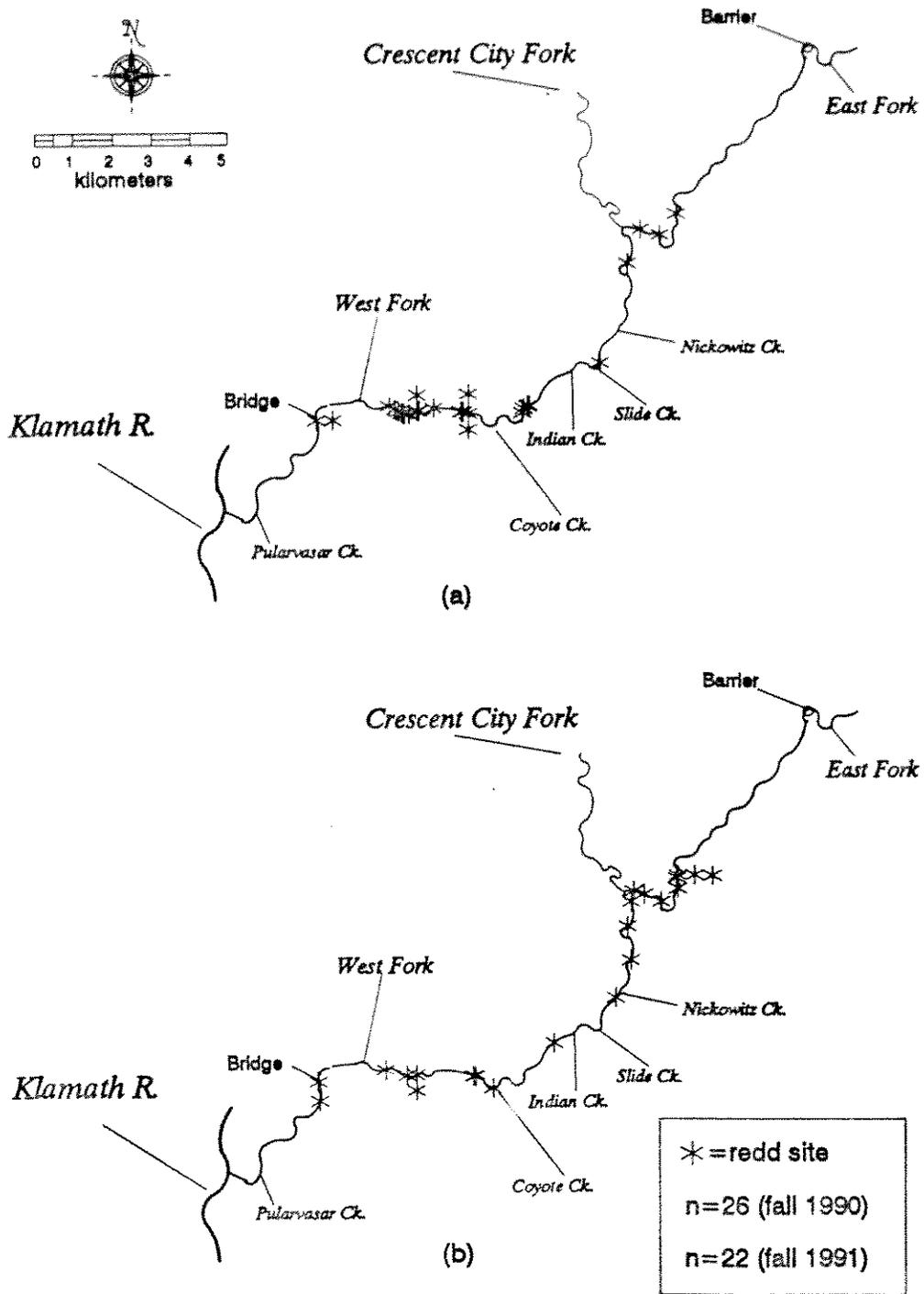


Figure 10. Map showing locations of chinook salmon redds in Blue Creek, in (a) fall 1990 and (b) fall 1991.

Table 3. Blue Creek redd locations (rkm & habitat type), dimensions, water velocities, and ages recorded during fall 1991/winter 1992 spawning surveys.

| Date | rkm | Habitat Type | Length (m) | Width (m) | Area (m ²) | Pit Depth(m) | Mound Depth(m) | Pit Velocity (ft/sec) | Mound Velocity (ft/sec) | Fish Present | Redd Age |
|----------------------------------|------|--------------|------------|-----------|------------------------|--------------------------|----------------|-----------------------|-------------------------|--------------|------------|
| 11/12/91 | 16.3 | 12 | 1.7 | 1.4 | 2.4 | 0.30 | 0.19 | | | 1 | 1 wk |
| 11/12/91 | 16.4 | 20 | 1.8 | 0.9 | 1.6 | 0.31 | 0.18 | | | 1 | 1 wk |
| 11/12/91 | 16.9 | 12 | 3.6 | 1.3 | 4.7 | 1.73 | 1.73 | | | 5 | 1 wk |
| 11/12/91 | 17.4 | 1 | 1.4 | 0.9 | 1.3 | 0.30 | 0.17 | | | 0 | 1 wk |
| 11/12/91 | 17.5 | 12 | 2.8 | 1.7 | 4.8 | 0.50 | 0.30 | | | 5 | 1 wk |
| 11/12/91 | 17.5 | 12 | 2.0 | 1.3 | 2.6 | 0.52 | 0.28 | | | 5 | 1 wk |
| 11/12/91 | 17.5 | 12 | 2.8 | 2.4 | 6.7 | 0.60 | 0.38 | | | 5 | 1 wk |
| 11/12/91 | 15.3 | 12 | 7.2 | 6.2 | 44.6 | 0.60 | 0.17 | 0.70 | 1.70 | 0 | N/A |
| 11/13/91 | 11.3 | 12 | 5.4 | 4.0 | 21.6 | 0.65 | 0.35 | 1.53 | 2.20 | 0 | 1 wk |
| 11/13/91 | 8.0 | 1 | 5.0 | 5.0 | 25.0 | 0.50 | 0.40 | 1.93 | 2.13 | 3 | 1 wk |
| 11/13/91 | 6.0 | 1 | 1.5 | 1.5 | 2.3 | 0.50 | 0.20 | | | 0 | 1 wk |
| 11/13/91 | 5.1 | 20 | 2.0 | 1.5 | 3.0 | 0.50 | 0.10 | | | 0 | 1 wk |
| 11/14/91 | 1.8 | 1 | | | | | | | | 3 (coho) | incomplete |
| 11/26/91 | 15.9 | 12 | 3.8 | 1.9 | 7.2 | 0.49 | 0.21 | 0.78 | 1.50 | 0 | 1 wk |
| 11/26/91 | 14.0 | 20 | 2.6 | 1.5 | 3.9 | 0.49 | 0.31 | 1.05 | 1.33 | 0 | 1 wk |
| 12/03/91 | 2.7 | 1 | 3.0 | 1.3 | 3.9 | 1.20 | 0.90 | 2.50 | 2.75 | 1 | 1 wk |
| 12/10/91 | 17.7 | 12 | 5.5 | 1.8 | 9.9 | 0.85 | 0.50 | | | 1 | 1 wk |
| 12/11/91 | 7.9 | 20 | 5.9 | 2.3 | 13.6 | 0.80 | 0.50 | | | 0 | 2 wks |
| 12/11/91 | 6.4 | 1 | 5.1 | 3.2 | 16.3 | 0.40 | 0.27 | 3.18 | 3.30 | 4 | 1 wk |
| 12/11/91 | 6.4 | 1 | 4.4 | 2.6 | 11.4 | 0.55 | 0.34 | 2.28 | 2.43 | 4 | 1 wk |
| 12/12/91 | 2.9 | 17 | 4.0 | 3.0 | 12.0 | 0.43 | 0.15 | 1.30 | 2.13 | 2 | 2 wks |
| 01/07/92 | 14.5 | 12 | 6.0 | 4.0 | 24.0 | 0.65 | 0.15 | 1.33 | 2.65 | 2 | fresh |
| 01/08/92 | 8.4 | 12 | 4.0 | 2.0 | 8.0 | 0.35 | 0.15 | 1.53 | 1.80 | 0 | 1-2 wks |
| Total Redds= 22 chinook + 1 coho | | | | | | | | | | | |
| rkm = river kilometer | | | m = meter | | | ft/sec = feet per second | | | wk = week | | |

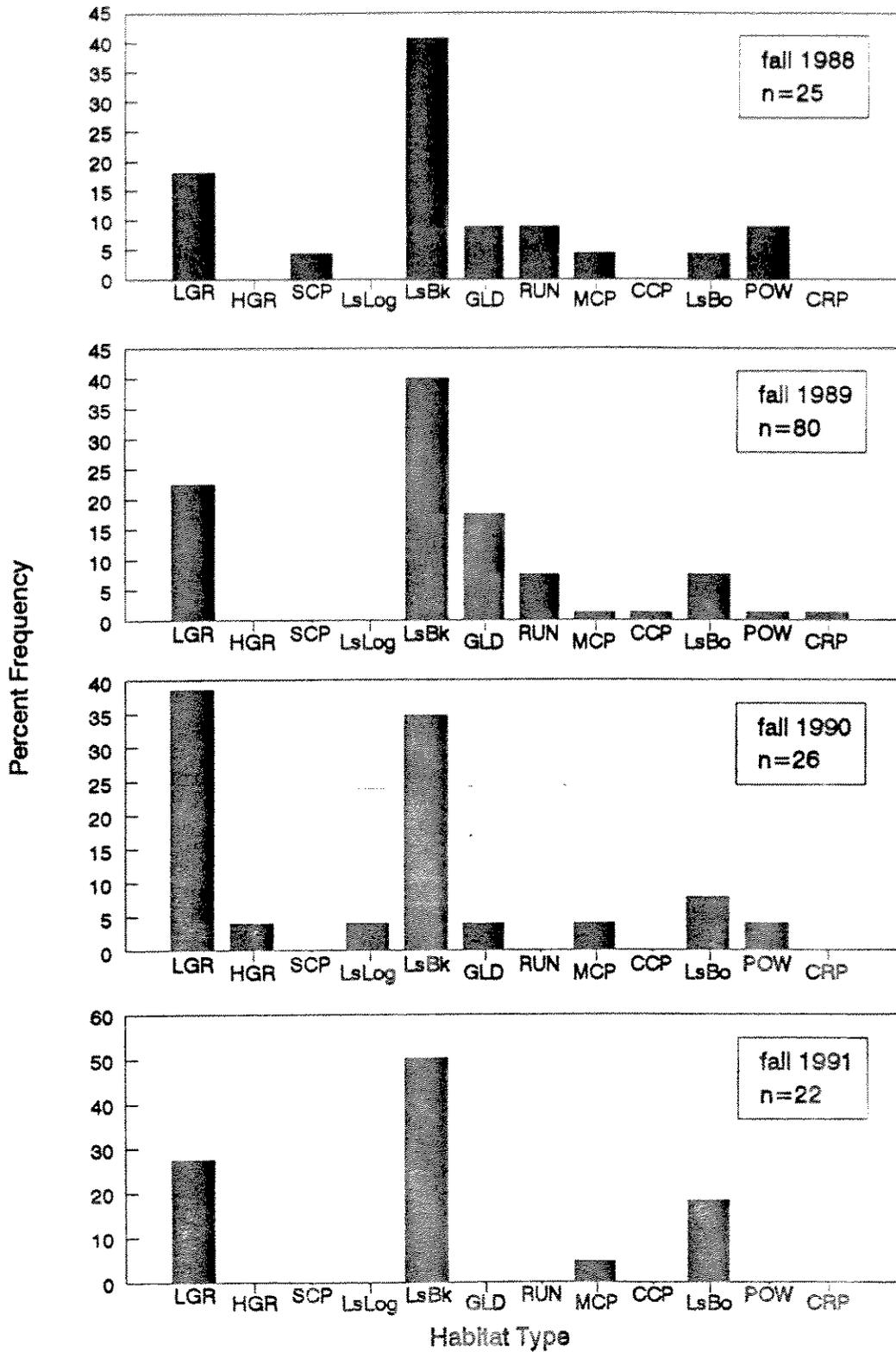


Figure 11. Chinook salmon redds in Blue Creek by habitat type in percent, fall of 1988 through fall of 1991 (refer to Appendix A for list of habitat types).

Table 4. Chinook carcass survey summary for Blue Creek, fall 1991/winter 1992.

| Date | rkm | Length (cm) | Sex | Condition | Reach | % Spent | Age | Comments |
|--|---------|-------------|-----------------|------------|-------|--------------------------|-------|--------------------------|
| 11-12-91 | 17.1 | 85 | F | depredated | 5 | - | - | |
| 11-25-91 | 17.4 | - | - | depredated | 5 | - | - | Skin and bones |
| 11-26-91 | 8.4 | 88 | F | fresh | 2 | 100 | age 4 | |
| 12-03-91 | 4.5 | 52 | M | fresh | 1 | 100 | age 3 | |
| 12-10-91 | CCF 1.2 | 80 | M | fresh | 6 | - | age 4 | Possibly unspawned |
| 12-10-91 | 16.0 | - | F | fresh | 4 | 50 | age 4 | Coho, possibly unspawned |
| 12-10-91 | 13.8 | 85 | M | fresh | 4 | 100 | age 4 | |
| 12-11-91 | 7.1 | 98 | M | fresh | 2 | 100 | age 4 | |
| 12-11-91 | 6.8 | - | - | depredated | 2 | - | - | Skin and bones |
| 01-07-92 | CCF 2.2 | - | - | depredated | 6 | - | - | Skin and bones |
| 01-07-92 | CCF 0.7 | - | - | depredated | 6 | - | - | Skin and bones |
| 01-07-92 | 18.3 | 64 | F | fresh | 5 | 100 | - | |
| 01-07-92 | 17.9 | - | M | depredated | 5 | - | - | Head and bones |
| 01-08-92 | 14.0 | - | - | depredated | 4 | - | - | Pieces; species? |
| 01-08-92 | 13.0 | - | - | depredated | 4 | - | - | Pieces; species? |
| 01-08-92 | 10.0 | 82 | F | fresh | 3 | 100 | - | |
| 01-08-92 | 5.0 | 76 | F | fresh | 2 | 99 | age 3 | |
| 01-08-92 | 4.8 | - | - | depredated | 2 | - | - | Pieces; species? |
| 01-09-92 | 2.0 | 77 | F | fresh | 1 | 100 | - | |
| 01-09-92 | 2.0 | - | - | depredated | 1 | - | - | Head |
| Total Carcasses = 16 chinook + 1 coho + 3 undetermined | | | | | | | | |
| rkm = river kilometer | | | cm = centimeter | | | CCF = Crescent City Fork | | |

Table 5. Salmonid live counts by reach, Blue Creek, fall 1991/winter 1992.

| Date | Reach | Chinook | | Steel head | |
|----------|--------|------------|------|--------------|--------|
| | | Adult/Jack | Coho | 1/2 pounders | Adults |
| 11-12-91 | 6 | 1/0 | 0 | 0 | 0 |
| 11-12-91 | 5 | 11/2 | 0 | 0 | 0 |
| 11-12-91 | 4 | 28/4 | 3 | 2 | 2 |
| 11-13-91 | 3 | 21/0 | 1 | 0 | 0 |
| 11-13-91 | 2 | 25/2 | 4 | 0 | 4 |
| 11-14-91 | 1 | 3/0 | 3 | 8 | 0 |
| | Total: | 89/8 | 11 | 10 | 6 |
| 11-25-91 | 6 | 2/0 | 0 | 0 | 0 |
| 11-25-91 | 5 | 0 | 0 | 0 | 0 |
| 11-26-91 | 4 | 8/1 | 0 | 0 | 0 |
| 11-26-91 | 3 | 6/0 | 1 | 0 | 3 |
| 11-26-91 | 2 | 13/0 | 3 | 0 | 0 |
| 12-03-91 | 1 | 3/0 | 0 | 0 | 1 |
| | Total: | 32/1 | 4 | 0 | 4 |
| 12-10-91 | 6 | 1/0 | 0 | 0 | 0 |
| 12-10-91 | 5 | 3/0 | 0 | 0 | 0 |
| 12-10-91 | 4 | 3/0 | 0 | 0 | 1 |
| 12-11-91 | 3 | 2/0 | 0 | 8 | 3 |
| 12-11-91 | 2 | 16/1 | 1 | 23 | 5 |
| 12-12-91 | 1 | 3/0 | 0 | 12 | 2 |
| | Total: | 28/1 | 1 | 43 | 11 |
| 01-07-92 | 6 | 0 | 0 | 0 | 0 |
| 01-07-92 | 5 | 0 | 0 | 11 | 2 |
| 01-07-92 | 4 | 2/0 | 0 | 2 | 1 |
| 01-08-92 | 3 | 0 | 0 | 0 | 0 |
| 01-08-92 | 2 | 0 | 0 | 75 | 9 |
| 01-09-92 | 1 | 0 | 0 | 5 | 3 |
| | Total: | 2/0 | 0 | 93 | 15 |

Juvenile Salmonid Investigations

Chinook Salmon

A total of 10,688 juvenile chinook were captured by the screw trap in 75 days of trapping (Table 6). Chinook were captured throughout the entire sampling period. Weekly catches ranged from a low of 10, during the second week of trapping, to a high of 1,940, which occurred during the week of May 24.

A total of 9,166 juvenile chinook were captured in the weir in 57 days of trapping (Table 7). Weekly chinook catches in the weir ranged from a high of 2,334 during the week of May 24 to a low of 23 during the final week of trapping. Due to high flows, only a portion of the stream was trapped with the weir during the first week of trapping.

The juvenile chinook index for the period from April 8 through July 16 was estimated to be 49,590 (Table 8). Based on index values, the juvenile chinook emigration peaked during the week of May 17 (Figure 12). This peak coincided with a minor storm event on May 19 (Figure 9). In addition, heavy equipment operation occurred in and around the creek at rkm 8.5 by Simpson Timber on May 20. This work increased turbidity substantially in the Creek for that trapping day, and may have influenced emigration. However, the timing of peak emigration is similar to that observed in the previous 3 years (USFWS 1990, 1992). It is accordingly difficult to distinguish the effect of the unnatural increase in turbidity.

The low index value for the week of April 12 may be the result of another storm event that increased the stream discharge to over 2000 cfs. Only 10 chinook were captured in 3 nights of trapping during this week (Table 6). Due to the high flows the trap was placed out of the main flow and may have under-sampled the numbers of juvenile salmonids emigrating past the trap site. By April 20, stream discharge had decreased to levels at which the trap could be effectively operated. Based on index values, over 97% of the juvenile chinook that emigrated from Blue Creek during the trapping period did so by the week of June 28. Although 78 chinook were captured during the final week of trapping, it is believed that the majority of the chinook had already left the system.

Juvenile trapping was discontinued on July 17. Based on the last week of sampling in 1992, as well as the 3 previous summers, it appears that a few juvenile chinook were still emigrating at least through August and probably throughout the fall. Because some emigration occurs before and after the trapping period and at least 2 chinook redds were identified below the trap site, the index of 49,590 should be viewed only as a measure of juvenile production for the period from April 8 through July 16.

The index of production for the 1992 trapping season appears relatively high considering the relatively low adult return for fall 1991. This apparent increase in survival of YOY chinook may be attributed to the mild fall and winter conditions experienced during the 1991-1992 spawning season. Relatively mild flows and temperatures may have increased survival of redds and brood. Preliminary observations suggest similar tendencies in natural chinook production were seen throughout the Klamath Basin.

Mean length of juvenile chinook captured in the screw trap and weir generally increased throughout the 1992 juvenile trapping season (Figure 13). Mean length of juvenile chinook ranged from 41.0 mm during the week of April 12, to 83.7 mm during the final week of trapping, July 12 (Table 9). The decrease in mean fork length of juvenile chinook captured by the screw trap during the week of April 12, may be attributed to the small sample size (n=10) of that week. Mean length of chinook captured in the weir ranged from a low of 53.6 mm during the week of May 10 to a high of 84.7 mm during the week of July 12

Table 6. Weekly juvenile salmonid catches by the screw trap, Blue Creek 1992.

| Week | # Days Sampled | Chinook | Steelhead | | | Coho | | | |
|--------------|-------------------|---------------|------------|------------|-----------|-----------|------------|-----------|-----------|
| | | | YOY | 1+ Parr | 1+ Smolt | 2+ Parr | 2+ Smolt | YOY/Parr | 1+ Smolt |
| 04/05/92 | 3 | 41 | 0 | 48 | 0 | 4 | 40 | 0 | 0 |
| 04/12/92 | 3 | 10 | 6 | 5 | 0 | 1 | 0 | 0 | 1 |
| 04/19/92 | 2 | 75 | 1 | 17 | 0 | 4 | 8 | 0 | 1 |
| 04/26/92 | 4 | 171 | 1 | 101 | 3 | 1 | 19 | 0 | 2 |
| 05/03/92 | 4 | 336 | 14 | 84 | 0 | 4 | 25 | 6 | 0 |
| 05/10/92 | 4 | 957 | 6 | 34 | 1 | 2 | 21 | 3 | 2 |
| 05/17/92 | 5 | 1,855 | 54 | 62 | 2 | 5 | 18 | 16 | 3 |
| 05/24/92 | 6 | 1,940 | 57 | 69 | 4 | 0 | 6 | 16 | 2 |
| 05/31/92 | 7 | 1,767 | 42 | 57 | 1 | 3 | 1 | 9 | 0 |
| 06/07/92 | 7 | 1,502 | 51 | 38 | 1 | 1 | 1 | 3 | 0 |
| 06/14/92 | 7 | 477 | 22 | 15 | 2 | 1 | 0 | 6 | 0 |
| 06/21/92 | 7 | 538 | 22 | 37 | 13 | 0 | 1 | 7 | 0 |
| 06/28/92 | 7 | 725 | 72 | 179 | 25 | 0 | 7 | 18 | 0 |
| 07/05/92 | 6 | 239 | 14 | 31 | 11 | 0 | 0 | 4 | 0 |
| 07/12/92 | 3 | 55 | 2 | 6 | 5 | 0 | 0 | 0 | 0 |
| Total | 75 | 10,688 | 364 | 783 | 68 | 26 | 147 | 88 | 11 |

YOY = young of year

Table 7. Weekly juvenile salmonid catches by the weir, Blue Creek 1992.

| Week | # Days Sampled | Chinook | YOY | | | Steelhead | | | Coho | |
|--------------|----------------|--------------|-----------|----------|----------|-----------|----------|------------|----------|----------|
| | | | 1+ Parr | 1+ Smolt | 2+ Smolt | 1+ Parr | 1+ Smolt | 2+ Smolt | YOY/Parr | 1+ Smolt |
| 04/05/92 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/12/92 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/19/92 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 04/26/92 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 05/03/92 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 05/10/92 | 3 | 330 | 7 | 7 | 0 | 2 | 0 | 4 | 4 | 0 |
| 05/17/92 | 5 | 1,952 | 4 | 4 | 0 | 0 | 0 | 13 | 22 | 0 |
| 05/24/92 | 7 | 2,334 | 4 | 4 | 0 | 0 | 1 | 22 | 0 | 0 |
| 05/31/92 | 7 | 1,470 | 9 | 1 | 1 | 1 | 1 | 8 | 0 | 0 |
| 06/07/92 | 7 | 1,339 | 4 | 0 | 0 | 1 | 0 | 19 | 0 | 0 |
| 06/14/92 | 7 | 703 | 9 | 1 | 0 | 0 | 0 | 15 | 0 | 0 |
| 06/21/92 | 7 | 262 | 8 | 1 | 0 | 0 | 0 | 12 | 0 | 0 |
| 06/28/92 | 7 | 612 | 11 | 0 | 0 | 0 | 0 | 27 | 0 | 0 |
| 07/05/92 | 5 | 141 | 6 | 0 | 0 | 0 | 0 | 6 | 0 | 0 |
| 07/12/92 | 3 | 23 | 3 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| Total | 58 | 9,166 | 65 | 4 | 4 | 4 | 2 | 127 | 0 | 0 |

YOY = young of year

Table 8. Weekly juvenile salmonid abundance indexes, Blue Creek 1992.

| Week | Chinook | Steelhead | | | | Coho | | | |
|--------------|---------------|--------------|--------------|------------|------------|--------------|------------|------------|--|
| | | YOY | 1+ Parr | 1+ Smolt | 2+ Parr | 2+ Smolt | YOY/Parr | 1+ Smolt | |
| 04/05/92 | 451 | 0 | 633 | 0 | 53 | 541 | 0 | 0 | |
| 04/12/92 | 272 | 154 | 139 | 0 | 26 | 0 | 0 | 26 | |
| 04/19/92 | 2,563 | 0 | 611 | 0 | 134 | 268 | 0 | 30 | |
| 04/26/92 | 2,047 | 12 | 1,190 | 36 | 23 | 225 | 0 | 24 | |
| 05/03/92 | 2,945 | 126 | 743 | 0 | 37 | 226 | 56 | 0 | |
| 05/10/92 | 6,413 | 40 | 227 | 7 | 13 | 140 | 21 | 13 | |
| 05/17/92 | 9,803 | 283 | 328 | 10 | 25 | 93 | 84 | 17 | |
| 05/24/92 | 7,935 | 182 | 288 | 14 | 0 | 19 | 59 | 7 | |
| 05/31/92 | 5,921 | 123 | 163 | 4 | 10 | 3 | 31 | 0 | |
| 06/07/92 | 4,679 | 174 | 122 | 3 | 3 | 3 | 13 | 0 | |
| 06/14/92 | 1,285 | 61 | 49 | 6 | 3 | 0 | 16 | 0 | |
| 06/21/92 | 1,937 | 89 | 205 | 44 | 0 | 3 | 27 | 0 | |
| 06/28/92 | 2,128 | 223 | 520 | 96 | 0 | 22 | 57 | 0 | |
| 07/05/92 | 889 | 52 | 65 | 28 | 0 | 0 | 14 | 0 | |
| 07/12/92 | 322 | 12 | 35 | 29 | 0 | 0 | 0 | 0 | |
| Total | 49,590 | 1,531 | 5,318 | 276 | 329 | 1,546 | 378 | 118 | |

YOY = young of year

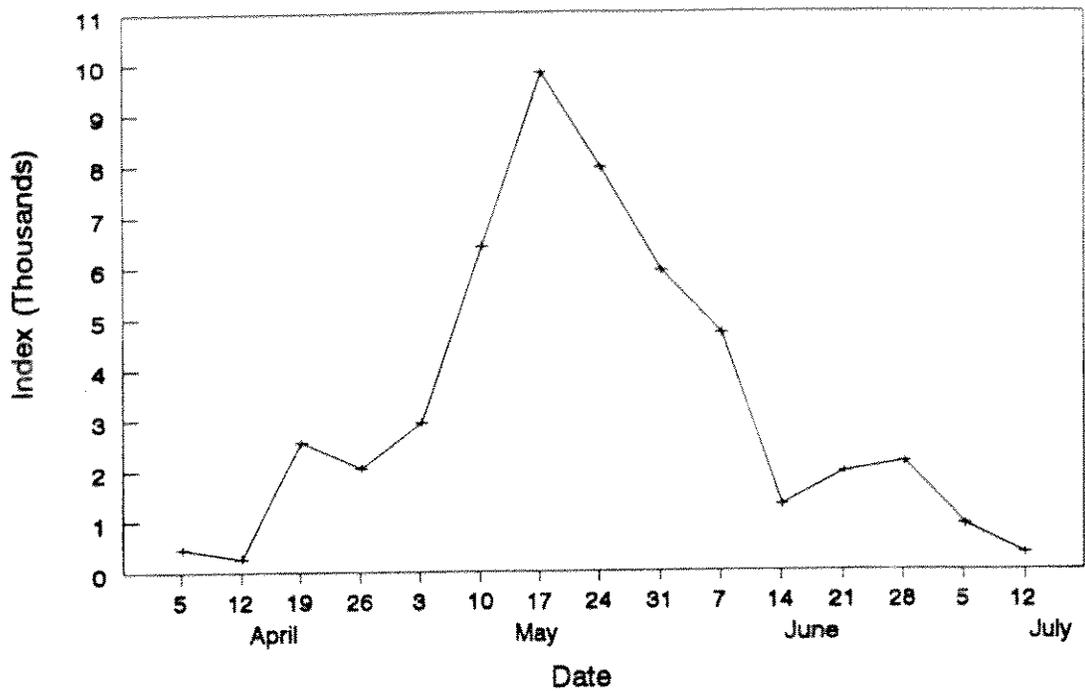


Figure 12. Weekly juvenile chinook abundance index, Blue Creek 1992.

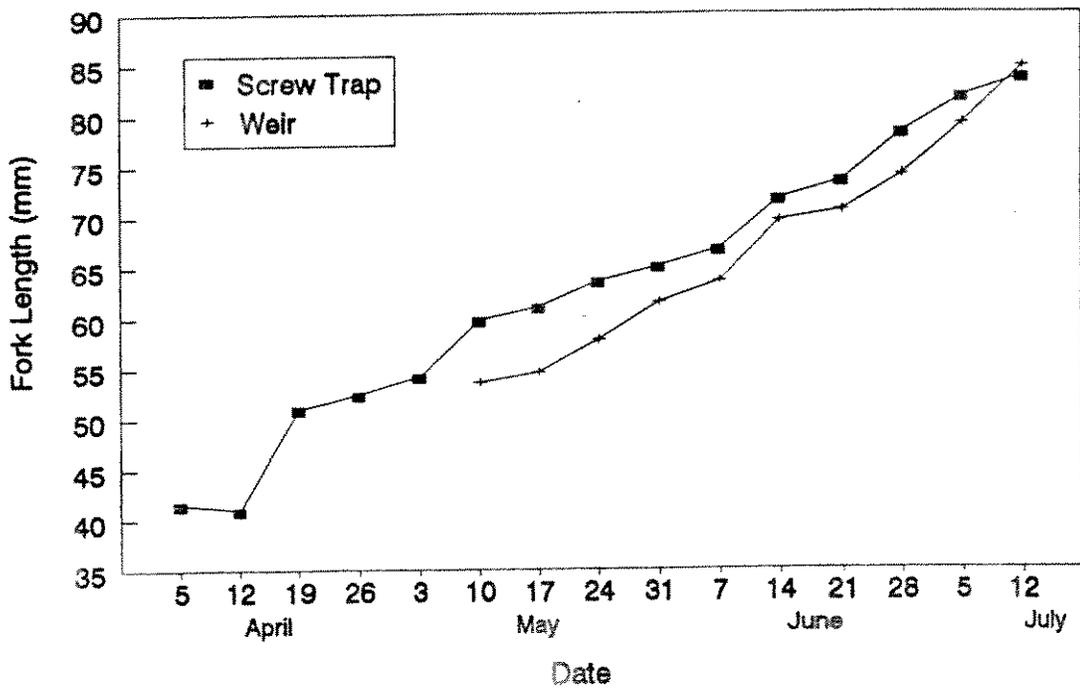


Figure 13. Weekly mean fork length of chinook captured in the screw trap and weir during 1992 juvenile trapping on Blue Creek.

Table 9. Weekly mean fork length (mm), standard deviation (s), and sample size (n) of chinook captured in the screw trap and weir during 1992 juvenile trapping on Blue Creek.

| Week | Screw Trap | | | Weir | | | P-value for significant difference |
|----------|------------|-------|-----|------|------|-----|------------------------------------|
| | Mean | s | n | Mean | s | n | |
| 04/05/92 | 41.6 | 3.65 | 41 | | | 0 | |
| 04/12/92 | 41.0 | 7.42 | 10 | | | 0 | |
| 04/19/92 | 51.0 | 7.65 | 72 | | | 0 | |
| 04/26/92 | 52.4 | 7.47 | 114 | | | 0 | |
| 05/03/92 | 54.2 | 7.92 | 120 | | | 0 | |
| 05/10/92 | 59.8 | 7.75 | 126 | 53.6 | 5.44 | 93 | 0.0000 |
| 05/17/92 | 61.1 | 7.80 | 163 | 54.6 | 6.47 | 150 | 0.0000 |
| 05/24/92 | 63.6 | 10.30 | 158 | 57.8 | 8.37 | 184 | 0.0000 |
| 05/31/92 | 65.1 | 9.17 | 216 | 61.5 | 7.96 | 223 | 0.0000 |
| 06/07/92 | 66.8 | 8.58 | 212 | 63.6 | 8.47 | 222 | 0.0002 |
| 06/14/92 | 71.8 | 8.79 | 205 | 69.6 | 7.78 | 208 | 0.0082 |
| 06/21/92 | 73.6 | 9.62 | 218 | 70.6 | 9.17 | 109 | 0.0071 |
| 06/28/92 | 78.3 | 8.43 | 221 | 74.1 | 8.86 | 200 | 0.0000 |
| 07/05/92 | 81.8 | 7.36 | 185 | 79.1 | 7.80 | 113 | 0.0031 |
| 07/12/92 | 83.7 | 7.10 | 44 | 84.7 | 7.81 | 23 | 0.6020 |

(Table 9). Mean fork length of YOY chinook captured in the weir was generally less than that of chinook captured in the screw trap (Figure 13). There was a significant difference in mean fork lengths of chinook captured in the weir and screw traps ($F=174.3$; $df_1=1$, $df_2=3262$; $P=0.000$) and a significant difference between weeks ($F=293.8$; $df_1=9$, $df_2=3262$; $P=0.000$). There was a significant difference in the length of chinook captured in the two traps in 7 of the 10 comparisons, with the length of chinook captured in the screw trap being greater on all 7 occasions (Table 9). The greater length of chinook captured in the screw trap may be due to larger fish emigrating in the swifter current in which the screw trap is placed, making them more susceptible to capture. Additionally, larger chinook maybe able to avoid capture by the weir during lower flows. Juvenile chinook were observed swimming out of the frame net during some lower flows.

Chinook Coded Wire Tagging

Coded wire tagging began on May 15 and continued through July 9. A total of 13,637 chinook were tagged and released. This represented more than 65% of the total number of chinook YOY (19,854) caught by the screw trap and juvenile weir. The CWT retention rate was measured weekly and averaged 94%, with an average mortality of 4%.

Steelhead Trout

Three age classes (YOY, 1+, and 2+) of steelhead were captured in the screw trap. A total of 364 YOY, 851 1+, and 173 2+ steelhead were captured in the screw trap during the 1992 trapping season (Table 6). Steelhead were captured throughout the entire juvenile trapping period, but individual age classes or developmental stages (parr/smolt) were not captured during all weeks. A total of 1,121 YOY, 69 age 1+, and 6 age 2+ steelhead were captured in the weir during the trapping period (Table 7).

YOY steelhead were first captured in the screw trap during the week of April 12, $n=6$. After YOY steelhead were first encountered, weekly screw trap catches of YOY steelhead ranged from 1 (during each of the weeks of April 19 and April 26) to 72 during the week of June 28 (Table 6). The YOY steelhead abundance index was 1,531 (Table 8). Based on indices for the trapping period, the majority of YOY steelhead (75%) had emigrated past the trap by the week of June 14 (Figure 14).

Mean fork length of YOY steelhead captured in the screw trap remained fairly constant from the week of April 5 to the week of June 14 of the trapping season, fluctuating between 29.0 mm and 35.3 mm. Following the week of June 14, mean fork length increased significantly to 58.3 mm (Figure 15). Mean fork length then generally increased during the remaining period of trapping, ranging from 54.8 mm to 66.4 mm (Table 10).

A total of 851 1+ steelhead were captured in the screw trap (Table 6). Of these, 783 (92%) were classified as parr. Age 1+ steelhead were captured during each week of trapping. Peak catch of 1+ steelhead (179 parr and 25 smolts) occurred during the week of June 28. This time period corresponds with a late storm event which encouraged emigration and is reflected by an increase in catch. The 1+ steelhead abundance index was 5,594 (5,318 parr and 276 smolts) for the juvenile trapping season (Table 8). Based on the 1+ steelhead index, the majority of 1+ steelhead (75%) emigrated from Blue Creek during April 5 to May 31 and peaked during the week of April 26 (Figure 14). A secondary peak (index of 616) occurred during the week of June 28. This secondary peak corresponds to a storm event which encouraged emigration (Figure 9).

A total of 69 age 1+ steelhead were captured in the weir (Table 7). The majority of these, 65 (94%) were classified as parr. This percentage of age

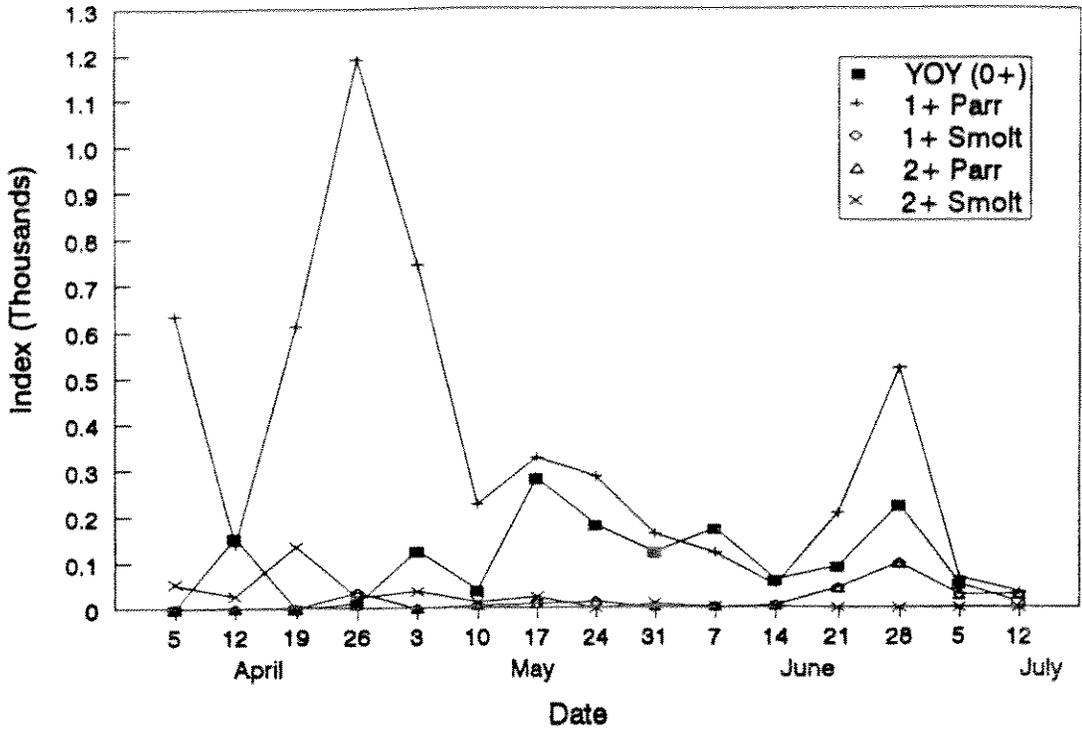


Figure 14. Weekly juvenile steelhead abundance index, Blue Creek 1992.

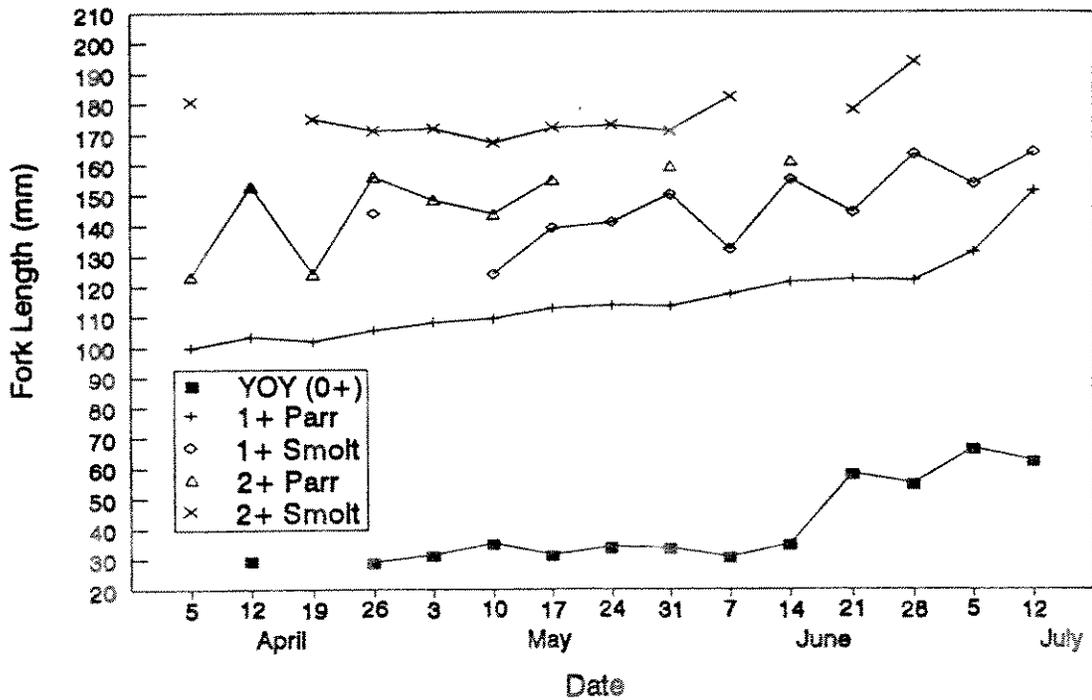


Figure 15. Weekly mean fork length of steelhead captured in the screw trap during 1992 juvenile trapping on Blue Creek.

Table 10. Weekly mean fork length (mm), standard deviation (s), and sample size (n) of steelhead captured in the screw trap during 1992 juvenile trapping on Blue Creek.

| Week | YOY (0+) | | | 1 + Parr | | | 1 + Smolt | | | 2 + Parr | | | 2 + Smolt | | |
|----------|----------|-------|----|----------|-------|-----|-----------|-------|----|----------|------|---|-----------|-------|----|
| | Mean | s | n | Mean | s | n | Mean | s | n | Mean | s | n | Mean | s | n |
| 04/05/92 | | | 0 | 100.0 | 10.57 | 39 | | | 0 | 123.3 | 5.77 | 3 | 180.8 | 15.10 | 23 |
| 04/12/92 | 29.7 | 1.03 | 6 | 103.4 | 8.53 | 5 | | | 0 | 153.0 | 0.00 | 1 | | | 0 |
| 04/19/92 | | | 0 | 101.9 | 10.18 | 18 | | | 0 | 124.2 | 2.50 | 4 | 174.9 | 10.78 | 8 |
| 04/26/92 | 29.0 | 0.00 | 1 | 105.7 | 15.83 | 92 | 144.0 | 4.58 | 3 | 156.0 | 8.49 | 2 | 171.3 | 13.36 | 18 |
| 05/03/92 | 31.4 | 2.41 | 14 | 108.3 | 15.51 | 72 | | | 0 | 148.3 | 3.51 | 3 | 171.8 | 13.36 | 21 |
| 05/10/92 | 35.3 | 5.89 | 6 | 109.4 | 15.47 | 34 | 124.0 | 0.00 | 1 | 143.5 | 2.12 | 2 | 167.2 | 10.18 | 21 |
| 05/17/92 | 31.5 | 1.60 | 54 | 112.7 | 15.05 | 62 | 139.0 | 7.07 | 2 | 155.0 | 3.54 | 5 | 172.1 | 10.33 | 18 |
| 05/24/92 | 34.1 | 7.64 | 34 | 113.5 | 15.71 | 55 | 141.0 | 13.09 | 4 | | | 0 | 172.8 | 7.29 | 5 |
| 05/31/92 | 33.9 | 7.28 | 37 | 113.2 | 11.87 | 55 | 150.0 | 0.00 | 1 | 159.3 | 1.15 | 3 | 171.0 | 0.00 | 1 |
| 06/07/92 | 30.8 | 3.93 | 40 | 117.3 | 15.18 | 28 | 132.0 | 0.00 | 1 | | | 0 | 182.0 | 0.00 | 1 |
| 06/14/92 | 35.1 | 8.06 | 17 | 121.5 | 24.90 | 8 | 155.0 | 0.00 | 2 | 161.0 | 0.00 | 1 | | | 0 |
| 06/21/92 | 58.3 | 5.89 | 15 | 122.3 | 18.44 | 18 | 144.2 | 17.80 | 13 | | | 0 | 178.0 | 0.00 | 1 |
| 06/28/92 | 54.8 | 10.67 | 49 | 121.8 | 14.55 | 139 | 163.2 | 14.02 | 23 | | | 0 | 193.6 | 7.30 | 7 |
| 07/05/92 | 66.4 | 7.30 | 11 | 131.2 | 23.08 | 14 | 153.5 | 17.83 | 6 | | | 0 | | | 0 |
| 07/12/92 | 62.5 | 0.71 | 2 | 151.2 | 20.79 | 6 | 164.0 | 6.32 | 5 | | | 0 | | | 0 |

YOY = young of year

1+ steelhead classified as parr was similar to that observed for the screw trap catch. Peak weir catch of 1+ steelhead (11 parr and 0 smolts) also occurred during the week of June 28.

Mean fork length of 1+ steelhead parr captured in the screw trap gradually increased throughout the trapping season (Figure 15) ranging from 100.0 mm during the first week of trapping and increasing to 151.2 mm during the last week of trapping (Table 10). Mean fork length of 1+ smolts generally increased throughout the trapping season and was in all cases greater than the mean fork length of 1+ parr (Figure 15). Mean fork length of 1+ smolts ranged from 124.0 mm during the second week of trapping to 164.0 mm during the last week of trapping.

A total of 173 2+ steelhead were captured in the screw trap (Table 6). Peak weekly catch of 2+ steelhead, 44, occurred during the first week of trapping. Twenty-six (15%) of the 2+ steelhead were classified as parr. Age 2+ steelhead were captured during all but the last two weeks of the trapping period, although both developmental stages (parr and smolts) were not always present. Catches of 2+ steelhead were infrequent after the week of May 31, but increased slightly during the storm event which occurred the week of June 28. The 2+ steelhead abundance index for the trapping season was 1,875 (Table 8). Based on the 2+ abundance index, the majority (82%) of the 2+ steelhead captured during the trapping season emigrated from Blue Creek from April 5 to May 10, and peaked during the week of April 19 (Figure 14).

Only six age 2+ steelhead were captured in the weir (Table 7). Two of these were classified as smolts. All of the age 2+ steelhead were captured between the first and fifth week (May 5 to June 7) of trapping with the weir. The low catch of 2+ steelhead by the weir can be attributed to the ability of the larger fish to swim out of and evade capture by the weir, especially during lower flows.

Mean fork length of 2+ steelhead smolts captured in the screw trap ranged from 171.0 mm (n=1) during the week of May 31 to 193.6 mm during the week of June 28 (Table 10). Mean fork length of age 2+ steelhead smolts generally decreased throughout the early portion of the trapping season (Figure 15). This trend of decreasing length over time was also observed during the 1989 and 1990 trapping season and to a lesser degree in 1991 season (USFWS 1990, 1992).

Due to the relatively high number of 1+ and 2+ steelhead captured during the first week of trapping, it is obvious that the steelhead emigration had commenced some time before trapping began. Because of this, abundance indexes presented are not intended to reflect the entire production of age 1+ and 2+ steelhead but only the emigration of steelhead observed during the trapping period.

Coho Salmon

Two age classes of coho salmon, YOY/parr and 1+, were captured during the 1992 trapping operation. A total of 99 juvenile coho salmon (88 YOY/parr and 11 1+ smolts) were captured in the screw trap (Table 6). The juvenile weir captured a total of 127 YOY/parr. No coho smolts were caught in the weir (Table 7).

The weekly catch of YOY/parr coho in the screw trap ranged from 0 during the first 4 weeks of trapping and the final week of trapping, to 18, during the week of June 28; the week of a storm event encouraging emigration (Table 6 and Figure 9). The YOY coho abundance index for the trapping season was 378 (Table 8). Based on index values, the peak of YOY coho emigration occurred during the week of May 17 (Figure 16). Smaller peaks in abundance occurred during the weeks of May 3 and June 28.

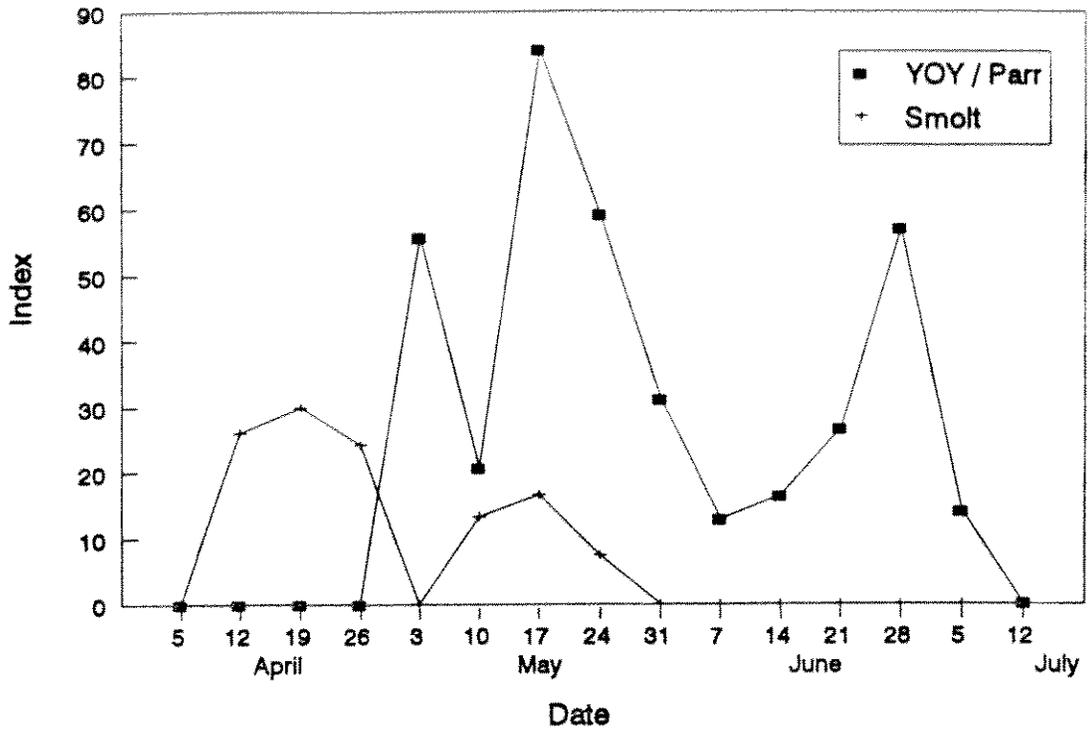


Figure 16. Weekly juvenile coho abundance index, Blue Creek 1992.

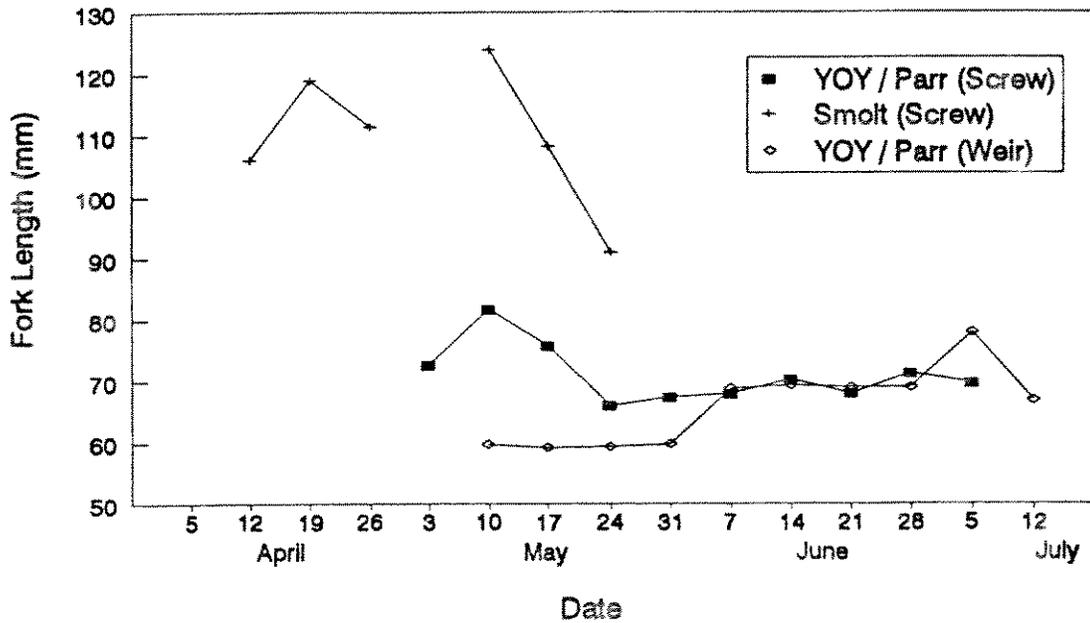


Figure 17. Weekly mean fork length of coho captured in the screw trap and weir during 1992 juvenile trapping on Blue Creek.

YOY/parr coho were captured in the juvenile weir throughout the trapping season which began the week of May 10. The catch ranged from 1, during the last week of weir operation, to 27, during the week of June 28 (Table 7).

Mean fork length of YOY coho captured in the screw trap ranged from 66.1 mm during the week of May 24, to 81.7 mm, during the week of May 10 (Table 11). Mean fork length of YOY coho sharply increased and then decreased between the weeks of May 3 and May 24, but after May 24, it gradually increased throughout the remainder of the trapping season (Figure 17).

Mean fork length of YOY coho captured in the weir generally increased throughout the trapping period, with the exception of a sharp drop in fork length during the final trapping week (Figure 16). This drop can probably be attributed to the small sample size for that week (n=1). Mean fork length ranged from 59.3 mm during the week of May 10, to 78.0 mm, during the week of July 5 (Table 11).

Age 1+ coho were predominately captured in the screw trap during the early part of the trapping operation, with the peak weekly catch of 3 occurring during the week of May 14. Coho smolts were not captured after the week of May 24 (Table 6). The 1+ coho abundance index was 118 (Table 8). Based on the observed timing, the majority of the 1+ coho (68%) emigrated from Blue Creek by the week of May 3, with a peak occurring during the week of April 19 (Figure 16). A secondary peak (index of 17) occurred during the week of May 17. As with the 1+ and 2+ steelhead, trapping was apparently initiated after the 1+ coho smolt emigration began and the index of abundance is only indicative of the trapping period.

Mean fork length of 1+ coho generally increased during the early part of the juvenile trapping period, and then decreased by May 24, the last week 1+ coho were captured (Figure 17). Mean fork length ranged from 124.0 mm the week of May 10, to a low of 91.0 mm during the week of May 24 (Table 11).

Coastal Cutthroat Trout

Nine cutthroat parrs and 1 smolt were captured by the screw trap and only a single parr was captured by the weir during the juvenile trapping season. The first fish was caught during the week of May 17, the last cutthroat was caught during the week of July 5. Fork length of parrs ranged from 120 mm to 163 mm, and the single smolt 255 mm. Juvenile cutthroat have been identified in only one other trapping year during the USFWS investigations on Blue Creek. Two individuals were caught during the month of June in 1990. Possible sea-run adults were observed sporadically during fall 1991 adult surveys and the 1992 juvenile trapping season while snorkeling.

Other Species

Additional species captured by the screw trap and juvenile weir included (in decreasing order of abundance) speckled dace (Rhinichthys osculus), threespine stickleback (Gasterosteus aculeatus), Prickly sculpin (Cottus asper), Klamath smallscale sucker (Catostomus rimiculus), Pacific lamprey adults and ammocoetes (Lampetra tridentata), western toad (Bufo boreas), foothill yellow-legged frog (Rana boylei), and juvenile Pacific giant salamander (Dicamptodon ensatus).

Table 11. Weekly mean fork length (mm), standard deviation (s), and sample size (n) of coho captured in the screw trap and weir during 1992 juvenile trapping on Blue Creek.

| Week | Screw | | | Trap | | | Weir | | |
|----------|----------|-------|----|-------|------|---|----------|-------|----|
| | YOY/Parr | | n | Smolt | | n | YOY/Parr | | n |
| | Mean | s | | Mean | s | | Mean | s | |
| 04/05/92 | | | 0 | | | 0 | | | 0 |
| 04/12/92 | | | 0 | 106.0 | 0.00 | 1 | | | 0 |
| 04/19/92 | | | 0 | 119.0 | 0.00 | 1 | | | 0 |
| 04/26/92 | | | 0 | 111.5 | 4.95 | 2 | | | 0 |
| 05/03/92 | 72.7 | 12.77 | 6 | | | 0 | | | 0 |
| 05/10/92 | 81.7 | 9.12 | 3 | 124.0 | 2.83 | 2 | 59.8 | 10.40 | 4 |
| 05/17/92 | 75.9 | 8.73 | 16 | 108.3 | 2.25 | 3 | 59.3 | 8.67 | 13 |
| 05/24/92 | 66.1 | 5.82 | 12 | 91.0 | 0.00 | 2 | 59.4 | 6.88 | 18 |
| 05/31/92 | 67.5 | 6.81 | 6 | | | 0 | 59.8 | 10.14 | 7 |
| 06/07/92 | 68.0 | 3.20 | 3 | | | 0 | 68.9 | 6.87 | 16 |
| 06/14/92 | 70.3 | 4.27 | 6 | | | 0 | 69.3 | 8.01 | 15 |
| 06/21/92 | 68.1 | 4.66 | 7 | | | 0 | 69.1 | 9.17 | 12 |
| 06/28/92 | 71.4 | 4.69 | 18 | | | 0 | 69.1 | 6.94 | 27 |
| 07/05/92 | 69.8 | 8.11 | 4 | | | 0 | 78.0 | 13.13 | 6 |
| 07/12/92 | | | 0 | | | 0 | 67.0 | 0.00 | 1 |

YOY = young of year

SUMMARY

Continuing investigations on Blue Creek have monitored the trends of chinook spawning and juvenile emigrations. Previous reports on this project have included habitat classifications, densities of juvenile chinook, and quantitative estimates of spawning and rearing habitats.

Numbers of returning adult fall run chinook continued to be very low in 1991. Based on the total estimated area of suitable spawning habitat, only 2% of the maximum potential number of redds were seen during fall 1991. This compares with 2% in 1990, 6% in 1989 and 2% in 1988. Continued harvest of this stock should be of concern if recovery of the population is expected to occur in a reasonable period of time. A total of four Blue Creek chinook (brood year 1989) were identified in the 1991 ocean harvest from CWT recoveries (PSMFC 1993). Two CWT Blue Creek chinook (brood year 1989) were identified by the in-river net harvest monitoring program in fall 1991 (USFWS 1992). Ocean and in-river harvest of this stock should continue to be examined for effects on escapement. In addition, the continued take of these fish for artificial propagation may contribute to the insufficient escapement of spawners to Blue Creek.

Radiotelemetry of adult spawners proved to be a useful, although time consuming method to locate remote areas of spawning activity. It was also a feasible alternative when high flows prevented wading surveys. Radiotelemetry helped to identify the use of the lower 3.5 km of Crescent City Fork by spawning chinook during fall 1991.

Emigrating juvenile salmonids were trapped using both a rotary screw trap and weir. On average, larger fish were caught by the rotary screw trap than by the weir. Calculated abundance index for total chinook juveniles was 49,590 for 1992, compared with 12,500 for 1991 and 32,000 for 1990. A total of 12,687 chinook YOY were coded wire tagged during the trapping period.

Low flows in late summer and early fall 1991 may have delayed immigration of spawners, but no barriers were noted after fish began moving upstream. Mild temperatures and stream flows during late fall and winter may have contributed to an increase in survival of the 1991 brood year of juvenile salmonids. Water levels continued to be relatively low and stream temperatures warm during summer 1992, although no specific problems were noted with rearing fish. In summer and early fall, water from Blue Creek continued to provide a cool-water refuge at the confluence to spawners migrating in the Klamath River.

CONTINUED INVESTIGATIONS

Investigations are projected to continue for FY 1993. Surveys of adult spawners (species, numbers and locations) and chinook redds (numbers and locations) will be carried out. Counts will be made of emigrating juvenile salmonids, and recommendations will be made for enhancement activities likely to stimulate stock production. The marking of emigrating chinook with coded wire tags will be continued, in order to assess the contribution of Blue Creek stocks to the fishery. Flow and temperatures will also be monitored. Based on observed use of specific habitats, and general knowledge of stream restoration methods, proposals may be made for projects to restore riparian and aquatic habitats.

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PERSONAL COMMUNICATIONS

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Appendix A. Habitat types and descriptions.

| <u>CODE</u> | <u>HABITAT TYPE</u> | <u>DESCRIPTION</u> |
|-------------|--|---|
| 0 | Dry Channel (DRY) | |
| 1 | Low Gradient Riffle (LGR) | Shallow reaches with swiftly flowing, turbulent water with some partially exposed substrate. Gradient <4%, substrate is usually cobble dominated. |
| 2 | High Gradient Riffle (HGR) | Steep reaches of moderately deep, swift, and very turbulent water. Amount of exposed substrate is relatively high. Gradient is >4%, and substrate is boulder dominated. |
| 3 | Cascade (CAS) | The steepest riffle habitat, consisting of alternating small waterfalls and shallow pools. Substrate is usually bedrock and boulders. |
| 4 | Secondary Channel Pool (SCP) | Pools formed outside of the average wetted channel width. During summer, these pools will dry up or have very little flow. Mainly associated with gravel bars and may contain sand and silt substrates. |
| 5 | Backwater Pool (BwBo) Boulder Formed | Found along channel margins and caused by eddies around obstructions such as boulders, rootwads, or woody material. These pools are usually shallow and are dominated by fine grain substrates. Current velocities are quite low. |
| 6 | Backwater Pool (BwRw) Rootwad Formed | |
| 7 | Backwater Pool (BwLog) Log Formed | |
| 8 | Trench/Chute (TRC) | Channel cross sections typically U-shaped with bedrock or coarse grained bottom flanked by bedrock walls. Current velocities are swift and the direction of flow is uniform. May be pool-like. |
| 9 | Plunge Pool (PLP) | Found where stream passes over a complete or nearly complete channel obstruction and drops steeply into the streambed below, scouring out a depression; often large and deep. Substrate size is highly variable. |
| 10 | Lateral Scour Pool (LsLog) Log Formed | Formed by flow impinging against a streambank or against a partial channel obstruction. The associated scour is generally confined to <60% of wetted channel width. Channel obstructions include root-wads, woody material, boulders and bedrock. |

Appendix A. (continued).

| <u>CODE</u> | <u>HABITAT TYPE</u> | <u>DESCRIPTION</u> |
|-------------|---|--|
| 11 | Lateral Scour Pool (LsRw) Rootwad Formed | |
| 12 | Lateral Scour Pool (LsBk) Bedrock Formed | |
| 13 | Dammed Pool (DPL) | Water impounded from a complete or nearly complete channel blockage (log jams, rock landslides or beaver dams). Substrates tend toward smaller sized gravels and sand. |
| 14 | Slides (GLD) | A wide uniform channel bottom. Flow with low to moderate velocities, lacking pronounced turbulence. Substrate usually consists of cobble, gravel and sand. |
| 15 | Run (RUN) | Swiftly flowing reaches with little surface agitation and no major flow obstructions. Often appears as flooded riffles. Typical substrates are gravel, cobble and boulders. |
| 16 | Step Run (STR) | A sequence of runs separated by short riffle steps. Substrates are usually cobble and boulder dominated. |
| 17 | Mid-Channel Pool (MCP) | Large pools formed by mid-channel scour. The scour hole encompasses more than 60% of the wetted channel. Water velocity is slow, and the substrate is highly variable. |
| 18 | Edgewater (EGW) | Quiet, shallow area found along the margins of the stream, typically associated with riffles. Water velocity is low and sometimes lacking. Substrates vary from cobbles to boulders. |
| 19 | Channel Confluence Pool (CCP) | Large pools formed at the confluence of two or more channels. Scour can be due to plunges, lateral obstructions or scour at the channel intersections. Velocity and turbulence are usually greater than those in other pool types. |
| 20 | Lateral Scour Pool (LsBo) Boulder Formed | Formed by flow impinging against boulders that create a partial channel obstruction. The associated scour is confined to <60% of wetted channel width. |
| 21 | Pocket Water (POW) | A section of swift flowing stream containing numerous boulders or other large obstructions which create eddies or scour holes (pockets) behind the obstructions. |

Appendix A. (continued).

| <u>CODE</u> | <u>HABITAT TYPE</u> | <u>DESCRIPTION</u> |
|-------------|---------------------|--|
| 22 | Corner Pool (CRP) | Lateral Scour Pools formed at a bend in the channel. These pools are common in lowland valley bottoms where stream banks consist of alluvium and lack hard obstructions. |
| 23 | Step Pool (STP) | A series of pools separated by short riffles or cascades. Generally found in high gradient, confined mountain streams dominated by boulder substrate. |
| 24 | Bedrock Sheet (BRS) | A thin sheet of water flowing over a smooth bedrock surface. Gradients are highly variable. |