Progress Report:
Fisheries Investigations in New River, Tributary to Trinity River, Northern California.

FY 1994 and 1995

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ABSTRACT

Monitoring of adult and juvenile salmonids in New River continued for the sixth (1993/1994) and seventh (1994/1995) seasons from October 1, 1993 to September 30, 1994 and October 1, 1994 to September 30, 1995. Surveys of adult salmonids have indicated that spring and fall chinook (Oncorhynchus tshawytscha) runs are relatively low (compared to earlier years); a total of 53 chinook redds were counted during the fall of 1993. Of these, 28 spring chinook redds and 25 fall chinook redds were counted. During the fall of 1994 a total of 24 chinook redds were counted. Three were believed to be spring chinook redds and 21 were fall chinook redds. The spring chinook redd count during 1993 was the highest to date and corresponds with the highest adult count (31) since the surveys began. Above normal rainfall during the winter of 1992/1993 resulted in higher river flows and cooler water temperatures during 1993. These conditions may have helped the movement of adult spawners into New River. Conversely, the drought like conditions during the winter of 1993/1994, probably made it harder for adult spawners to move into New River during the fall of 1994.

Summer steelhead (Oncorhynchus mykiss) runs in New River are among the highest in California. During 1994, a total of 404 adults and 23 "half-pounders" were counted during late summer snorkel surveys. The 1995 count was 776 adults and 41 "half-pounders" which were the highest number observed during this study (1988 to 1995). Annual counts in New River have ranged from a low of 250 in 1980 to a high of 817 (including "half-pounders" and adults) in 1995. During 1994 and 1995, New River had the third highest adult summer steelhead count in the state.

A resistance-board weir (rkm 3.5) was used to trap immigrating adult chinook and steelhead. A total of 31 Chinook and 29 steelhead were trapped by the weir from October 27, 1992 to January 17, 1993. A total of 19 chinook and 230 steelhead were also trapped from October 21, 1993 to July 11, 1994. A total of zero chinook and 16 steelhead were trapped at the weir from November 5, 1994 to January 3, 1995. Based on the 1993/1994 run timing results, the dominant steelhead run in New River is composed predominantly of early summer (spring) run steelhead with the remainder consisting of late summer (fall) run fish. Scale analysis for all years of weir data revealed a dominant steelhead life history of 2.2 (two year's fresh and two years salt water) with less than 5 percent of the scales having

spawning checks. Most of the adult chinook returning to New River were two year olds (combined years spent in fresh and salt water) during 1992/1993 and three year olds during 1993/1994. No chinook adults were captured by the weir during the 1994/1995 trapping season.

The weir appeared to delay adult immigration and emigration in New River. Based on the many adult salmonids observed in pools immediately upstream and downstream of the weir, CDFG spaghetti tag recoveries, redd locations, and run timing and intensity, it appears the weir had impeded migration.

A rotary screw trap (rkm 3.7) was used to trap emigrating juvenile salmonids during the spring and summers of 1989 to 1995. These data were used to derive an abundance index of total emigration in New River. During 1994, the YOY chinook abundance index (29,574) was almost eight times higher than during any other year of this study, while in 1995, no juvenile chinook were observed. The lack of chinook juveniles captured in 1995 may be due to low numbers of redds located upstream of the rotary screw trap and poor survival of eggs and fry due to high winter flows which probably "washed out" redds. During 1994 the YOY steelhead (8,830) and smolt (6,832) numbers were high, while parr numbers (4,061) were the lowest during this study. During 1995, YOY steelhead numbers (8,150) were high, while parr numbers were low (11,024) and smolt numbers were the lowest on record (1,088).

Water temperature and river flows have been monitored throughout the investigation from October 1 to September 30 of each year. Discharge was lower than normal during 1993/1994 and ranged from 0.69 to 37.14 cubic meters per second (cms). During the same time, daily mean water temperatures ranged from a low of 1.6°C on December 24, 1993 to a high of 24.8°C on July 22, 1994. The highest discharges during this study were recorded during the 1994/1995 field season and ranged from 0.75 to 899 cms. Daily mean water temperatures during 1994/1995 ranged from 2.7°C on November 23, 1994 to 23.3°C on August 5, 1995. In the summer of 1994 (July to August), high water temperatures in the mainstem of New River from Devils Canyon confluence (rkm 24.3) to the mouth of New River, may have limited juvenile salmonid growth.

INTRODUCTION

The Trinity River Basin has experienced substantial declines in anadromous fish stocks during recent years. It has been estimated that during the two decades between 1960 and 1980, populations of chinook salmon (Oncorhynchus tshawytscha), coho salmon (O. kisutch) and steelhead trout (O. mykiss) declined to about 20 percent of historic levels (USFWS, 1990). In 1963, the U.S. Bureau of Reclamation completed development of the Trinity River Division of the Central Valley Project. Construction of Clair Engle and Lewiston dams enabled the storage of Trinity River water for a regulated diversion through a trans-mountain aqueduct into the Sacramento River Valley. The dams blocked access to approximately 175 river kilometers (rkm) of salmon and steelhead spawning and rearing habitats. In addition, the reduction in flows below the dams reduced habitat availability in the stretch of river that historically had supported the greatest concentration of chinook salmon spawning habitats. Although the Trinity River Hatchery was constructed to mitigate for habitat losses, both salmon and steelhead populations have continued to decline (USFWS, 1994).

Besides development associated with dam and road construction, countless other factors may have significant effects on salmonid populations. Ocean conditions such as food availability and natural and fishing mortality affect their return to fresh water. The quantity and quality of spawning, resting, and nursery habitats in fresh water are influenced by natural events (forest fires, droughts, landslides and floods), and human activities (road construction, mining, logging, and water diversion). The combined effects of many factors have resulted in the widespread reduction of fishery resources within the Trinity Basin. The Trinity River Basin Fish and Wildlife Management Plan (TRBFWMP) has begun to address this problem by providing management options designed to restore salmonid populations and habitats to historic levels in the Trinity River and its larger tributaries.

New River, a major tributary to the Trinity River, is a free-flowing river draining a relatively undisturbed watershed. Although gold mining operations (placer and lode) were numerous throughout the drainage in the past, mining is now limited primarily to small-scale suction-dredging operations. Logging has been moderate within the watershed. The upper watershed of New River received federal protection in 1984 by inclusion within the Trinity Alps Wilderness Area. Because intentional manipulations of the aquatic and riparian habitats have been small, New River may be a suitable index tributary to monitor changes in wild salmonid populations that are not associated within stream habitat improvement projects or watershed rehabilitation programs.

In 1988, the USFWS began a project, funded by the Trinity River Fish and Wildlife Restoration Act (TRFWRA) (P.L. 98-541), to identify the quantity, quality, and use of spawning and rearing habitats, relative production of natural stocks, and enhancement potential for chinook salmon in the basin. In 1989, the project scope was broadened to include all races of chinook and steelhead. Current studies include the assessment and monitoring of habitats used by juveniles, adult counts, redd surveys, and monitoring of juvenile emigrants.

Although the abundance of summer steelhead in New River seems to have declined substantially since the early 1900's (Roelofs, 1983), the river still supports one of the larger populations in the state. An estimated 80.5 km of the New River drainage is accessible to adult steelhead and provides excellent nursery areas for the juveniles.

According to the California Department of Fish and Game (CDFG), the statewide total number of natural summer steelhead ranges from 1,500 to 4,000 fish (Gerstung, pers. comm., 1995). The estimated number of adult summer steelhead entering New River has ranged from approximately 200 to 776 individuals over the past decade.

Remnant populations of spring and fall chinook are also present in New River. Chinook salmon mainly use the lower 32 rkm of the New River mainstem. These populations may be critically low. CDFG estimates the total number of natural spring chinook statewide to be a few thousand individuals (Gerstung, pers. Comm., 1995). Over the past five years, the estimated number of adult spring chinook in New River has ranged from a total of only 2 to 31 individuals. CDFG estimated the total natural fall chinook spawner escapement within the Trinity Basin (above Willow Creek) to be 13,411 during 1994 and 95,713 in 1995, (Hubbell, 1995). The number of fall chinook in New River was less than 100 individuals. Because of chinook declines within Washington, Idaho, Oregon, and California, the National Marine Fisheries Service (NMFS) is currently conducting a status review for chinook salmon to see if petitioning them under the Endangered Species Act (ESA) is warranted.

For ease in reporting, calendar years will be used throughout this report. Physical measurements such as, water temperatures and stream discharges were carried out from October 1 to September 30 of each year. Weir operations were also carried out from October 1, to September 30, and each season of operation will be presented as occurring over two years (e.g., 1993/1994). Because 1995 was the last year the weir was operated, all four years of weir operation (1992 to 1995) will be presented in this report. Information from other years activities may also be presented for comparative purposes in an attempt to clarify the results.

STUDY AREA

DESCRIPTION

New River is a fifth-order tributary to the Trinity River in northern California. The 614 km^2 drainage is intermediate in size between the other two major tributaries, the North and South Forks of the Trinity River. The mouth of New River is 140.1 rkm from the ocean, and 70.2 rkm from the junction of the Trinity and Klamath rivers (Figure 1). New River has three major tributaries and many smaller tributaries used by salmonids (Figure 2). A more thorough description of the study site may be obtained from previous project reports (USFWS, 1991, 1992, 1994b, and 1995).

MATERIALS AND METHODS

STREAM PHYSICAL MEASUREMENTS

Water Temperature Monitoring

During October 1, 1988 through September 30, 1995, a Ryan Instruments TempMentor digital temperature recorder (Model #RTM) placed between rkm 3.4 and 3.7 (by the mouth of Dyer Creek) was used to monitor stream temperature. During October 1, 1993 to the September 30, 1995, the TempMentor was housed within a steel pipe and anchored with steel cable to the river bottom. Temperature data were recorded at 2-hour intervals and downloaded using RTM software. Maximum, minimum, and mean daily temperatures were calculated from the raw data. The ambient water temperature was also taken (at rkm 3.5) using a hand-held thermometer, whenever a field crew was at the site.

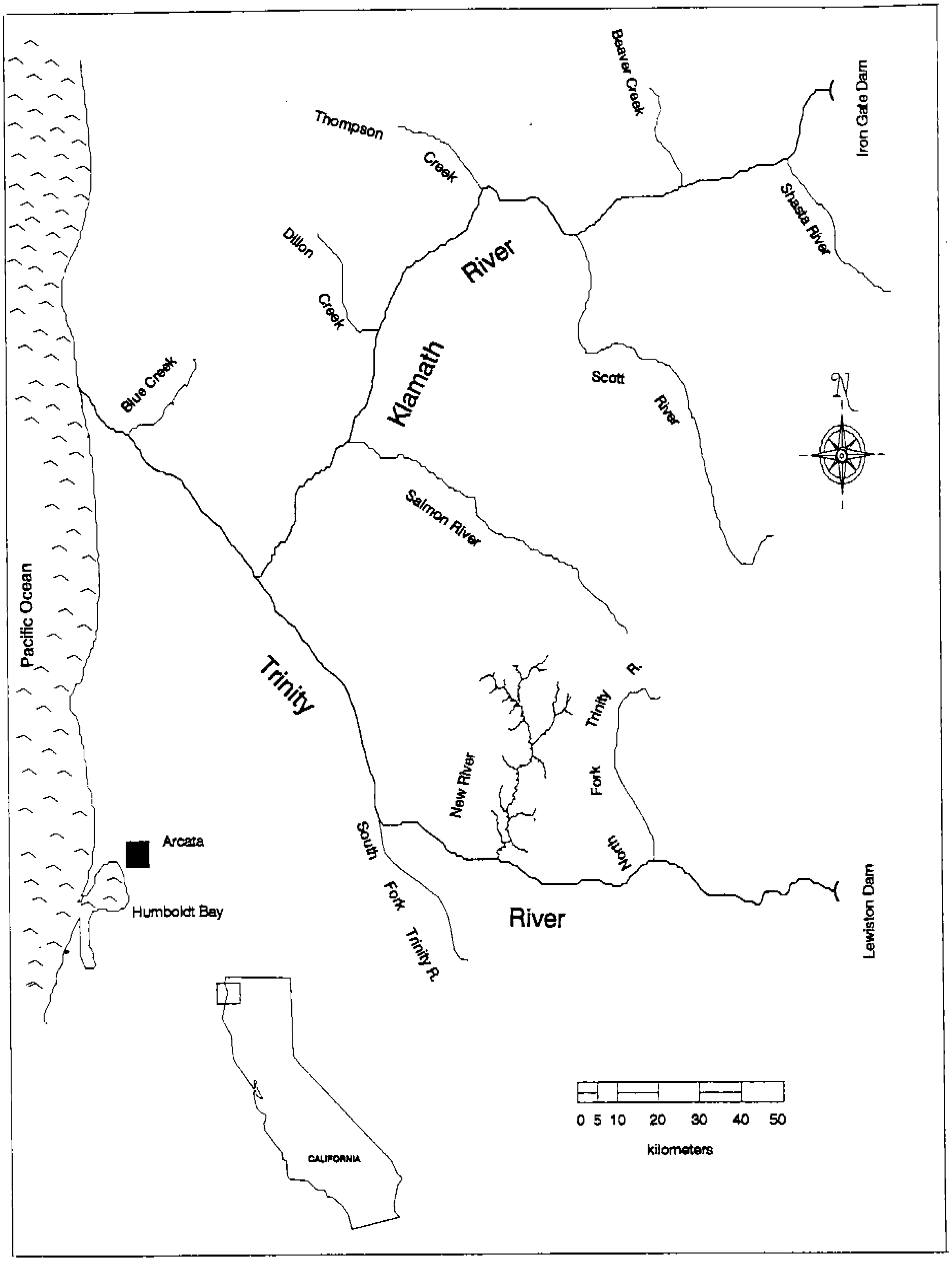

Figure 1. Location of New River, a major tributary of the Trinity River, in northwestern California.

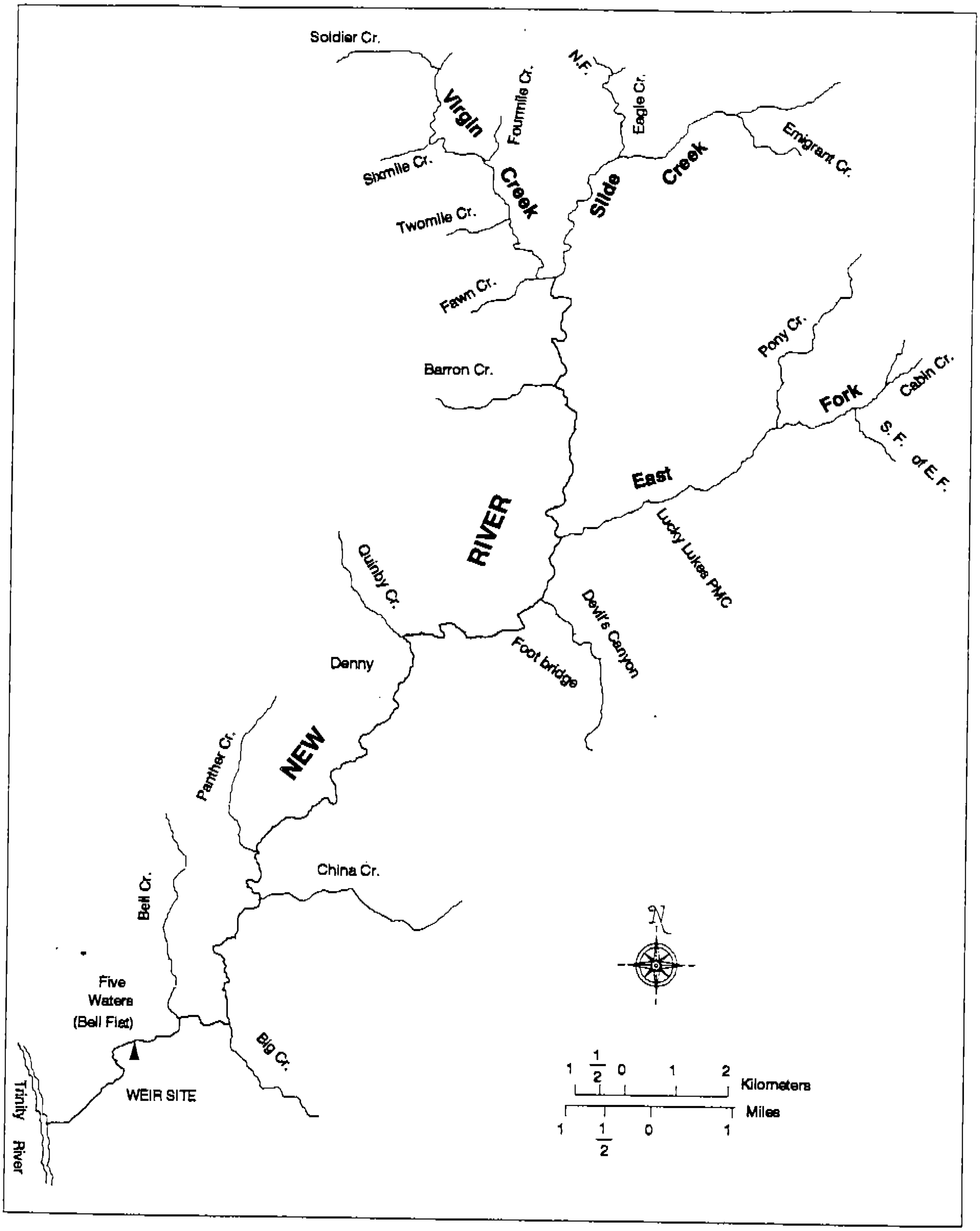

Figure 2. New River and its major tributaries, Trinity County, CA.

Flows

A staff-gage was installed at rkm 3.4 in 1988 by the USFWS and used for current readings. Gage reading from June 1959 to September 1969 were recorded by the USGS at rkm 19.0 (USGS 1970). Gage heights (rkm 3.4) were recorded on a daily basis whenever a field crew was at the site. The gage-height/flow relationship established in 1988 (USFWS, 1991) and the following equation was used to determine the flows for the varying gage heights recorded:

$Y = \{10^{[1.3549 + 3.04959(\log X+1)]}\}-1$, where

X = gage height (ft), Y = flows (cfs).

The relationship was recalibrated at a variety of flows at rkm 3.5 by use of a Price AA current meter and top-setting rod. Flows were taken across a transect line (rkm 3.5) following the methodology described by Platts et al. (1983).

A crest gage (2.5 cm diameter polyethylene tubing) was used to determine peak storm flows. The crest gage was attached to the staff gage with the bottom end submerged in the water. Before storm flows, fine burnt cork shavings were placed inside the tubing top and washed down to the meniscus. The raising and lowering of the water level left a cork mark on the inside tubing indicating the peak flow height. Stage of the crest gage was recorded after storm waters receded. During the earlier years of this study (1988 to 1991), gage readings were not taken as often during the fall and winter months because field crews were not stationed at the weir site (rkm 3.5). Gage readings were recorded between October 1, 1988 to September 31, 1995.

HABITAT EVALUATIONS

Index Reaches

Approximately 66 rkm of New River and its tributaries have been classified as seven different channel geomorphic types and 25 standard micro-habitat types. Channel types were classified using methods described by Rosgen (Appendix A). While, micro-habitat types were modified by the USFWS (1990, 1992) from methods presented by McCain et al. (1990) and described in Appendix B. After assessing the micro-habitat type information collected during 1988 to 1990, permanent index reaches were established in 1990 for long-term monitoring of juvenile abundance and possible changes in micro-habitat types (USFWS, 1991).

All the micro-habitat types identified within the mainstem and major tributaries are represented in the index reaches. Index reaches were chosen based on geomorphic characteristics, the representation of micro-habitat types, and the accessibility and location of tributaries. As a result, 14 index reaches were designated in the New River system (Figure 3). Eight index reaches are found in the mainstem, one in East Fork, two in Slide Creek, and the remaining three in Virgin Creek. Three reaches are found within a B1 channel type, three are within a C1 channel type, and four each are in B2 and B3 channel types. Index reaches were temporarily marked for the duration of the study by using flagging and metal tags on trees. Lengths of index reaches range from 125 to 720 m, for a combined total length of 4,286 m. Index reaches comprise 7% of the 65.8 km of mainstem and headwater channels that have had habitats classified. The index reaches on the mainstem alone comprise 9% of total mainstem habitats.

Snorkel surveys of juvenile salmonids have been completed in mid- to late-summer every year since 1989. Since most emigrating salmonids have left the drainage by this time, the surveys provide an index (estimate of the numbers) of juveniles that have over-summered and may overwinter in the system. Summer water flows are low and stable and water temperatures are highest (18-27°C) at this time. Hillman et al. (1992) found that snorkel counts were most accurate at temperatures above 14°C. They decided that at temperatures below 14°C most counts revealed only half the number of fish present. At temperatures below 9°C less than 20% of the fish present were observed.

All index reaches were snorkeled between July 26 and August 10 during 1994 and from August 10 to 25 during 1995. Teams of two to four people were used to count numbers of juvenile salmonids remaining in the system. The teams began snorkeling at the downstream end of each index reach to minimize disturbance to fish and went upstream to the upper end of the index. Total numbers of observed salmonids, classified by species and age class (0+, 1+, 2+), were tallied at the upstream end of individual habitat units. Snorkelers recorded water visibility for each index reach. Calibration by electrofishing was not a practical option due to the rugged terrain, deep pools, and time limitations.

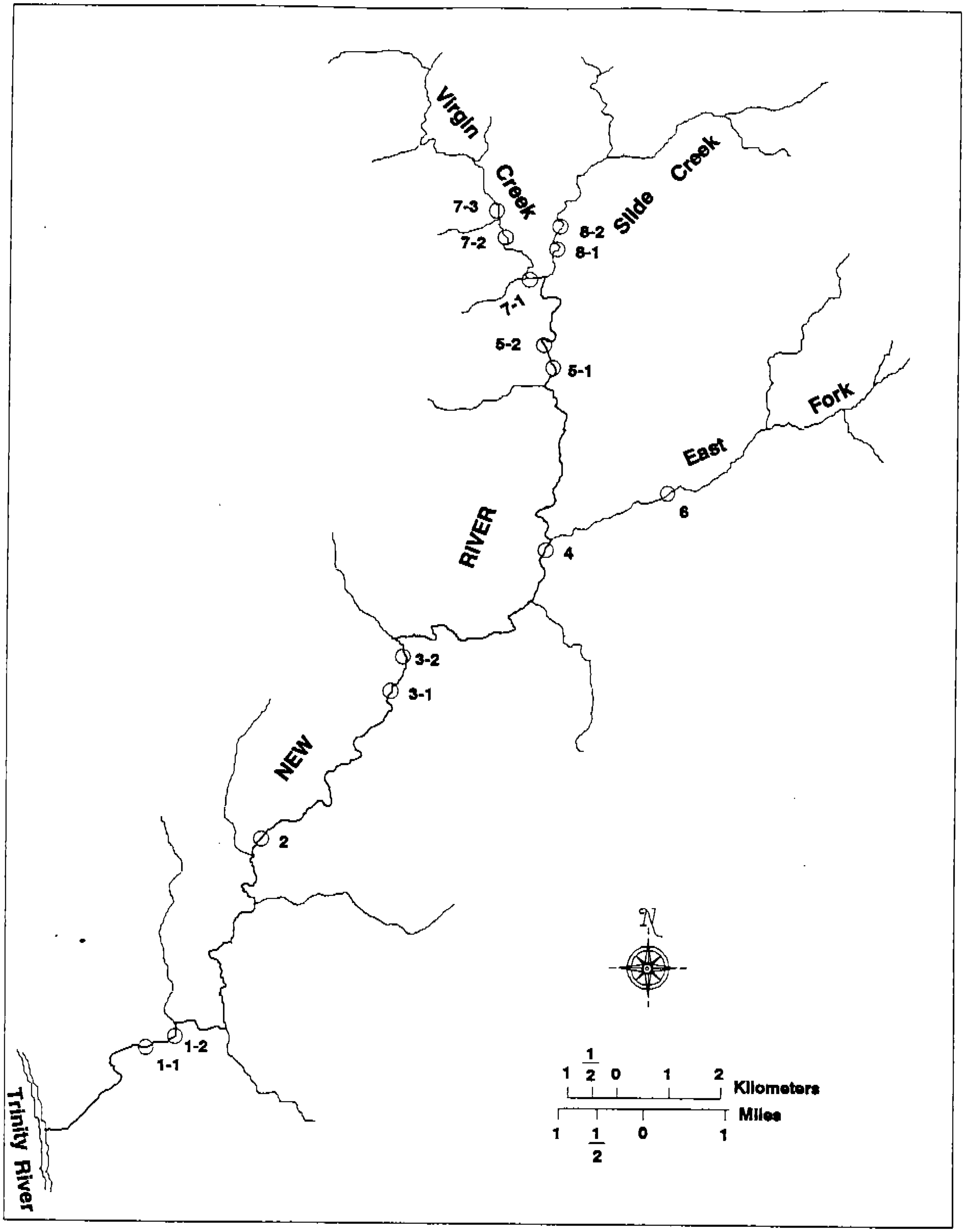

Figure 3. Map of juvenile salmonid index reach locations in New River, CA.

Divers used one of two methods for counting salmonids in each habitat unit. In narrow units (< 2 m), a single diver made two passes through the habitat unit. The second pass was made after the fish in the unit were believed to have redistributed themselves after disturbance from the first pass. Total fish counts from each pass were then averaged for a final count.

The second method was used whenever the habitat unit was too wide for one diver to see both banks clearly. These units were split lengthwise into two or more lanes. Each diver was assigned a lane and counted only those fish observed within their lane. Counts for each lane were then summed for a total count within the unit. When large numbers (> 20) of juvenile salmonids accumulated at the top of a habitat unit, each diver would count a single age class. All fish in each age class were summed for a total count for that unit.

Physical measurements were taken at designated transect points (downstream end, 1/4 length, 1/2 length, 3/4 length, upstream end) for each habitat unit within the index. Stream widths were measured with a range-finder at each transect point. Unit lengths were measured with a belt chain (in 1995 all width and length measurements were taken with a measuring tape). Depths were measured across each transect from the right bank edge (facing downstream), 1/4 width, 1/2 width, 3/4 width, and the left bank edge using a stadia rod. Maximum unit depth was also recorded.

Additional information obtained included the percent of total cover, the dominant/subdominant cover type, and the dominant/subdominant substrate. Cover types include undercut banks, small woody material (< 10.0 cm diameter), large woody material, terrestrial vegetation, surface turbulence, boulders, bedrock ledges and depth. Types of substrates include bedrock, boulder (> 30.0 cm), cobble (8.0 - 30.0 cm), gravel (0.5 - 8.0 cm), sand (1.0 mm - 0.5 cm), and fines (sand, silts, and clays).

The physical measurements, with the snorkel counts, were used to learn fish densities (fish/m^2) in each habitat unit. The average density of fish in each micro-habitat type was determined separately for 0+, 1+, and 2+ steelhead and 0+ chinook in the mainstem New River, Virgin Creek, Slide Creek, and the East Fork. Micro-habitat types were later collapsed down from a possible total of 24 types, to three macro-habitat types (pool, riffle, run) to reduce subjectivity by samplers in naming habitats. Densities were calculated by area rather than volumes to more easily determine which macro-habitats had higher densities of fish and to be more consistent with methods utilized by other government agencies. Because index sections were not representative of all channel types, population estimates were not calculated using the Representative Reach Extrapolation Technique (RRET), as described by Dolloff et al. (1993). The number of macro-habitat types, maximum, minimum and mean fish densities by habitat type were reported for each index section (Appendix C). For graphical purposes, two index reaches for the mainstem (2-0, 4-0), and one index section each for Virgin Creek (7-3), Slide Creek (8-1), and the East Fork of New River (6-0), were compared. Fish densities in these index reaches, were also compared because they had the largest number and greatest variety of macro-habitats. The mainstem index sections were designated as "upper" (section 4-0) and "lower" (section 2-0) because one is upstream of the other, and not because one is in the upper basin and the other in the lower basin.

POPULATION TRENDS

Summer Steelhead and Spring Chinook Counts

Snorkel surveys for summer steelhead and spring chinook adults were conducted from September 13 to 16, 1994 and September 9 to 23, 1995. The surveys included the entire mainstem of New River (mouth to rkm 34.7), Virgin Creek (Soldier Creek confluence to the mouth), Eagle Creek (North Fork confluence to the mouth), Slide Creek (Eagle Creek confluence to the mouth), and the East Fork (South Fork confluence to the mouth)(Figure 3). All habitat units believed to be deep enough to hold adult salmonids within these sections were snorkeled by experienced observers in teams of two to four. Numbers of summer steelhead (half-pounders and adults) and spring chinook (jacks and adults) along with their locations and the habitat types were recorded. Any steelhead adults that were already upstream of the survey reaches would not have been observed.

Spring and Fall Chinook Redd Counts

During the fall of 1993, one comprehensive redd survey was conducted over the entire mainstem of New River (confluence of Virgin and Slide Creeks to the mouth of New River) from October 26 to 28, 1993. Because some evidence suggests that spawning often occurs within the same sections of New River from year to year, six selected reaches were surveyed during November (Table

1). These surveys were conducted in areas that were most likely to contain redds.

During the fall of 1994, one survey was conducted from Barron Creek to the Trinity River from October 24 to 27, 1994. The second survey (November 7 to 14) was from Barron Creek to the confluence of the Trinity River. Two surveys (November 29 and December 13, 1993) were conducted from the weir (rkm 3.5) to the Trinity River.

Table 1. Dates and reach locations of spring and fall chinook redd surveys conducted in the New River watershed during the fall of 1993.

Date	Survey Reach
10-26-93	Denny Campground to weir (rkm 3.5)
10-27-93	Confluence of Virgin and Slide to Denny Campground
10-28-93	New River weir to Trinity River
11-14-93	Weir downstream 1 rkm (rkm 2.5)
11-18-93	1 rkm below weir to Trinity River
11-19-93	Quinby Creek to Denny Campground
11-20-93	0.5 rkm above Bell Creek to weir
11-23-93	Megram Cabin area to Barron Creek
11-30-93	East Fork Bridge to Footbridge

Physical information gathered at each redd location included habitat unit type, redd location within unit, redd size (length, mean width, depth of the pit, depth of the mound), apparent age of redd, adjacent water depth, mean stream width, and substrate size (large cobble 15 - 30.0 cm, small cobble 8.0 - 15.0 cm, large gravel 3.5 - 8.0 cm, small gravel 0.5 - 3.5 cm, and fines < 0.5 cm). The age of redds was categorized as "fresh," 2 weeks to one-month-old, or greater than one-month-old. Age determination was used to separate spring from fall chinook runs and was based upon the presence or absence of live fish, a relative amount of algae on rocks, and the distinctness of the pit and mound.

Resistance-board Weir

The status of natural winter steelhead within the Trinity River Basin has been difficult to assess. Snorkel surveys are impractical due to high flows and turbid water during the winter months. Therefore, a fish weir was installed in New River (rkm 3.5), as described by USFWS (1995), to trap winter steelhead (and fall chinook) immigrating upstream to spawn. A floating resistance-board weir (Figure 4) was chosen because they are comparatively inexpensive and can be used to trap fish during relatively high winter flows. The original weir was designed after a model described by Bartlett (1989) and was installed during the fall of 1992. The weir operated from October 19, 1992 to January 20, 1993 (reported as 1992/1993) when the weir foundation and panels were severely damaged by flood waters caused by a rain on snow event. The original design was modified and reinforced during the summer of 1993 to withstand higher flows. The weir was reinstalled in the fall of 1993 where it operated from October 25, 1993 to July 12, 1994 (reported as 1993/1994).

Some changes for 1993/1994 included:

(1) Each panel was individually attached to a rail section instead of all panels being attached to a single cable.

(2) Chain-link fencing was placed on top of the weir foundation (instead of beneath it) and covered with cobbles to resist scour.

(3) The live box was moved closer to the near abutment, where water velocities are less.

(4) The live box was secured with two additional deadmen and a safety cable.

(5) The floor of the live box was perforated to alleviate some upward force of the water against it.

(6) The floor of the live box was weighted down with steel plates to decrease buoyancy.

(7) A reinforced, lower-profile chute panel was installed.

(8) The size of the resistance-boards was reduced to decrease drag on the weir panels.

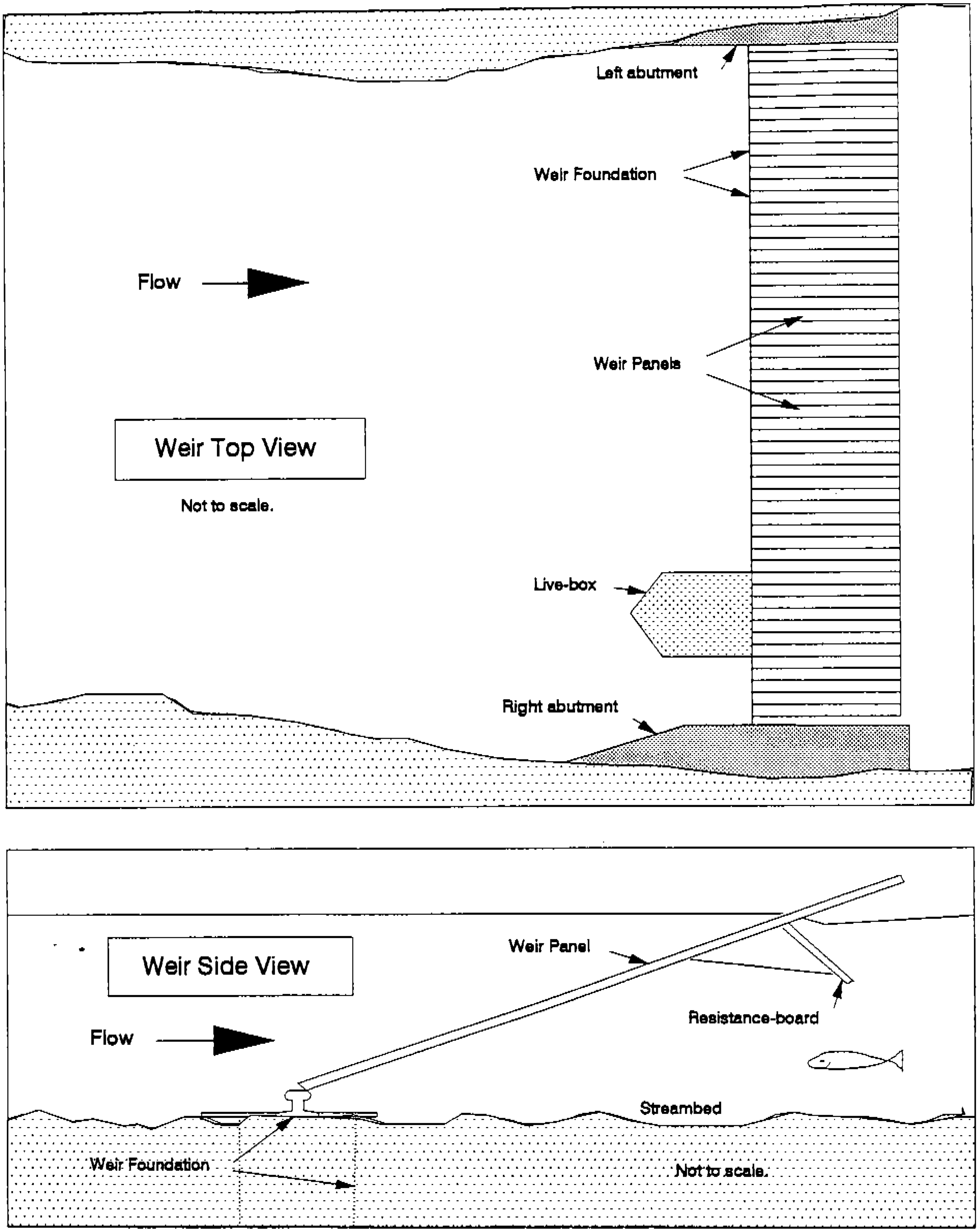

Figure 4. Overhead and lateral schematics of the floating resistance-board weir used to trap adult steelhead and chinook in New River (river kilometer 3.5).

(9) Hardened (grade 8) bolts were used throughout the foundation.

(10) Forged I-bolts were used to connect the weir panels to the rail foundation.

(11) The 2" x 4" on the upstream end of the weir panel was reinforced with steel plate.

The modified weir was reinstalled on November 2, 1994 and operated until Jan 8, 1995 (reported as 1994/1995) when the weir was extensively damaged by high winter flows and ceased to operate. The method in which the trap operated and fish were sampled are as follows.

Fish immigrating upstream to the weir were directed into a 10 m^3 live box. Trapped fish were sampled when first noticed. Species were identified, measured and sexed, scale samples were taken and external characteristics (existing tags, fin clips, scars, missing scales, condition of fish, etc.) were noted. All trapped fish were marked with a 6.0 mm diameter dorsal or caudal fin punch or dorsal fin clip, before they were released above the weir. Mortalities that washed up on the weir were checked for a fin punch/clip and evidence of spawning. Carcasses were then cut in half and discarded downstream. Additional data collected included the time of sampling, weather, ambient air and water temperature, river stage, rainfall, and lunar cycle.

Steelhead (summer and winter) and chinook (spring and fall) races are differentiated by the timing of their entrance into a river mouth from the ocean. Because New River is 140.1 rkm from the mouth of the Klamath River, we cannot accurately differentiate between races solely by the timing of their arrival in New River. For the purposes of this study, we used appearance (bright, non-bright), tag information, and run timing to distinguish between races.

Scale samples from adult salmonids were cleaned and imprinted upon cellulose acetate using a hydraulic press equipped with heating elements. Age analyses of the scale impressions were conducted by two independent readers using a microfiche reader. A third reader aged the scale impressions whenever there were discrepancies in the two original analyses. Scales not aged confidently after the third reading were excluded from the age analyses. Freshwater and saltwater annuli and spawning checks were identified and reported for steelhead, while only total age (combined fresh water and salt water annuli) was reported for chinook.

During the spring of 1994, adult steelhead "run backs" (spawned out fish) accumulated above the weir from March to May. Weir panels were removed periodically for intervals ranging from 2 to 48 hours for a total of approximately 152 hours to allow "run-backs" (spawned out fish) a chance to move downstream past the weir site. The following active and passive methods were employed to ease downstream movement through the weir:

(1) The fish were allowed to move on their own volition downstream through the open weir panels.

(2) Snorkelers "herded" fish downstream through the weir during daylight hours.

(3) Fish were crowded through the weir using a beach seine.

(4) Fish were "spooked" downstream at night by snorkelers carrying flashlights.

Juvenile Trapping

A rotary-screw trap (Figure 5) was used to trap emigrating juvenile salmonids. The "screw" consists of a fiberglass spiral vane enclosed in a funnel-shaped aluminum framework (cone) covered with galvanized hardware-cloth (6.0 mm rectangular mesh size). The cone is oriented with the large opening (trap mouth) facing upstream into the current. The spiral vane rotates to overcome the drag created by the current. When a fish enters the cone, the rotating vanes prevent escape and direct the fish into a live box (1.4 m^3). Small-sized floating debris is automatically removed from the live-box by a rotating, perforated cylinder located across the rear of the live-box. The trap mouth has a diameter of 2.44 m, and can sample an area of 2.43 m^2 at a maximum operating depth of 1.22 m. Two 6.1 m long pontoons support the cone and live-box, and provide flotation and a walkway. Three hand-crank winches allow each end of the cone and the live-box to be raised clear of the water for maintenance or fish removal. Wooden walkways across the front and rear of the trap allow access to the winches and live-box. The floating trap was moored to trees and steel posts. The screw-trap was operated at the same location (rkm 3.7) since April 1989.

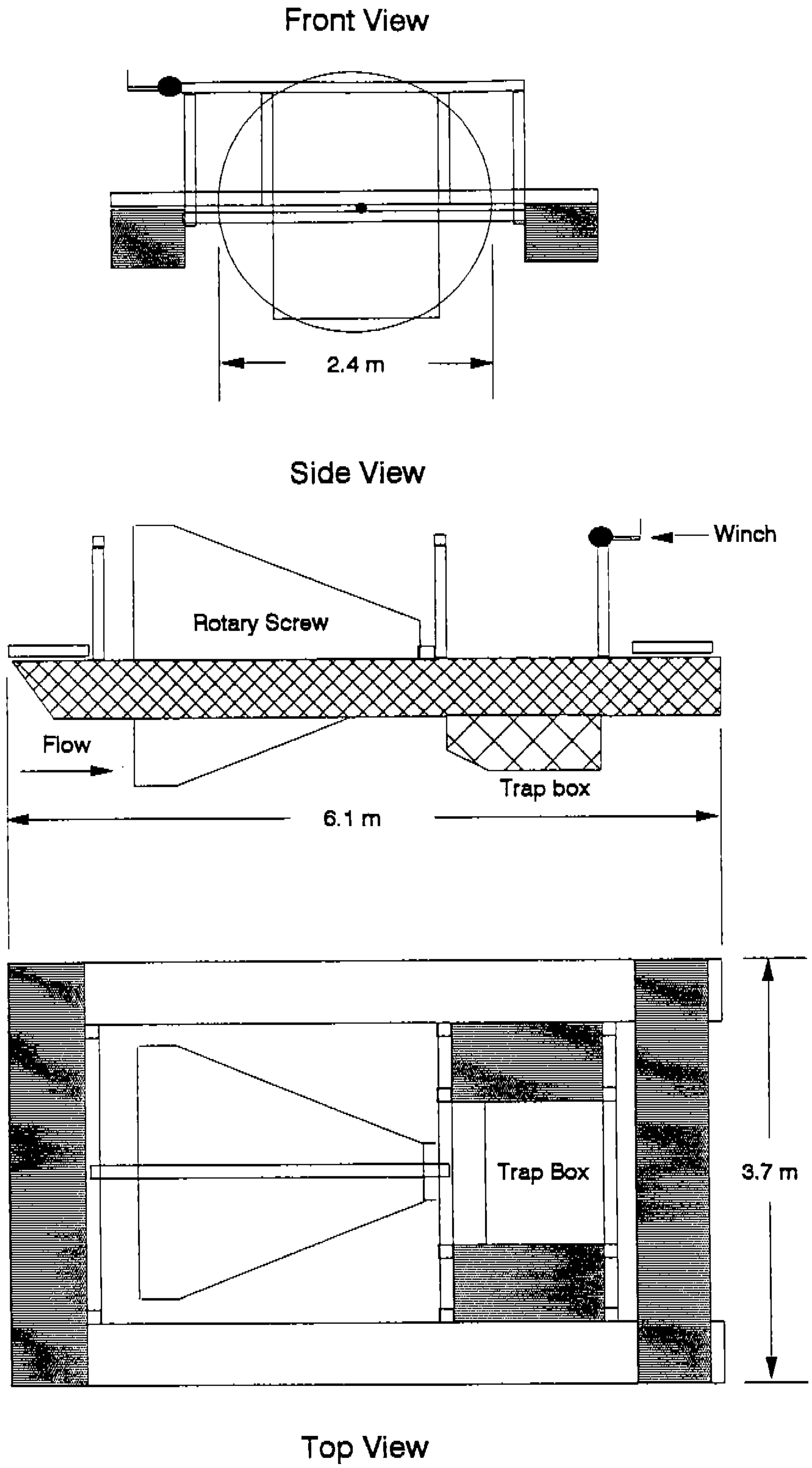

Figure 5. Lateral and overhead schematic of the rotary-screw trap used to trap emigrating juveniles in New River (river kilometer 3.7) during 1989 to 1995.

The site was chosen primarily because of its accessibility and proximity to the mouth of New River. The rotary screw trap was moved, depending on flows, between adjoining pool and run habitat types. Generally, in high/fast flows, the trap was placed in the pool and during low/slower flows, the trap was operated in the run. The trap was placed so the cone will rotate at a rate of 5 - 11 revolutions per minute. Rotations of less than five revolutions per minute (rpm) are believed to be insufficient to prevent an escapement from the mouth of the cone (depending on fish species and size). Greater rotations than 11 rpm can cause excessive wear and tear on the trap and cone. The depth in which the cone was fished varied from 1.07 m (3.5 ft) to 1.22 m (4.0 ft) depending on stream flow and depth.

The trap operated from February 19 through July 15, 1994 and from April 24 to September 9, 1995. The trap was pulled during both years, after the river flow became too low to provide effective rotation of the screw or too few fish were trapped. The screw trap was checked daily (during 1994 and 1995) throughout the trapping seasons unless field crews were unavailable, in which case the trap was checked every other day. The velocity of water entering the cone was measured at the center, and right and left sides of the cone with a Price AA current meter and top-setting rod. When the cone was fished at a depth of 1.22 m, flow measurements were taken at depths of 0.2, 0.6, and 0.8 m. At a cone depth of 1.07 m, flow velocities were measured at depths of 0.2 and 0.8 m. Flow volume through the trap was calculated by multiplying the flow velocity at the trap mouth by the area of the trap mouth in the water. The percentage of total river flow sampled was then calculated by dividing the flow through the trap by the total river flow.

An abundance indices of total numbers of fish emigrating past the trap site on a daily basis were extrapolated from the daily capture rate and percent flow sampled. On single days not sampled, the number of juvenile salmonid emigrants was estimated using the average catch and flows on the one day before, and the one day following, the non trapping period. For multiple days not sampled (two or more days), the average catch was calculated by using the catch from two days before and two days' following, non trapping periods. The duration and size of peak emigration were determined for juvenile chinook and steelhead. Because emigrating fish are not randomly distributed, and sampling periods were non-random and discontinuous, calculated estimates of fish numbers are only indices of total production and not numeric estimates.

All fish captured were identified to species, degree of development (fry, parr, and smolt), and enumerated. Separation into parr and smolt categories was based upon the presence or absence of parr marks, of silvery coloration, of a black caudal-fin margin, and on the looseness of scales. Lengths and volumetric displacements were taken from random samples of up to 30 fish of each development stage of each species. Fish were also examined externally for any symptoms of disease or parasites. Scale samples (for age determinations) were taken from up to 15 juvenile steelhead each day.

Mark-recapture efficiency tests were conducted on May 17 and June 3, 1994. No mark-recapture efficiency tests were conducted during 1995 because chinook were not available. Only chinook smolts were used in efficiency tests because they are less apt to "hold" in one place than are steelhead smolts. Bismark Brown Y stain was selected as the marking method because many fish can be marked quickly with a minimum of handling stress. Fish were placed in a large plastic barrel filled with a solution of 20 mg Bismarck Brown Y per liter of water for approximately 20 minutes. The water was aerated using a canister of compressed air attached to air stone bubblers and a regulator to control air flow. Marked fish were held in a net pen until sundown, because salmonids are more likely to migrate at night. At dusk, all but 50 marked fish were released in pools found approximately 100 - 150 m upstream. The low water velocity of pools is believed to be more conducive for reorientation of fish after handling. A control group of 50 marked fish and 50 unmarked fish were held in a 1.0 m x 1.0 m x 1.2 m net pen downstream of the screw trap as a control group for 1 - 2 days. The control group was used to determine mortality levels from handling stress and marking. If the marked group sustained mortality greater than the unmarked group, the percentage of differential marking mortality was applied to the marked releases when calculating efficiency. Conversely, if the unmarked control group sustained equal or higher mortality than the marked control after the holding period, then the differential mortality was assumed to be zero. During the five days following the release of marked fish above the screw trap, all captured fish (of the same species as those marked) were examined for signs of the stain. After three to five days, fish stained with Bismark Brown Y stain were indistinguishable from unstained fish. Trap efficiency was determined by dividing the number of marked fish recaptured by the number released and correcting for marking mortality.

Juvenile steelhead fork lengths (during 1994 and 1995) were used to make monthly frequency histograms. These histograms were used to differentiate between age classes. When overlap existed between age classes, scales were examined and a artificial break between ages was assigned.

RESULTS AND DISCUSSION

STREAM PHYSICAL MEASUREMENTS

Water Temperature Monitoring

Daily maximum, mean, and minimum water temperatures were calculated for 1988 to 1995 (Figures 6 and 7). The maximum daily mean water temperature recorded during this study was 27.3°C (July 22, 1994) and the lowest mean minimum daily water temperature was 0.5°C (December 2, 1990) (Figure 6). The minimum daily mean water temperature for October 1, 1993 to September 30, 1994 (reported as 1993/1994) was 1.3°C and occurred on January 14, 1994. During October 1, 1994 to September 30, 1995 (reported as 1994/1995), the maximum daily mean water temperature was 23.3°C (August 5, 1995) and the minimum was 2.7°C (November 23, 1994). Overall, the mean daily water temperatures reported for 1993/1994 were warmer than mean daily temperatures for 1994/1995. Years with a below-normal snow pack during the winter (like the winter of 1993/1994) and low runoff, contributed to higher than normal spring and summer water temperatures. Conversely, years with higher than normal snow packs (like the winters of 1992/1993 and 1994/1995) had cooler water temperatures. According to Reiser and Bjornn (1979), water temperature during rearing can influence growth rate, population density, swimming ability, ability to capture food, and ability to withstand disease outbreaks and affect migration rates.

Maximum daily water temperatures during 1990 to 1992 and 1994 exceeded the upper lethal limits (> 23.9°C) for steelhead (Bell 1973), but rarely (> 26.2°C) for chinook (Brett 1952), in the mainstem of New River from mid June to mid August. Water temperatures in New River mainstem during July to October of 1991 were higher (26.6°C) in the mid-mainstem area (rkm 19) than in lower-mainstem (rkm 3.4) area (Nakamoto, 1994). During 1989 to 1995, water temperatures exceeded 20°C reported by Rich (1987) to be limiting to juvenile salmonid growth. However, juvenile salmonids could seek out thermal refugia (depth, shade, cool tributaries, etc.) during this time. It is possible that

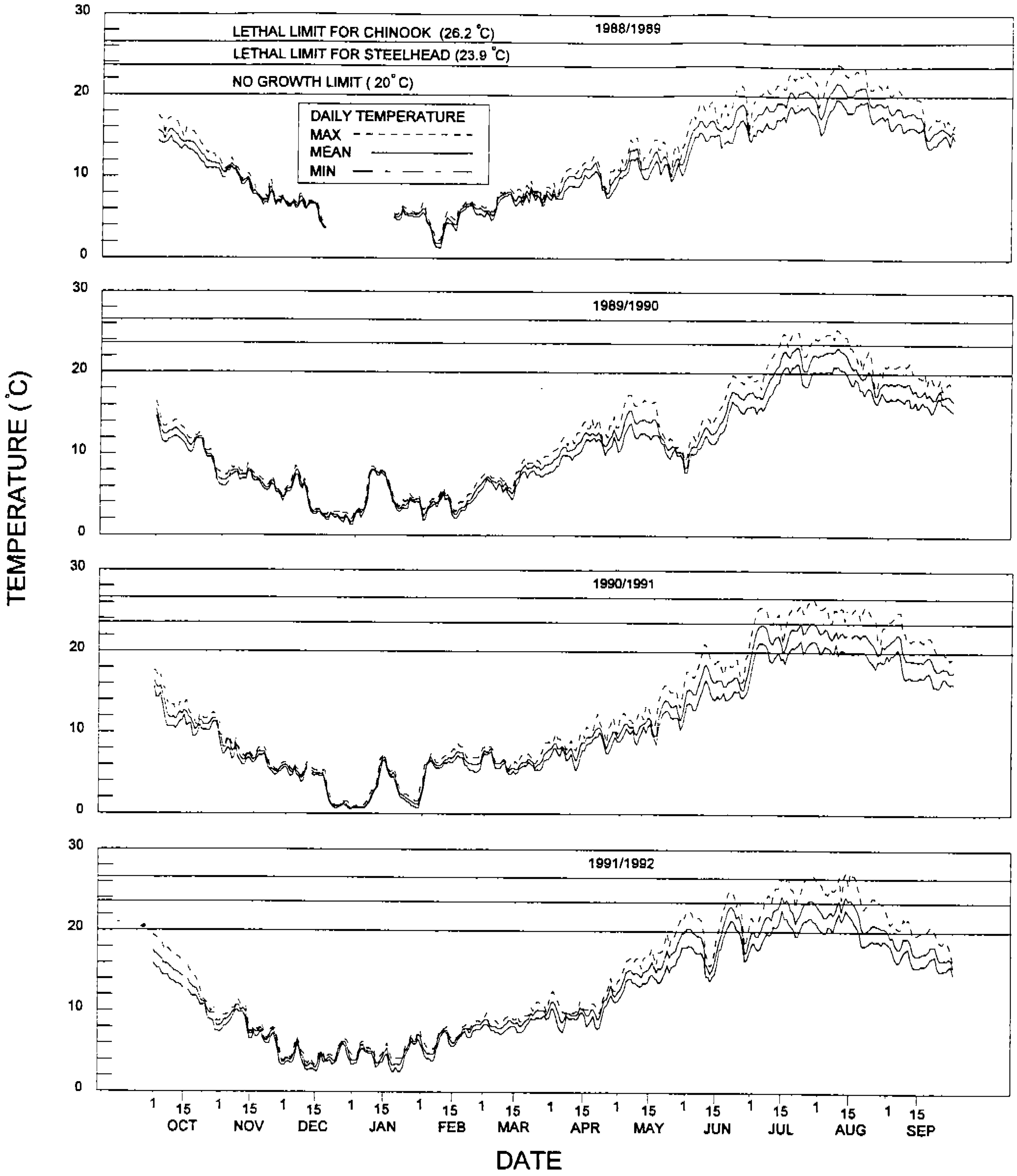

Figure 6. New River mean, maximum, and minimum daily water temperatures (river kilometer 3.4), no-growth and upper-lethal water temperature limits for chinook and steelhead from October 1, 1988 to September 30, 1992.

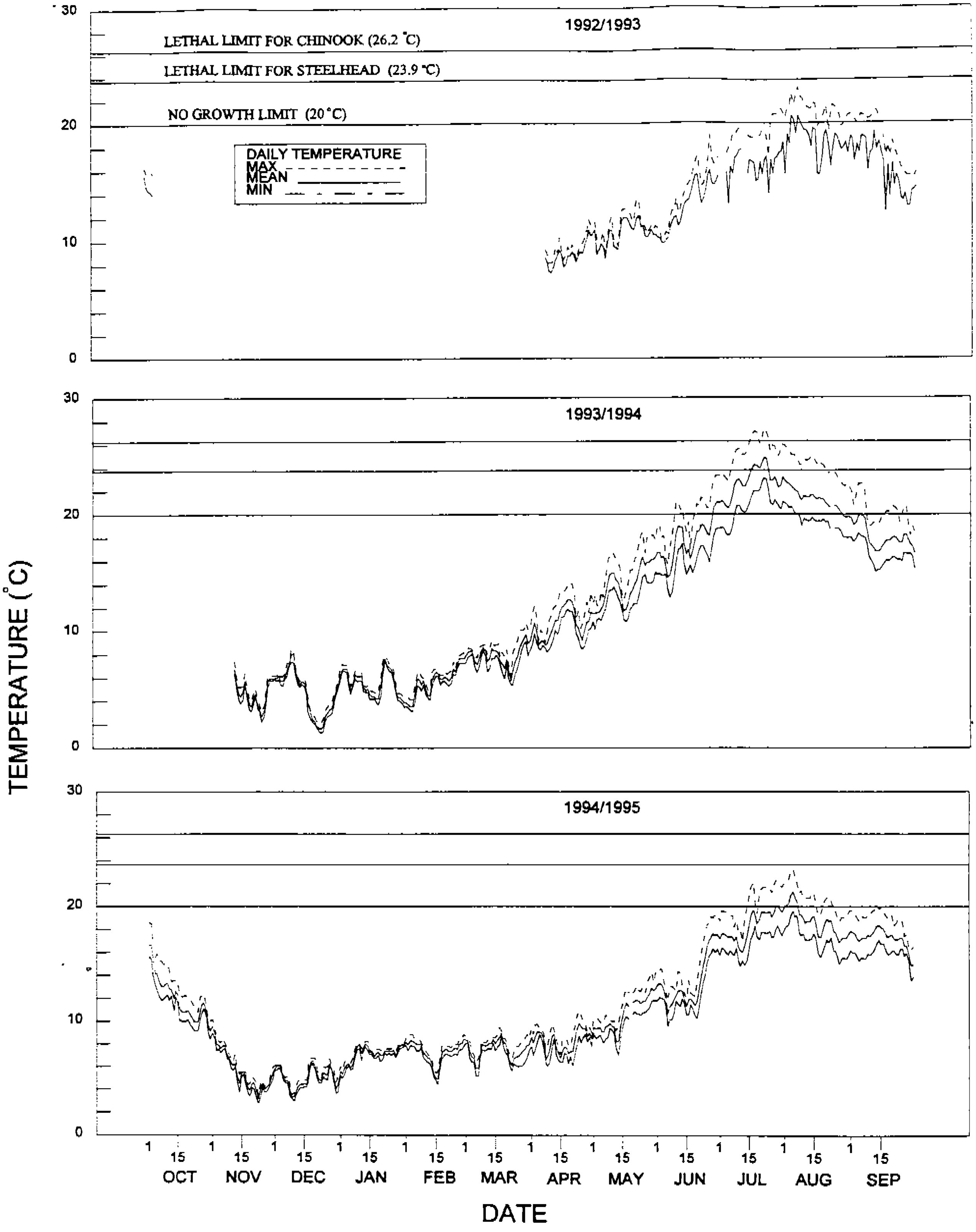

Figure 7. New River mean, maximum, and minimum daily water temperatures (river kilometer 3.4), no-growth and upper-lethal water temperature limits for chinook and steelhead from October 1, 1993 to September 30, 1995.

temperatures as low as 13°C may limit migration of spring chinook, as discussed by Bell (1973).

Flows

Mean monthly discharges for New River (rkm 3.4) has been reported for 1988 to 1995 (Table 2), while daily discharges were reported for 1993 to 1995 (Figure 8). Some of the lowest river flows recorded on New River (rkm 3.4) occurred during 1990/1991 (October 1, 1990 to September 30, 1991) to 1991/1992 and 1993/1994. Some of the highest flows occurred during the years of 1992/1993 and 1994/1995. During 1993/1994 daily flow measurements (rkm 3.4) indicated that flows ranged from a low of 0.69 cms (37 cfs) on September 16 to a high of 37 cms (1,326 cfs) on January 24. During 1994/1995, daily flows ranged from a low of 0.75 cms (27 cfs) on October 4 through October 10, 1994 with a high of 899 cms (32,093 cfs) on January 8, 1995.

Suitable stream velocities are important during migration upstream, spawning, incubation, and rearing of steelhead (Thompson 1972). Low summer flows during both 1991, 1992 and 1994 may have limited upstream migration of adult steelhead and spring chinook. Low summer flows limited rearing habitat for juvenile salmonids. Thompson (1972) suggested depths less than 0.18 m for steelhead and less than 0.24 m for adult chinook can restrict their upstream migration. Even greater depths may be required for upstream migration past waterfalls and other barriers.

The high winter flows during 1992/1993 and 1994/1995 could have limited successful spawning and juvenile rearing. Although water velocities were not measured during high winter flows on New River, Thompson (1972) stated that the maximum water velocity for successful upstream migration of both steelhead and chinook is 2.4 m^3/s although they could seek out slower water velocities along the stream margins.

HABITAT EVALUATIONS

Index Reaches

The 14 index reaches in New River (Figure 3) represent 10 different micro-habitat types or three macro-habitat types in 69 separate units (as described in Table 3), and span a total length of 4,286 m. The mean juvenile chinook and steelhead densities

Table 2. New River mean monthly river flow in cubic feet per second for the combined years of 1959 to 1969 (river kilometer 19.0) and for the individual years from 1988 to 1995 (river kilometer 3.4).

Month	Water Year							
	59/69	88/89	89/90	90/91	91/92	92/93	93/94	94/95
Oct	44	24	55	47	33	60	63	28
Nov	263	223	80	52	78	128	58	120
Dec	493	382	233	113	156	515	191	378
Jan	673	578	980	293	277	1586	425	2064
Feb	937	854	1126	360	354	985	371	2459
Mar	707	996	1045	462	431	1242	437	2840
Apr	840	851	319	416	800	1320	240	1306
May	564	403	402	267	172	937	201	826
Jun	218	203	638	126	79	675	93	406
Jul	75	89	129	57	54	173	50	167
Aug	41	55	72	34	24	84	29	84
Sep	31	53	59	25	15	61	26	64

varied substantially between macro-habitat type, index reach, and years (Appendix C).

Juvenile surveys in the index reaches were initiated in late July or early August each year when mainstem river stages (at rkm 3.4) are at low summer flows. Flows have varied from 0.8 to 3.4 cms from 1990 to 1995 (2.6 cms in 1990, 2.1 cms in 1991, 0.8 cms in 1992, 2.6 cms in 1993, 1.0 cms in 1994, and 3.4 cms in 1995).

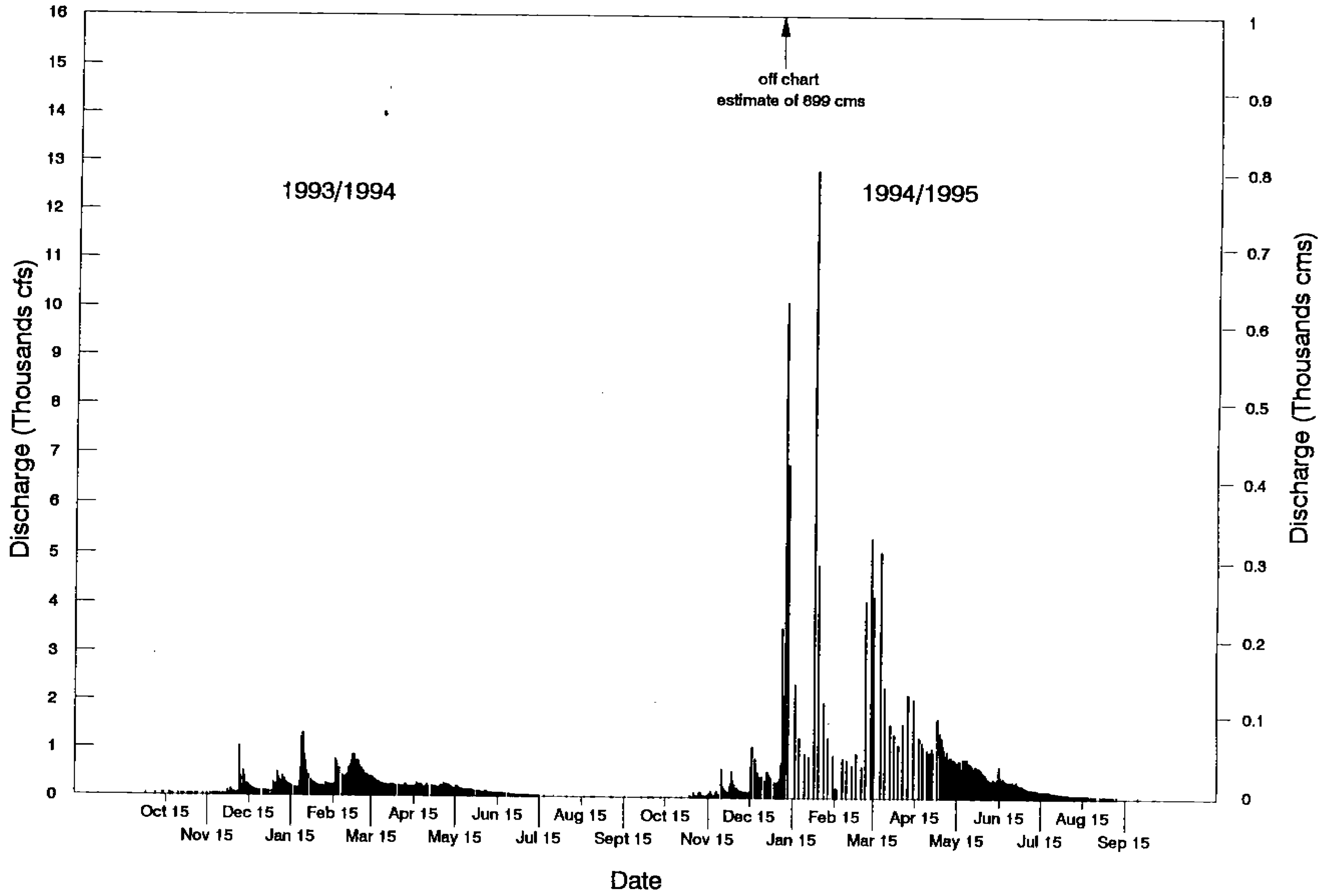

Figure 8. New River daily discharge (river kilometer 3.4) in cubic feet per second (cfs), and cubic meters per second (cms) from October 1, 1993 to September 30, 1995.

Table 3. Types and numbers of macro- and micro-habitats observed on New River (micro-habitat types are listed in Appendix B). Macro-habitat types are riffles, runs, and pools (McCain et al. 1990).

Original Micro-Habitat types observed	# of Micro-Habitat types observed	New Macro-habitat types
1 = LGR	171	Riffle
2 = HGR	38	Riffle
3 = CAS	13	Riffle
4 = SCP	4	Pool
7 = BwBo	1	Pool
12 = LsBk	137	Pool
14 = GLDA	30	Run
15 = RUN	78	Run
16 = SRN	17	Run
17 = MCP	66	Pool
18 = EGW	8	Riffle
20 = LsBo	80	Pool
21 = POW	89	Run
22 = CRP	24	Pool

YOY Chinook

YOY chinook were found only in the mainstem of New River during this study although suitable spawning habitat exists in the tributaries. The highest densities were observed during the summer of 1991 with the second highest in 1994 and none observed in 1995 (Figure 9). The high numbers observed in 1994 may be due to the high number of adult spawners (n = 31) and lower than normal flows during the preceding winter (causing fewer redds to "wash out"). In 1995, juvenile chinook emergence times were

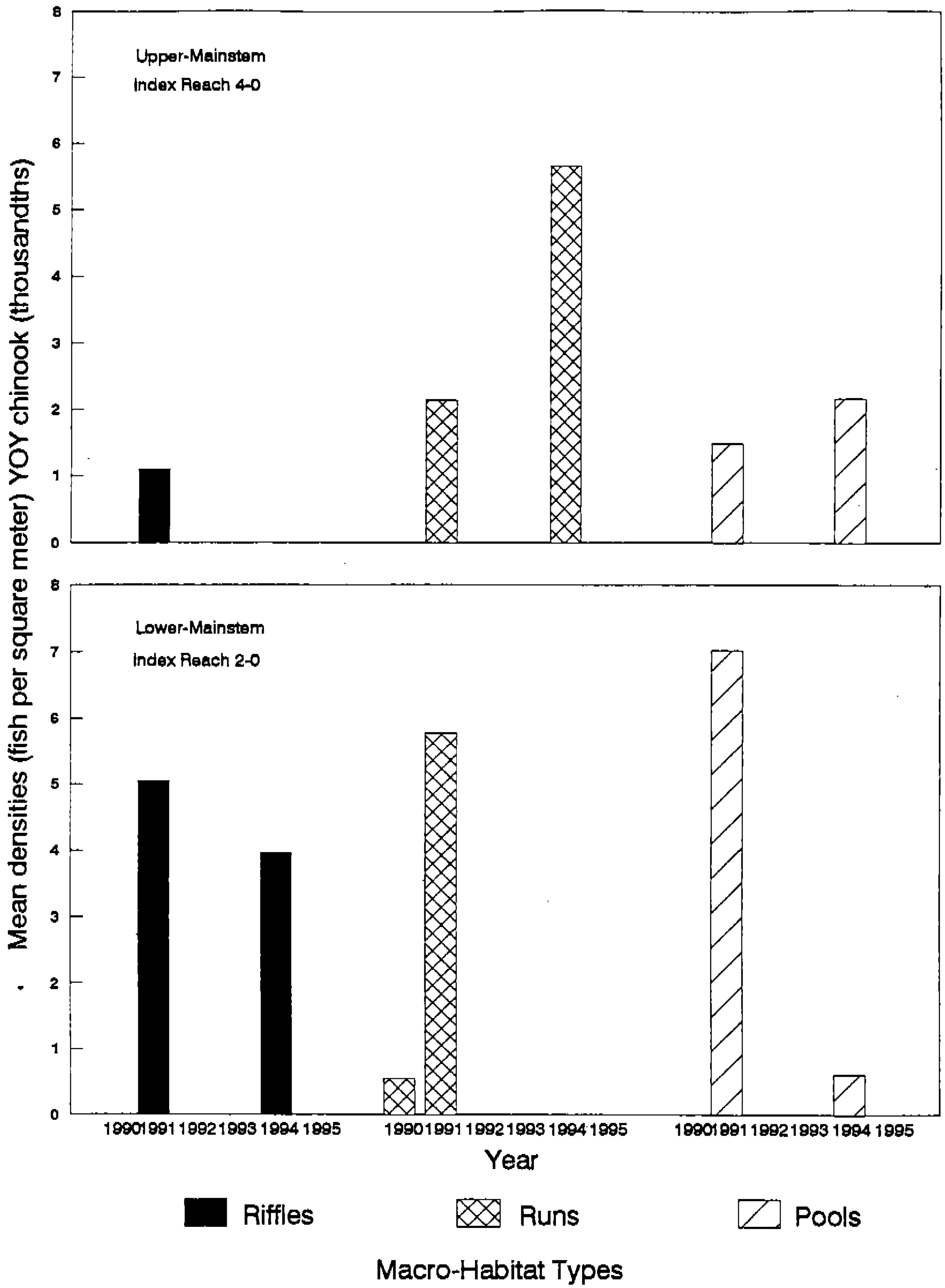

Figure 9. Mean densities (fish/m^2) of YOY chinook in index reaches of New River and its major tributaries during 1990 to 1995. Mean densities for all index reaches are in Appendix C.

determined by using Daily Temperature Units (DTU) as described by Piper et al. (1986). The emergence time estimates revealed that juveniles would have been unable to emerge before high winter flows destroyed their redds. This could explain why no chinook were observed during 1995. Juvenile chinook were observed in greater numbers in the lower-mainstem than in the upper-mainstem during 1991 and 1994. This is due to the large number of spawners in the lower river during 1990 and 1993. The preference of chinook for deeper habitats could be explained by the findings of Everest and Chapman (1972) who found that initially chinook fry seek fine substrates and low water velocities, progressively moving into deeper, faster, and rockier habitats.

YOY Steelhead

YOY steelhead densities (fish/m^2) were higher in the tributaries and upper mainstem than in the lower mainstem of New River (Figure 10). This is due to the more favorable environmental conditions (more cover, cooler water temperatures), smaller habitat units in the upper mainstem and tributaries, and closer proximity to redd locations. Johnson (1985) found cover to play an important role in the selection of habitats by young steelhead. In as much as this cover provides food, temperature stability, and protection from predators, the densities of young steelhead are highest in areas containing in-stream cover. The USFWS (1986) reported that smaller YOY steelhead prefer to occupy shallow areas within streams, which could explain why YOY were found in higher densities within shallow index reaches in the upper-mainstem of New River and its tributaries.

Overall, the lowest densities of YOY steelhead were observed in 1993 which corresponds with a low (n = 272) adult return in 1992. The highest densities were observed in 1992 and 1994 (except in the lower mainstem) which corresponds with high adult returns during 1991 (n = 702) and favorable juvenile rearing conditions during the winter of 1993/1994. The low densities of YOY steelhead observed in 1995 is from a relatively lower number of adult spawners (n = 427) in 1994 and poor juvenile rearing conditions.

In the upper-mainstem and tributaries of New River, YOY steelhead preferred pools and run habitat types over riffles (Figure 10). the same relative numbers of fish being spread over a larger area of the habitats within the lower mainstem. However, in the lower-mainstem, riffles and runs contained higher concentrations of YOY steelhead. This may be due to the larger area of pools with less

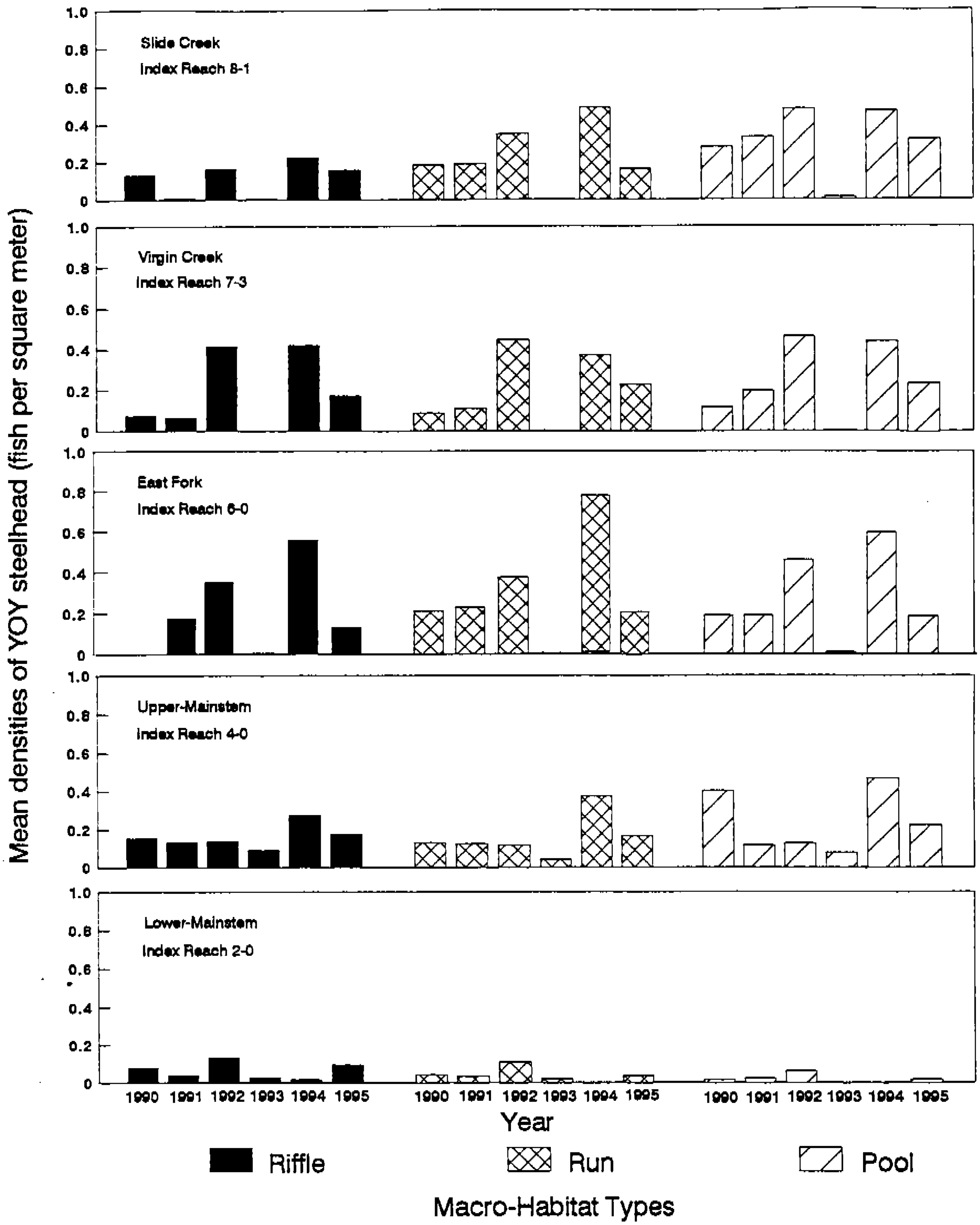

Figure 10. Mean densities (fish/m²) of YOY steelhead in index reaches of New River and its major tributaries during 1990 to 1995. Mean densities for all index reaches are reported in Appendix C.

preferred habitat in the lower mainstem.

1+ Steelhead

Steelhead 1+ were observed to be in greater densities in the upper-mainstem and tributaries than in the lower-mainstem (Figure 11). This could be due to cooler water temperatures, smaller habitat units, and closer proximity to natal areas. Overall 1995, had higher densities than 1994, except in pool habitats. The difference in densities between years could be related to the number of redds, winter flow conditions, and environmental conditions during the previous year. Cooler summer water temperatures could explain why densities during 1995 were generally higher than 1994 (especially in the lower-mainstem).

Steelhead 1+ were observed to be more abundant in the pool habitats in the upper mainstem and tributaries than in the lower-mainstem. In the lower mainstem they were more abundant in runs and riffles than in pools. This is due to less preferred habitat in large deep pools and a relatively constant number of fish having a larger area in which to distribute themselves.

2+ Steelhead

The low 2+ steelhead densities observed during summer snorkel surveys is probably because most of them leave New River during the high spring flows. Their densities were higher in 1995 than in 1994 for all index sections and habitat types (Figure 12). This is probably due to the more favorable water temperatures in 1995 that caused 2+ steelhead to hold in New River longer. Warmer water temperatures in 1994 (especially below rkm 19) could have stimulated more steelhead to emigrate out of New River during the spring.

In general, 2+ steelhead densities were the higher in the upper-mainstem and tributaries (especially in pool habitats). These high densities could be due to cooler water temperatures, closer proximity to natal areas, and smaller habitat units. Riffles and runs were preferred over pools in the lower-mainstem. This could be due to the larger pools of the lower-mainstem having less preferred habitat than smaller pools of the upper mainstem.

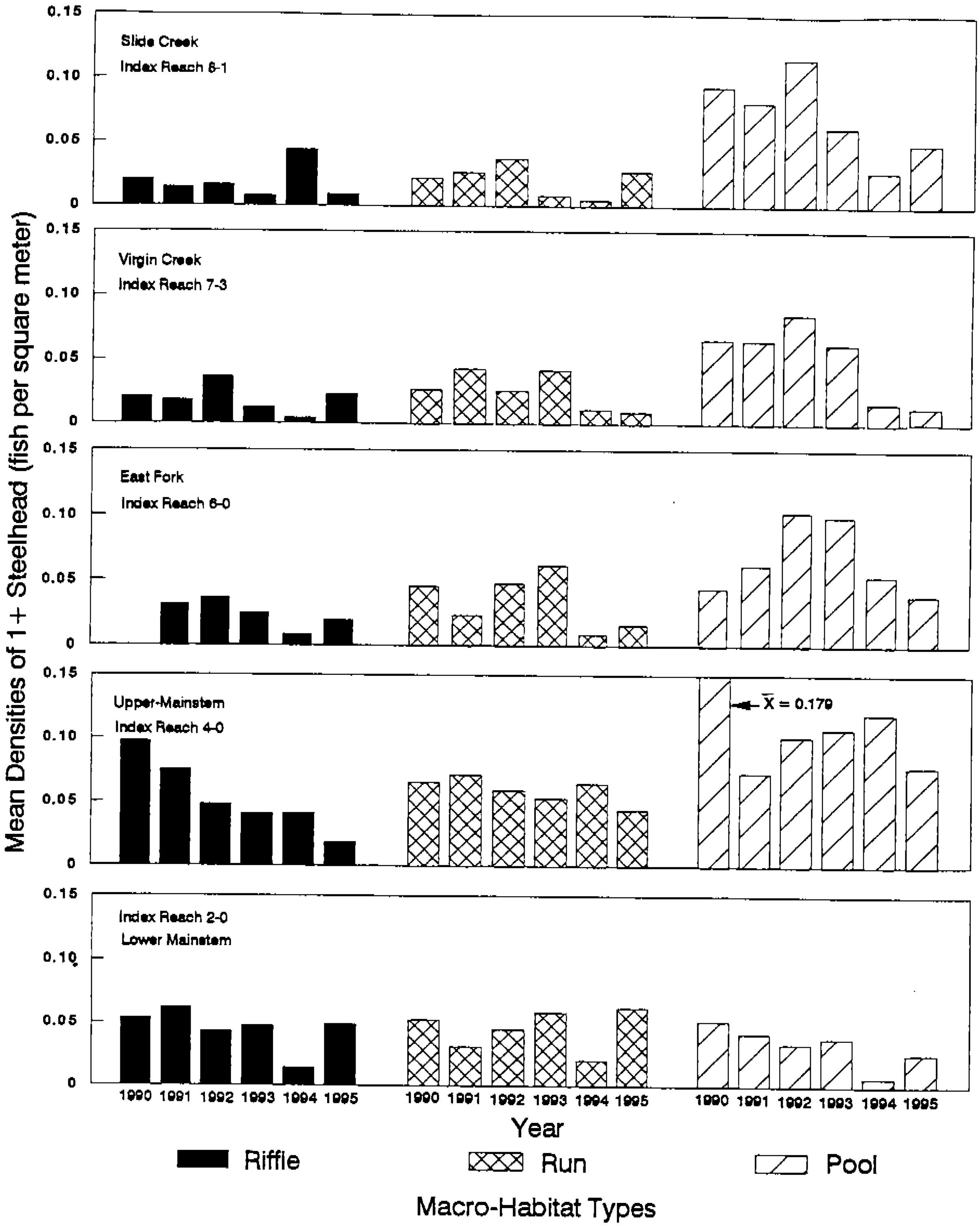

Figure 11. Mean densities (fish/m²) of 1+ steelhead in index reaches of New River and its major tributaries during 1990 to 1995. Mean densities for all index reaches are reported in Appendix C.

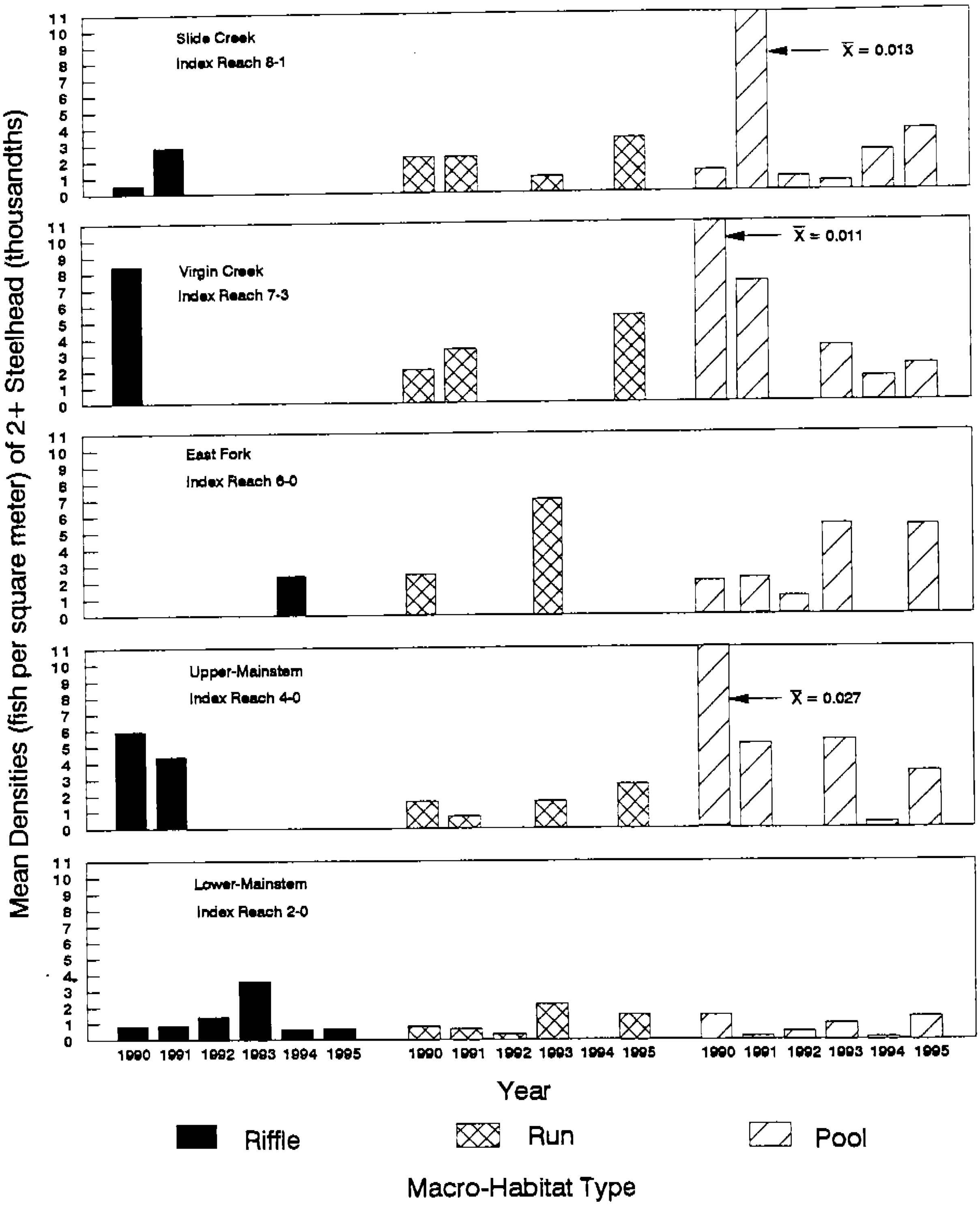

Figure 12. Mean densities (fish/m²) of 2+ steelhead in index reaches of New River and its major tributaries during 1990 to 1995. Mean densities for all index reaches are reported in Appendix C.

POPULATION TRENDS

Summer Steelhead and Spring Chinook Adult Counts

A total of 404 adult summer steelhead, 23 "half-pounder" steelhead, and six adult spring chinook were observed during mask and snorkel surveys of September 13 to 16, 1994. In 1995 a total of 776 adult summer steelhead and 41 "half-pounders," and 21 spring chinook were observed during surveys from September 6 to 23 (Table 4). The 1995 adult summer steelhead count was the highest since the onset of this study. Previous September counts of steelhead have ranged from 702 in 1991 to 272 in 1992 (Table 4). The lowest steelhead count in New River was 250 reported by CDFG in 1981 (Table 5).

During 1994, steelhead were more concentrated in the lower mainstem than during any other year of this study (Table 4). The low numbers of fish in the upper mainstem may be due to a combination of the weir's effect on migration behavior, low river flows, and high water temperatures. In 1995, steelhead numbers were more evenly distributed throughout the New River Basin. This distribution is due to the higher river flows, cooler water temperatures, and fewer barriers (e.g. the lack of a weir).

Although steelhead are regularly observed in the tributaries and the mainstem, adult chinook have only been observed in the mainstem (1989 to 1995). A total of only five spring chinook were observed in New River during 1994. Previous counts have ranged from 31 in 1993 to two in 1991. A combination of below-normal rainfall, above-normal water temperatures, and poor year-class strength may have resulted in the low spring chinook numbers in 1994.

In 1995, 21 spring chinook (14 adults and seven jacks) were observed in the mainstem of New River. This was the second highest count during this study. As in past years, most spring chinook are still migrating to their preferred spawning areas during adult surveys. High river flows and low water temperatures were not as much of a limiting factor in upstream migration in 1995 as they were in 1994.

Spring and Fall Chinook Redd Counts

Redd surveys during the fall of 1993 were initiated in late October and continued through November (Table 6). The high number of spring chinook adults (31) observed in September 1993

Table 4. Numbers of adult summer steelhead and spring chinook counted in New River and its major tributaries during summer mask and snorkel surveys during 1989 to 1995.

Location	1989 Spring Chinook	1989 Summer Steelhead	1990 Spring Chinook	1990 Summer Steelhead	1991 Spring Chinook	1991 Summer Steelhead	1992 Spring Chinook	1992 Summer Steelhead	1993 – July Spring Chinook	1993 – July Summer Steelhead	1993 – September Spring Chinook	1993 – September Summer Steelhead	1994 Spring Chinook	1994 Summer Steelhead	1995 Spring Chinook	1995 Summer Steelhead
VIRGIN CREEK																
Soldier Ck. to Four Mile Ck.	0	10	0	10	0	40	0	0	0	35	0	5	0	1	0	34
Four Mile Ck. to Confluence Pool	0	5	0	2	0	7	0	2	0	15	0	28	0	6	0	30
SLIDE CREEK																
N.F. Eagle Ck. to Mouth of Eagle Ck.	0	7	0	20	0	8	0	0	0	8	0	6	0	0	0	4
Mouth of Eagle Ck. to Confluence Pool	0	14	0	18	0	6	0	0	0	6	0	1	0	2	0	19
EAST FORK																
Mouth of South Fork to Lucky Lukes PMC	No Surveys		0	8	0	3	0	0	0	16	0	1	0	1	0	6
Lucky Lukes PMC to Mouth of East Fork	No Surveys		0	2	0	0	0	0	0	2	0	0	0	0	0	5
NEW RIVER																
Confluence Pool to Barron Creek	0	104	1	31	0	74	0	44	0	74	0	82	0	10	0	117
Barron Creek to East Fork Confluence	1	116	0	18	0	82	0	0	7	27	10	51	0	16	1	124
East Fork Confluence to Footbridge Area	5	177	0	50	0	93	0	73	2	42	0	39	0	5	1	82
Footbridge Area to Denny Campground	1	73	3	46	0	167	1	65	0	22	4	48	1	36	6	89
Denny Campground to Panther Creek	3	50	0	17	0	16	0	12	0	16	11	57	0	34	1	46
Panther Creek to Bell Flat (Five Waters)	1	23	2	60	1	109	8	52	1	33	1	60	0	125	4	66
Bell Flat to Mouth of New River	6	108	7	61	1	97	9	24	0	12	5	51	4	191	8	195
TOTAL	17	687[1]	13	343	2	702	18[2]	272	10	308[3]	31	427[4]	5	427[5]	21	817[6]

[1] Count includes 32 half–pounders.

[2] 15 chinook believed to be jacks.

[3] Count includes 53 half–pounders.

[4] Count includes 59 half–pounders.

[5] Count includes 23 half–pounders.

[6] Count includes 41 half–pounders.

Table 5. Preliminary numbers of summer steelhead populations in northern California during 1980 to 1994, ("half-pounders" are not included) () = Estimated, NS = Survey, ND = No Data, (Gerstung, pers. comm., 1995).

Stream	1995	1994	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980
New River	776	404	368	272	702	343	687	204 (350)	NS	NS	NS	335 (340)	NS	114 (300)	236 (250)	320 (355)
M.Fk. Eel	1149	701	605	516	691	449	726	711	1550	1000	1463	1524	666	1051	1600	1052
Van Duzen	1	NS	NS	0	31 (38)	4 (5)	42 (49)	52	NS	NS	58	13 (16)	8	7 (8)	25	31
S.Fk. Trinity	30	22	42	29	9 (43)	66	37	30	NS	73 (100)	3 (20)	8 (30)	NS	26	NS	NS
N.Fk. Trinity	828	990	604	369	825-1037	554	347 (600)	624	36 (300)	NS	57 (112)	179	160	193 (210)	219	456
Canyon Creek	17	45	24	6	3	15	NS	32	NS	NS	10	20	3	20	3	6
Bluff Creek	1	4	31	23	49	14	14	33	59	73	6	26	11	37	16	17
Bluff Creek (late)	NS		77	ND	ND	77	44	40	41	ND	17	22	12	57	41	20
Camp Creek	0	0	0	ND	0	3	7	0	1	0	NS	0	NS	NS	NS	2
Red Cap Creek	0	0	9	6	2	7	23 (33)	25 (35)	29 (40)	NS	18	10	12	45	NS	10
Dillon Creek	73	NS	77	NS	88	74	294 (320)	38 (60)	77	NS	NS	200	300-500	295	194	236 (268)
Clear Creek	79	58	64	47	76	91	920	678 (838)	512	428 (458)	162 (222)	156 (167)	257 (275)	610	270 (300)	241 (251)
Indian Creek	13	61	28	27	8	12	154	41	NS	NS	NS	NS	NS	5 (17)	NS	1 (7)
Elk Creek	27	26	24	22	72	31	150 (188)	63	31	NS	NS	58	NS	249	47	90
Salmon	25		44	ND	21	15	13	128	NS	NS	NS	NS	NS	120	NS	36
N.Fk. Salmon	12	20	16	16	17	12	17	8 (32)	4 (19)	6 (28)	8 (37)	NS	NS	41	13 (60)	69
S.Fk Salmon	21	47	47	59	26	21	11 (66)	155 (200)	20 (84)	13 (78)	9 (54)	NS	NS	223	10 (60)	166
Wooley Creek	22	22	49	17	25	73 (76)	234 (244)	379 (481)	280 (291)	NS	290 (307)	92 (96)	78	353	245 (269)	165 (177)
S.Fk Smith	4	7	4	8	13	8 (10)	4 (6)	12 (16)	NS	NS	NS	NS	NS	5 (7)	0 (3)	
N.Fk. Smith	4	1	0	ND	0	NS	NS	NS	NS	NS	NS	NS	2	NS	0	0
M.Fk. Smith	11	2	5	13	11	21	1	2	NS	NS	NS	NS	2			
Mad River	590	287	48	34	66 (76)	33 (47)	20 (28)	60 (85)	18 (22)	134 (188)	52 (71)	134 (188)	31 (40)	167	6 (50)	2 (16)
Redwood Creek	7	24	8	5	15	14	0	8	15	44	44	44	7	3	16	

Table 6. Spring and fall chinook redd survey dates, counts, and reaches in New River watershed during the fall of 1993.

Date	# of Redds	Survey Reach
10-26-93	12	Denny Campground to weir (rkm 3.5)
10-27-93	9	Confluence of Virgin and Slide to Denny Campground
10-28-93	7	New River weir to Trinity River
11-14-93	5	Weir downstream 1 rkm (rkm 2.5)
11-18-93	16	1 rkm below weir to Trinity River
11-19-93	1	Quinby Creek to Denny Campground
11-20-93	2	0.5 rkm above Bell Creek to weir
11-23-93	1	Megram Cabin area to Barron Creek
11-30-93	0	East Fork Bridge to Footbridge
Total	53	

corresponded with the highest number of chinook redds (53) observed to date. A total of 28 redds were counted in late October. These are believed to be from spring chinook (Figure 13), using the October 31 break between spring and fall chinook (Aguilar, pers. comm., 1995). However, seven of these redds were in the lower 3.4 rkms of the river and may have been made by early arriving fall chinook. Another 25 redds were counted between November 14 to 30. Based on the timing, condition, and the presence or absence of fish, these are probably all fall chinook redds (Figure 14).

The above-normal rainfall and resultant cool summer water temperatures during 1993 could have helped the upstream passage of spring chinook adults. The adult spring chinook count (31) and redd count (28) were the highest recorded to date.

During the fall of 1994, redd surveys were conducted from October 26 to November 30 with a total of 24 redds observed (21 falls, and three spring run chinook). The first survey was conducted over the entire mainstem of New River from October 24 to 27, and resulted in a count of nine redds. Of these nine, three were spring chinook redds, based on their location, timing and condition (Figure 13). The remaining 6 redds were from fall chinook.

All redds observed during the subsequent surveys were considered made by fall chinook (Figure 14). A November 7 to 13 survey from Barron Creek to the Trinity River revealed nine additional redds (all in the lower 3.5 rkm). Two surveys of the lower 3.5 rkms of New River on October 29 and December 13 resulted in counts of six and zero new redds, respectively.

During both 1993 and 1994 surveys, a high concentration of fall chinook redds were observed in the first (one) rkm of New River. During the early years of this study, the use of this area by spawning salmonids may have gone partially unnoticed due to the relative inaccessability (especially when river flows are over 2.2 cms), rough terrain, and dangerous working conditions.

A good relationship seems to exist between adult spring chinook counts in September and the subsequent number of spring chinook redds (Figure 15). The regression is highly significant ($r^2 = 0.95$, $P < 0.05$), and may be used to predict redds from adults and vice versa.

The mean area of fall and spring chinook redds (n = 104) measured during spawning surveys on the mainstem of New River from 1988 to 1994 (Figure 16) was 5.14 m^2. The redd area measurements on New River were similar to the mean measurements reported for fall (5.1 m^2) and spring (6.0 m^2) chinook by Reiser and Bjornn (1979).

<u>Resistance-Board Weir</u>

The modified resistance-board weir was first installed in the fall of 1992 and operated from October 19, 1992 until January 20, 1993, when a rain on snow event caused river flows to peak at 540 cms (19,081 cfs) causing excessive damage to the weir (USFWS 1995). The original weir design was modified and the weir was reinstalled during the fall of 1993. The modified weir was operated from October 25, 1993 to July 12, 1994 with no major damage sustained by the weir. The modified weir worked well during the low winter flows of the 1994 trapping season. The smaller resistance boards caused the weir panels to submerge at lower flows than in 1993. The smaller chute panel collected fewer leaves than the original design and the

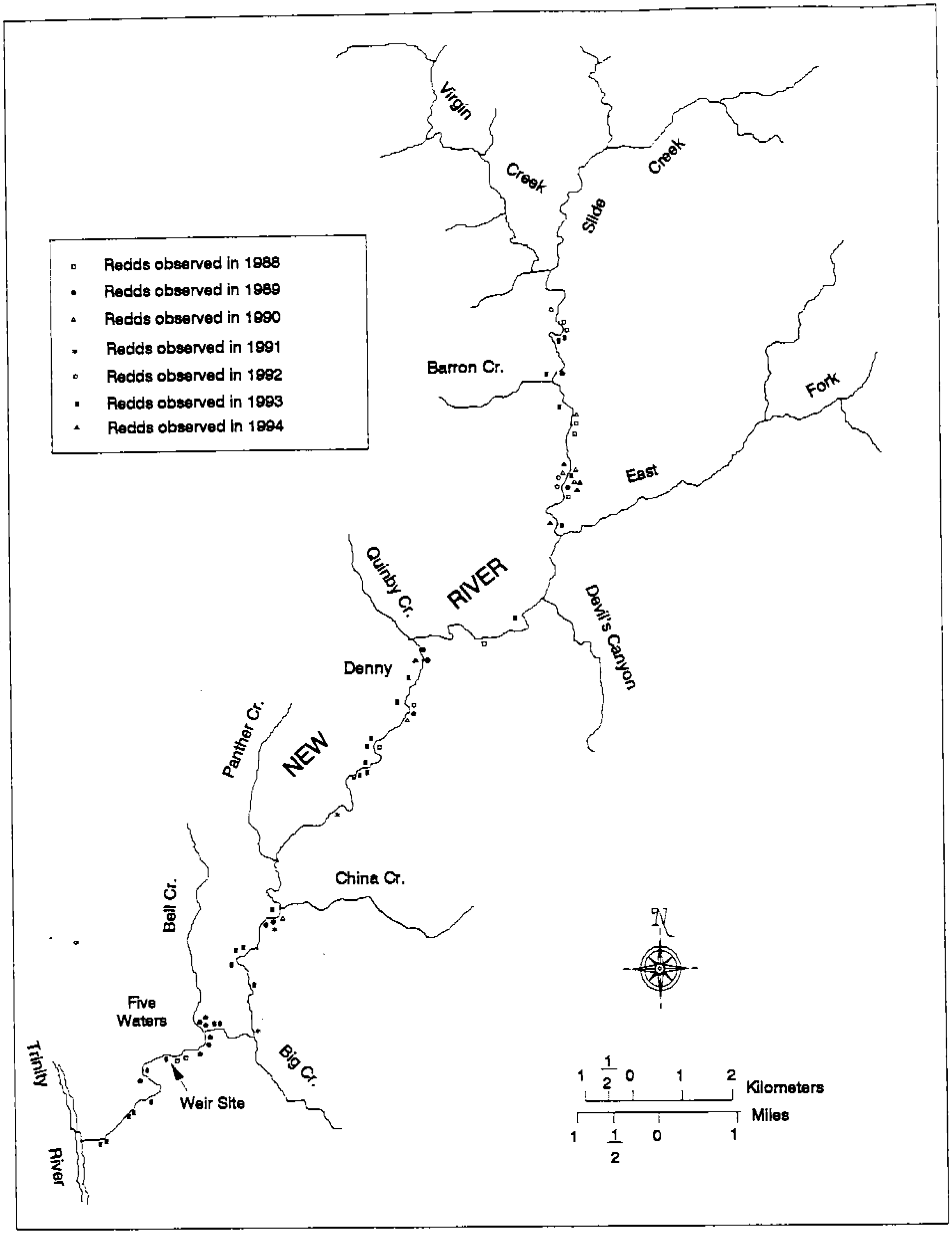

Figure 13. Locations of spring chinook redds observed during New River fall redd surveys during 1988 to 1994.

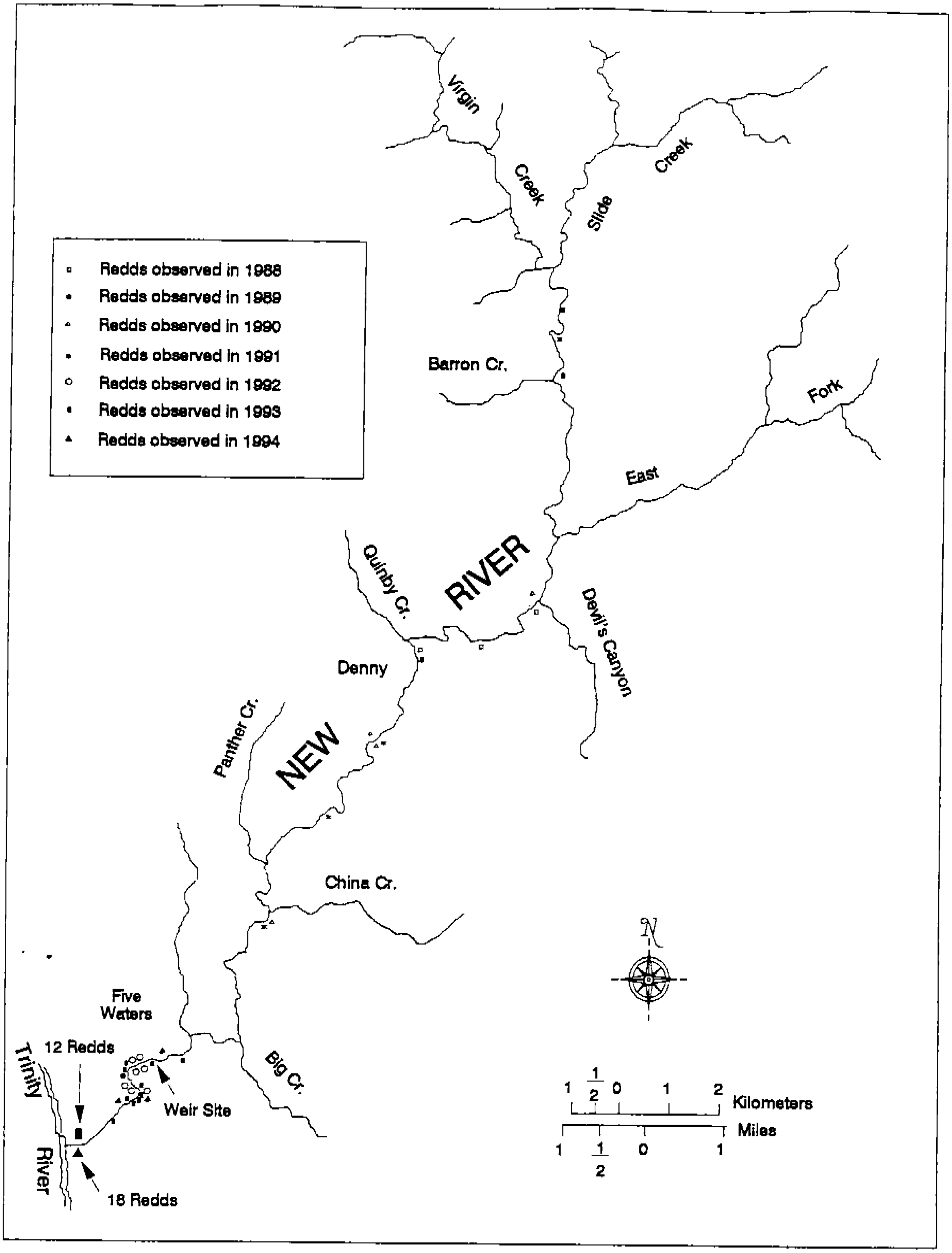

Figure 14. Locations of fall chinook redds observed during New River fall redd surveys during 1988 to 1994.

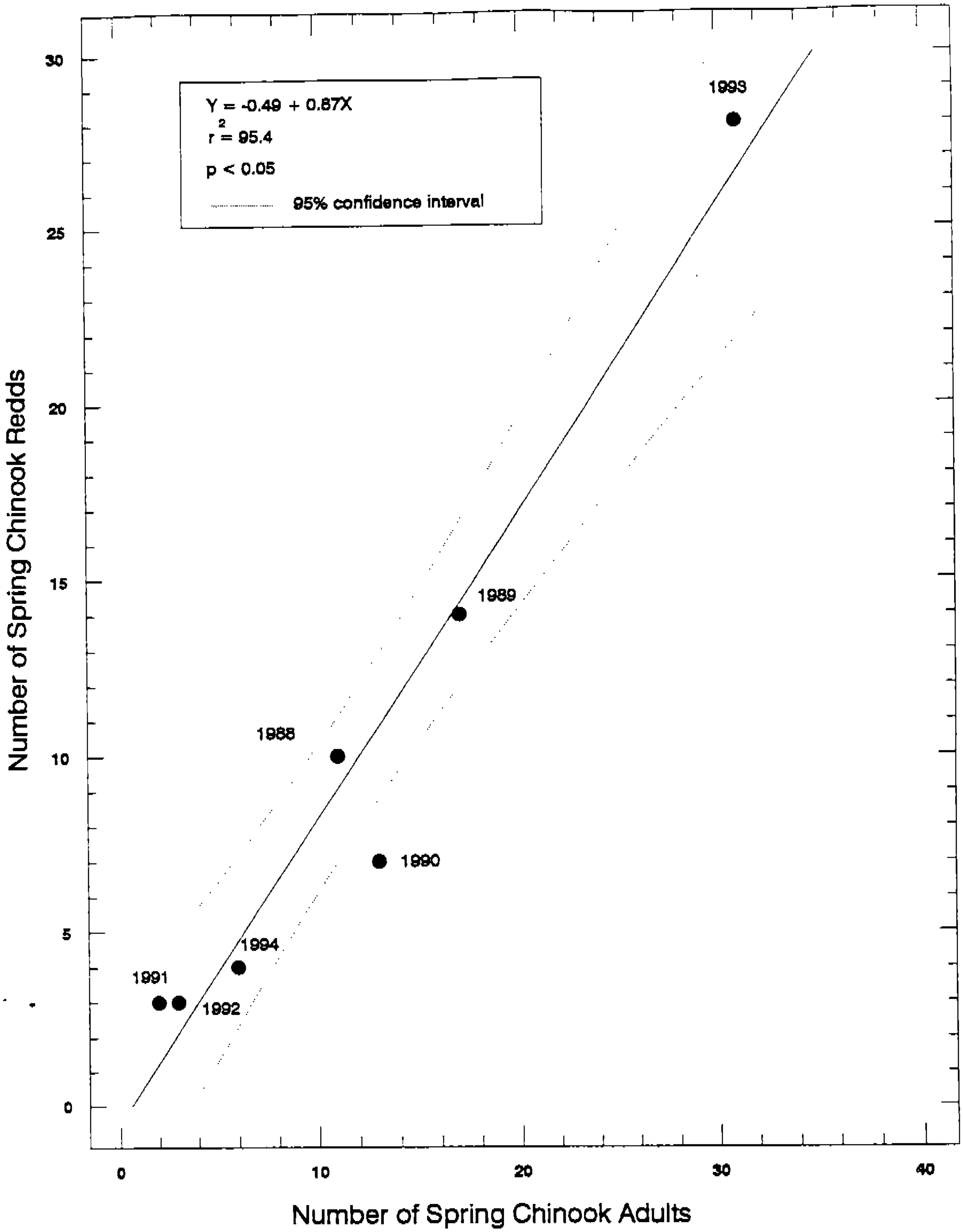

Figure 15. The correlation between the number of adult spring chinook observed during summer snorkel surveys and the subsequent number of spring chinook redds counted during fall (October to December) redd surveys.

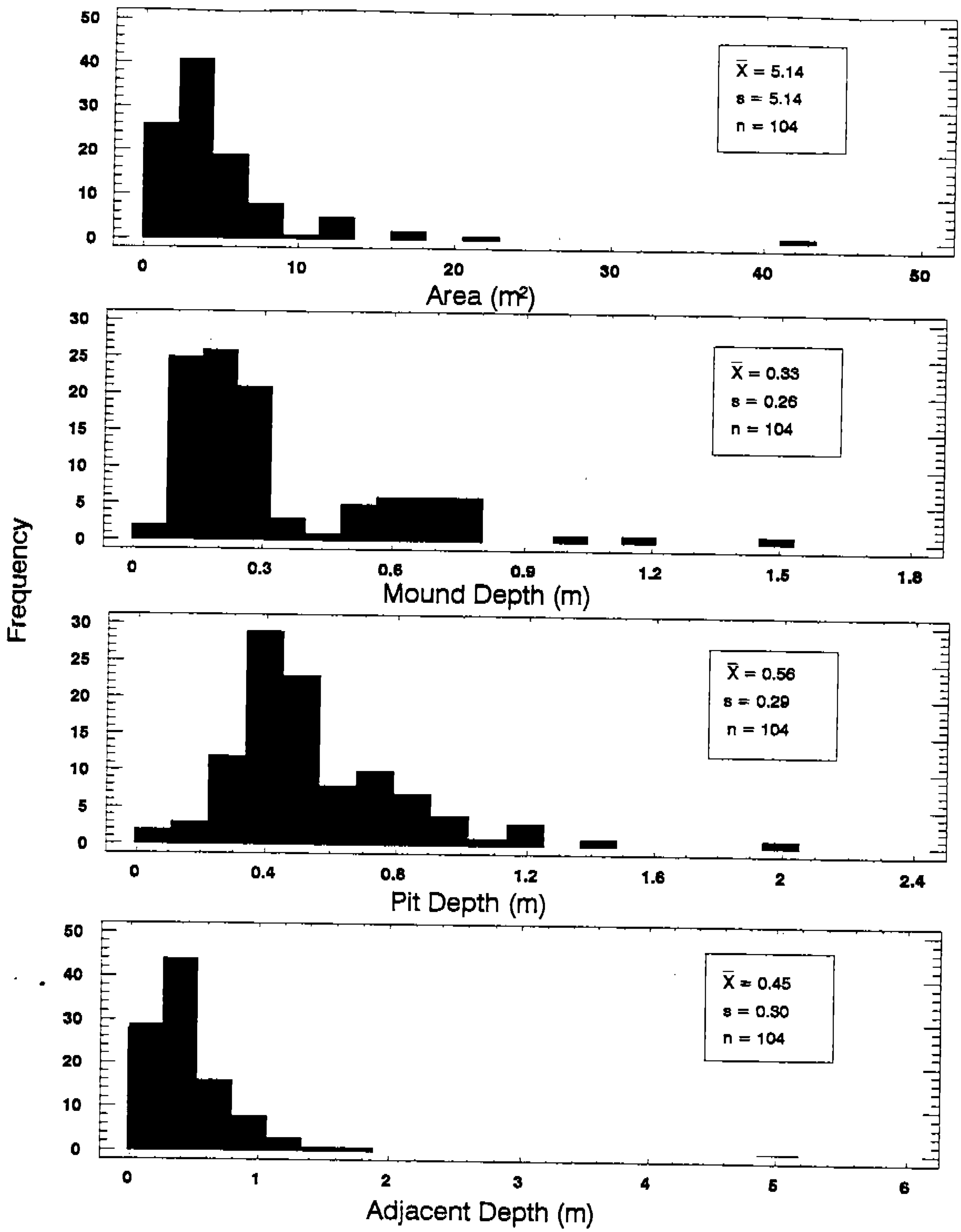

Figure 16. The frequency of combined fall, and spring chinook redd measurements (redd area, mound depth, pit depth and adjacent depth) from 104 chinook redds observed during fall redd surveys during fall redd surveys during 1988 to 1994 on New River, CA.

stability of the live box was increased. The weir was again reinstalled during the 1995 field season and operated from November 2, 1994 until January 8, 1995 when high winter flows peaked at 899 cms (32,093 cfs) and again damaged the weir.

Further modification to the weirs design probably wouldn't have resisted the damaging affects of higher flows during the 1995 field season. The weir site location seemed to play a greater role in the weirs ability to withstand higher flows than futher modifications of the weir's design.

Things to consider before installing a resistance-board weir are:

1. The modified resistance-board weir was not able to withstand high winter flows due to bedload movment.

2. To minimize bedload movement, a weir should be placed in a wider section of river where confinement and entrenchment is minimal to allow high flows to fan out (like the riffle at rkm 4.0 on New River).

3. Even during moderate flows (>644 cfs), the weir submerged and potentially allowed fish to swim past the weir.

4. Future weirs on New River should be placed where the flow runs more parallel to the stream banks, similar to the site at rkm 4.0.

5. The stream bottom should be relatively level.

6. Water depth over the weir during high winter flows should be less than 4 feet to minimize scouring of the weir.

7. The foundation should be pinned deep enough into the substrate to resist bedload movement.

8. The weir should be easily accessible by crews and heavy equipment.

9. The weir probably delayed run timing, which may have affected redd placement and survival.

A much wider section of stream where the river fans out more and which may decrease the scouring affect of high flows was located at rkm 4.0 approximately 500m upstream of our weir site. A weir of this type may be more suited for use on a small coastal stream which is not as flashy as New River.

During the fall of 1992, high water ~~accompanied by~~ floating leaves caused ~~the weir to~~ submerge for ~~a total of~~ 42 hours between December 9 and 12. During the fall of 1993, high river flows and debris (11.65 - 34.8 cms) caused the weir panels to sink (for approximately 82 hours) during two storm events (December 8 to 9, 1993 and January 23 to 26, 1994). In addition, several panels were removed (for an additional 152 hours) to allow steelhead "down runners" to move past the weir in the spring.

In the fall of 1994 the weir submerged (19 - 34 cms) for a total of 168 hours during three storm events (November 23 to 26, December 1 and 2, and December 16 to 20). It is unknown how many adult steelhead and chinook moved over the weir panels during the periods when the weir was submerged or after the weir panels were removed. Since the panels are elevated at an angle off the river bottom even during submergence, this may have directed migrating fish into the live box.

Although migrating fish can move upstream during periods of higher flows and can dart past obstructions, several studies have shown that adult salmonids prefer to wait until storm flows subside before moving upstream (Shapovalov and Taft, 1954; Thompson, 1972).

Chinook 1992/1993

Chinook run timing is presented in Figure 17 from the fall of 1992 to the summer of 1994. Adult chinook were not captured at the weir during the fall of 1994. The largest number of adult chinook (n = 31) moved through the weir between October 27 and November 24, 1992 (reported as 1993) with a peak catch (2 adult chinook and 10 jacks) occurring on October 30. Chinook fork lengths ranged from 40 to 95 cm (mean 51.5 $\pm$ 13.1 cm). A length frequency histogram revealed that the modal frequency was 45 cm (Figure 18). Scale samples revealed that 23 of the chinook (74.2%) were age 2, five (16.1%) were age 3, and three (9.7%) were age 4. The good condition (bright coloration) of these fish suggested that they were all fall chinook as opposed to spring chinook which are darker (non-bright coloration) because they have been in fresh water longer.

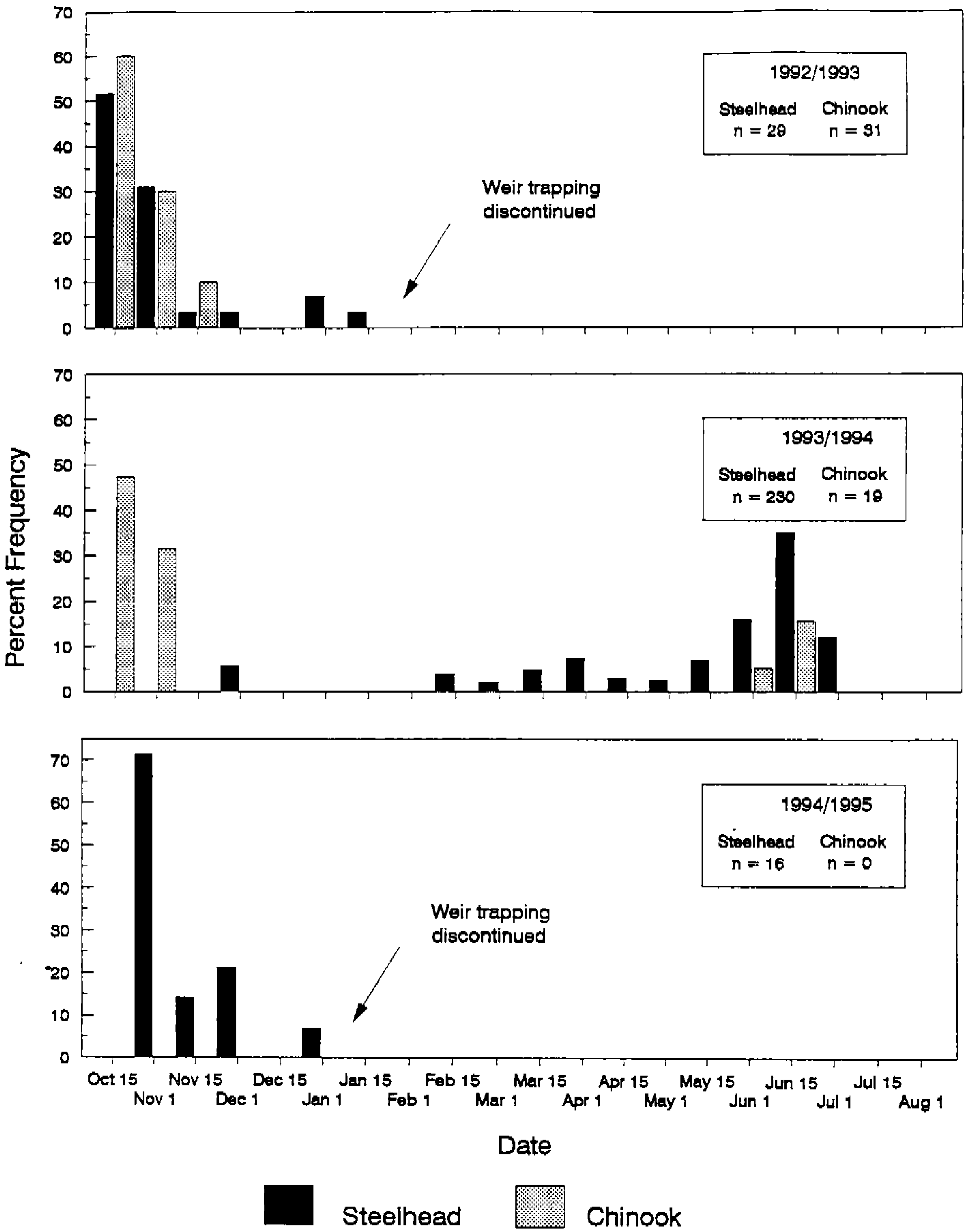

Figure 17. Timing of the adult fall, spring chinook, and summer steelhead runs in New River, based on numbers of fish trapped in the resistance-board weir (river kilometer 3.5) during 1992 to 1995.

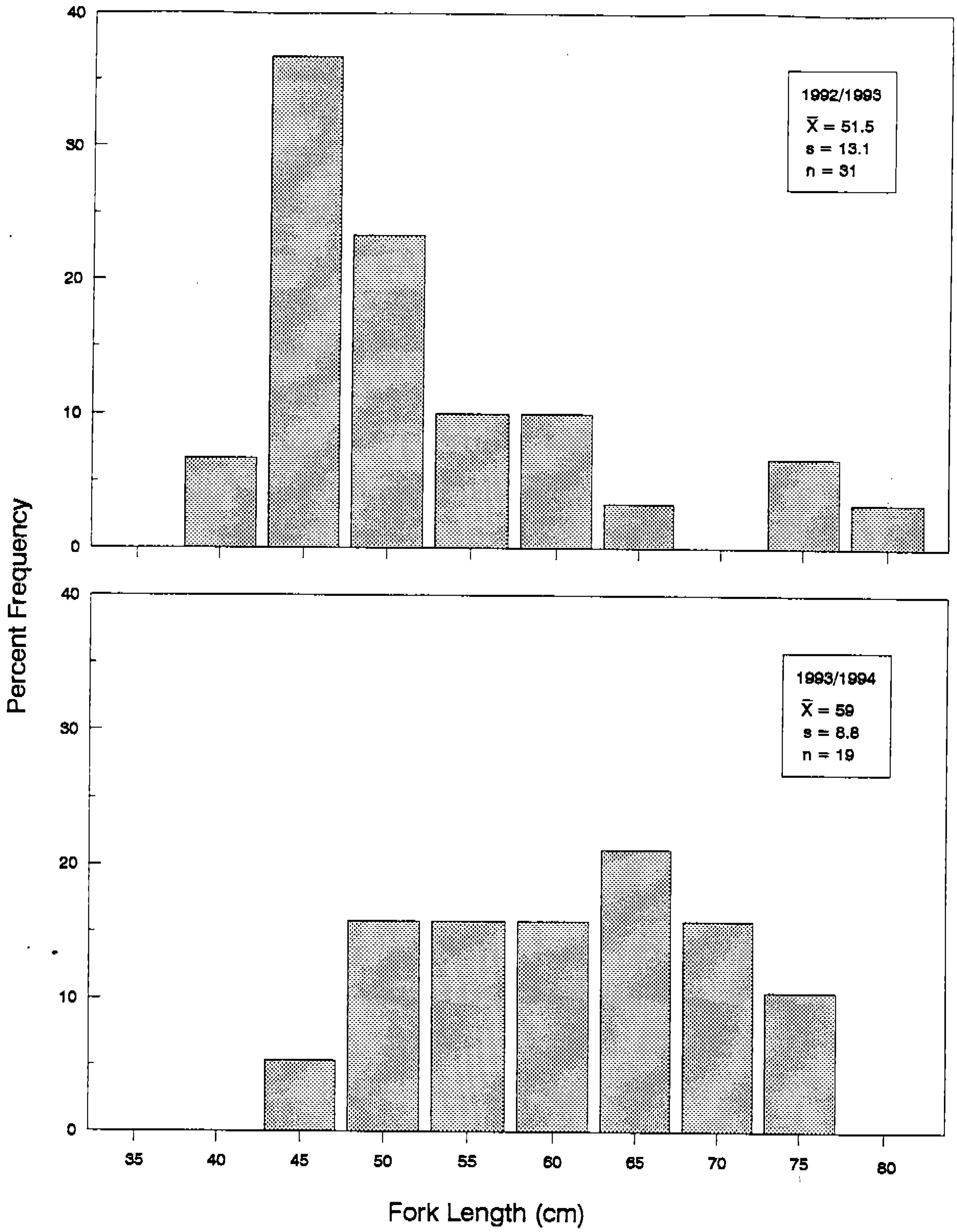

Figure 18. Length-frequency histograms of adult fall and spring chinook trapped at the New River weir (river kilometer 3.5) during 1992 to 1995.

Besides chinook captured in the live box, a total of 17 chinook carcasses washed up on the weir panels and 11 more were found near the weir. Scale samples from 21 of the carcasses revealed that 12 (57.1%) were age 2, two (9.5%) were age 3, and seven (33.3%) were age 4.

The ranges of fork lengths by age class were determined from 52 chinook (including carcasses) aged from scales. Fork lengths of age 2 chinook ranged from 38 - 55 cm, age 3 chinook ranged from 59 - 73 cm, and age 4 chinook ranged from 68 - 95 cm.

Only one chinook was tagged with a California Department of Fish and Game (CDFG) spaghetti tag. This fish had been tagged at the CDFG Willow Creek weir on October 13 and was recovered at the New River weir on October 30, 1992 (Table 7).

Chinook 1993/1994

During the 1993/1994 weir trapping season, only 19 chinook were captured at the weir between October 21, 1993 and June 28, 1994, with a peak of three adult chinook captured on October 26, 1993 (Figure 17). The fork lengths ranged from 42.0 to 75.0 cm (mean 59.0 $\pm$ 8.8 cm) with a mode of 65 cm. Fork lengths of age 2 chinook ranged from 42 - 62 cm, age 3 chinook ranged from 45 - 71 cm, and the one age 4 chinook was 62 cm (Figure 18). Scale samples collected from 33 chinook (including carcasses) revealed that 14 of the chinook (42.4%) were age 2, 18 (54.5%) were age 3, and one (3.0%) was age 4.

Results obtained from adult snorkel surveys suggest that fall chinook begin entering the New River drainage in late October. The majority of fall chinook seem to spawn in the lower 3.5 rkm of New River below the weir site (Figure 14). Others may remain in the lower 3.5 rkm until fall storms increase the river flow, stimulating them to migrate to upriver areas.

Snorkel surveys and the subsequent number of spring/fall chinook redds were counted during fall (October-December) surveys. In addition to the chinook trapped in the live box, a total of 18 chinook carcasses washed up on the weir panels, two were found close to the weir, and three carcasses were recovered from spawning surveys. The deteriorated condition of recovered carcasses made it difficult to distinguish a dorsal-fin mark (6mm hole punch) so it is unknown how many of these were sampled at the New River weir.

Table 7. California Department of Fish and Game (CDFG) spaghetti tag recoveries at the New River weir (river kilometer 3.5) during the fall of 1992 to the winter of 1995. All fish had been tagged at the Willow Creek weir (26.9 river kilometers downstream) U = unknown, M = male, F = female.

Species	Tag Code	Tagging Date	Recovery Date	Transit Time (days)	Fork Length (cm)	Sex
Chinook	R006189	10/13/92	10/30/92	17	53	U
Steelhead	R004010	10/20/92	10/30/92	10	62	U
Steelhead	W005349	10/20/92	10/30/92	10	62	M
Steelhead	W005158	10/06/92	10/30/92	24	56	M
Steelhead	R006020	09/04/92	10/30/92	56	58	F
Coho	W005477	10/27/92	12/24/92	58	64	M
Chinook	W004133	10/12/93	12/29/93	78	56	M
Chinook	W004179	10/13/93	12/02/93	50	45	M
Steelhead	R005107	09/23/93	12/04/93	72	56	F
Steelhead	R005028	09/13/93	12/10/93	88	68	M
Steelhead	R005641	11/30/93	2/23/94	85	63	F
Steelhead	ROO5557	10/20/93	2/24/94	127	64	M
Steelhead	ROO4976	09/02/93	3/17/94	197	55	M
Steelhead	R005534	10/19/93	3/28/94	160	58	M
Steelhead	R005501	10/14/93	3/30/94	167	58	F
Steelhead	ROO6677	8/18/94	11/05/94	79	62	M
Steelhead	R006952	9/08/94	11/11/94	64	61	F
Steelhead	R006524	8/04/94	11/30/94	118	56	F
Steelhead	R006728	8/24/94	12/03/94	101	53	F
Steelhead	R006747	8/26/94	12/04/94	100	58	M

During the fall of 1993, two-chinook were tagged with (CDFG) spaghetti tags. These fish had been tagged at the CDFG Willow Creek weir on October 12 and 13, 1993. They were recovered at the New River weir (a distance of 26.9 km) on December 2 and 29, 1993 (Table 7). The transit times were 50 and 78 days, respectively. In contrast, 19 chinook moving up the Trinity River between the CDFG Willow Creek weir and the Junction City weir (a difference of 88.7 rkm) took from 8 to 42 days and the mean travel time was 20.8 days (Mark Zuspan, Pers. Comm., 1995). The difference in transit times between weirs may be affected by stream gradient, flows, water temperatures, stress, and barriers (e.g. the weir).

Coho 1992/1993

Only two adult coho salmon have been observed in New River during the New River study (1988 to 1995). Two male coho salmon carcasses (41 and 64 cm fork lengths) were collected at the weir on December 24, 1992. One Coho's transit time (days at large) from Willow Creek weir to the New River weir was 58 days (including time spent above New River weir) (Table 7). It appears likely that both fish were strays because no other coho salmon have been observed during other years of this study. No juvenile coho were observed during the following spring and summer of 1993, so it is unknown if any coho spawned successfully.

Although some coho may stray into New River from time to time, no juveniles have been observed during the New River study (1988 to 1995) which indicates that New River is only marginally used by coho salmon.

Steelhead 1992/1993

During the 1992/1993 weir trapping season, a total of 29 adult steelhead were trapped at the weir from October 29 to January 6 with a peak catch occurring October 30, 1992 (Figure 17). Adult steelhead fork lengths ranged from 36 - 71 cm (mean 58.7 ± 7.3). The modal frequency was 65 cm (Figure 19). Of the 18 steelhead aged during 1993, one was aged 1.2 (5.5%)(1.2 = one year fresh and one year salt), one was aged 1.3 (5.5%), one was aged 2.1 (5.5%), 11 were aged 2.2 (61%), three were aged 2.3 (16.7%) and one was aged 3.2 (5.5%). At least four fish (two 4 year olds and two 5 year olds) were repeat spawners. Mean fork lengths by age and their percent frequencies by age are presented for 1992 to 1995 in Figures 20 and 21 respectively. The sex (female:male) ratio of 23 steelhead was 1.1:1 (12 females (52%) and 11 males (48%)).

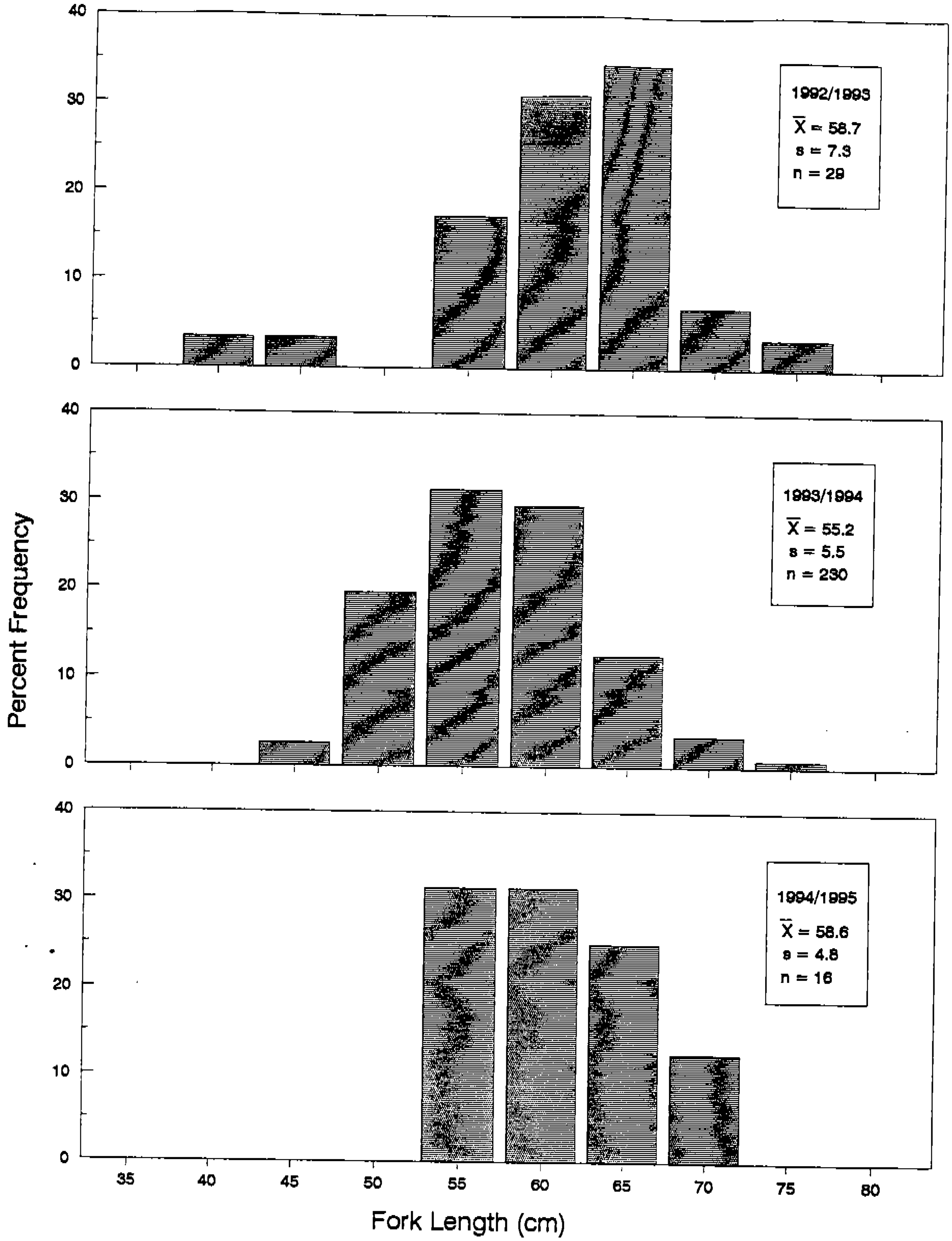

Figure 19. Length-frequency histograms of adult summer and winter steelhead trapped at New River weir (river kilometer 3.5) during 1992 to 1995.

Four steelhead during 1992, were trapped at New River weir and had CDFG spaghetti tags from Willow Creek weir (Table 7). Transit times between weirs (a distance of 26.9 km) varied from 10 to 56 days, with a mean transit time of 23 days.

Steelhead 1993/1994

During the fall of 1993 to the summer of 1994, a total of 230 steelhead adults were trapped at the weir from October 5, 1993 to July 12, 1994, with a peak occurring in June (Figures 17 and 22). Fork lengths ranged from 42 - 71 cm (mean 55.2 $\pm$ 5.5 cm) (Figure 19). Of the 214 steelhead aged for 1993/1994 (Figures 20 and 21), 2 (0.9%) were age 1.1, 14 (6.5%) were age 1.2, two (0.9%) were age 1.3, 90 (42.1%) were age 2.1, 98 (45.8%) were 2.2, four (1.9%) were 2.3 and four (1.9%) were age 3.2. Scale analysis revealed that at least 5% of the fish had spawned previously. Half-pounder life histories were not determined. The sex (female:male) ratio of the 230 steelhead was 1.88:1 (150 females (70%), and 80 males (30%)).

During the spring of 1994, an increase in the number of "down running" steelhead was first observed in a pool above the weir on March 16, 1994 (n = 40). Down runner numbers peaked by March 22 (n = 127) and tapered off by May 27, 1994 (n = 9). Several weir panels were removed for a total of 152 hours from March to May to help fish movement downstream.

Active methods (herding fish) were more effective than passively allowing fish to move through the open weir panels. Snorkeling at night using flashlights to herd fish worked the best. We were unable to accurately count the number of run-backs above the weir because, snorkelers did not consistently begin snorkeling far enough upstream to obtain a complete count. In addition, fish may have voluntarily moved through the open panels when the weir was unattended.

At times, a relationship between mean water temperature and discharge influences migration, but their effects on fish behavior were over-ridden by the presence of the weir. The weir appeared to inhibit or delay migration in the New River Basin based on adult distribution and run timing. Based on the condition of steelhead (bright/non-bright), CDFG tag returns, and run timing (Table 7) of steelhead moving through the weir suggests the lack of a winter run on New River (Figure 22). Additional sampling would provide clarification on the presence

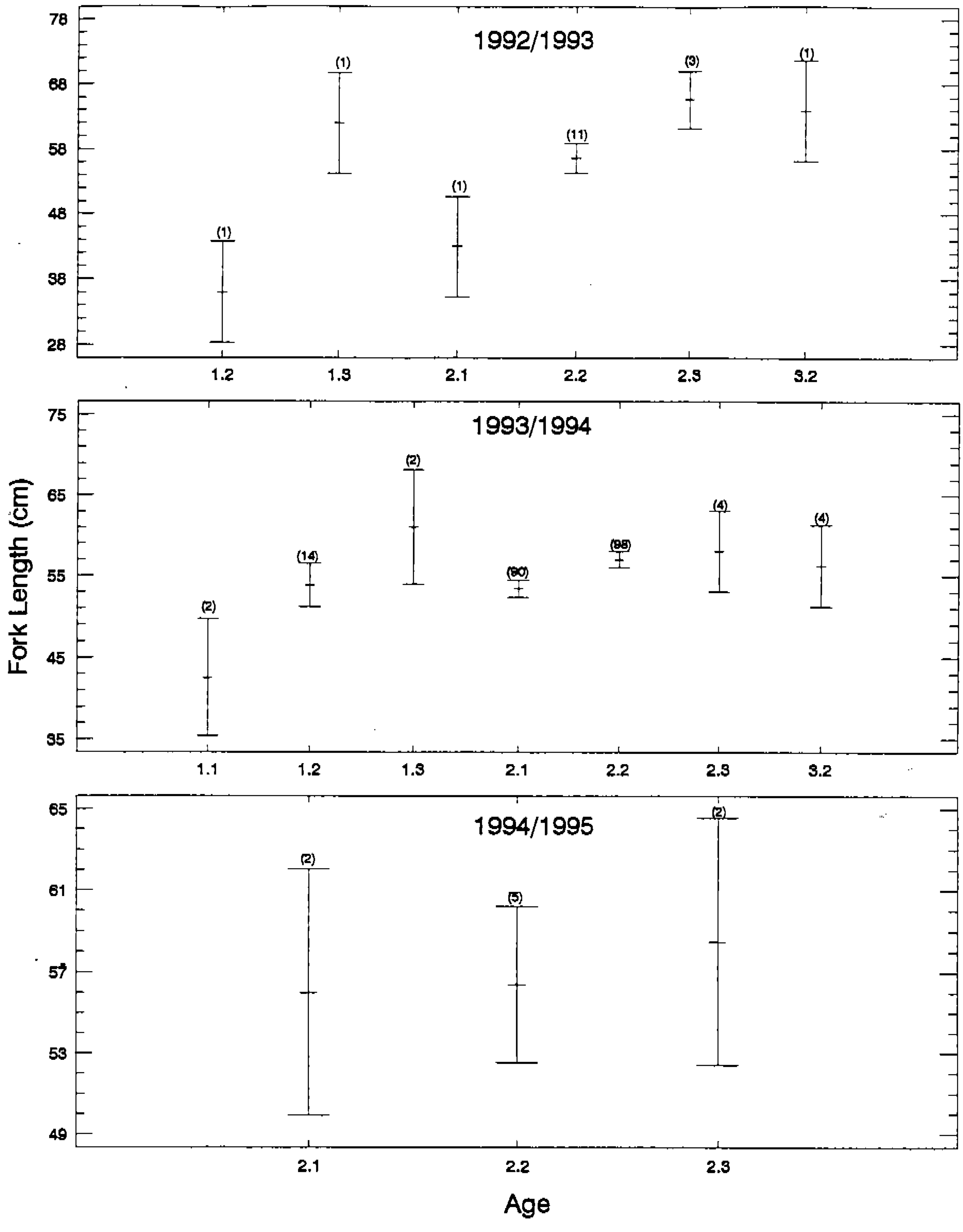

Figure 20. Mean fork lengths (and 95% confidence intervals) by age classes for adult summer and winter steelhead trapped at the New River weir (river kilometer 3.5) during 1992 to 1995. Sample sizes are in parentheses.

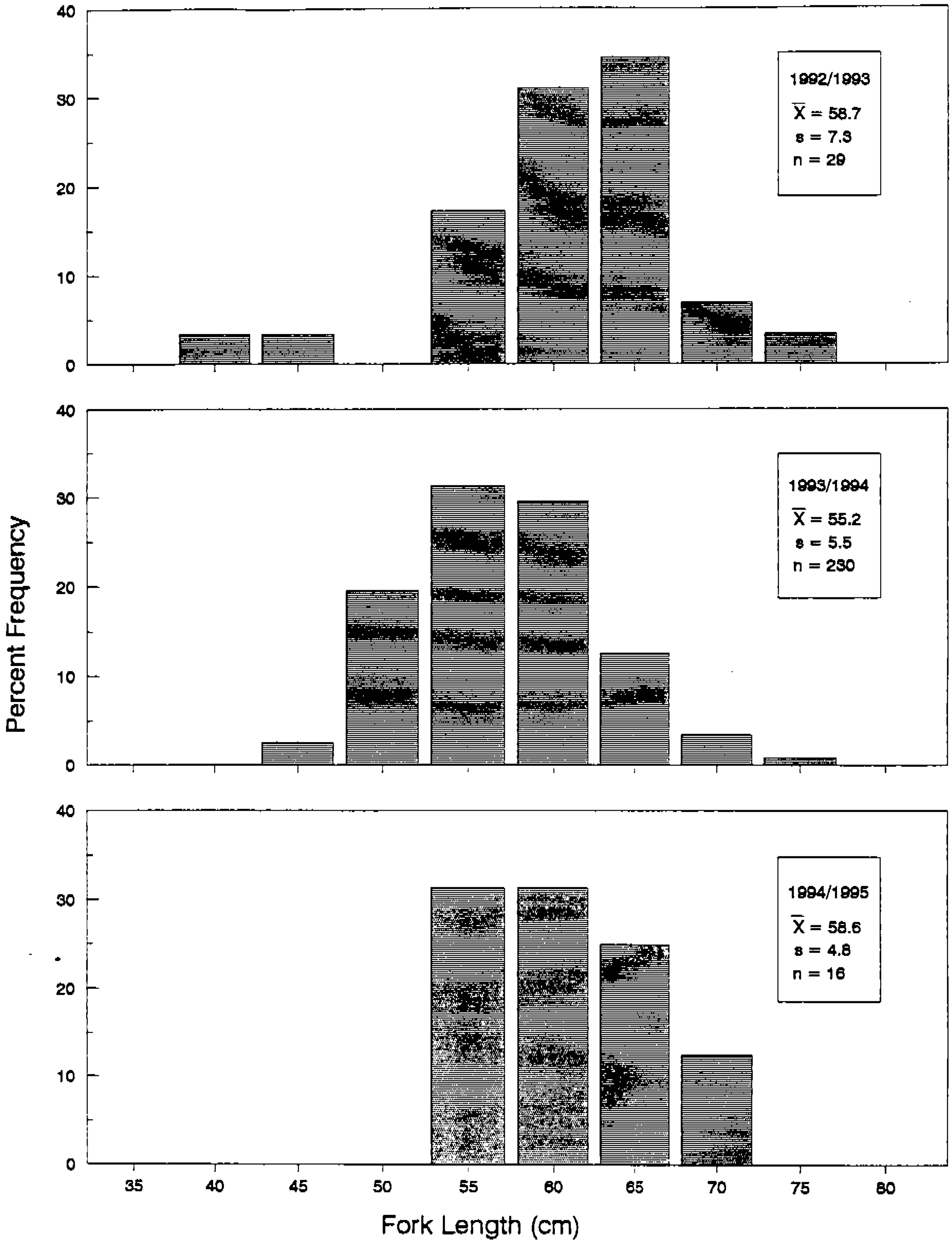

Figure 21. Percent frequencies of age classes (1.1 = one year fresh water and one year ocean growth) of adult summer and winter steelhead sampled at New River weir (river kilometer 3.5) during 1992 to 1995.

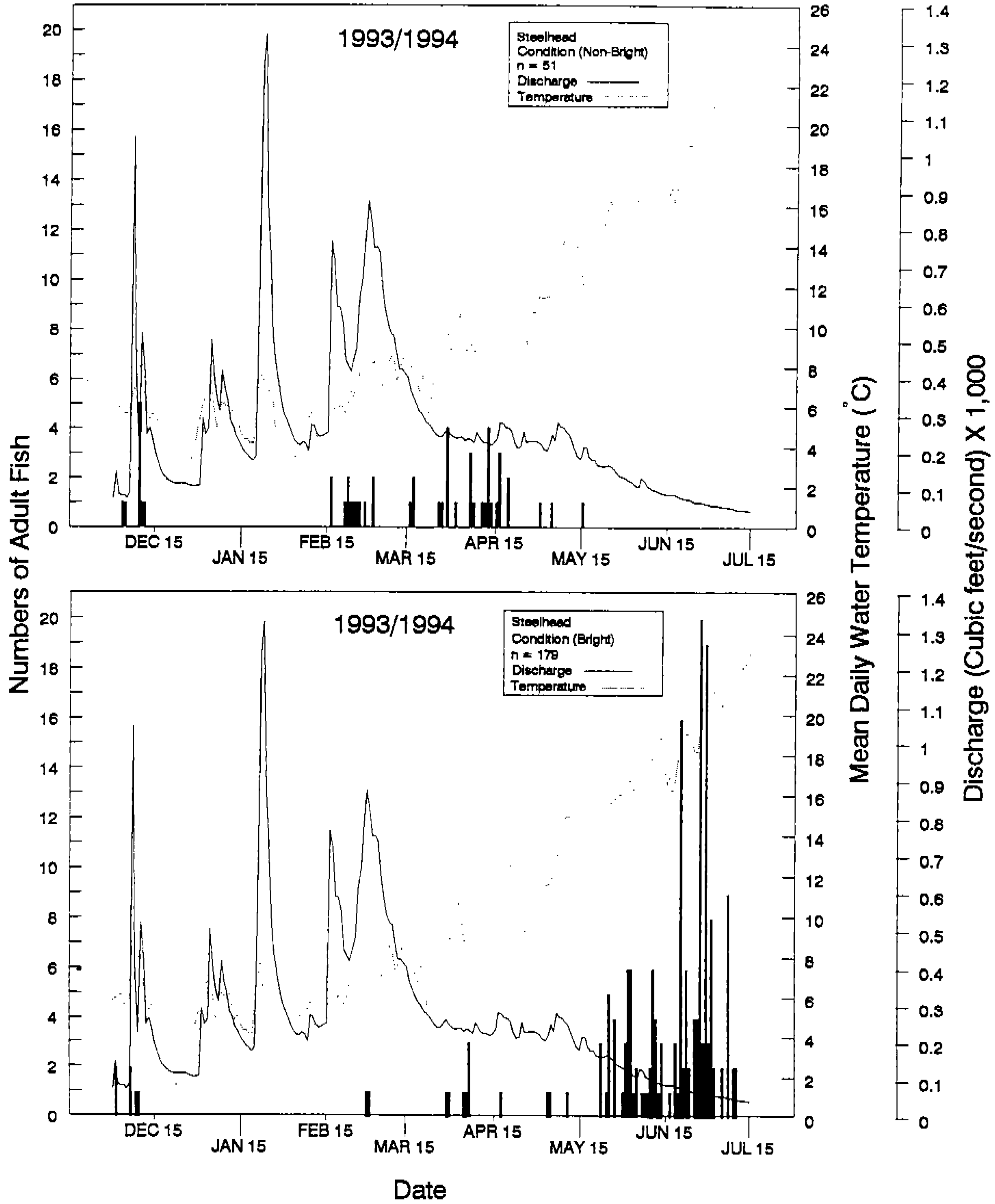

Figure 22. Timing and condition (bright/non-bright) of the adult summer and winter steelhead run in New River, based on numbers of fish trapped in the resistance-board weir (river kilometer 3.5) during October 5, 1993 to July 12, 1994. Water temperatures and discharge were recorded at river kilometer 3.4.

or absence of a winter race. The largest part of the summer run (includes spring and fall steelhead) is primarily spring run steelhead.

Seven steelhead trapped at New River weir during the fall of 1993 to the summer of 1994 had CDFG spaghetti tags from Willow Creek weir (Table 7). Transit times between weirs ranged from 72 to 196 days with a mean transit time of 129 days.

Steelhead 1994/1995

During the last season of operation, a total of 16 adult steelhead were trapped between November 5, 1994 and January 3, 1995 with a peak of six steelhead on November 5, 1994 (Figure 17). Fork lengths of the 16 steelhead ranged from 53 - 69 (mean 58 ± 4.7 cm) (Figure 19). Of the nine aged steelhead during 1995, two were 2.1 (22%), five were 2.2 (55%), and 2 were 2.3 (22%) (Figures 20 and 21). The sex (female:male) ratio of 16 steelhead trapped at the weir was 1:1 (eight females (50%) and eight males (50%)).

Six steelhead trapped at New River weir during the fall of 1994 and winter of 1995 had CDFG spaghetti tags from Willow Creek weir (Table 7). Transit times between weirs took between 64 and 166 days, with a mean transit time of 105 days. The shorter transit times during 1992/1993 and 1994/1995 could be affected by stream gradient, flows, water temperatures, stress, and barriers (ex. the weir).

Juvenile Trapping

The rotary screw trap was operated for 135 nights between February 19, 1993 and July 15, 1994. A total of 14,300 YOY chinook, zero 1+ chinook, 4,580 YOY steelhead, 1,072 steelhead parr, and 2,433 steelhead smolts were trapped (Table 8). During 1995, zero YOY chinook and zero age 1+ chinook, 3,162 YOY steelhead, 2,348 steelhead parr, and 136 steelhead smolts were trapped during the 123 nights of operation (April 24 to September 9, 1995). Weekly screw trap totals and index totals appear in Appendix D.

The expanded number of fish captured provides an abundance indices of juvenile emigrants. Indices of daily abundance, compared between years, show a wide variation in emigration timing and size. Some factors that may influence the timing of emigration include length of photo-period, timing of storms and

Table 8. Monthly catch and expanded indices totals using rotary-screw trap (river kilometer 3.7) and late-season frame trap catches in New River, CA during 1989 to 1995.

		MONTHLY CATCH TOTALS					MONTHLY INDEX TOTALS				
		Steelhead			Chinook		Steelhead			Chinook	
Month Year	Nights Sampled	YOY	Parr	Smolt	YOY	Yearling	YOY	Parr	Smolt	YOY	Yearling
1989											
APR	13	0	67	3	4	0	0	2,491	139	93	0
MAY	18	2	662	173	55	0	17	5,751	1,562	466	0
JUN	21	140	364	22	375	0	450	1,730	103	1,356	0
JUL	7	46	6	2	61	0	247	82	11	353	0
1989 Yearly Totals=	59	188	1,099	200	495	0	714	10,054	1,815	2,268	0
1990											
APR	23	1	4,669	1,349	24	0	3	20,987	5,122	77	0
MAY	26	31	645	231	341	0	297	4,462	616	1,882	0
JUN	24	319	53	7	363	0	1,408	444	45	1,632	0
JUL	18	180	26	3	93	0	433	64	7	214	0
AUG	3	0	0	0	0	0	0	0	0	0	0
SEP	13	28	4	0	0	0					
OCT	10	6	0	0	0	0					
NOV	4	9	0	0	0	0					
1990 Yearly Totals=	121	574	5,397	1,590	821	0	2,141	25,957	5,790	3,805	0
1991											
MAR	6	0	20	48	0	1	0	156	363	0	6
APR	19	0	1,234	542	1	1	0	8,457	3,838	7	9
MAY	18	1	2,268	844	108	2	4	12,015	4,382	390	10
JUN	19	504	183	21	447	0	1,502	855	179	1,428	0
JUL	15	2	2	0	9	0	10	16	0	39	0
AUG	9	2	0	0	0	0	18	0	0	0	0
SEP	10	19	6	0	0	0	37	11	0	0	0
OCT	4	0	2	0	0	0	0	3	0	0	0
1991 Yearly Totals=	100	528	3,715	1,455	565	4	1,570	21,513	8,763	1,864	26
1992											
APR	7	0	1,423	446	0	5	0	11,783	3,806	0	34
MAY	13	741	411	330	52	0	2,736	1,717	1,590	214	0
JUN	17	1,170	55	8	81	0	4,871	281	34	335	0
JUL	9	625	42	2	1	0	3,215	256	10	2	0
1992 Yearly Totals=	46	2,536	1,932	786	134	5	10,822	14,037	5,440	551	34
1993											
MAR	2	0	39	10	0	0	0	449	116	0	0
APR	18	1	254	60	0	0	8	4,405	1,217	0	0
MAY	23	7	535	149	4	0	94	6,616	1,795	69	0
JUN	17	138	276	22	52	0	838	2,063	144	433	0
JUL	21	664	127	12	47	0	1,896	435	33	154	0
AUG	2	6	0	0	0	0	13	0	0	0	0
1993 Yearly Totals=	83	816	1,231	253	103	0	2,849	13,968	3,305	656	0
1994											
FEB	3	0	3	1	0	0	0	209	10	0	0
MAR	29	0	355	170	1	0	0	1,896	643	4	0
APR	29	1	372	1,023	350	0	3	1,068	2,880	975	0
MAY	31	321	306	1,192	5,457	0	545	827	3,217	13,860	0
JUN	30	3,507	30	44	8,351	0	6,722	50	76	14,397	0
JUL	13	751	6	3	141	0	1,560	11	6	338	0
1994 Yearly Totals=	135	4,580	1,072	2,433	14,300	0	8,830	4,061	6,832	29,574	0
1995											
APR	3	4	38	16	0	0	78	658	268	0	0
MAY	27	8	672	77	0	0	100	4,723	668	0	0
JUN	28	417	1,194	23	0	0	1,400	4,566	99	0	0
JUL	29	1,759	249	9	0	0	4,199	618	21	0	0
AUG	27	869	167	11	0	0	2,142	398	32	0	0
SEP	9	105	28	0	0	0	231	61	0	0	0
1995 Yearly Totals=	123	3,162	2,348	136	0	0	8,150	11,024	1,088	0	0

high flows, water temperatures, and lunar phases. The numbers of emigrants are affected not only by the number of spawners, but by many physical and biotic factors as well. The fraction of the total river flow sampled by the screw trap influences the daily index estimate.

Flows from October 1, 1993 to September 30, 1994 were among the lowest since the start of the study (40%), resulting in an increase in the fraction of river flow sampled by the screw trap. An average of 33% of the river volume was sampled throughout the trapping season in 1995, compared with 34% for 1990, 44% for 1991, 41% for 1992, 22% in 1993, and 40% in 1994. The average percent flow trapped in 1994 may appear deceptively high for a low flow year, this may be because juvenile trapping started more than a month earlier (during high winter/early spring flows) than previous years. Conversely, trapping started nearly a month later than normal during 1995, and continued almost two months later, causing the percent flow to be deceptively low.

Chinook

During 1994, the first YOY chinook were trapped on March 14 (Figure 23). The abundance index estimates of 29,574 YOY chinook and zero 1+ chinook for the season is much higher than all other years of this study. Monthly chinook length-frequency histograms, based on rotary screw trap catch totals, show that the mean fork lengths increased each month from April-July (Figure 24). The frequency distribution was bimodal during 1994, with peak numbers arriving at the screw trap on May 14 and June 10 (Figure 23).

Generally, few fish moved downstream during periods when there was a full moon (Figure 23). Peak numbers seemed to have been related to periods when there was a new moon, which was shown to be a primary factor in downstream migration of juvenile salmonids by Mason (1975). The record numbers of YOY chinook in 1994, may be explained by the correspondingly high number of redds observed in 1993 and favorable winter flows, which did not "wash out" redds in the mainstem of New River. During 1995, juvenile chinook were not observed (Table 8) which may be due to a low number of adult spawners the preceding fall and high winter flows which caused redds to "wash out". Early emigrating chinook could have also been missed because downstream migrant trapping started after they already left New River.

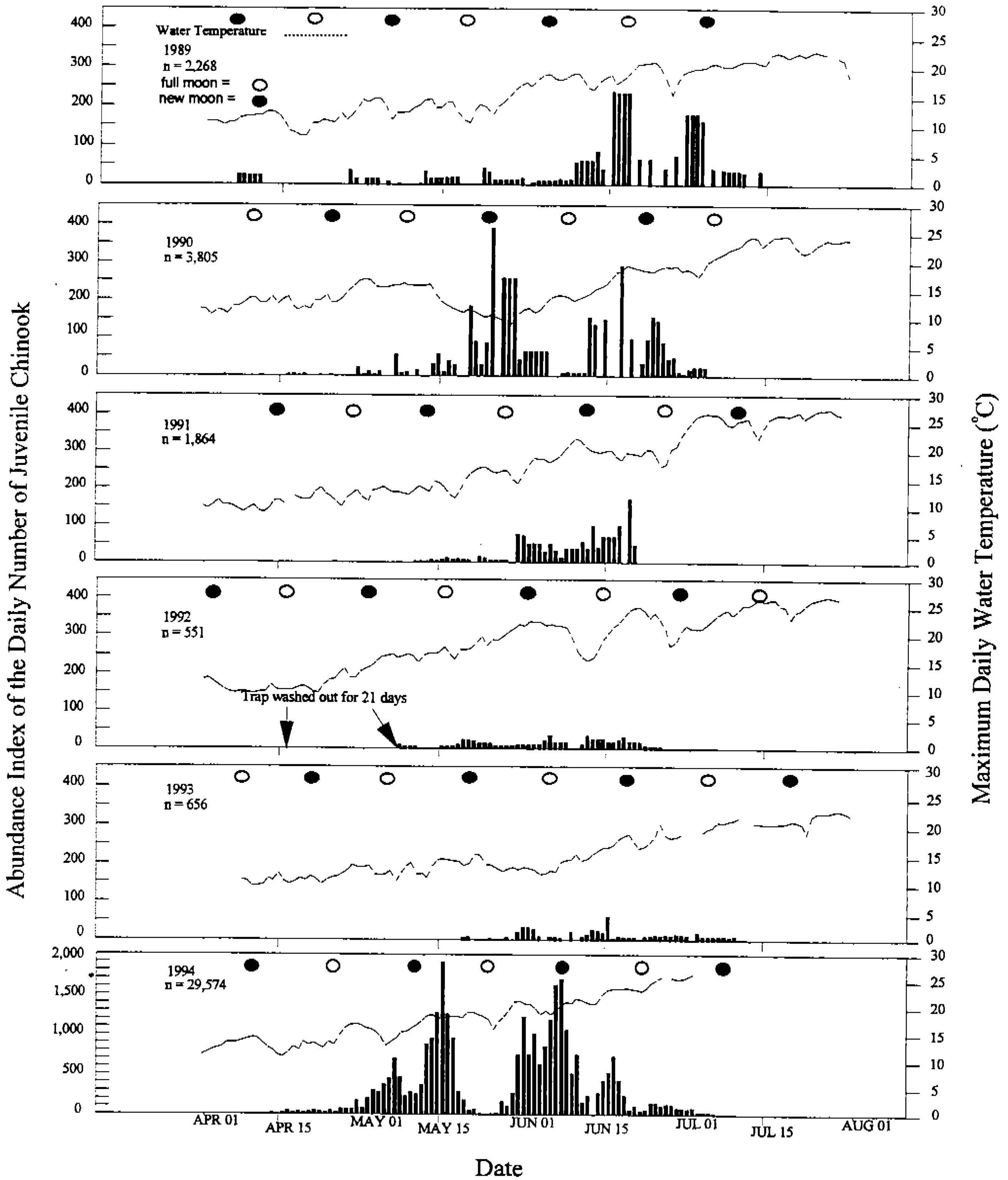

Figure 23. Daily juvenile chinook abundance indices estimates, based upon New River rotary-screw trap catches (river kilometer 3.7) during 1989 to 1995. Maximum daily water temperatures during the trapping season are presented on the second Y-axis (the Y-axis in 1994 differs from the 1989 to 1993 figures).

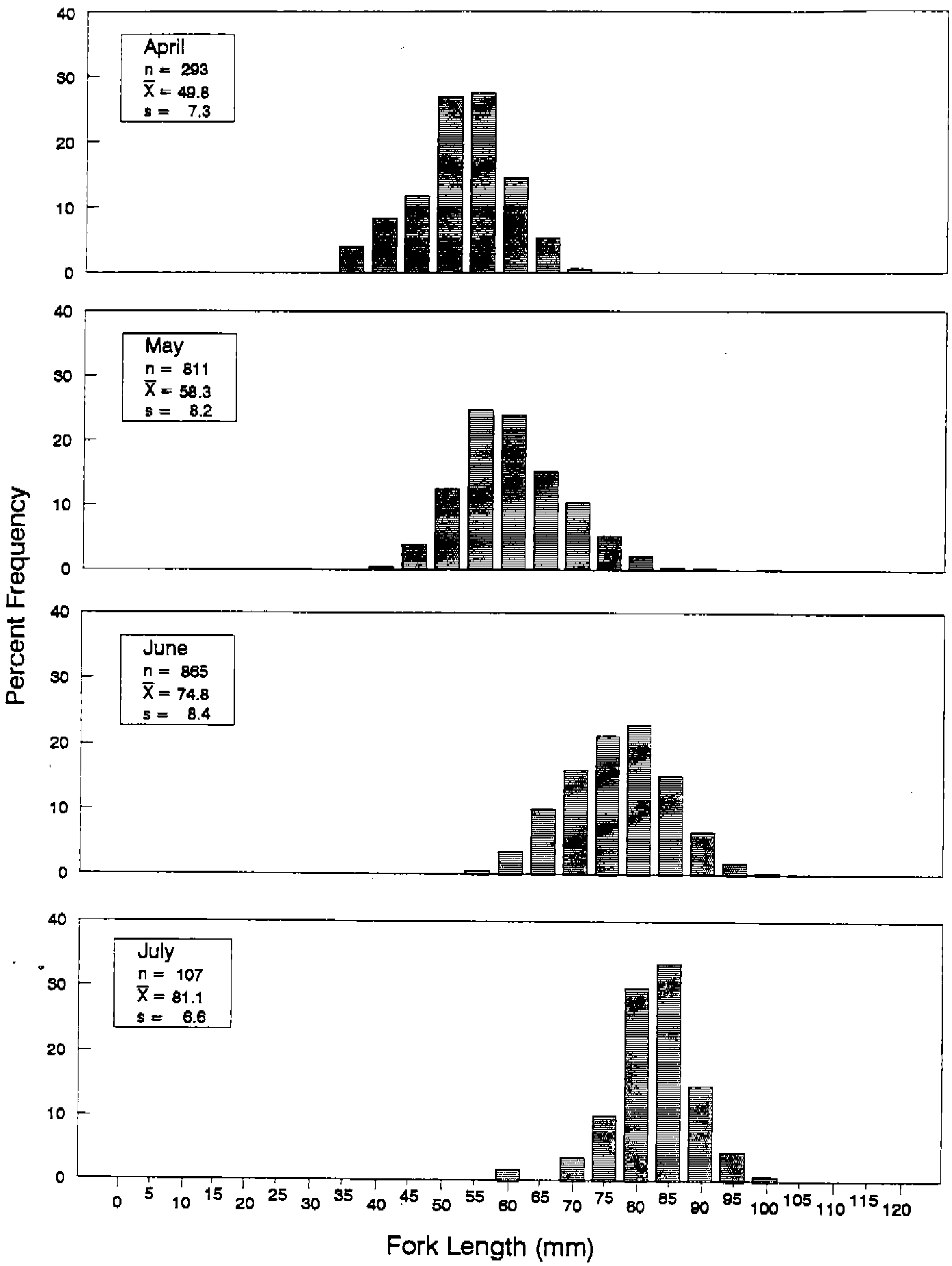

Figure 24. Juvenile chinook length-frequency histograms based on daily New River rotary-screw trap catches (river kilometer 3.7) during 1994.

YOY steelhead

The first YOY steelhead (mean fork length = 27 mm) was observed on April 29, 1994 and on April 26, 1995 (mean fork length = 26) (Figures 25 and 26). In 1994, the number of emigrating YOY steelhead peaked in early June, although a smaller peak occurred in early July. A bimodal distribution has been observed every year but in 1991 and a trimodal curve appeared in 1995. Lunar phase and water temperature seemed to have a direct relationship on the magnitude of numbers of emigrating YOY steelhead and run timing. Generally, YOY emigrant numbers declined during the full moon and increased with the new moon. The largest pulse of YOY emigrants occurred at a mean daily water temperature of 15.5°C (maximum temperature of 16.3°C).

The estimated (expanded) number of emigrating YOY steelhead was much higher in 1992 (n = 10,822) than any other year except 1994 (n = 8,830) and 1995 (n = 8,150) (Figures 25 and 26). This may be the result of the high numbers of adults that returned to spawn in (the preceding year) 1991 (n = 702), 1993 (n = 368), and 1994 (n = 404).

The numbers of emigrating YOY progeny is influenced not only by the number of spawners, but by many other factors such as the stability of flows during incubation, rearing habitat availability, food availability and mortality from predation. In addition, September counts of adult steelhead (Table 3) do not include all summer steelhead and possible winter steelhead.

Monthly juvenile steelhead length-frequency histograms (1994 and 1995), based on rotary screw trap catch totals, show that the mean fork lengths of YOY steelhead were longer in 1994 than they were for the same months in 1995 (Figures 27 and 28). Age analysis of juvenile steelhead (Table 9) also shows that YOY steelhead were longer in 1994 than in 1995. This may be due to warmer water temperatures in 1994 that caused shorter incubation times and faster growth rates. During both 1994 and 1995 mean fork lengths for YOY steelhead also increased throughout the trapping seasons.

Steelhead parr and smolts

In 1994, trapping began in late February which was earlier than in previous years. This earlier trapping time probably allowed trapping a larger percentage of the run than in previous years. Parr numbers peaked in early March, and diminished to low

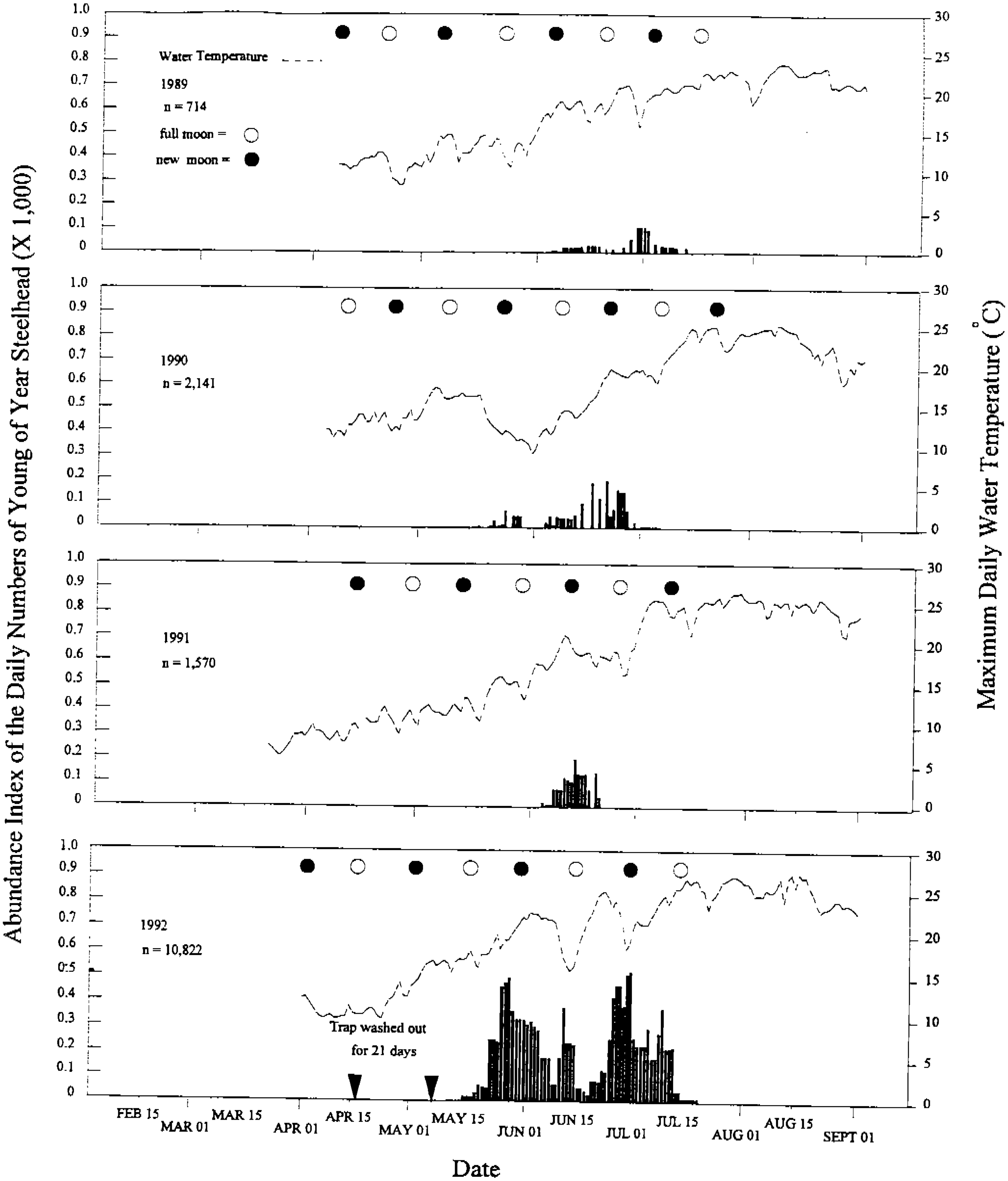

Figure 25. Daily YOY steelhead abundance indices estimates, based upon New River rotary-screw trap catches (river kilometer 3.7) during 1989 to 1992. Maximum daily water temperatures during the trapping season are presented on the second Y-axis.

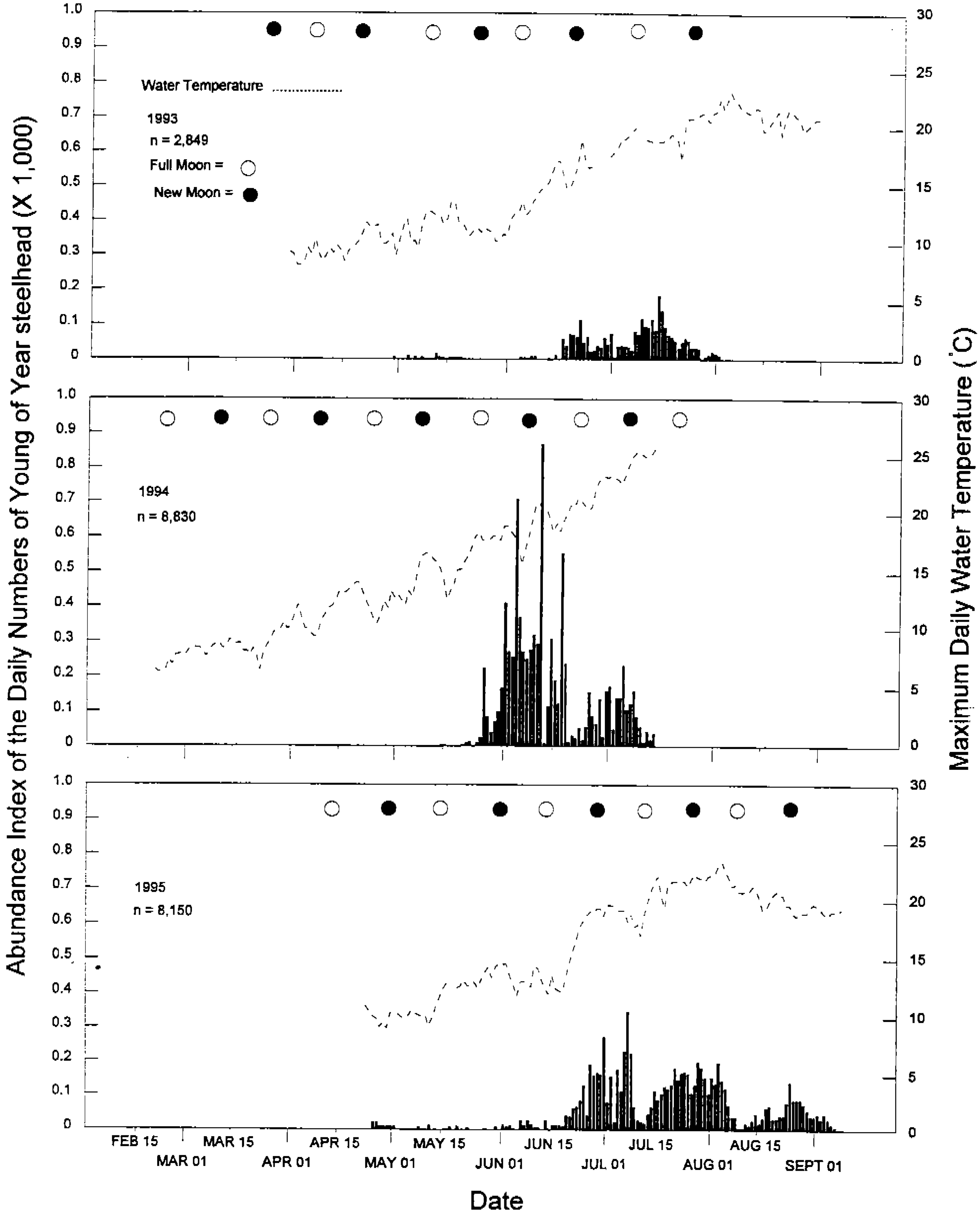

Figure 26. Daily YOY steelhead abundance indices estimates, based on New River rotary-screw trap catches (river kilometer 3.7) during 1993 to 1995. Maximum daily water temperatures during the trapping season are presented on the second Y-axis.

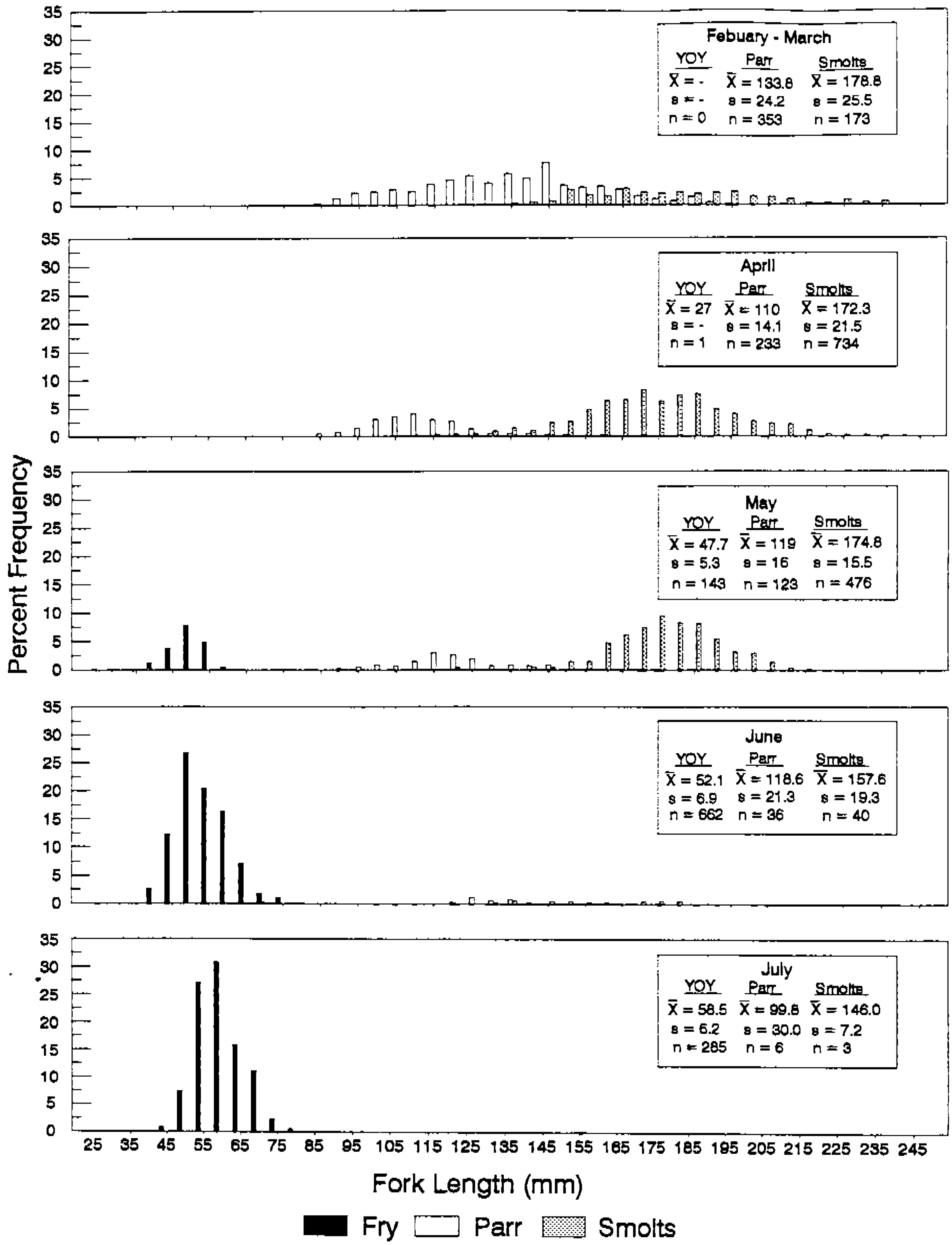

Figure 27. Juvenile steelhead length-frequency histograms by month, based on rotary-screw trap catches during 1994.

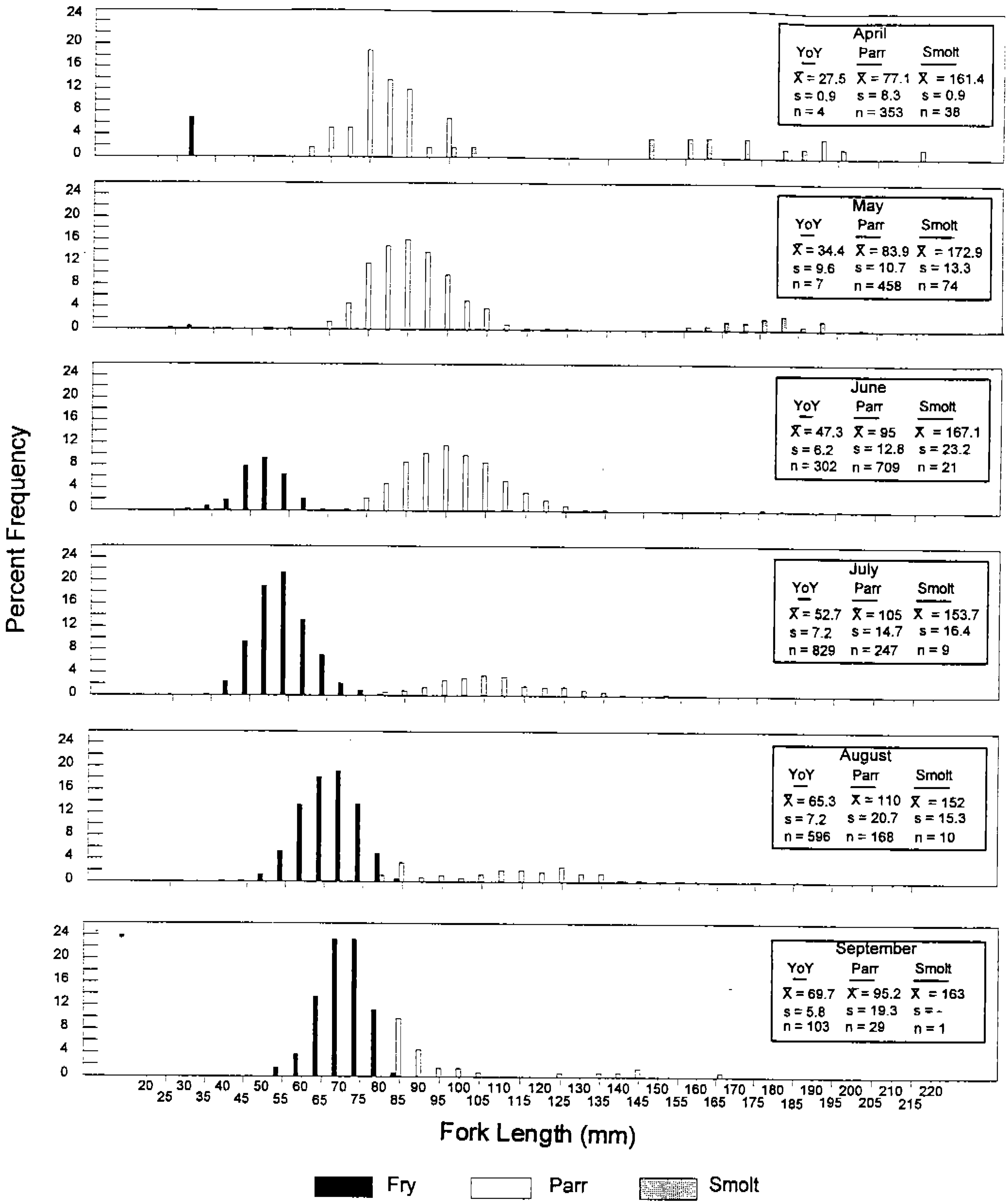

Figure 28. Juvenile steelhead length-frequency histograms by month, based on rotary-screw trap catches during 1995.

Table 9. Biosampled juvenile steelhead age class compositions and their monthly percentages based on scale samples from rotary-screw trap catches (river kilometer 3.7) during 1994 and 1995 ($\bar{x}$ = mean, s = standard deviation, n = sample size).

1994

	0+				1+				2+				3+			
	$\bar{X}$	s	n	% by Month	$\bar{X}$	s	n	% by Month	$\bar{X}$	s	n	% by Month	$\bar{X}$	s	n	% by Month
February	–	–	–	–	100	–	1	25	173	51.7	3	75	–	–	–	–
March	–	–	–	–	114	13.1	163	31.4	164	23.7	353	68.1	241	2.8	2	0.39
April	42.0	20.5	2	0.21	113	14.6	275	28.6	175	17.4	677	70.5	231	3.3	6	0.63
May	48.0	5.3	143	19.2	118	13.0	128	17.2	178	13.6	472	63.5	–	–	–	–
June	52.0	7.1	667	90.5	138	17.6	60	8.14	181	7.2	10	1.36	–	–	–	–
July	58.0	6.7	289	98.3	140	3.7	4	1.36	140	–	1	0.34	–	–	–	–

1995

	0+				1+				2+				3+			
	$\bar{X}$	s	n	% by Month	$\bar{X}$	s	n	% by Month	$\bar{X}$	s	n	% by Month	$\bar{X}$	s	n	% by Month
April	27.5	0.87	4	7.14	93	32.7	49	87.5	197	11.7	3	5.36	–	–	–	–
May	38.9	10.6	10	1.86	86	15.7	469	87.0	177	10	58	10.7	241	64.5	2	0.37
June	52.3	12.1	367	35.5	97	11.8	649	62.8	185	20.2	17	1.65	–	–	–	–
July	53	7.6	840	77.3	107	14	240	22.1	188	51.0	6	0.55	–	–	–	–
August	66	8.3	638	82.4	121	18.1	136	17.5	–	–	–	–	–	–	–	–
Sept.	71.4	7.0	118	88.7	112	24.3	15	11.2	–	–	–	–	–	–	–	–

numbers by early June (Figures 29 and 30). Smolts peaked in early May and declined sharply in June and July (Figures 31 and 32).

In 1995, screw trapping began later than during all previous years (due to high flows). This late start probably caused fewer parrs (n = 11,024) and smolts (n = 1,088) to be observed. Monthly length-frequency histograms for juvenile steelhead trapped during 1994 and 1995 are presented in Figures 27 and 28 respectively. Usually, steelhead juveniles (parr and smolts) with longer mean fork lengths left the system earlier. Scale samples for 1994 and 1995 were age-analyzed to learn monthly age compositions (0+, 1+, 2+, 3+) for juvenile steelhead leaving New River (Table 9). Overall, 1+ steelhead were longer in 1994 than in 1995. This size difference could be explained by better growing conditions during the summer of 1993 than in the summer of 1994. In 1994, steelhead 2+ comprised the largest percentage (46%) of out-migrants but, in 1995, steelhead 1+ were the most dominant age class (48%) leaving New River. However, this age analysis may be misleading because downstream migrant trapping started later in 1995 (April versus February) after many steelhead 2+ left the system.

During the 1994 and 1995 trapping seasons, juvenile steelhead appeared to be in good health. Visual inspection of juvenile steelhead showed fungus, discoloration, bite marks, and hook scars were observed on a small number (< 1%) of fish. Mortality rates were negligible (less than 0.1%) from trapping operations.

In 1994, two mark-recapture efficiency tests were used to check trap efficiency. The first test was carried out on May 17 when river discharge was 6.06 cms (217 cfs). A total of 198 Bismark Brown Y stained fish were released in a pool found 150 m above the screw trap. A control group of 50 stained chinook were placed in a net pen in a pool 50 m below the trap. A total of 64 stained fish were recaptured over the next 48 hours. During this time there were two mortalities in the control group. Because there were no unmarked fish in the control group, we were unable to say if mortality was caused by the effects of the stain or from the holding conditions. If the mortality is assumed to have been caused by the stain, then the mortality rate was 4% and estimated trapping efficiency was 34% and the percent of the flow sampled by the trap was 33%. The second mark-recapture efficiency test was carried out on June 3, a total of 250 chinook

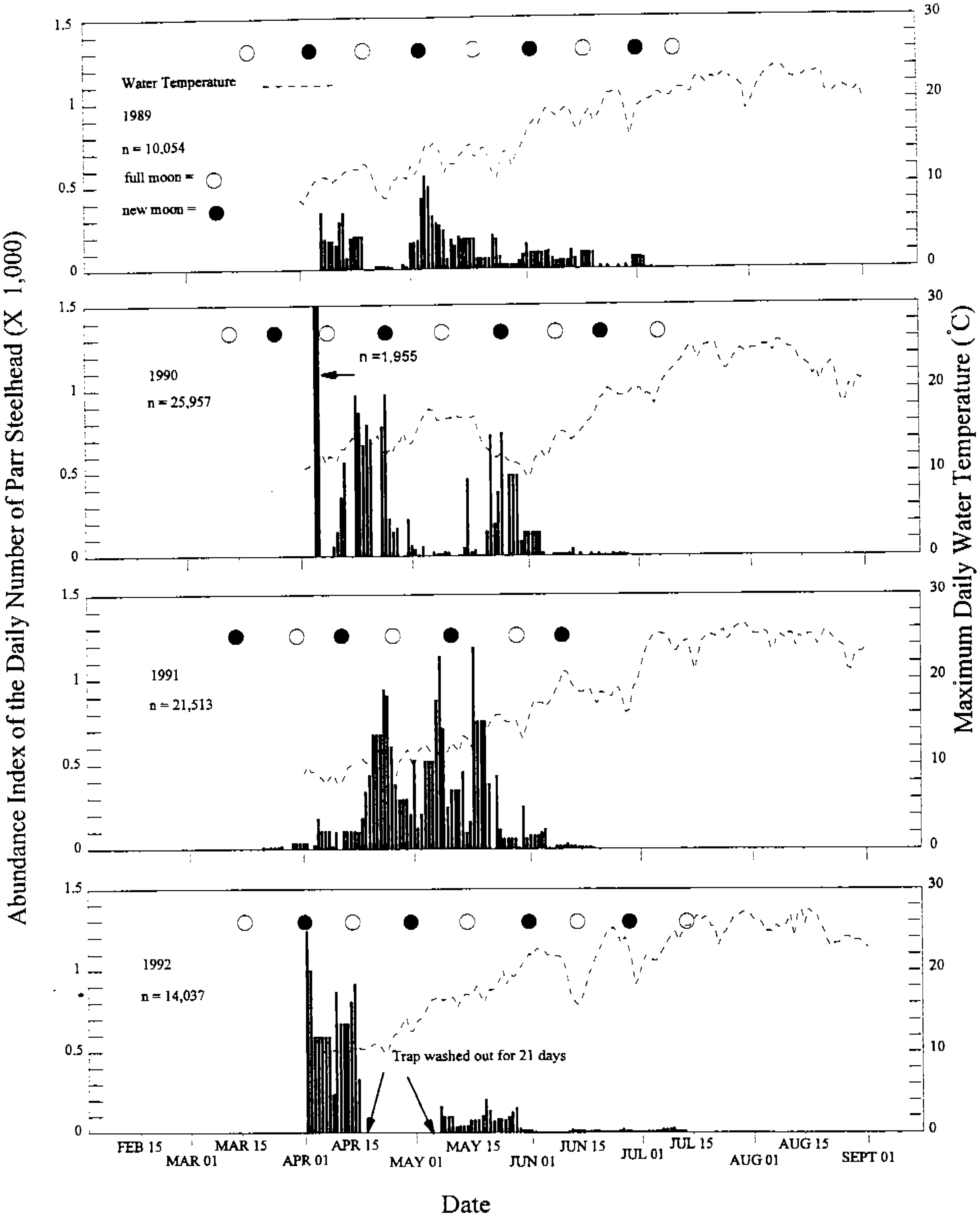

Figure 29. Daily steelhead parr abundance indices estimates, based on New River rotary-screw trap catches (river kilometer 3.7), during 1989 to 1992. Maximum daily water temperatures during the trapping season are presented on the second Y-axis.

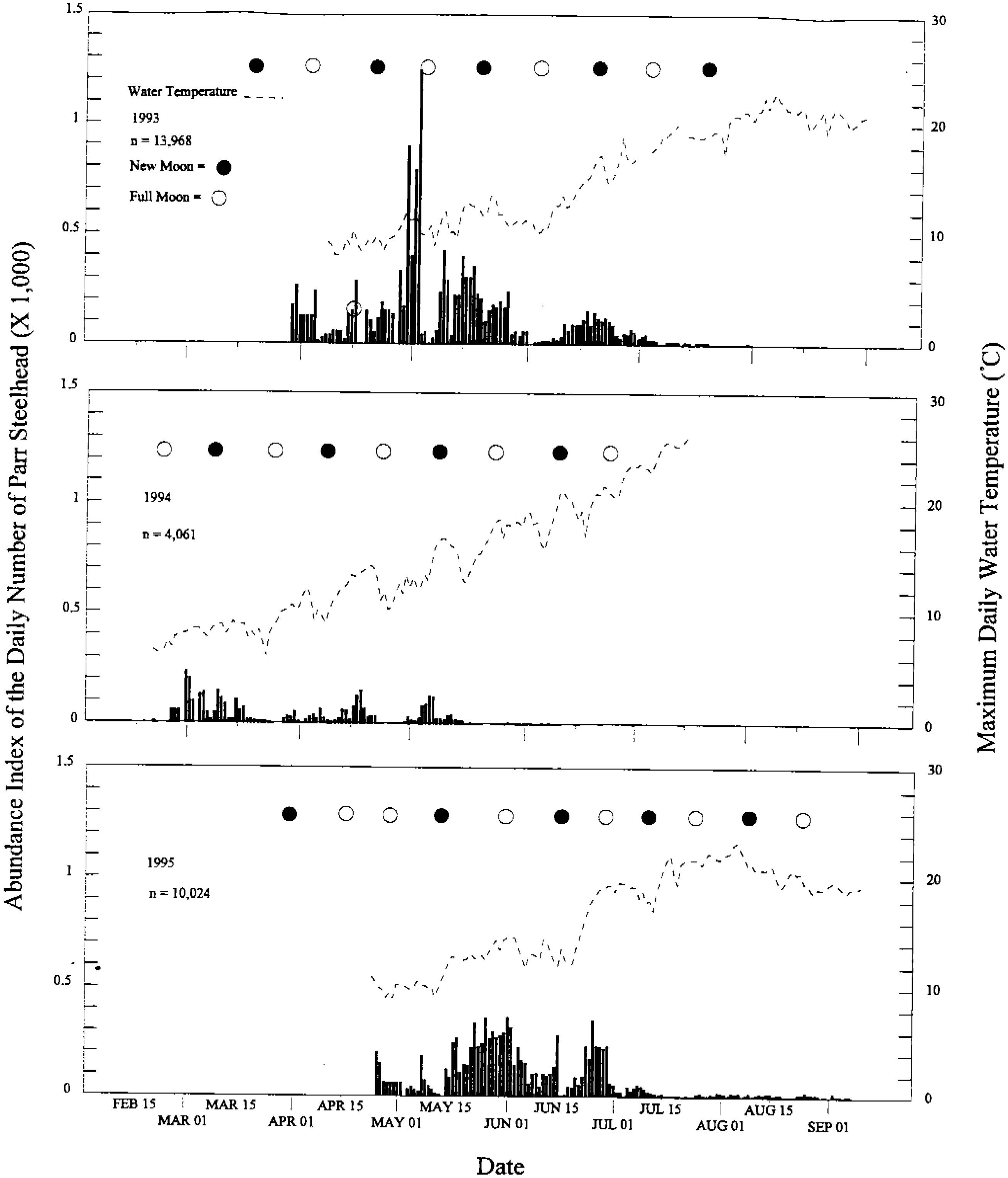

Figure 30. Daily steelhead parr abundance indices estimates, based on New River rotary-screw trap catches (river kilometer 3.7), during 1993 to 1995. Maximum daily water temperatures during the trapping season are presented on the second Y-axis.

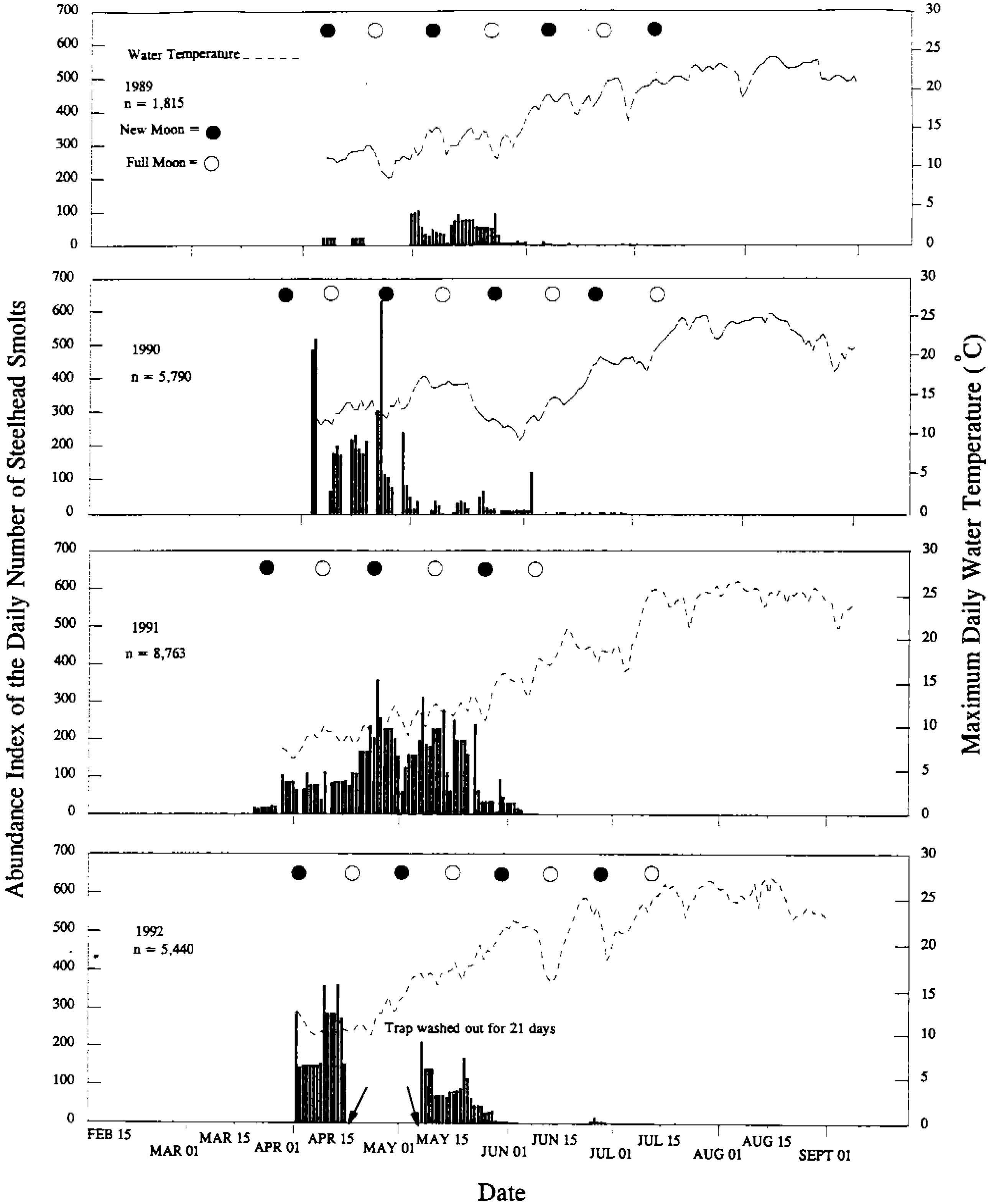

Figure 31. Daily steelhead smolt abundance indices estimates, based on New River rotary-screw trap catches (river kilometer 3.7) during 1989 to 1992. Maximum daily water temperatures during the trapping season are presented on the second Y-axis.

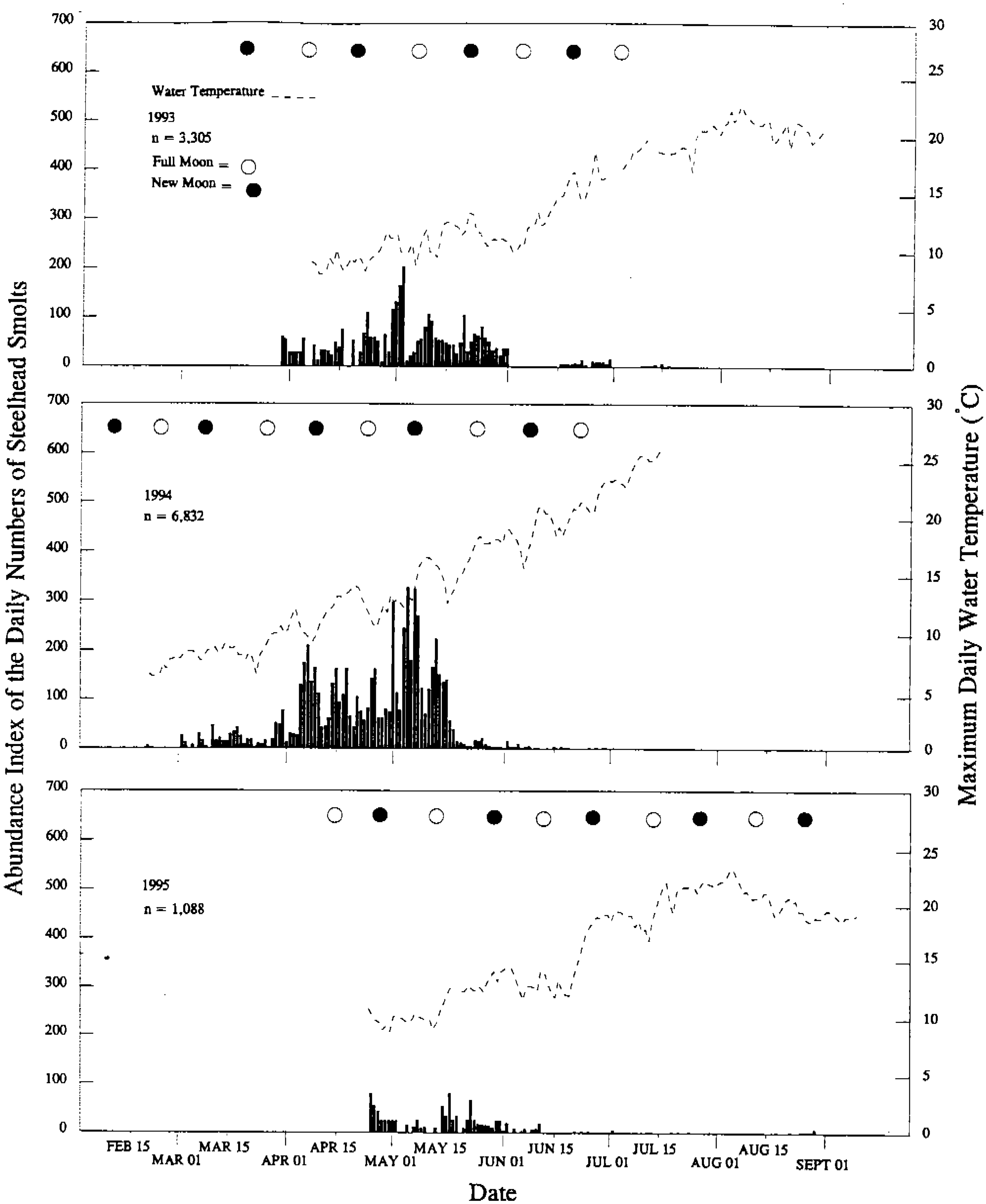

Figure 32. Daily steelhead smolt abundance indices estimates, based on New River rotary-screw trap catches (river kilometer 3.7) during 1993 to 1995. Maximum daily water temperatures during the trapping season are presented on the second Y-axis.

were stained with Bismark Brown Y stain. Of these, 200 were released into the pool above the screw trap. A control group composed 50 marked fish and 50 unmarked fish were held in a net pen 50 m below the screw trap. During the next 48 hrs, a total of 86 stained chinook were recaptured in the screw trap. There were no mortalities in the control group. Screw trap efficiency was estimated to be 43% and the percentage of flow sampled by the trap was 57%. However, because only two efficiency tests were conducted, there was not enough data to determine the relationship between stream flow and trap efficiency.

SUMMARY

The 1993/1994 (October 1, 1993 to September 30, 1994) field season had some of the lowest stream flows and highest water temperatures of any previous year of the study, while the 1994/1995 season had some of the highest flows and lowest water temperatures. Low flows in the winter of 1993/1994 seemed to have a beneficial effect because downstream migrant trapping resulted in many YOY chinook being trapped, probably because redds were not "washed out" and mortality rates were low. However, during summer months the low flows and high water temperatures probably had a negative affect on both adult and juvenile salmonids holding or migrating through the lower mainstem of New River. As water temperatures increase, dissolved oxygen levels decrease, thereby increasing stress, disease and mortality in fish. High water temperatures also cause decreased growth rates (Brett, 1952) and affect the timing of migration.

More than 80 km of high-quality steelhead spawning and rearing habitats are available in New River. Consequently, the numbers of summer steelhead is the third highest in the state.

During 1995, the highest number of adult summer steelhead (n = 776) and half-pounders (n = 41) were observed during fall snorkel surveys. During 1994, a total of 404 adult summer steelhead and 23 half-pounders were observed. Because snorkel, surveys are not feasible during high winter flows, the numbers of fall and possible winter steelhead using the drainage are uncertain. A resistance-board weir was installed and operated during 1992 to 1995 to trap immigrating steelhead. A total of 275 steelhead were trapped on their upstream migration during all years of weir operation (1992 to 1995). Based on "run-backs" observed at the weir, most steelhead spawn before March. Scale analysis suggests the most common life history pattern for all years was 2.2 (two years spent in fresh water, and two years salt water). Less than 5% of the scales analyzed had spawning checks. The spring steelhead run appears to be the dominant run. Initial observations during the winter of 1993/1994 seem to indicate few if any winter run steelhead use New River. However, one year of data collected during a low water year is inconclusive.

The chinook populations in New River are very low. A survey of potential spawning habitats in the mainstem New River (USFWS, 1991) revealed that an estimated 1,442 to 2,351 chinook pairs could potentially spawn in New River's mainstem. A total of 31 spring chinook adults were counted during the adult surveys in September of 1993. The spawner surveys during the fall of 1993 identified a total of 28 spring chinook redds, and 25 fall chinook redds. The 1993 adult and redd counts were the highest observed during this study (1988 to 1994). These high counts may be attributed to high river discharge and decreased water temperatures during the summer that helped the movement of spring chinook into New River. Conversely, during adult surveys in 1994 only 5 spring chinook were observed. During following spawner surveys in the fall of 1994, three spring and 21 fall chinook redds were counted. A total of 19 chinook, including four spring chinook, had passed through the weir site during the preceding 8 months. The low 1994 adult and redd count could be attributed to low flows and warmer than normal water temperatures that may have impeded migration and/or affected survival in New River.

Although the USFWS was able to collect some valuable information on summer and winter steelhead and also spring and fall chinook numbers and run timing, careful consideration should be made before installing any type of fish barrier such as a weir. Based on the large numbers of adult salmonids observed in pools immediately upstream and downstream of the weir, CDFG spaghetti tag recoveries, redd locations, and also run timing and intensity, it appears the weir had a tendency to impede migration. During low water years, such as 1993/1994, summer steelhead and spring chinook may not be able to reach tributaries where thermal refugia can increase chances of survival. Also delayed run-timing from weirs can cause redds in the lower reaches of a stream to become "washed out" as river flows increase.

Juvenile snorkel surveys of designated index reaches have been undertaken in late summer every year since 1990. Relatively high numbers of juvenile chinook were sighted during 1994 surveys. This was related to the large number of redds (n = 53) during the preceding fall (1993) and favorable in stream conditions. During 1995, no juvenile chinook were observed during juvenile index snorkel surveys. The lack of chinook juveniles reflects the low number of adult spawners and poorer instream conditions during incubation and rearing. High winter and spring flows could have "washed out" redds and/or flushed juveniles downstream before juvenile monitoring was initiated.

A rotary-screw trap was operated for the sixth and seventh season during 1994 and 1995. An average of 40% in 1994 and 33% in 1995 (a range of 11 - 65%) of the total stream flow was sampled by the screw trap. During 1994, a total of 14,300 YOY chinook, zero age 1+ chinook, 4,581 YOY steelhead, 1,071 steelhead parr, and 2,433 steelhead smolts were trapped during the 135 nights of operation (February 19, 1993 to July 15, 1994). During 1995, a total of zero YOY chinook and 1+ chinook, 3,162 YOY steelhead, 2,348 steelhead parr, and 136 steelhead smolts were trapped during the 123 nights of operation (April 24 to September 9, 1995).

The 1994 abundance indices estimate for emigrating YOY chinook (30,334), and YOY steelhead (8,903) were much higher than all previous trapping years. The number of emigrating juveniles is determined by many factors including the run size of the adult spawners, the stability of river flows during incubation, food availability and depredation rates. In this case, high numbers of summer steelhead spawners were probably a factor for YOY numbers but not as much a factor for smolt numbers.

The 1995 abundance indices estimate for juvenile chinook (0), was the lowest during this study (1989 to 1995). Although the low number of chinook redds (n = 23) had an effect, the high winter flows probably played more of a role in washing out redds (especially in the lower mainstem), or displacing YOY chinook downstream. The 1995 YOY steelhead count (8,150) was the third highest observed during this study. High winter flows did not have as much of an impact on their numbers as it did for juvenile chinook, since it is believed that most of the adults spawn in the tributaries (where flows are less). The relatively low numbers of steelhead parr and smolts could be due to a later trapping season than normal (since larger steelhead tend to emigrate earlier), and because high winter flows could have helped push more of them out earlier.

Most juvenile steelhead emigrated from New River as 2+ (46%) in 1994 and 1+ (48%) during 1995. Scale samples taken from returning adults suggested that 70% had spent their first two years of life in freshwater. The age analysis from two years (1994 to 1995) of juvenile data is not enough to decide if suitable down stream rearing habitats in the Trinity and Klamath rivers is a limiting factor for the recovery of the New River populations.

New River has not been subjected to any major restoration projects and lies within a relatively undisturbed watershed (compared to other northern California rivers). Because eight years of baseline data have already been collected, New River should be regarded as an index tributary to monitor salmonid population trends. However, unless future funding is secured, valuable information on juvenile and adult salmonid abundance and run timing will be unavailable.

Perspective and Future Planning

Because of New River's relatively pristine nature, invaluable information on wild salmonid population trends has been collected during this study (1988 to 1995). This wild stock data base has included juvenile and adult summer steelhead, spring and fall chinook as well as coho salmon. This information has been compiled in progress reports from 1989 to 1995 and distributed to numerous parties.

Adult Surveys

CDFG has determined that New River has the third largest summer steelhead population in the state. The relatively small run size and large fluctuations of adult spawners entering New River, indicates the importance of continuing adult snorkel surveys on the Mainstem of New River, Virgin and Slide Creeks, as well as the East Fork of New River.

Redd Surveys

Fall (October to December) redd surveys have been used to monitor spring and fall chinook returns to the mainstem of New River. Run size data for spring and fall chinook has revealed their levels to be dangerously low. Redd surveys need to be continued in order to monitor spawning levels on the mainstem of New River. Future redd surveys of the major tributaries (Virgin and Slide Creek, and the East Fork of New River) should also be conducted at least once each fall in an effort to determine if fall or spring chinook utilize them for spawning.

Although visual winter (January to April) steelhead redd surveys, in the New River basin, have not been conducted by CCFWO staff in the past, they could be a usefull tool to identify spawning ground locations, redd number, spawning time, and the upper-most limits of migration. Although some steelhead may spawn in the mainstem of New River, most spawning is believed to occur in Virgin and Slide Creek, as well as in the East Fork of New River.

The Klamath River Technical Team estimated the New River escapement goal to be 7,200 fall chinook adults (based on available spawning habitat)(Hayes 1985). CDFG records indicate that fall chinook have not re-established themselves since the 1964 flood. Current USFWS redd survey data indicates the fall chinook run size to be less than 110 fish.

Barrier Evaluation and Modification

A total of nine partial barriers to steelhead migration have been identified in New River Basin (Freese and Taylor 1979). Four of these partial barriers are in the mainstem of New River with three in the lower two rkms and one in the upper 0.75 rkms of the mainstem. Past efforts to remove a partial barrier in the lower one rkm of the mainstem of New River was attempted by the USFS during 1979 (Brouha 1979). Current redd distribution data collected from 1989 to 1994, seems to indicate partial barriers may still impede immigration through New River. More than half of the fall chinook redds observed from 1993 to 1994 were located between the mouth of New River and the lowest partial barriers. This evidence suggests that a partial barrier problem may still exist in the lower river. No chinook redds have been observed in the upper mainstem above the partial barrier located 0.75 rkm downstream of the confluence of Virgin and Slide Creeks even though adequate spawning gravel is found upstream. However, a more thorough assessment of the partial barriers should be conducted by CCFWO and interested parties. If after further evaluation, barrier problems are confirmed, then CCFWO staff could coordinate with interested parties to remove them and make spawning areas more accessible to immigrating chinook salmon.

Downstream Migrant Trapping

Juvenile salmonid species, numbers and characteristics (fork lengths, displacements, age and health) have been monitored using a downstream migrant trap at Five Waters Ranch (rkm 3.7). Though Five Waters Ranch is the lowest easily accessible location in the New River Basin, Hoboken Ranch or the Panther Creek area may be potential sites for downstream migrant trapping (depending on prior consent by landowners). Continued trapping is essential to determine year class strength and run timing for salmonids and other species.

Juvenile Index Reaches

Continued summer-time monitoring of permanent index reaches is needed to record annual changes to habitat-types and salmonid densities through time. Information from New River juvenile index surveys could be useful in determining how limiting factors such as, habitat type, stream discharge, water temperature, substrate type, and in-stream cover, affects salmonid densities. Since New River is relatively pristine and a "control" stream within the Trinity River Basin, this information could be used by fisheries managers to compare impacted streams to New River.

Water Temperature Monitoring

The collection of water temperature data plays a valuable role in timing and intensity of juvenile and adult salmonid migration, as well as growth and mortality rates of salmonids. Continued water temperature monitoring is important because elevated water temperatures during summer and fall months may be affecting fish density and health in the mainstem of New River. To better understand the relationship between water temperature and fish density, thermographs should be placed within the main-stem juvenile index sections throughout the summer and fall months of 1997. At each location a temperature recorder should be placed in an adjoining riffle (for surface water temperatures) and pool (for bottom water temperatures). Monitoring sites could be integrated into the juvenile index survey sections at Barron Creek (5-1), below the mouth of the East Fork of New River (4-1), below School House Bridge in Denny (3-1), Panther Creek (2-0), Five Waters (1-1), and also just above the Trinity River confluence. When sections of New River with potentially detrimental water temperatures are located, then further water quality monitoring could be focused in these areas.

Flows

The relationship between gage height and river flow at rkm 3.4 has been established by the CCFWO. The continued collection of river flow data is important to compare Water Years (WY) and establish a relationship between river flow and water temperature during summer and fall months. High winter flows may be limiting juvenile salmonid production on New River by "washing out" redds and increasing mortality rates, while low summer/fall flows can limit adult migration into New River and affect their distribution. Redd "wash out" could be verified by using USFWS personnel to identify redd locations throughout the mainstem of New River during fall months. Field crews could then install and monitor scour chains at redd sites along the length of the mainstem of New River.

Dredge Mining Assessment

The assesment of dredge mining activities in the New River Basin should be addressed. Illegal mining operations have been observed in the East Fork, Eagle Creek, and the mainstem of New River during 1994 and 1995. Problems from mining exist when high levels of silt are redistributed from the river bed into the water column. This results in greatly increased turbidity, and siltation of spawning gravels. Dredge tailings and pits in potential spawning habitat may also limit available spawning areas for spring and fall chinook in the mainstem of New River. Scour chains on dredge tailings could be used to monitor the movement of dredge tailings through fall and winter months to determine when flows are high enough to re-level the stream bottom.

Illegal fishing in the upper mainstem of New River (in the no fishing section) was observed by CCFWO personnel on two separate occasions during the summer of 1995. Law enforcement should be increased in the upper-mainstem of New River and its tributaries during summer and fall months when over-summering salmonids are the most vulnerable to poaching activities. Tributaries are also the primary nursury areas for juvenile steelhead. If fishing in the tributaries of New River was made illegal, then spawning and nursury areas would be less impacted.

The potential for poaching of adult salmonids by some miners has been reported to CCFWO personnel during this study. This poaching may be a limiting factor in the recovery of salmonid populations within the New River Basin. Increased law enforcement of dredge sites is needed. Work-shops between CCFWO staff and miners could be usefull in educating miners on the importance of protecting fisheries resouces.

Supplementation

Adult fall and spring chinook salmon runs into New River now consist of less than 200 fish each and are not considered sustainable by some geneticists. Only a few coho salmon have been observed in New River. Currently, the run size of summer steelhead on New River is self sustaining and does not indicate a need for supplementation. Supplementation may be a viable alternative to increase chinook and coho salmon runs on New River. Although, it appears past CDFG stocking of spring chinook, and coho salmon were not very successful, other possible limiting factors within the New River basin (such as partial barriers, and poaching) should be investigated first. After studying all options, if no other feasible alternative exists, then supplementation could be considered.

Our recommendations for supplementation are:

1. A hatch box or a small scale (Horse Linto size) supplementation project could be used to increase fall chinook on New River.

2. The collection of spawning stock by gill nets, seines or weirs in the lower river during the spring and fall months.

3. The best locations for a supplementation operation would be Five Waters Ranch or Hoboken Ranch.

4. No inter-basin transfer of stocks should occur.

5. Supplementation should last for a short period of time (less than 10 years).

6. Supplementation operations should be evaluated on an annual basis.

7. Yearly adult and redd surveys should be conducted to monitor run size of supplemented and wild fish.

8. All supplemented fish should be adipose fin clipped and tagged with coded wire tags.

9. Maximum efforts should be made to minimize the inbreeding of propagated fish.

10. Disease monitoring of hatchery and wild fish and removal of all diseased supplemented fish.

Disease Monitoring

Disease monitoring of juvenile salmonids for bacterial kidney disease (BKD) in chinook and infections by the trematode (Nanophyetus salmincola) in steelhead should be continued by the USFWS Fish Health Center (FHC in Red Bluff) in conjunction with CCFWO staff. Although 70 to 80% of the juvenile chinook within the Trinity Basin are infected with BKD, little is known about the survival rates of infected fish. Snails of the genus Juga (which are the intermediate hosts for the trematode Nanophyetus) are abundant in New River during low water years. Trematodes in these snails are highly infectious to steelhead and may be limiting juvenile abundance (especially during low water years). Snails and juvenile salmonids could be collected by field crews and delivered to the FHC. FHC employees could then determine infection rates of snails and juvenile salmonids with BKD and Nanophyetus. This information could possibly be used to predict mortality rates among infected wild fish in New River.

Sediment Monitoring

Relatively high levels of silt has been observed in tributaries near Panther Creek and in Dixie Creek, Slide Creek and in the mainstem of New River. Dredging operations have also increased siltation by redistributing the silt in New River. Although fall and winter storm events usually flush silt from New River, high silt levels and dredging activities during summer may cause salmonids to avoid those sections of stream. In the future, sources of erosion and siltation could be monitored by CCFWO and the USFS. Where practical, CCFWO could then coordinate with the USFWS and other interested parties in taking steps (limit dredging, logging, and road building) to reduce man caused erosion. After studying past erosion problems within the New River basin, Pacific Watershed Associates (1991) recommended watershed restoration on watershed hillslopes as having greater long-term benefit to the aquatic environment than placemnent of in-stream or channel structure work.

Watershed Restoration

Future findings on New River may be compared to other waterways within the Trinity River Basin (the South Fork and North Fork of the Trinity River, Canyon Creek, etc.) in an effort to identify limiting factors affecting salmonids. Continued monitoring of salmonid population trends and factors which influence them (water temperature, stream flow, disease monitoring, stream productivity, etc.) is needed. Where practical, restoration efforts (barrier removal, erosion control, supplementation, law enforcement, etc.) could be implimented.

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APPENDIX A. Channel classification as described by Rosgen 1985.

Stream Type	Gradient (%)	Dominant Particle Size of Channel Materials	Channel Entrenchment Valley Confinement
A1	4-10	Bedrock	Very deep; very well confined
A1-a	10+	Same as A1	
A2	4-10	Large & small boulders w/mixed cobbles	Same as A1
A2-a	10+	Same as A2	
A3	4-10	Small boulders, cobbles, coarse gravels, some sand.	Same as A1
A3-a	10+	Same as A3	
A4	4-10	Predominantly gravel, sand, and some silts.	Same as A1
A4-a	10+	Same as A4	
A5	4-10	Silt and/or clay bed and bank materials.	Same as A1
A5-a	10+	Same as A5	
B1-1	1.5-4.0	Bedrock bed: banks are cobble, gravel, some sand.	Shallow entrenchment; moderate confinement
B1	2.5-4.0 (X=3.5)	Predominately small boulders and very large cobble.	Moderate entrenchment; moderate confinement
B2	1.5-2.5 (X=2.0)	Large cobble mixed w/small boulders and coarse gravels	Moderate entrenchment; moderate confinement
B3	1.5-4.0 (X=2.5)	Cobble bed w/mixture of gravel and sand. Some small boulders	Moderate entrenchment; well confined
B4	1.5-4.0 (X=2.0)	Very coarse gravel w/cobbles, sand and finer materials	Deeply entrenched; well
B5	1.5-4.0 (X=2.5)	Silt / clay	Deeply entrenched; well confined.
B6	1.5-4.0	Gravel w/few cobbles and w/noncohesive sand and finer soil.	Deeply entrenched; slightly confined

Stream type	Gradient (%)	Dominant Particle Size of Channel Materials	Channel Entrenchment Valley Confinement
C1-1	1.5 or less (X=1.0)	Bedrock bed, gravel sand or finer banks.	Shallow entrenchment; partially confined.
C1	1.0-1.5 (X= 1.3)	Cobble, coarse gravel bed, gravel, sand banks.	Moderate entrenchment; well confined.
C2	0.3-1.0 (X=0.6)	Large cobble bed w/mixture of small boulders and coarse gravel.	Moderate entrenchment; well confined.
C3	0.5-1.0 (X=0.8)	Gravel bed w/mixture of small cobble and sand.	Moderate entrenchment; slightly confined.
C4	0.1-0.5 (X=0.3)	Sand bed w/mixture of gravel and silt. No bed armor.	Moderate entrenchment; slightly confined.
C5	0.1 or less (X=0.05)	Silt clay w/mixture of medium to fine sand, no bed armor.	Moderate entrenchment; slightly confined.
C6	0.1 or less (X=0.05))	Sand bed w/mixture of silt and some gravel.	Deeply entrenched; unconfined.
D1	1.0 or greater (X=2.5)	Cobble bed w/mixture of coarse gravel, sand, and small boulders.	Slightly entrenched; no confinement.
D2	1.0 or less (X=1.0)	Sand bed w/mixture of small to medium gravel and silt.	Slightly entrenched; no confinement.
F1	1.0 or less	Bedrock bed w/few boulders, cobble and gravel.	Total confinement.
F3	1.0 or less	Cobble/gravel bed with locations of sand in depositional sites.	Same as F1
F4	1.0 or less	Sand bed with smaller amounts of silt and gravel.	Same as F1
F5	1.0 or less	Silt/clay bed and banks with smaller amounts of sand.	Same as F1

APPENDIX B. Habitat types and descriptions.

CODE	HABITAT TYPE	DESCRIPTION
0	Side Channel (SCH)	Less than half the flow in a parallel channel.
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 formed by Boulder (BwBo)	Found along channel margins and caused by eddies around obstructions such as boulders, rootwads, or woody debris. These pools are usually shallow and are dominated by fine-grain substrates. Current velocities are quite low.
6	Backwater Pool formed by Root-wad (BwRw)	
7	Backwater Pool formed by Log (BwL)	
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 stream bed below, scouring out a depression; often large and deep. Substrate size is highly variable.

10 Lateral-Scour Pool formed by Log (LsL)

Formed by flow impinging against one stream-bank or against a partial channel obstruction. The associated scour is generally confined to <60% of wetted channel width. Channel obstructions include rootwads, woody debris, boulders and bedrock.

11 Lateral-Scour Pool formed by Root-wad (LsRw)

12 Lateral-Scour Pool formed by Bedrock (LsBk)

13 Dammed Pool (DPL)

Water impounded from a complete or nearly complete channel blockage (debris jams, landslides or beaver dams). Substrates tend toward smaller gravels and sand.

14 Glides (GLDA)

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 (SRN)

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 formed by boulder (LsBo)

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.

22 Corner Pool (CRP)

Pools formed at a sharp 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.

Appendix C. Juvenile steelhead and chinook densities by macrohabitat type for each index reach on New River.

1990

			RIFFLE				RUN				POOL			
REACH	SPECIES	AGE	MAX	AVG	MIN	N	MAX	AVG	MIN	N	MAX	AVG	MIN	N
1–1	STH	0+		0.054		1		0.047		1	0.032	0.027	0.016	3
		1+		0.016		1		0.079		1	0.021	0.017	0.013	3
		2+				0				0	0.002	0.001	0.001	3
	CHN	0+				0				0		0.001		3
1–2	STH	0+	0.175	0.139	0.074	3	0.068	0.038	0.009	3	0.080	0.038	0.011	3
		1+	0.030	0.018	0.006	3	0.036	0.030	0.023	3	0.078	0.041	0.002	3
		2+	0	0.001	0	3	0.001	0.000	0	3	0.000	0.002	0	3
	CHN	0+	0.001	0.001	0.001	3	0	0	0	3	0.000	0.000	0	3
2–0	STH	0+	0.056	0.080	0.104	2	0.114	0.043	0.012	5	0.030	0.016	0.009	5
		1+	0.062	0.059	0.044	2	0.089	0.052	0.021	5	0.095	0.051	0.095	5
		2+	0.001	0.000	0	2	0.002	0.000	0	5	0.003	0.001	0.000	5
	CHN	0+	0	0	0	2	0.002	0.000	0	5	0	0	0	5
3–1	STH	0+	0.109	0.101	0.094	2		0.017		1	0.042	0.028	0.015	4
		1+	0.061	0.060	0.060	2		0.000		1	0.050	0.039	0.022	4
		2+	0	0	0	2		0.000		1	0.006	0.004	0.001	4
	CHN	0+	0	0	0	2		0		1	0.001	0.000	0	4
3–2	STH	0+	0.093	0.086	0.079	2	0.082	0.053	0.024	2	0.093	0.086	0.079	2
		1+	0.069	0.048	0.027	2	0.097	0.087	0.076	2	0.069	0.048	0.027	2
		2+	0.002	0.001	0	2	0.002	0.002	0.002	2	0.022	0.001	0	2
	CHN	0+	0	0	0	2	0	0	0	2	0	0	0	2
4–0	STH	0+	0.167	0.154	0.141	2	0.075	0.129	0.075	5	1.462	0.402	0.097	5
		1+	0.119	0.097	0.075	2	0.087	0.065	0.023	5	0.568	0.178	0.061	5
		2+	0.011	0.005	0	2	0.003	0.001	0	5	0.108	0.027	0	5
	CHN	0+	0	0	0	2	0	0	0	5	0	0	0	5
5–1	STH	0+	0.222	0.213	0.205	2		0.186		1	0.319	0.169	0.102	4
		1+	0.050	0.031	0.012	2		0.057		1	0.021	0.014	0.003	4
		2+	0.006	0.003	0	2		0		1	0.013	0.004	0	4
	CHN	0+	0	0	0	2		0		1	0	0.001	0	4
5–2	STH	0+	0.284	0.227	0.171	2		0.309		1	0.582	0.416	0.260	3
		1+	0.066	0.033	0	2		0.017		1	0.111	0.052	0.012	3
		2+	0	0	0	2		0		1	0.004	0.001	0	3
	CHN	0+	0	0	0	2		0		1	0	0	0	3
6–0	STH	0+	0.182	0.147	0.105	4	0.351	0.212	0.115	5	0.275	0.190	0.146	4
		1+	0.058	0.041	0.029	4	0.121	0.045	0.010	5	0.055	0.044	0.033	4
		2+	0	0	0	4	0.012	0.002	0	5	0.004	0.000	0	4
	CHN	0+	0	0	0	4	0	0	0	5	0	0	0	4
7–1	STH	0+	0.188	0.171	0.154	2	0.177	0.112	0.052	2	0.110	0.092	0.066	3
		1+	0.061	0.054	0.047	2	0.044	0.037	0.023	2	0.055	0.039	0.044	3
		2+	0	0	0	2	0.011	0.003	0	2	0.004	0.001	0	3
	CHN	0+	0	0	0	2	0	0	0	2	0	0	0	3
7–2	STH	0+	0.171	0.104	0.054	3		0.219		1	0.351	0.218	0.122	3
		1+	0.121	0.056	0.013	3		0.031		1	0.090	0.056	0.037	3
		2+	0	0	0	3		0.005		1	0.006	0.003	0	3
	CHN	0+	0	0	0	3		0		1	0	0	0	3
7–3	STH	0+	0.073	0.077	0.050	3	0.065	0.089	0.064	3	0.137	0.119	0.088	3
		1+	0.025	0.020	0.010	3	0.070	0.027	0	3	0.115	0.066	0.026	3
		2+	0.025	0.008	0	3	0.006	0.002	0	3	0.019	0.010	0.006	3
	CHN	0+	0	0	0	3	0	0	0	3	0	0	0	3
8–1	STH	0+	0.224	0.134	0.031	5	0.258	0.184	0.088	4	0.441	0.278	0.077	6
		1+	0.048	0.020	0	5	0.037	0.021	0.011	4	0.146	0.094	0.029	6
		2+	0.002	0.000	0	5	0.004	0.002	0	4	0.004	0.001	0	6
	CHN	0+	0	0	0	5	0	0	0	4	0	0	0	6
8–2	STH	0+	0.137	0.094	0.042		0.142	0.121	0.099	2		0.127		1
		1+	0.037	0.015	0		0.013	0.034	0.013	2		0.066		1
		2+	0.002	0.000	0		0	0	0	2		0.005		1
	CHN	0+	0	0	0		0	0	0	2		0		1

Appendix C. Juvenile steelhead and chinook densities by macrohabitat type for each index reach on New River.

1991

			RIFFLE				RUN				POOL			
REACH	SPECIES	AGE	MAX	AVG	MIN	N	MAX	AVG	MIN	N	MAX	AVG	MIN	N
1–1	STH	0+		0.127		1		0.007		1	0.022	0.021	0.012	3
		1+		0.026		1		0.039		1	0.021	0.022	0.016	3
		2+		0.002		1		0		1	0.001	0.000	0	3
	CHN	0+		0		1		0		1	0.000	0.000	0	3
1–2	STH	0+	0.048	0.066	0.018	3	0.052	0.037	0.021	2	0.121	0.036	0.001	4
		1+	0.035	0.013	0	3	0.083	0.045	0.027	2	0.218	0.067	0.003	4
		2+	0	0	0	3	0	0	0	2	0.013	0.003	0	4
	CHN	0+	0	0	0	3	0.02	0.001	0	2	0.000	0.000	0	4
2–0	STH	0+	0.052	0.040	0.028	2	0.073	0.035	0.013	5	0.056	0.025	0.003	5
		1+	0.079	0.062	0.045	2	0.069	0.030	0.004	5	0.080	0.041	0.018	5
		2+	0.001	0.000	0	2	0.003	0.000	0	5	0.001	0.000	0	5
	CHN	0+	0.008	0.005	0.001	2	0.019	0.005	0	5	0.013	0.007	0	5
3–1	STH	0+	0.066	0.056	0.045	2		0.007		1	0.005	0.008	0.005	3
		1+	0.078	0.048	0.019	2		0.000		1	0.020	0.013	0.008	3
		2+	0	0	0	2		0		1	0.001	0.000	0.000	3
	CHN	0+	0.009	0.004	0	2		0.004		1	0.002	0.001	0	3
3–2	STH	0+	0.049	0.039	0.029	2		0.033		1	0.025	0.016	0.010	3
		1+	0.006	0.003	0	2		0.006		1	0.031	0.015	0.007	3
		2+	0	0	0	2		0		1	0	0	0	3
	CHN	0+	0.009	0.004	0	2		0.004		1	0.003	0.002	0.002	3
4–0	STH	0+	0.135	0.132	0.129	2	0.241	0.124	0.024	5	0.241	0.114	0.058	5
		1+	0.017	0.075	0.017	2	0.119	0.071	0.031	5	0.156	0.072	0.033	5
		2+	0.008	0.004	0	2	0.003	0.000	0	5	0.012	0.005	0	5
	CHN	0+	0.022	0.001	0	2	0.010	0.002	0	5	0.006	0.001	0	5
5–1	STH	0+	0.178	0.137	0.097	2		0.085		1	0.170	0.106	0.044	4
		1+	0.034	0.028	0.022	2		0.141		1	0.073	0.037	0.006	4
		2+	0	0	0	2		0		1	0	0	0	4
	CHN	0+	0	0	0	2		0.006		1	0.001	0.000	0	4
5–2	STH	0+	0.078	0.065	0.052	2		0.161		1	0.240	0.170	0.122	3
		1+	0.021	0.020	0.019	2		0.088		1	0.182	0.100	0.026	3
		2+	0.019	0.009	0	2		0		1	0.006	0.002	0	3
	CHN	0+	0	0	0	2		0		1	0.003	0.001	0	3
6–0	STH	0+	0.219	0.168	0.13	4	0.384	0.229	0.161	5	0.255	0.189	0.130	4
		1+	0.036	0.032	0.028	4	0.087	0.023	0	5	0.074	0.061	0.045	4
		2+	0	0	0	4	0	0	0	5	0.004	0.002	0	4
	CHN	0+	0	0	0	4	0	0	0	5	0	0	0	4
7–1	STH	0+	0.334	0.170	0.006	3	0.045	0.044	0.043	2	0.206	0.132	0.055	3
		1+	0.334	0.175	0.017	3	0.054	0.033	0.012	2	0.142	0.085	0.020	3
		2+	0.008	0.007	0.006	3	0	0	0	2	0.010	0.005	0	3
	CHN	0+	0	0	0	3	0	0	0	2	0	0	0	3
7–2	STH	0+	0.062	0.052	0.040	3		0.081		1	0.368	0.218	0.098	3
		1+	0.015	0.013	0.010	3		0		1	0.081	0.074	0.063	3
		2+	0	0	0	3		0		1	0.011	0.003	0	3
	CHN	0+	0	0	0	3		0		1	0	0	0	3
7–3	STH	0+	0.123	0.069	0.018	4	0.158	0.112	0.041	3	0.256	0.199	0.108	3
		1+	0.029	0.018	0	4	0.059	0.043	0.024	3	0.075	0.065	0.057	3
		2+	0	0	0	4	0.009	0.003	0	3	0.018	0.007	0	3
	CHN	0+	0	0	0	4	0	0	0	3	0	0	0	3
8–1	STH	0+	0.045	0.012	0	4	0.262	0.189	0.116	2	0.416	0.328	0.197	6
		1+	0.056	0.014	0	4	0.044	0.026	0.008	2	0.164	0.082	0.030	6
		2+	0.011	0.002	0	4	0.004	0.002	0	2	0.020	0.013	0	6
	CHN	0+	0	0	0	4	0	0	0	2	0	0	0	6
8–2	STH	0+	0.290	0.155	0.070	0	0.179	0.157	0.136	2		0.333		1
		1+	0.013	0.004	0	0	0.013	0.006	0	2		0.050		1
		2+	0	0	0	0	0	0	0	2		0.003		1
	CHN	0+	0	0	0	0	0	0	0	2		0		1

Appendix C. Juvenile steelhead and chinook densities by macro-habitat type for each index reach on New River.

1992

			RIFFLE				RUN				POOL			
REACH	SPECIES	AGE	MAX	AVG	MIN	N	MAX	AVG	MIN	N	MAX	AVG	MIN	N
1–1	STH	0+		0.180		1		0.158		1	0.105	0.041	0.006	3
		1+		0.037		1		0.147		1	0.051	0.029	0	3
		2+		0		1		0.007		1	0.001	0.000	0	3
	CHN	0+		0		1		0		1	0	0	0	3
1–2	STH	0+	0.233	0.152	0.075	3		0.301		1	0.159	0.082	0.010	5
		1+	0.082	0.034	0	3		0		1	0.157	0.049	0	5
		2+	0	0	0	3		0		1	0	0	0	5
	CHN	0+	0	0	0	3		0		1	0	0	0	5
2–0	STH	0+	0.194	0.131	0.090	3	0.209	0.111	0.058	4	0.047	0.063	0.034	5
		1+	0.065	0.043	0.012	3	0.082	0.045	0.014	4	0.050	0.033	0.019	5
		2+	0.004	0.001	0	3	0.001	0.000	0	4	0.002	0.000	0	5
	CHN	0+	0	0	0	3	0	0	0	4	0	0	0	5
3–1	STH	0+	0.17	0.126	0.082	2		0.032		1	0.317	0.122	0.021	3
		1+	0.04	0.027	0.015	2		0		1	0.203	0.077	0.007	3
		2+	0	0	0	2		0		1	0	0	0	3
	CHN	0+	0	0	0	2		0		1	0	0	0	3
3–2	STH	0+	0.046	0.092	0.137	2		0.168		1		0.063		3
		1+	0.019	0.009	0	2		0.017		1		0.007		3
		2+	0	0	0	2		0		1		0.000		3
	CHN	0+	0	0	0	2		0		1		0.000		3
4–0	STH	0+	0.065	0.137	0.209	2	0.256	0.116	0.021	7	0.336	0.127	0.043	9
		1+	0.072	0.048	0.023	2	0.173	0.059	0	7	0.501	0.101	0	9
		2+	0	0	0	2	0	0	0	7	0	0	0	9
	CHN	0+	0	0	0	2	0	0	0	7	0	0	0	9
5–1	STH	0+	0.171	0.148	0.126	2	0.112	0.106	0.101	2	0.091	0.063	0.041	3
		1+	0.024	0.015	0.007	2	0.031	0.016	0.002	2	0.022	0.013	0.003	3
		2+	0	0	0	2	0	0	0	2	0	0	0	3
	CHN	0+	0	0	0	2	0	0	0	2	0	0	0	3
5–2	STH	0+	0.204	0.197	0.191	2		0.471		1	0.251	0.108	0.016	4
		1+	0.044	0.022	0	2		0.021		1	0.040	0.010	0	4
		2+	0	0	0	2		0		1	0	0	0	4
	CHN	0+	0	0	0	2		0		1	0	0	0	4
6–0	STH	0+	0.387	0.350	0.321	4	0.435	0.375	0.241	5	0.548	0.461	0.381	4
		1+	0.024	0.036	0.024	4	0.176	0.047	0.009	5	0.158	0.102	0.068	4
		2+	0	0	0	4	0	0	0	5	0.004	0.001	0	4
	CHN	0+	0	0	0	4	0	0	0	5	0	0	0	4
7–1	STH	0+	0.611	0.471	0.336	3	0.826	0.652	0.534	3	0.673	0.656	0.608	4
		1+	0.084	0.038	0.012	3	0.085	0.063	0.043	3	0.048	0.042	0.020	4
		2+	0	0	0	3	0.008	0.002	0	3	0	0	0	4
	CHN	0+	0	0	0	3	0	0	0	3	0	0	0	4
7–2	STH	0+	1.027	0.501	0.233	3		0.483		1	0.814	0.576	0.348	3
		1+	0.049	0.026	0.007	3		0.037		1	0.092	0.074	0.058	3
		2+	0	0	0	3		0.007		1	0.003	0.001	0	3
	CHN	0+	0	0	0	3		0		1	0	0	0	3
7–3	STH	0+	0.494	0.416	0.336	4	0.491	0.448	0.404	2	0.584	0.463	0.277	3
		1+	0.069	0.036	0	4	0.007	0.026	0.007	2	0.092	0.085	0.074	3
		2+	0	0	0	4	0	0	0	2	0	0	0	3
	CHN	0+	0	0	0	4	0	0	0	2	0	0	0	3
8–1	STH	0+	0.299	0.164	0.054	6	0.389	0.346	0.284	3	0.629	0.475	0.371	5
		1+	0.075	0.016	0	6	0.058	0.036	0.009	3	0.152	0.116	0.067	5
		2+	0	0	0	6	0	0	0	3	0.004	0.000	0	5
	CHN	0+	0	0	0	6	0	0	0	3	0	0	0	5
8–2	STH	0+	0.281	0.146	0.044	4	0.232	0.175	0.118	2		0.288		1
		1+	0.021	0.008	0	4	0.024	0.022	0.020	2		0.079		1
		2+	0	0	0	4	0	0	0	2		0		1
	CHN	0+	0	0	0	4	0	0	0	2		0		1

Appendix C. Juvenile steelhead and chinook densities by macrohabitat type for each index reach on New River.

1993

			RIFFLE				RUN				POOL			
REACH	SPECIES	AGE	MAX	AVG	MIN	N	MAX	AVG	MIN	N	MAX	AVG	MIN	N
1-1	STH	0+		0.02		1		0		1	0.004	0.002	0	3
		1+		0.025		1		0.029		1	0.026	0.012	0.026	3
		2+		0		1		0.006		1	0.001	0.000	0	3
	CHN	0+		0		1		0		1	0	0	0	3
1-2	STH	0+	0.045	0.040	0.035	3		0		1	0.007	0.004	0	5
		1+	0.066	0.028	0	3		0		1	0.051	0.025	0.000	5
		2+	0	0	0	3		0		1	0.002	0.000	0	5
	CHN	0+	0	0	0	3		0		1	0	0	0	5
2-0	STH	0+	0.043	0.029	0.014	3	0.047	0.022	0.007		0.006	0.003	0	5
		1+	0.073	0.047	0.031	3	0.052	0.058	0.037		0.083	0.038	0	5
		2+	0.006	0.003	0	3	0.005	0.002	0		0.002	0	0	5
	CHN	0+	0	0	0	3	0	0	0		0	0	0	5
3-1	STH	0+	0.059	0.036	0.012	2	0.047	0.027	0.006	1	0.012	0.01	0.007	2
		1+	0.055	0.040	0.025	2	0.148	0.074	0	1	0.051	0.051	0.051	2
		2+	0	0	0	2	0	0	0	1	0.003	0.001	0	2
	CHN	0+	0	0	0	2	0	0	0	1	0	0	0	2
3-2	STH	0+	0.037	0.036	0.036	2	0.033	0.031	0.029	2	0.012	0.009	0.009	2
		1+	0.067	0.037	0.007	2	0.132	0.102	0.073	2	0.085	0.063	0.042	2
		2+	0.003	0.001	0	2	0.002	0.002	0.001	2	0.003	0.002	0.001	2
	CHN	0+	0	0	0	2	0	0	0	2	0	0	0	2
4-0	STH	0+	0.055	0.089	0.055	2	0.118	0.042	0.012	8	0.161	0.076	0.011	9
		1+	0.053	0.040	0.027	2	0.100	0.053	0.006	8	0.181	0.107	0.013	9
		2+	0	0	0	2	0.005	0.001	0	8	0.035	0.005	0	9
	CHN	0+	0	0	0	2	0	0	0	8	0	0	0	9
5-1	STH	0+	0.123	0.103	0.082	2	0.049	0.064	0.049	2	0.046	0.048	0.043	3
		1+	0.044	0.033	0.021	2	0.042	0.042	0.042	2	0.021	0.036	0.021	3
		2+	0	0	0	2	0	0	0	2	0	0.001	0	3
	CHN	0+	0	0	0	2	0	0	0	2	0	0	0	3
5-2	STH	0+	0.072	0.069	0.066	2		0.113		1	0.093	0.061	0.015	4
		1+	0.058	0.039	0.020	2		0.087		1	0.074	0.040	0.006	4
		2+	0	0	0	2		0.005		1	0	0	0	4
	CHN	0+	0	0	0	2		0		1	0	0	0	4
6-0	STH	0+	0.007	0.007	0.006	3	0.014	0.005	0	6	0.018	0.010	0.004	4
		1+	0.042	0.025	0.007	3	0.114	0.061	0.03	6	0.134	0.099	0.075	4
		2+	0.007	0.002	0	3	0.025	0.007	0	6	0.007	0.005	0	4
	CHN	0+	0	0	0	3	0	0	0	6	0	0	0	4
7-1	STH	0+	0.025	0.022	0.02	3	0.020	0.017	0.010	3	0.233	0.067	0.001	4
		1+	0.040	0.029	0.022	3	0.045	0.037	0.020	3	0.327	0.121	0.001	4
		2+	0	0	0	3	0	0	0	3	0.001	0.001	0	4
	CHN	0+	0	0	0	3	0	0	0	3	0	0	0	4
7-2	STH	0+	0.035	0.017	0.005	3		0.028		1	0.015	0.012	0.006	3
		1+	0.058	0.034	0.005	3		0.005		1	0.072	0.040	0.022	3
		2+	0	0	0	3		0		1	0.006	0.002	0	3
	CHN	0+	0	0	0	3		0		1	0	0	0	3
7-3	STH	0+	0.005	0.001	0	3	0.008	0.004	0	2	0.011	0.005	0	
		1+	0.023	0.012	0	3	0.051	0.042	0.033	2	0.070	0.062	0.050	
		2+	0	0	0	3	0	0	0	2	0.007	0.003	0	
	CHN	0+	0	0	0	3	0	0	0	2	0	0	0	
8-1	STH	0+	0.024	0.008	0	5	0.011	0.006	0.002	3	0.026	0.015	0.007	6
		1+	0.018	0.007	0	5	0.015	0.008	0	3	0.149	0.061	0.019	6
		2+	0	0	0	5	0.002	0.000	0	3	0.003	0.000	0	6
	CHN	0+	0	0	0	5	0	0	0	3	0	0	0	6
						5								
8-2	STH	0+	0.016	0.008	0	3	0.021	0.018	0.015	2		0.009		1
		1+	0.033	0.011	0	3	0.011	0.031	0.011	2		0.032		1
		2+	0	0	0	3	0.003	0.001	0	2		0		1
	CHN	0+	0	0	0	3	0	0	0	2		0		1

Appendix C. Juvenile steelhead and chinook densities by macro-habitat type for each index reach on New River.

1994

			RIFFLE				RUN				POOL			
REACH	SPECIES	AGE	MAX	AVG	MIN	N	MAX	AVG	MIN	N	MAX	AVG	MIN	N
1-1	STH	0+		0.137		1		0.029		1	0.038	0.015	0.002	3
		1+		0.032		1		0.042		1	0.007	0.003	0	3
		2+		0.002		1		0		1	0	0	0	3
	CHN	0+		0		1		0.006		1	0	0	0	3
1-2	STH	0+	0.061	0.036	0.010	3					0.054	0.022	0.001	5
		1+	0.043	0.018	0.001	3					0.075	0.020	0	5
		2+	0.003	0.001	0	3					0.001	0.000	0	5
	CHN	0+	0.001	0.000	0	3					0	0	0	5
2-0	STH	0+	0.029	0.020	0.008	3	0.005	0.002	0	4	0.008	0.002	0	5
		1+	0.026	0.014	0.004	3	0.068	0.020	0.001	4	0.024	0.007	0	5
		2+	0.002	0.000	0	3	0	0	0	4	0.000	0.000	0	5
	CHN	0+	0.011	0.003	0	3	0	0	0	4	0.002	0.000	0	5
3-1	STH	0+	0.184	0.121	0.058	2		0.035		1	0.129	0.050	0.008	3
		1+	0.056	0.034	0.013	2		0		1	0.051	0.025	0.005	3
		2+	0	0	0	2		0		1	0.000	0.000	0	3
	CHN	0+	0	0	0	2		0		1	0.002	0.002	0	3
3-2	STH	0+	0.031	0.025	0.018	2	0.009	0.007	0.005	2	0.007	0.004	0.000	2
		1+	0.028	0.025	0.022	2	0.008	0.008	0.004	2	0.025	0.013	0.000	2
		2+	0	0	0	2	0	0	0	2	0	0	0	2
	CHN	0+	0	0	0	2	0	0	0	2	0.001	0.000	0	2
4-0	STH	0+	0.343	0.276	0.209	2	0.442	0.374	0.281	8	0.846	0.468	0.202	8
		1+	0.081	0.040	0	2	0.132	0.064	0.015	8	0.335	0.119	0.017	8
		2+	0	0	0	2	0	0	0	8	0.002	0.000	0	8
	CHN	0+	0	0	0	2	0.028	0.005	0	8	0.003	0.002	0	8
5-1	STH	0+	0.492	0.649	0.492	2	0.557	0.538	0.519	2	0.521	0.387	0.248	3
		1+	0.007	0.034	0.007	2	0.028	0.017	0.006	2	0.067	0.052	0.036	3
		2+	0.002	0.001	0	2	0	0	0	2	0.001	0.000	0	3
	CHN	0+	0.002	0.001	0	2	0.030	0.018	0.006	2	0.055	0.017	0.017	3
5-2	STH	0+	0.403	0.374	0.345	2		0.425		1	0.504	0.435	0.369	4
		1+	0.043	0.032	0.020	2		0.047		1	0.052	0.036	0.022	4
		2+	0	0	0	2		0		1	0.005	0.001	0	4
	CHN	0+	0	0	0	2		0		1	0.055	0.037	0.028	4
6-0	STH	0+	0.793	0.556	0.404	4	1.088	0.773	0.468	5	0.802	0.599	0.485	4
		1+	0.017	0.009	0.003	4	0.025	0.009	0	5	0.093	0.054	0.036	4
		2+	0	0	0	4	0	0	0	5	0	0	0	4
	CHN	0+	0	0	0	4	0	0	0	5	0	0	0	4
7-1	STH	0+	0.366	0.245	0.181	3	0.844	0.548	0.292	3	0.370	0.306	0.220	4
		1+	0.007	0.004	0	3	0.024	0.014	0.024	3	0.017	0.009	0.003	4
		2+	0	0	0	3	0	0	0	3	0	0	0	4
	CHN	0+	0	0	0	3	0	0	0	3	0	0	0	4
7-2	STH	0+	0.253	0.182	0.104	3		0.239		1	0.553	0.510	0.452	3
		1+	0.035	0.016	0	3		0.005		1	0.051	0.030	0.016	3
		2+	0	0	0	3		0		1	0	0	0	3
	CHN	0+	0	0	0	3		0		1	0	0	0	3
7-3	STH	0+	0.653	0.424	0.246	4	0.374	0.372	0.370	2	0.478	0.442	0.377	3
		1+	0.009	0.003	0	4	0.013	0.011	0.009	2	0.030	0.017	0.006	3
		2+	0	0	0	4	0	0	0	2	0.004	0.001	0	3
	CHN	0+	0	0	0	4	0	0	0	2	0	0	0	3
8-1	STH	0+	0.393	0.226	0.074	5	0.530	0.484	0.417	3	0.589	0.469	0.191	6
		1+	0.214	0.043	0	5	0.010	0.004	0	3	0.052	0.027	0.014	6
		2+	0	0	0	5	0	0	0	3	0.014	0.002	0	6
	CHN	0+	0	0	0	5	0	0	0	3	0	0	0	6
8-2	STH	0+	0.792	0.316	0.062	4	0.386	0.321	0.255	2		0.241		1
		1+	0.180	0.045	0	4	0.018	0.009	0	2		0.011		1
		2+	0	0	0	4	0	0	0	2		0		1
	CHN	0+	0	0	0	4	0	0	0	2		0		1

Appendix C. Juvenile steelhead and chinook densities by macro-habitat type for each index reach on New River.

1995

			RIFFLE				RUN				POOL			
REACH	SPECIES	AGE	MAX	AVG	MIN	N	MAX	AVG	MIN	N	MAX	AVG	MIN	N
1-1	STH	0+		0.072		1		0.130		1	0.078	0.058	0.036	3
		1+		0.011		1		0.067		1	0.042	0.032	0.015	3
		2+		0.005		1		0.017		1	0.01	0.009	0.009	3
	CHN	0+		0		1		0		1	0	0	0	3
1-2	STH	0+	0.075	0.054	0.010	4		0.057		1	0.127	0.069	0.010	4
		1+	0.052	0.020	0.010	4		0.063		1	0.079	0.033	0.006	4
		2+	0.003	0.001	0	4		0.006		1	0.025	0.008	0	4
	CHN	0+	0	0	0	4		0		1	0	0	0	4
2-0	STH	0+	0.121	0.096	0.076	3	0.056	0.037	0.022	4	0.025	0.018	0.008	5
		1+	0.075	0.049	0.016	3	0.129	0.062	0.01	4	0.047	0.025	0.006	5
		2+	0.002	0.000	0	3	0.004	0.001	0	4	0.003	0.001	0	5
	CHN	0+	0	0	0	3	0	0	0	4	0	0	0	5
3-1	STH	0+	0.065	0.062	0.058	2		0.006		1	0.019	0.015	0.010	3
		1+	0.041	0.031	0.022	2		0.001		1	0.020	0.018	0.015	3
		2+	0	0	0	2		0		1	0.000	0.000	0	3
	CHN	0+	0	0	0	2		0		1	0	0	0	3
3-2	STH	0+	0.090	0.055	0.020	2	0.026	0.025	0.025	2	0.009	0.008	0.006	2
		1+	0.060	0.037	0.014	2	0.028	0.024	0.020	2	0.022	0.011	0.000	2
		2+	0	0	0	2	0.006	0.003	0	2	0.003	0.001	0	2
	CHN	0+	0	0	0	2	0	0	0	2	0	0	0	2
4-0	STH	0+	0.193	0.175	0.157	2	0.224	0.165	0.067	9	0.498	0.222	0.079	6
		1+	0.037	0.018	0	2	0.114	0.044	0.015	9	0.163	0.077	0.007	6
		2+	0	0	0	2	0.011	0.002	0	9	0.009	0.003	0	6
	CHN	0+	0	0	0	2	0	0	0	9	0	0	0	6
5-1	STH	0+	0.213	0.168	0.123	2	0.201	0.138	0.076	2	0.126	0.081	0.048	3
		1+	0.012	0.006	0	2	0.024	0.015	0.005	2	0.012	0.008	0.004	3
		2+	0.002	0.001	0	2	0.001	0.001	0.001	2	0.001	0.000	0	3
	CHN	0+	0	0	0	2	0	0	0	2	0	0	0	3
5-2	STH	0+	0.179	0.175	0.172	2		0.273		1	0.036	0.110	0.020	4
		1+	0.027	0.019	0.011	2		0.024		1	0.005	0.004	0	4
		2+	0	0	0	2		0.006		1	0	0	0	4
	CHN	0+	0	0	0	2		0		1	0	0	0	4
6-0	STH	0+	0.240	0.132	0.087	4	0.421	0.206	0.126	5	0.195	0.187	0.182	4
		1+	0.048	0.020	0	4	0.025	0.016	0.009	5	0.055	0.039	0.043	4
		2+	0	0	0	4	0	0	0	5	0.008	0.005	0.003	4
	CHN	0+	0	0	0	4	0	0	0	5	0	0	0	4
7-1	STH	0+	0.200	0.160	0.137	3	0.319	0.240	0.155	3	0.352	0.162	0.028	4
		1+	0.045	0.020	0	3	0.093	0.040	0.005	3	0.030	0.021	0.003	4
		2+	0.003	0.001	0	3	0	0	0	3	0.003	0.000	0	4
	CHN	0+	0	0	0	3	0	0	0	3	0	0	0	4
7-2	STH	0+	0.257	0.150	0.074	3		0.130		1	0.319	0.235	0.186	3
		1+	0.049	0.030	0.011	3		0.013		1	0.064	0.048	0.020	3
		2+	0.015	0.005	0	3		0		1	0.004	0.002	0	3
	CHN	0+	0	0	0	3		0		1	0	0	0	3
7-3	STH	0+	0.290	0.174	0.078	4	0.240	0.231	0.222	2	0.327	0.240	0.193	3
		1+	0.058	0.023	0	4	0.019	0.009	0	2	0.013	0.012	0.009	3
		2+	0	0	0	4	0.007	0.005	0.003	2	0.006	0.002	0	3
	CHN	0+	0	0	0	4	0	0	0	2	0	0	0	3
8-1	STH	0+	0.258	0.160	0.100	5	0.190	0.164	0.129	4	0.391	0.315	0.177	5
		1+	0.020	0.009	0.006	5	0.092	0.026	0	4	0.075	0.048	0.017	5
		2+	0	0	0	5	0.013	0.003	0	4	0.018	0.003	0	5
	CHN	0+	0	0	0	5	0	0	0	4	0	0	0	5
8-2	STH	0+	0.070	0.061	0.052	2	0.070	0.061	0.052	2		0.161		1
		1+	0.006	0.003	0	2	0.006	0.003	0	2		0.042		1
		2+	0	0	0	2	0	0	0	2		0		1
	CHN	0+	0	0	0	2	0	0	0	2		0		1

Appendix D. Weekly catch, abundance index and related flow data - New River rotary screw trap, 1989.

Week	River Flow (cfs)	Trap Days	WEEKLY CATCH TOTALS Chinook YOY	Chinook Yearlings	Steelhead Fry	Steelhead Parr	Steelhead Smolts	Catch Total	WEEKLY INDEX TOTALS Chinook YOY	Chinook Yearlings	Steelhead Fry	Steelhead Parr	Steelhead Smolts	Catch Total
02/19 - 02/25/89														
02/26 - 03/04/89														
03/05 - 03/11/89														
03/12 - 03/18/89														
03/19 - 03/25/89														
03/26 - 04/01/89														
04/02 - 04/08/89	1666	2	0	0	0	20	2	22	0	0	0	526	53	579
04/09 - 04/15/89	1245	5	1	0	0	43	1	45	37	0	0	1522	50	1609
04/16 - 04/22/89	901	2	0	0	0	1	0	1	0	0	0	336	36	372
04/23 - 04/29/89	563	3	3	0	0	2	0	5	56	0	0	88	0	144
04/30 - 05/06/89	521	5	5	0	0	262	37	304	45	0	0	2244	322	2611
05/07 - 05/13/89	456	5	14	0	1	181	47	243	90	0	9	1425	326	1850
05/14 - 05/20/89	331	3	9	0	0	88	45	142	109	0	0	971	505	1585
05/21 - 05/27/89	317	4	22	0	0	101	39	162	173	0	1	859	352	1385
05/28 - 06/03/89	273	4	10	0	1	88	8	107	86	0	10	649	80	825
06/04 - 06/10/89	230	4	42	0	16	125	9	192	185	0	68	654	47	954
06/11 - 06/17/89	179	4	150	0	32	115	3	300	548	0	128	470	16	1162
06/18 - 06/24/89	144	5	63	0	17	21	2	103	301	0	66	113	7	487
06/25 - 07/01/89	131	6	115	0	75	46	5	241	342	0	222	138	12	714
07/02 - 07/08/89	112	4	40	0	33	6	2	81	212	0	155	59	7	433
07/09 - 07/15/89	91	3	21	0	13	0	0	34	84	0	55	0	3	142
07/16 - 07/22/89														
07/23 - 07/29/89														
07/30 - 08/05/89														
08/06 - 08/12/89														
08/13 - 08/19/89														
08/20 - 08/26/89														
08/27 - 09/02/89														
09/03 - 09/09/89														
09/10 - 09/16/89														
09/17 - 09/23/89														
09/24 - 09/30/89														
10/01 - 10/07/89														
10/08 - 10/14/89														
10/15 - 10/21/89														
10/22 - 10/28/89														
10/29 - 11/04/89														
11/05 - 11/11/89														
11/12 - 11/18/89														
Spring Total		59	495		188	1099	200	1982	2268	0	714	10054	1816	14852

Appendix D. Weekly catch, abundance index and related flow data - New River rotary screw trap, 1990.

	River		WEEKLY CATCH TOTALS						WEEKLY INDEX TOTALS					
	Flow	Trap	Chinook		Steelhead			Catch	Chinook		Steelhead			Catch
Week	(cfs)	Days	YOY	Yearlings	Fry	Parr	Smolts	Total	YOY	Yearlings	Fry	Parr	Smolts	Total
02/18 - 02/24/90														
02/25 - 03/03/90														
03/04 - 03/10/90														
03/11 - 03/17/90														
03/18 - 03/24/90														
03/25 - 03/31/90														
04/01 - 04/07/90	452	2	2	0	0	1955	263	2220	10	0	0	9444	1325	10779
04/08 - 04/14/90	354	5	1	0	0	514	239	754	7	0	0	5322	1330	6659
04/15 - 04/21/90	289	7	8	0	0	1469	395	1872	22	0	0	3947	1073	5042
04/22 - 04/28/90	300	7	8	0	0	683	400	1091	22	0	1	2124	1231	3378
04/29 - 05/05/90	197	7	26	0	1	116	118	261	76	0	2	347	354	779
05/06 - 05/12/90	156	7	42	0	2	53	38	135	95	0	3	113	78	289
05/13 - 05/19/90	138	7	139	0	11	135	89	374	232	0	17	223	143	615
05/20 - 05/26/90	386	7	133	0	19	376	37	565	908	0	163	2563	159	3793
05/27 - 06/02/90	820	1	6	0	0	13	1	20	618	0	162	1445	49	2274
06/03 - 06/09/90	822	4	3	0	15	5	0	23	134	0	221	142	8	505
06/10 - 06/16/90	418	5	123	0	61	21	2	207	703	0	340	135	15	1193
06/17 - 06/23/90	272	7	93	0	120	13	2	228	365	0	471	49	8	893
06/24 - 06/30/90	200	7	144	0	122	14	3	283	401	0	328	38	8	775
07/01 - 07/07/90	168	7	75	0	152	21	2	250	163	0	330	46	4	543
07/08 - 07/14/90	132	6	17	0	16	4	1	38	39	0	40	9	2	90
07/15 - 07/21/90	110	3	1	0	9	1	0	11	12	0	40	6	0	58
07/22 - 07/28/90	91	3	0	0	3	0	0	3	0	0	23	3	0	26
07/29 - 08/04/90	75	3	0	0	0	0	0	0	0	0	0	0	0	0
08/05 - 08/11/90														
08/12 - 08/18/90														
08/19 - 08/25/90														
08/26 - 09/01/90														
09/02 - 09/08/90	47	3	0	0	1	0	0	1						
09/09 - 09/15/90														
09/16 - 09/22/90	44	4	0	0	3	2	0	5						
09/23 - 09/29/90	56	6	0	0	24	2	0	26						
09/30 - 10/06/90	47	2	0	0	3	0	0	3						
10/07 - 10/13/90	44	2	0	0	1	0	0	1						
10/14 - 10/20/90	51	2	0	0	0	0	0	0						
10/21 - 10/27/90	49	2	0	0	0	0	0	0						
10/28 - 11/03/90	50	3	0	0	5	0	0	5						
11/04 - 11/10/90	48	2	0	0	4	0	0	4						
11/11 - 11/17/90	47	1	0	0	2	0	0	2						
Spring Total		122	821	0	574	5397	1590	8335	3807	0	2141	25956	5787	37691

Note: Fall catch was not expanded due to low and sporatic trapping effort.

Appendix D. Weekly catch, abundance index and related flow data - New River rotary screw trap, 1991.

Week	River Flow (cfs)	Trap Days	Weekly Catch Totals: Chinook YOY	Weekly Catch Totals: Chinook Yearlings	Weekly Catch Totals: Steelhead Fry	Weekly Catch Totals: Steelhead Parr	Weekly Catch Totals: Steelhead Smolts	Weekly Catch Totals: Catch Total	Weekly Index Totals: Chinook YOY	Weekly Index Totals: Chinook Yearlings	Weekly Index Totals: Steelhead Fry	Weekly Index Totals: Steelhead Parr	Weekly Index Totals: Steelhead Smolts	Weekly Index Totals: Catch Total
02/17 - 02/23/91														
02/24 - 03/02/91														
03/03 - 03/09/91														
03/10 - 03/16/91														
03/17 - 03/23/91	276	2	0	0	0	6	12	18	0	0	0	30	60	90
03/24 - 03/30/91	344	4	0	1	0	14	36	51	0	5	0	104	251	360
03/31 - 04/06/91	472	4	0	0	0	55	52	107	0	1	0	370	427	798
04/07 - 04/13/91	477	4	0	1	0	45	46	92	0	7	0	494	453	954
04/14 - 04/20/91	359	4	0	0	0	315	111	426	0	3	0	1925	688	2616
04/21 - 04/27/91	345	4	1	0	0	763	279	1043	5	0	0	4611	1633	6249
04/28 - 05/04/91	331	4	0	1	0	302	155	458	3	4	0	2536	1210	3753
05/05 - 05/11/91	299	4	1	0	0	885	267	1153	9	2	0	4546	1421	5978
05/12 - 05/18/91	256	4	14	1	0	649	241	905	58	4	0	3162	1234	4458
05/19 - 05/25/91	277	4	14	0	0	321	158	493	89	0	0	2072	837	2998
05/26 - 06/01/91	216	3	79	0	1	167	77	324	292	0	10	913	414	1629
06/02 - 06/08/91	173	4	66	0	22	118	18	224	284	0	122	522	126	1054
06/09 - 06/15/91	130	4	131	0	292	55	1	479	393	0	790	148	5	1336
06/16 - 06/22/91	105	5	180	0	153	8	0	341	506	0	512	45	1	1064
06/23 - 06/29/91	93	5	70	0	37	2	2	111	169	0	69	4	4	246
06/30 - 07/06/91	76	6	8	0	1	1	0	10	41	0	5	3	0	49
07/07 - 07/13/91	61	3	1	0	0	0	0	1	12	0	1	1	0	14
07/14 - 07/20/91	69	2	0	0	0	0	0	0	4	0	0	1	0	5
07/21 - 07/27/91	56	1	0	0	0	1	0	1	0	0	2	9	0	11
07/28 - 08/03/91	44	2	0	0	1	0	0	1	0	0	8	2	0	10
08/04 - 08/10/91	38	2	0	0	1	0	0	1	0	0	8	0	0	8
08/11 - 08/17/91	34	4	0	0	0	0	0	0	0	0	2	0	0	2
08/18 - 08/24/91	31	2	0	0	0	0	0	0	0	0	1	0	0	1
08/25 - 08/31/91	33	2	0	0	1	0	0	1	0	0	3	0	0	3
09/01 - 09/07/91	31	1	0	0	2	2	0	4	0	0	3	3	0	6
09/08 - 09/14/91	27	2	0	0	10	1	0	11	0	0	19	2	0	21
09/15 - 09/21/91	25	4	0	0	7	2	0	9	0	0	15	4	0	19
09/22 - 09/28/91	24	3	0	0	0	1	0	1	0	0	0	2	0	2
09/29 - 10/05/91	24	1	0	0	0	1	0	1	0	0	0	1	0	1
10/06 - 10/12/91	24	2	0	0	0	1	0	1	0	0	0	1	0	1
10/13 - 10/19/91	24	0	0	0	0	0	0	0	0	0	0	0	0	0
10/20 - 10/26/91	23	1	0	0	0	0	0	0	0	0	0	0	0	0
10/27 - 11/02/91														
11/03 - 11/09/91														
11/10 - 11/16/91														
Spring Total		97	565	4	528	3715	1455	6267	1865	26	1570	21511	8764	33736

* Frame and fyke nets were used beginning August 28.

Appendix D. Weekly catch, abundance index and related flow data - New River rotary screw trap, 1992.

			WEEKLY CATCH TOTALS						WEEKLY INDEX TOTALS					
	River Flow	Trap	Chinook		Steelhead			Catch	Chinook		Steelhead			Catch
Week	(cfs)	Days	YOY	Yearlings	Fry	Parr	Smolts	Total	YOY	Yearlings	Fry	Parr	Smolts	Total
02/23 - 02/29/92														
03/01 - 03/07/92														
03/08 - 03/14/92														
03/15 - 03/21/92														
03/22 - 03/28/92														
03/29 - 04/04/92	283	2	0	3	0	668	125	796	0	11	0	3097	678	3786
04/05 - 04/11/92	272	2	0	0	0	354	169	523	0	10	0	5196	1759	6965
04/12 - 04/18/92	584	3	0	2	0	401	152	555	0	13	0	3490	1370	4873
04/19 - 04/25/92		0												
04/26 - 05/02/92		0												
05/03 - 05/09/92	234	1	7	0	0	81	105	193	23	0	1	268	358	650
05/10 - 05/16/92	187	4	3	0	3	43	70	119	38	0	33	460	657	1188
05/17 - 05/23/92	154	4	25	0	60	139	118	342	77	0	352	499	427	1355
05/24 - 05/30/92	119	4	17	0	678	148	37	880	65	0	2037	458	140	2700
05/31 - 06/06/92	91	4	35	0	498	13	5	551	98	0	1666	91	27	1882
06/07 - 06/13/92	79	4	13	0	190	8	1	212	67	0	723	33	4	827
06/14 - 06/20/92	82	4	23	0	46	15	0	84	120	0	409	79	2	610
06/21 - 06/27/92	67	4	9	0	214	14	2	239	55	0	1155	74	8	1292
06/28 - 07/04/92	86	3	1	0	579	13	1	594	7	0	2591	89	6	2693
07/05 - 07/11/92	60	4	0	0	239	27	1	267	0	0	1432	132	6	1570
07/12 - 07/18/92	48	2	0	0	29	7	0	36	0	0	375	60	0	435
07/19 - 07/25/92	41	1	0	0	0	0	0	0	0	0	46	11	0	57
07/26 - 08/01/92														
08/02 - 08/08/92														
08/09 - 08/15/92														
08/16 - 08/22/92														
08/23 - 08/29/92														
08/30 - 09/05/92														
09/06 - 09/12/92														
09/13 - 09/19/92														
09/20 - 09/26/92														
09/27 - 10/03/92														
10/04 - 10/10/92														
10/11 - 10/17/92														
10/18 - 10/24/92														
10/25 - 10/31/92														
11/01 - 11/07/92														
11/08 - 11/14/92														
11/15 - 11/21/92														
Spring Total		46	133	5	2536	1931	786	5391	550	34	10820	14037	5442	30883

Appendix D. Weekly catch, abundance index and related flow data - New River rotary screw trap, 1993.

Week	River Flow (cfs)	Trap Days	WEEKLY CATCH TOTALS: Chinook YOY	WEEKLY CATCH TOTALS: Chinook Yearlings	WEEKLY CATCH TOTALS: Steelhead Fry	WEEKLY CATCH TOTALS: Steelhead Parr	WEEKLY CATCH TOTALS: Steelhead Smolts	WEEKLY CATCH TOTALS: Catch Total	WEEKLY INDEX TOTALS: Chinook YOY	WEEKLY INDEX TOTALS: Chinook Yearlings	WEEKLY INDEX TOTALS: Steelhead Fry	WEEKLY INDEX TOTALS: Steelhead Parr	WEEKLY INDEX TOTALS: Steelhead Smolts	WEEKLY INDEX TOTALS: Catch Total
02/21 - 02/27/93														
02/28 - 03/06/93														
03/07 - 03/13/93														
03/14 - 03/20/93														
03/21 - 03/27/93														
03/28 - 04/03/93	1110	2	0	0	0	39	10	49	0	0	0	823	203	1026
04/04 - 04/10/93	1686	4	0	0	0	10	4	14	0	0	0	446	149	595
04/11 - 04/17/93	1094	4	0	0	0	52	16	68	0	0	0	884	289	1173
04/18 - 04/24/93	1408	4	0	0	0	36	16	52	0	0	0	957	341	1298
04/25 - 05/01/93	1048	5	0	0	1	202	39	242	0	0	8	2149	483	2640
05/02 - 05/08/93	1186	7	0	0	3	143	38	184	0	0	30	1415	371	1816
05/09 - 05/15/93	857	4	0	0	2	137	36	175	0	0	38	1861	500	2399
05/16 - 05/22/93	800	5	2	0	2	135	32	171	19	0	26	1731	350	2126
05/23 - 05/29/93	694	4	2	0	0	74	28	104	24	0	0	1142	405	1571
05/30 - 06/05/93	1200	3	13	0	0	2	0	5	88	0	5	141	54	288
06/06 - 06/12/93	899	5	5	0	2	29	0	36	64	0	33	302	0	399
06/13 - 06/19/93	557	5	17	0	33	100	4	154	164	0	197	800	28	1189
06/20 - 06/26/93	385	5	15	0	65	96	10	186	77	0	417	638	55	1187
06/27 - 07/03/93	279	5	26	0	86	97	8	217	100	0	307	367	43	817
07/04 - 07/10/93	212	4	21	0	154	27	2	204	73	0	417	133	4	627
07/11 - 07/17/93	169	5	7	0	320	26	10	363	25	0	823	81	25	954
07/18 - 07/24/93	150	4	4	0	118	18	0	140	18	0	424	77	4	523
07/25 - 07/31/93	125	5	1	0	24	8	0		4	0	109	21	0	134
08/01 - 08/07/93	103	2	0	0	6	0	0		0	0	13	0	0	13
08/08 - 08/14/93														
08/15 - 08/21/93														
08/22 - 08/28/93														
08/29 - 09/04/93														
09/05 - 09/11/93														
09/12 - 09/18/93														
09/19 - 09/25/93														
09/26 - 10/02/93														
10/03 - 10/09/93														
10/10 - 10/16/93														
10/17 - 10/23/93														
10/24 - 10/30/93														
10/31 - 11/06/93														
11/07 - 11/13/93														
11/14 - 11/20/93														
Spring Total		82	103	0	816	1231	253	2364	656	0	2847	13968	3304	20775

Appendix D. Weekly catch, abundance Index and related flow data - New River rotary screw trap, 1994.

Week	River Flow (cfs)	Trap Days	WEEKLY CATCH TOTALS Chinook YOY	Chinook Yearlings	Steelhead Fry	Steelhead Parr	Steelhead Smolts	Catch Total	WEEKLY INDEX TOTALS Chinook YOY	Chinook Yearlings	Steelhead Fry	Steelhead Parr	Steelhead Smolts	Catch Total
02/20 - 02/26/94	480	4	0	0	0	3	1	4	0		0	148	10	158
02/27 - 03/05/94	751	5	0	0	0	69	4	73	0		0	747	48	795
03/06 - 03/12/94	574	7	0	0	0	111	22	133	0		0	628	118	746
03/13 - 03/19/94	389	6	1	0	0	97	48	146	4		0	344	186	534
03/20 - 03/26/94	281	7	0	0	0	26	27	53	0		0	85	88	173
03/27 - 04/02/94	248	7	4	0	0	60	86	150	11		0	176	250	437
04/03 - 04/09/94	239	6	11	0	0	83	313	407	43		0	247	876	1166
04/10 - 04/16/94	229	7	32	0	0	107	240	379	86		0	293	656	1035
04/17 - 04/23/94	257	7	106	0	0	160	217	483	301		0	468	625	1394
04/24 - 04/30/94	233	7	197	0	1	14	236	448	535		3	38	675	1251
05/01 - 05/07/94	233	7	888	0	1	146	572	1607	2458		3	409	1573	4443
05/08 - 05/14/94	237	7	1290	0	3	115	412	1820	3485		8	321	1135	4949
05/15 - 05/21/94	191	7	2160	0	7	23	152	2342	5977		19	62	416	6474
05/22 - 05/28/94	160	7	250	0	227	19	51	547	440		372	30	85	927
05/29 - 06/04/94	127	6	2868	0	757	12	19	3656	4767		1255	20	31	6073
06/05 - 06/11/94	112	7	4273	0	1505	18	16	5812	7039		2506	30	27	9602
06/12 - 06/18/94	90	7	1276	0	805	2	7	2090	2658		2181	4	13	4856
06/19 - 06/25/94	76	7	482	0	246	1	2	731	874		443	2	4	1323
06/26 - 07/02/94	64	7	409	0	457	2	6	874	725		817	4	11	1557
07/03 - 07/09/94	55	5	51	0	420	0	0	471	170		964	0	1	1135
07/10 - 07/16/94	46	6	2	0	151	4	2	159	4		260	7	3	274
07/17 - 07/23/94														
07/24 - 07/30/94														
07/31 - 08/06/94														
08/07 - 08/13/94														
08/14 - 08/20/94														
08/21 - 08/27/94														
08/28 - 09/03/94														
09/04 - 09/10/94														
09/11 - 09/17/94														
09/18 - 09/24/94														
09/25 - 10/01/94														
10/02 - 10/08/94														
10/09 - 10/15/94														
10/16 - 10/22/94														
10/23 - 10/29/94														
10/30 - 11/05/94														
11/06 - 11/12/94														
11/13 - 11/19/94														
Spring Total		136	14300	0	4580	1072	2433	22385	29577	0	8831	4063	6831	49302

Appendix D. Weekly catch, abundance index and related flow data - New River rotary screw trap, 1995.

	River		WEEKLY CATCH TOTALS						WEEKLY INDEX TOTALS					
	Flow	Trap	Chinook		Steelhead			Catch	Chinook		Steelhead			Catch
Week	(cfs)	Days	YOY	Yearlings	Fry	Parr	Smolts	Total	YOY	Yearlings	Fry	Parr	Smolts	Total
02/19 - 02/25/95														
02/26 - 03/04/95														
03/05 - 03/11/95														
03/12 - 03/18/95														
03/19 - 03/25/95														
03/26 - 04/01/95														
04/02 - 04/08/95														
04/09 - 04/15/95														
04/16 - 04/22/95														
04/23 - 04/29/95	1019	3	0	0	4	38	16	58	0	0	67	582	239	888
04/30 - 05/06/95	1325	3	0	0	0	7	1	8	0	0	45	421	133	599
05/07 - 05/13/95	865	7	0	0	2	32	6	40	0	0	25	401	75	501
05/14 - 05/20/95	762	7	0	0	2	108	26	136	0	0	21	1003	233	1257
05/21 - 05/27/95	762	7	0	0	1	299	29	329	0	0	6	1823	180	2009
05/28 - 06/03/95	630	7	0	0	8	387	20	415	0	0	40	1988	102	2130
06/04 - 06/10/95	438	7	0	0	26	206	9	241	0	0	108	885	38	1031
06/11 - 06/17/95	443	7	0	0	18	189	5	212	0	0	80	753	21	854
06/18 - 06/24/95	371	7	0	0	85	193	2	280	0	0	328	745	8	1081
06/25 - 07/01/95	319	7	0	0	378	465	2	845	0	0	1133	1405	6	2544
07/02 - 07/08/95	229	6	0	0	406	84	4	494	0	0	1138	229	9	1376
07/09 - 07/15/95	184	6	0	0	211	74	1	286	0	0	485	174	3	662
07/16 - 07/22/95	155	7	0	0	385	24	2	411	0	0	872	55	5	932
07/23 - 07/29/95	127	7	0	0	505	33	1	539	0	0	1093	72	2	1167
07/30 - 08/05/95	104	7	0	0	502	50	3	555	0	0	1079	108	6	1193
08/06 - 08/12/95	91	7	0	0	154	47	2	203	0	0	303	93	4	400
08/13 - 08/19/95	85	7	0	0	132	44	1	177	0	0	282	92	2	376
08/20 - 08/26/95	75	6	0	0	158	30	2	190	0	0	464	85	8	557
08/27 - 09/02/95	68	5	0	0	117	20	4	141	0	0	438	72	14	524
09/03 - 09/09/95	64	7	0	0	68	18	0	86	0	0	144	39	0	183
09/10 - 09/16/95														
09/17 - 09/23/95														
09/24 - 09/30/95														
10/01 - 10/07/95														
10/08 - 10/14/95														
10/15 - 10/21/95														
10/22 - 10/28/95														
10/29 - 11/04/95														
11/05 - 11/11/95														
11/12 - 11/18/95														
Spring Total		127	0	0	3162	2348	136	5646	0	0	8151	11026	1088	20264