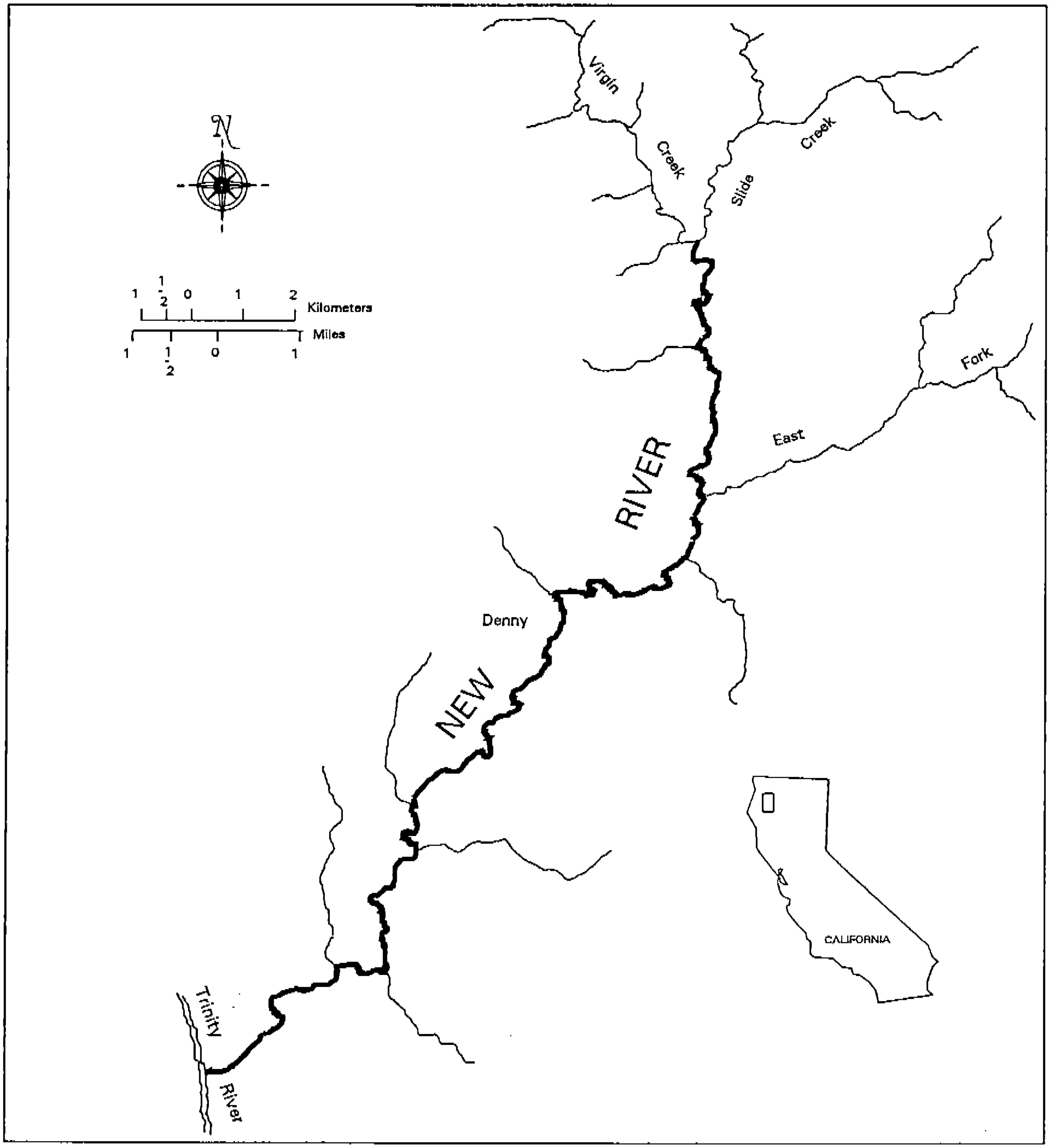
TRINITY RIVER FISHERIES ASSESSMENT PROGRAM

INVESTIGATIONS ON NEW RIVER

Progress Report FY 1992

November 1994

Coastal California Fishery Resource Office
Arcata, California
Region 1



Fisheries Investigations at New River, Tributary to Trinity River, Northern California.

FY 1992

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ABSTRACT

Continued declines of anadromous fish stocks in the Trinity River and its major tributaries have aroused concern in the basin and prompted a need to assess the current status of the salmonid stocks and their potential for restoration to historical levels. The U.S. Fish and Wildlife Service (USFWS) has been funded by the Trinity River Restoration Program for fisheries investigations in New River from 1988 to the present. Surveys of New River have determined that the spring chinook runs were dangerously low with similarly low numbers of fall chinook. Surveys of summer steelhead found that New River supports one of the larger runs in California with a total count of 272 adults in 1992. Annual counts of steelhead have been conducted since 1980 (except for no counts during 1983, and 1985-7), and have ranged from 250 in 1980 to 702 in 1991. Annual redd counts of spring chinook have ranged from 13 in 1989 to only 6 in fiscal year (FY) 1992. The third summer of juvenile rearing index snorkel surveys was also completed. Significant differences were observed between years for volummetric densities of young-of-year (YOY) steelhead in the main-stem. Significant differences were not found between years for steelhead parr densities, suggesting a potential carrying capacity for that age class. Contrary to the two previous years, only three juvenile chinook were observed rearing in New River index reaches during August and September, 1992. Significant differences were observed for both YOY and 1+ steelhead fish per cubic meter (fish/m^3) between habitat types with higher mean densities observed in side-channels, lateral-scour-bedrock pools, pocket-water, and low-gradient riffles. Low mean densities of rearing steelhead were observed in mid-channel pools, corner pools, and glides. Summer index assessments will be repeated in 1993 to compare with data collected in 1990, 1991, and 1992. Juvenile emigrant trapping operations were used to determine an index of total emigrants, and also the emigration period for juvenile chinook (May - July) and steelhead (March - July) to aid in management strategies to protect the native fish stocks. Temperature and flows have been monitored throughout the investigation; flows in FY 1992 ranged from 0.4 to 89 cubic meters per second (cms), and mean daily temperatures ranged from 3.0 to 24.4°C.

INTRODUCTION

The Trinity River Basin has experienced substantial declines in returns of anadromous fish stocks in recent years. In addition to unknown effects of ocean rearing conditions, there are many factors that influence spawning, resting, and rearing habitats in fresh water. Natural events such as forest fires, droughts, landslides and floods, as well as development associated with dams, mining, roads and logging, have contributed to widespread reductions in the fishery resource. The Trinity River Basin Fish and Wildlife Management Plan (TRBFWMP) has begun to address this problem by creating management options which would restore salmonid habitat availability and fish populations to historic levels in the Trinity River and its large tributaries.

New River, a major tributary to the Trinity River, is currently being investigated to assess anadromous fish numbers and habitats. New River is a free-flowing, nearly pristine watershed that is largely untouched by logging. Most of the river channel appears to have substantially recovered from the flood event in December, 1964, when very high sediment loads were deposited in the streambed and most riparian trees were washed away. Habitats for juvenile and adult salmonids now appear to be generally productive and available to fish but do not appear to be fully utilized. New River appears to be a suitable tributary to monitor changes in salmonid populations that are not associated directly with instream habitat improvement projects or watershed rehabilitation programs, because the aquatic habitats have not been intentionally manipulated.

New River has one of the larger summer steelhead populations in California in addition to small, remnant populations of spring and fall chinook salmon. According to the California Department of Fish and Game (CDFG), the statewide total number of wild summer steelhead ranges from 1,500 to 4,000 fish, with the number of wild spring chinook less than a few thousand (Gerstung, pers. comm., 1992). The potential for listing these races of fish as threatened or endangered in California under state and/or federal endangered species laws is increasing with the continued decline of their numbers.

Fisheries assessments of New River are funded by the Trinity River Fish and Wildlife Restoration Act (TRFWRA) (P.L. 98-541). In 1988, the USFWS began a project to identify the quantity and quality of spawning and rearing habitat, usage of habitat, 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. Studies underway include assessment and monitoring of habitat used by juveniles and adults, spawner assessment, and monitoring of juvenile emigrants. Annual progress reports have been prepared for FY 1989-90, and FY 1991.

STUDY AREA

Description

New River is one of the major tributaries to the Trinity River. The mouth is located 140.1 km from the ocean, and 70.2 km from the junction of the Trinity and Klamath Rivers (Figure 1).

Access to most of the river is limited due to steep canyon walls, areas of private ownership, and inclusion of headwaters in the Trinity Alps Wilderness Area, Shasta-Trinity National Forest. Main access roads to New River are Highway 299 to Hawkins Bar, and the road to Denny from Hawkins Bar. The Denny road parallels the river for approximately 27 km along the steep canyon walls. Access to the river is via privately owned land except

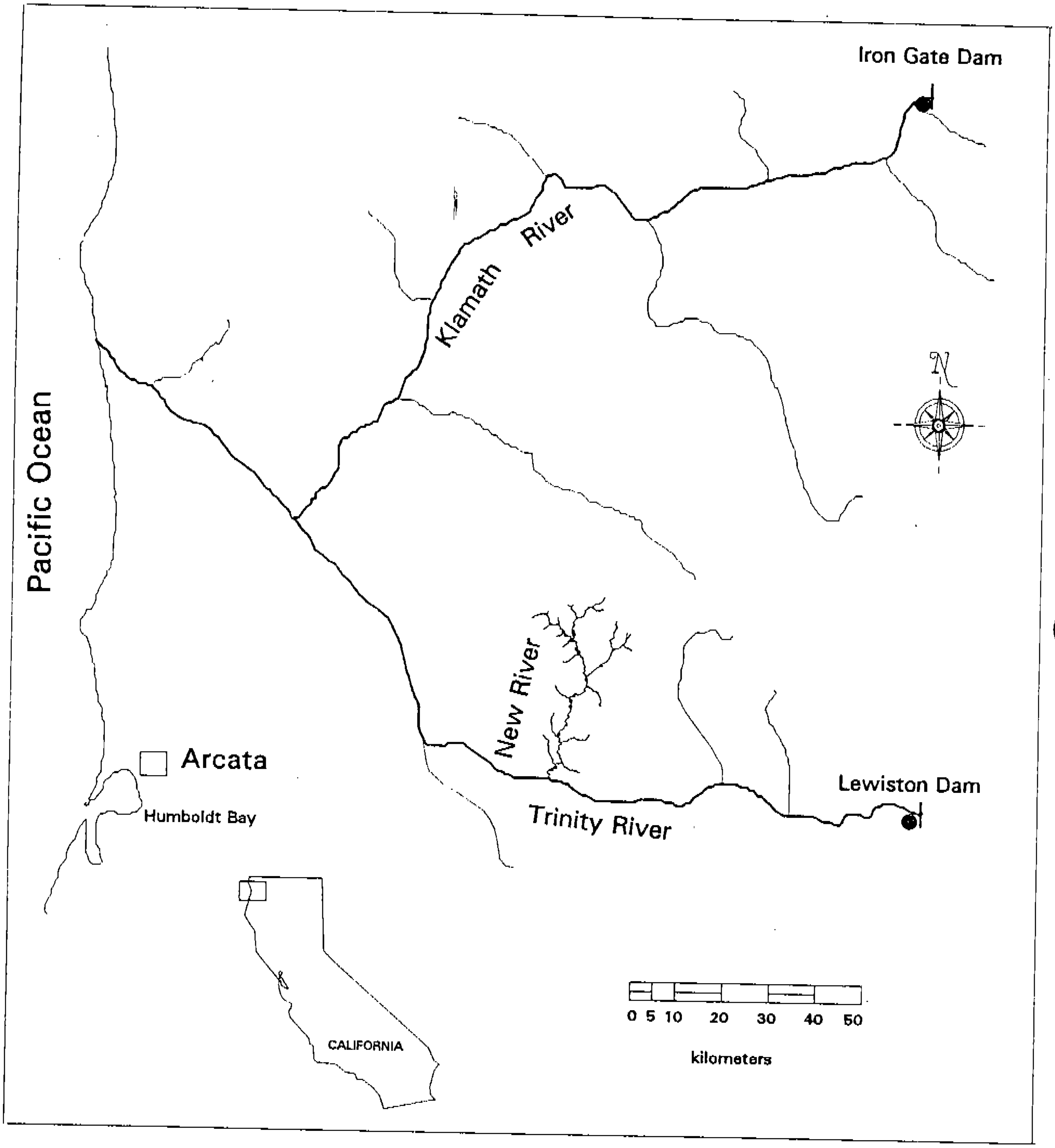

Figure 1. Location of New River in northwestern California

for the public campground areas near Denny, at river kilometer (rkm) 18.5. Past Denny, the road continues on National Forest for about 5 km where it branches into short routes that end at the New River, Jim Jam, and East Fork trail-heads. All access on the trails is non-motorized.

Currently, there are private landowners and mining claimants along the length of the river; however, the community of Denny is the only section of the river with a somewhat concentrated human population (25 - 50 residents). The U.S. Forest Service (USFS) administers National Forest lands that cover most of the basin.

Salmonid species of the basin are spring and fall runs of chinook salmon (Oncorhynchus tshawytscha), summer and perhaps fall and winter runs of steelhead (O. mykiss), resident rainbow trout (O. mykiss), and very low numbers of coho salmon (O. kisutch). An estimated 80.5 km of the New River drainage is accessible to adult steelhead and provides excellent nursery areas for the juveniles. Chinook mainly use 38.9 km of channel in the main-stem. Other known fish species of the drainage include speckled dace (Rhinichthys osculus), Klamath small scale sucker (Catostomus rimiculus), and the Pacific lamprey (Lampetra tridentata).

History

The Denny area of the New River drainage was extensively mined in the mid to late 1800's and a few areas show scars of logging and fires. Gold was discovered in the area in 1848 and mining began in 1851. Early settlers were Anglo-Americans, Europeans, and then Chinese. In the 1870's mining waned, but by 1880 a second gold rush had begun. The second wave of mining lasted until the early 1900's. The last mining town, Old Denny (located near Slide Creek, rkm 14.3), was abandoned in 1920 (USFS, 1989).

Numbers of steelhead in the early 1900's are unknown, but local residents claim that streams and pools were "so black with fish you couldn't see the stream bottom". The fish stocking history of New River was discussed in the FY91 Progress Report (USFWS, 1992).

The flood of 1964 had a dramatic effect on the habitats of the main-stem New River. Much of the channel was blanketed by deep deposits of coarse sediments. After the flood, there was a lack of pools and stream-side canopy, which elevated water temperatures and subsequently degraded the remaining habitat. The local state fishery biologist, John Thomas (pers. comm., 1989) stated, "New River was like a sidewalk from the confluence of Virgin and Slide Creeks to the mouth", a distance of nearly 35 km.

In 1980, approximately 33.6 km of New River were placed in the National Wild and Scenic River System. The Trinity Alps was designated as a Wilderness Area in 1984. About 68% of the New River uppermost watershed is within the Wilderness and moderate recreational trail use occurs in the summer months. Average summer air temperatures are 29 - 35°C daily and 4 - 7°C nightly.

Channel Morphology/Geology/Hydrology

New River is a fifth order river that flows in a southwesterly direction through deeply incised, "V" shaped canyons. Elevation ranges from 213 m at the mouth to a maximum of 2,279 m in the headwaters. Gradient over the 37.2 km of main-stem channel is 1.2% (61.2 feet/mile), with individual reaches having gradients ranging from 0.6% above rkm 3.5, to 2.6% in the lower canyon below rkm 1.2. Channel morphology shows an average width of 9 m, average depth of 1.1 m, with some pools as deep as 5.5 - 6.1 m. The pool to riffle ratio is 20:50 (Freese and Tayler, 1979). The primary sources of instream cover for fish are boulders, bedrock ledges, pool depth, and surface turbulence. Instream woody material and a well developed riparian canopy are lacking throughout most of the river. The upslope overstory vegetation consists of Douglas-fir (Pseudotsuga menziesii), tan oak (Lithocarpus densiflora), big-leaf maple (Acer macrophyllum), digger pine (Pinus sabiniana), madrone (Arbutus menziesii), and California black oak (Quercus kelloggii). Understory riparian vegetation includes herbaceous shrubs, alders (Alnus sp.), and willows (Salix sp.).

New River drainage is located in the Klamath Mountains Geomorphic Province. Sedimentary metamorphic rocks comprise 80% of the rock types of New River drainage and igneous rocks the remaining 20%. Predominant rock formations of the area are of the Rattlesnake Creek Plate type. Tectonic mixing is likely in this unit due to the highly variable rock compositions. The Ironside Mountain Batholith underlies the lower reaches of the river and the western side of the drainage into the headwaters. This area includes hornblende diorite which is known to be highly erodible (Young, 1978).

Boulder and bedrock streambanks are common throughout the system and bank slopes vary from 25 to 100 degrees. Exposed soil streambanks are rare and are mainly associated with logging, burning and over-steepened slopes with fine-textured soils. Sources of silt are from streambank landslides and recently dredged (placer mined) areas. Compaction of spawning gravels (by more than 30% silt content) is uncommon.

New River, predominantly a rain influenced basin, drains a total area of 614 square km and can be characterized as hydrologically "flashy". Average annual precipitation is 102-127 cm. The heaviest precipitation normally occurs between December and April with peak flows usually in February or March. The United States Geological Survey (USGS) recorded an extreme peak flow of nearly 1,300 cms (46,000 cfs) on December 22, 1964. Annual high flows have averaged 28 to 32 cms (990 to 1,130 cfs) each winter during 1989 to 1991. Summer and autumn flows have averaged 0.7 to 2.0 cms (25 to 71 cfs) in August, September, and October of 1989 to 1992. The USGS period of record was June, 1959 to September, 1969 (USGS, 1970).

Three headwater tributaries to New River have been identified as important to anadromous salmonid spawning, resting, and rearing. These include East Fork, Slide and Virgin creeks, which together cover about half the entire basin area. The East Fork covers 17% of the basin with Slide Creek and Virgin Creek each comprising 16% respectively.

MATERIALS AND METHODS

Stream Physical Measurements

Water Temperature Monitoring

A Ryan Instruments TempMentor digital temperature recorder (Model #RTM) has been used to monitor stream temperature, at rkm 3.5 (near the mouth of Dyer Creek), at 2 hour intervals beginning August 21, 1988. The thermograph was anchored within a portable cement casing (weighing approximately 40 kg) to prevent it dislodging during storm flow conditions. This casing also camouflaged the recorder to preclude disturbance. Temperature data were downloaded onto RTM software and maximum, minimum, and average daily water temperatures were calculated for FY 1992.

Flows

A staff-gage was established for this study at rkm 3.4. A crest gage (2.5

cm diameter polyethylene tubing) was attached to the staff with the bottom end submerged in the water. 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. The gage-height/flow relationship established in 1990 (USFWS, 1991) was used to determine the flows for the varying gage heights throughout the investigation.

$$Y = [10^{1.35 + 3.05(\log X+1)}] - 1$$

$$X = \text{gage height},\ Y = \text{flows}$$

The relationship was confirmed at a variety of flows by use of a Price AA Current Meter and top-setting rod. Flows were taken across a transect line (rkm 3.5) at 1.5 m intervals and at the recommended depths for the calculation of total stream flows.

Stage of the staff-gage was recorded during every field visit. Approximate dates and magnitudes of extreme floods were inferred from the crest gage and weather records at Willow Creek, CA. The lack of a recording stream gage, and infrequent field visits during winter months resulted in few records of stage during November, 1992, through March, 1993.

Habitat Evaluations

Index Reaches

New River and anadromous fish habitats in the contributing headwaters, covering a total length of 65.8 km of measured channels, have been classified into seven channel geomorphic types and 25 standard habitat types (USFWS, 1990, 1992). About 15 km of four headwater streams suspected of containing anadromous fish habitat have not had habitats classified because of difficult access for surveyors. After assessing the habitat type information collected from 1988 - 1990, permanent index reaches were established in 1990 for long-term monitoring of juvenile abundance and possible changes in habitat types and conditions.

Index reaches were selected to represent all habitat types in the main-stem and large tributaries of New River, in the same proportion as they occur. Index reaches were determined by the geomorphic characteristics, the proportional representation of habitat types, and the accessibility and the location of tributaries. As a result, 14 index reaches were developed on the New River system (Figure 2). Eight index reaches are on the main-stem, one on East Fork, two on Slide Creek, and the remaining three are on Virgin Creek. Three reaches are each located within B1 and C1 channel types, four each are in B2 and B3 channel types (see appendix A for listing of channel types). Index reaches were temporarily marked for the life of the study by flagging, spray paint and metal tags tacked to trees. Lengths of index reaches ranges from 125 to 720 m, for a total of 4,286 m. Index reaches represent 7% of all the 65.8 km of main-stem and headwater channels that have had habitats classified.

Index reaches were snorkeled in late July by two to four people in order to determine relative abundance of juvenile chinook and steelhead (YOY, 1+, 2+). Teams began snorkeling at the downstream end of an index in order to minimize fish disturbance by observers. Total numbers of fish, classified by species and age class, were tallied at upstream ends of individual habitat units. Snorkelers proceeded upstream in this fashion until they reached the upper end of the index. Salmonid adults and redds were also noted. Due to the large size of the river system, diver calibration as noted by Hankin and Reeves (1988) was practiced only in instances where each diver could clearly see both banks. For this method, each diver

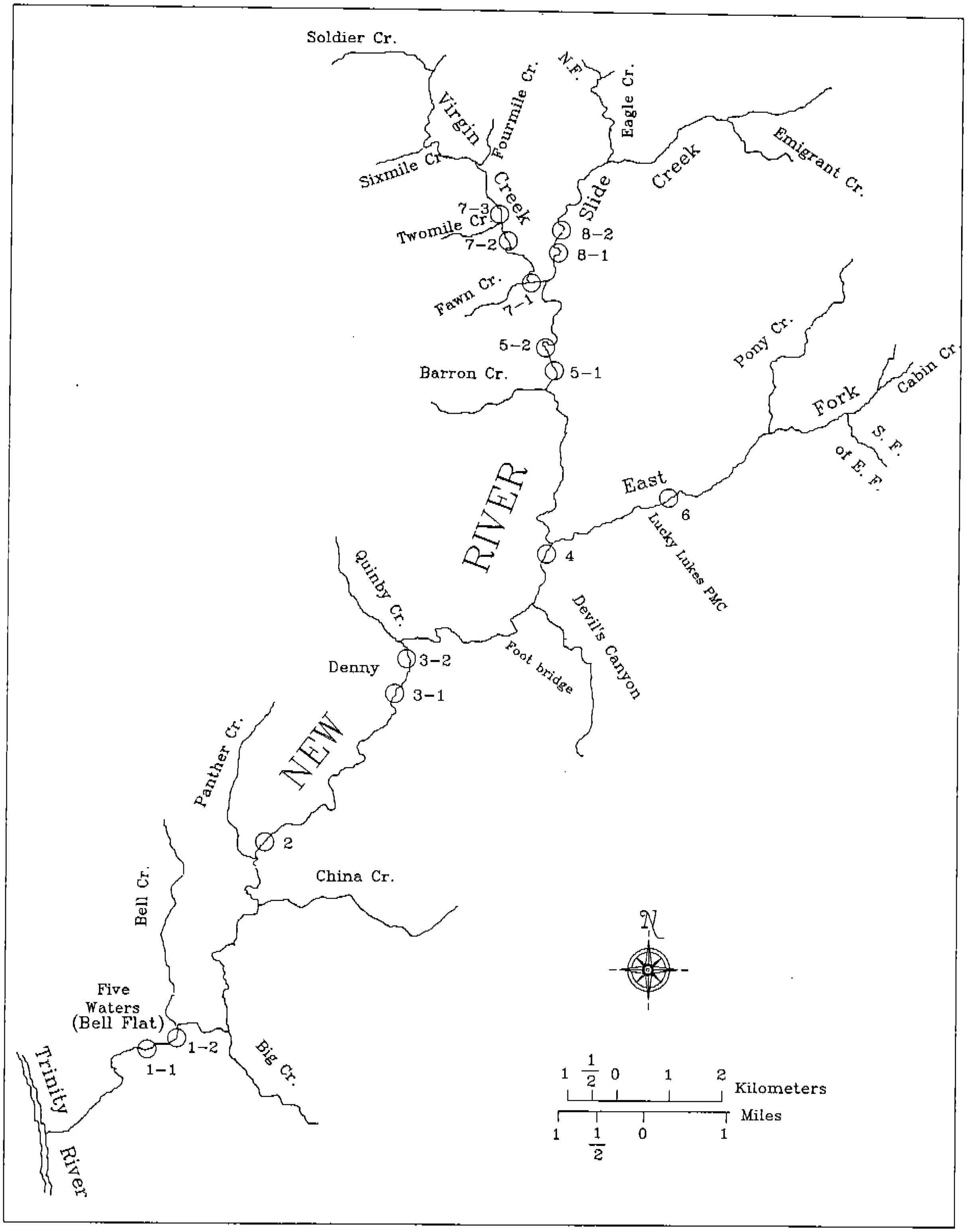

Figure 2. Map of juvenile salmonid index reach locations, New River, CA.

snorkeled the chosen unit and counted all fish observed. Teams then compared counts to determine their accuracy. Each diver also recorded a visibility estimate for each index reach to gain an idea of the accuracy of the counts. Calibration by electro-fishing was not a practical option due to the rugged terrain, large deep pools, and time limitations.

After the entire index reach was snorkeled, physical measurements were taken at designated transect points (downstream end, 1/4, 1/2, 3/4, upstream end) for each habitat unit within the index. Stream widths were measured with a range-finder at each transect point and depths were measured with a stadia rod across each transect from the right bank edge, 1/4 width, 1/2 width, 3/4 width, and the left bank edge. Maximum depths and mean unit lengths were also recorded. Additional information obtained included: percent total cover, dominant/subdominant cover type (bank, small woody material, large woody material, terrestrial vegetation, surface turbulence, boulders, bedrock ledges and depth), and dominant/subdominant substrate; bedrock, boulder (>30 cm), cobble (8-30 cm), gravel (.5-8 cm), sand (1 mm-.5 cm), and fines (sands, silts, and clays).

Average densities (measured as numbers of fish/m^3) for habitat types were determined separately for YOY, 1+, and 2+ steelhead in the main-stem New River, Virgin Creek, Slide Creek, and the East Fork. Average densities were also determined for any juvenile chinook observed during surveys. Densities were calculated by volume rather than area to better compare fish use of habitat types over a range of depths. Multivariate analyses (ANOVA) were used to determine if any significant differences occurred between years and habitat types for fish densities.

Snorkel surveys of juvenile salmonids performed since 1989 have determined that mid-summer is the best time for accurate counts of rearing fish, since fish hide in the streambed at cooler temperatures during daylight. Additionally, summer flows are stable and juvenile steelhead and chinook have generally finished emigrating from the drainage. Hillman et al. (1992) stated that snorkel counts were most accurate at temperatures above 14°C. In his studies, at temperatures below 14°C, most counts revealed only half the number of fish actually present. At temperatures below 9°C less than 20% of the fish present were observed.

Population Trends

Summer Steelhead and Spring Chinook Counts

One snorkeling survey for steelhead and spring chinook adults was completed from September 15 to 23, 1992. Survey reaches included the main-stem 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). All habitat units within these sections were snorkeled by experienced observers in teams of two. Numbers of summer steelhead and spring chinook along with their location and habitat type were recorded. All of the river that could be expected to be used by chinook was surveyed. Any steelhead adults that were already upstream of the surveyed reaches would not have been observed.

Spring and Fall Chinook Redd Counts

Three redd surveys were conducted on the main-stem New River from the confluence of Virgin and Slide creeks to the mouth of New River. The surveys were completed every two weeks from October 22 to November 20, 1991. Habitat unit type, location within unit, apparent age of redd, mean stream width, adjacent depth, redd size (length, mean width, depth of pit, depth over mound), and substrate size (large cobble 15 - 30 cm, small cobble 8 - 15 cm, large gravel 3.5 - 8 cm, small gravel 0.5 - 3.5 cm, and fines < 0.5 cm) were recorded at each redd location. The age of redds were categorized as fresh, two weeks to one month old, or greater than one month old, based on relative amount of algae on rocks, and the relative distinctness of pit and mound.

Juvenile Trapping

A screw trap (Figure 3) was again used in 1992 for the capture of emigrating juvenile salmonids. The screw is oriented with the large opening (trap mouth) facing upstream into the current. The screw is comprised of a fiberglass spiral vane enclosed in a funnel-shaped metal framework that is covered with galvanized hardware-cloth (6 mm rectangular mesh size). The flowing water turns the spiral vane that rotates a horizontal, 3 m long shaft at operating speeds of 3.3 to 10 rotations per minute. The trap mouth has a diameter of 2.44 m, and can sample an area of 1.17 m^2 at maximum operating depth (1.22 m). Two 6.1 m long pontoons support the screw and live-box as well as providing flotation and a walkway. Wooden walkways across the front and rear of the trap allow access to the winches and live-box. Three hand-crank winches allow each end of the screw and the livebox to be raised nearly clear of the water for maintenance and removing fish from the live-box. The floating trap is moored to trees and steel posts and was checked daily when operating. The trap was removed from the river during non-trapping seasons.

Fish of all sizes that enter the screw are prevented from leaving by the rotating vanes. Fish pass through the small end of the funnel (0.56 m diam.) into a live-box (1.4 m^3) at the rear of the structure. Small-sized floating debris are automatically removed from the live-box by a turning cylinder located across the rear of the live-box. Fish survived well in the live-box: several hundred salmonid fry have been held at one time with no ill effects.

Flows were measured at the right, center, and left side of the screw with a Price AA current meter. Flow through the trap was calculated by multiplying the flow passing the trap mouth by the area of the trap mouth in the water. Percent flow sampled was then calculated by dividing the flow through the trap by the river flows at that time. Emigrating fish were assumed to be equally distributed across the 8 - 13 m wide river at the trap location (top to middle of a fast run below a narrow riffle). An abundance index of fish passing by the trap site was extrapolated from the capture rate and percent flows sampled. Because fish are not randomly distributed, and sampling periods were non-random and discontinuous, calculated numbers are actually only indices of total production.

On days not sampled, numbers of juvenile salmonid emigrants were estimated using the average catch rates and flows sampled prior to and following the non-trapping periods. Emigrant traps have been operated annually at the same location (rkm 3.75) since April, 1989.

When the New River flows fell below 1.3 cms (beginning on July 15), the screw revolutions became too slow (<3 revolutions/minute) to continue fishing, and a frame net trap (1.1 x 1.5 m opening) was then utilized. Flows were also taken at the trap mouth to determine percent flows sampled and numbers of fish emigrating were extrapolated similarly to the rotary trap. Salmonids were not caught in two nights so this sampling was discontinued.

The trapping season for 1992 began on March 30 and ended on July 15. All fish captured after a nights fishing were separated into species, degree of development (YOY, parr, and smolt) and counted. Lengths and displacements

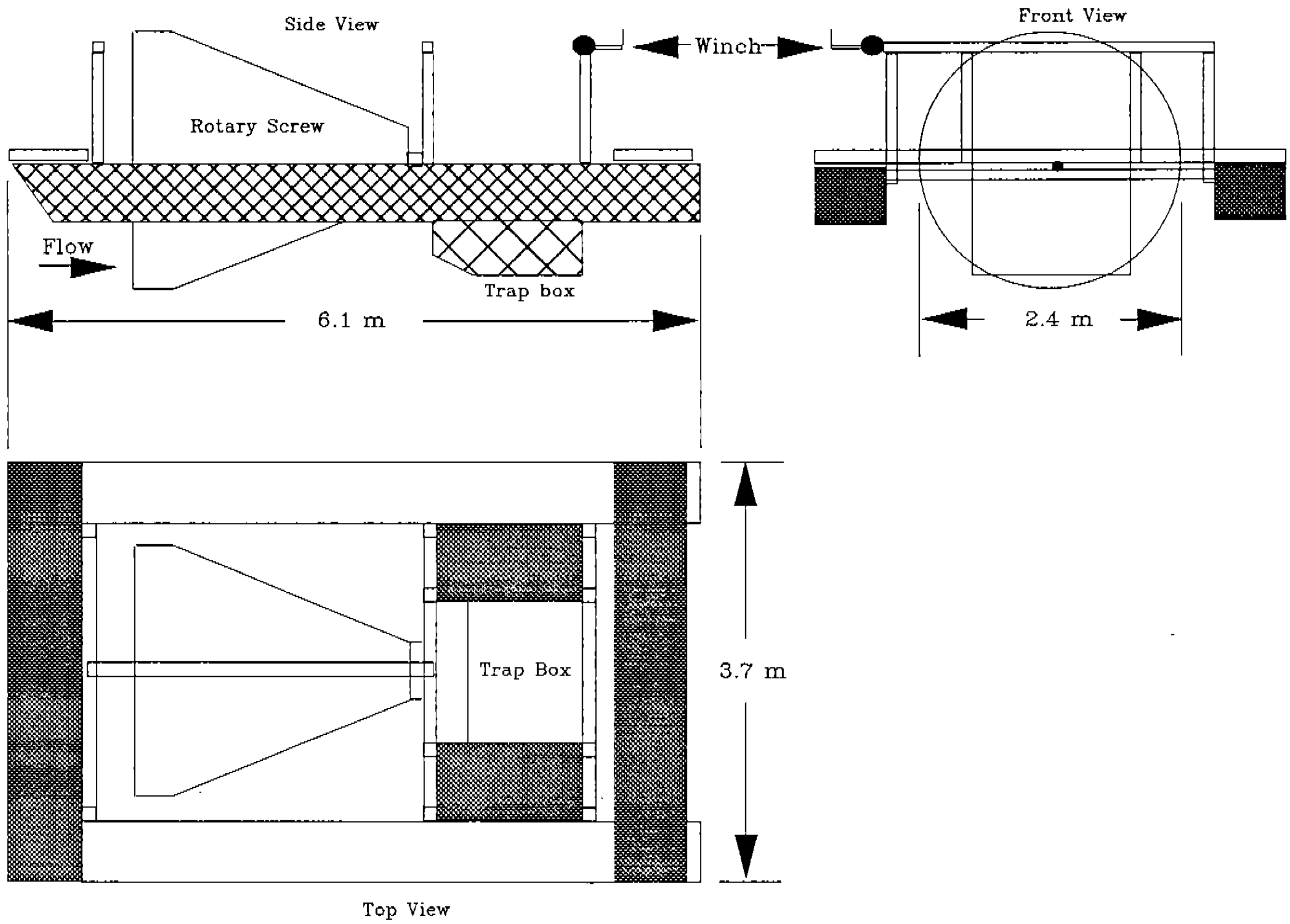

Figure 3. Views of the screw trap used on New River.

were taken from random samples of up to 50 fish of each salmonid species and development stage. Scales were taken from up to 25 juvenile steelhead, and examined later to determine the proportions of YOY, 1+ and 2+ aged fish. Fish were also examined externally for any symptoms of diseases and parasites.

Peak emigration periods were determined for juvenile chinook and steelhead. Juvenile steelhead were separated into parr and smolt categories based on the presence or lack of parr marks, silvery coloration, looseness of scales, and the presence or absence of a black caudal fin margin. Percentages of YOY steelhead, parr, and smolts passing through the trap location were calculated for the 1989 - 1992 trapping seasons. Juvenile length displacement relationships were derived from log-transformed linear regression analyses. Length-frequency histograms and average length at date were also derived for juvenile chinook and steelhead for the trapping season.

RESULTS AND DISCUSSION

Stream Physical Measurements

Water Temperature Monitoring

Mean daily water temperatures for FY 1992 ranged from a low of 3.0°C on December 24, to a high of 24.4°C in mid-July (Figure 4). Two-hour minimum temperatures were 2.5°C on several days in mid-December and mid-January. The two-hour maximum of 27.4°C occurred on August 14, 1992. Temperatures in the headwaters were not measured.

As observed in the other recent drought years, hydrologic conditions observed in FY 1992 influenced water temperatures through the summer months. Reduced snow pack, rainfall, and runoff throughout the water year contributed to spring and summer water temperature increases beyond that noted in the previous two years. Summer water temperatures often exceeded the ranges for optimum juvenile steelhead rearing and also for optimum adult chinook holding and juvenile rearing.

Some salmonids that are acclimated can be expected to die after 100 minutes of exposure to temperatures ranging from 26.5 to 28.0°C: this range was rated "marginal" by an investigator in the Eel River (Kubicek, 1977). Lethal temperatures for rainbow trout have been reported as 24°C for juveniles acclimated at 11°C (Black, 1953). Marginally lethal temperatures may be related to low numbers of juvenile steelhead parr mortalities observed in the lower New River in late July and mid-August, 1992. Temperatures were equal to or exceeded 26.5°C for 120 min during afternoons of thirteen days between July 16 and August 18, 1992 (Figure 4). Adult mortalities were not observed but deliberate searches were not made during that time.

Based on a study of preferred resting habitats for summer steelhead done in New River in summer, 1991, it is expected that most adult salmon and steelhead sought cooler pools with abundant cover and moderate velocities (Nakamoto, 1994). During snorkeling in New River in 1992, both juvenile and adult steelhead and chinook were observed to congregate near cool-water tributaries during the surveys in late July and mid-September. It is unknown whether steelhead in New River are physiologically adapted to high temperatures or whether these fish employ primarily behavioral means of dealing with elevated water temperatures.

Temperatures from May through September were again above the threshold (3.3 -13.3°C) for the successful upstream migration of spring chinook (Reiser

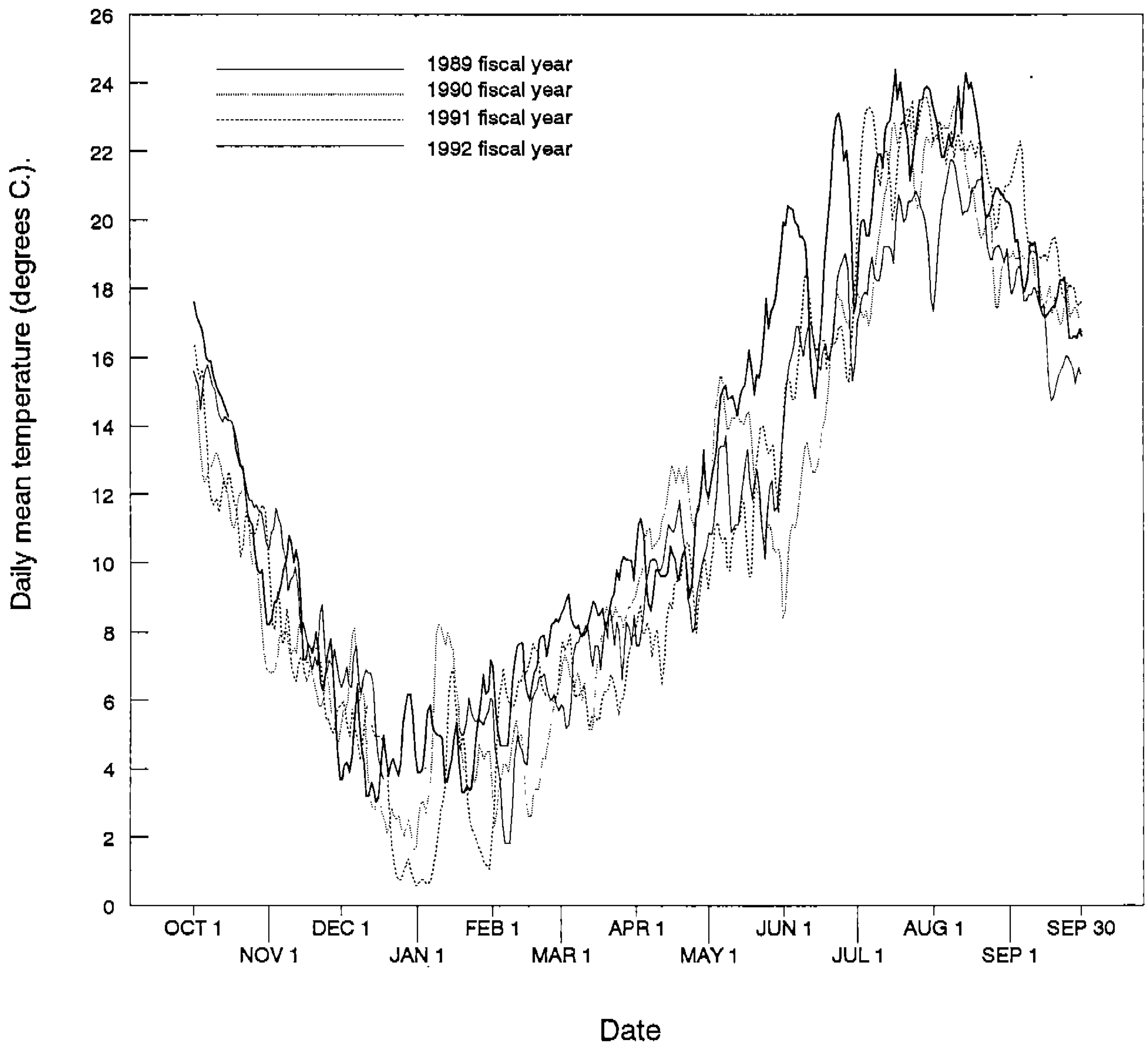

Figure 4. New River water temperatures, recorded at rkm 3.5, downstream of Dyer Creek, during fiscal years 1989-92.

and Bjornn 1979). Minimum daily temperatures exceeded 13.3°C for almost every day from May 5 to September 30, 1992. This began about one month earlier than in 1991 (June 1) and nearly two months earlier than in 1990 (June 27). Warmer waters in May and June of 1992 may have deterred some spring chinook from immigrating into New River. Warm resting pools likely stressed the few spring chinook that did enter, and may have contributed to an unknown amount of pre-spawning mortality. Temperatures in the Trinity River near the confluence with New River were apparently not recorded before July 1992. Throughout July and August, the average daily temperatures were consistently about one or two degrees cooler than in New River (P. Zedonis, pers. comm., 1993). Trinity River daily means ranged from 17.0 to 23.3°C during this time. Daily maximum temperatures were as much as 5 degrees warmer in New River than in the Trinity River.

Low water temperatures in New River during winter do not appear to hinder egg development. The lower and higher temperature threshold for the incubation of spring chinook eggs is between 5.0 - 14.4°C (Reiser and Bjornn 1979). Piper et al., 1982, and Reiser and Bjornn, 1979, also noted that these thresholds can be exceeded if the embryo development has progressed to a stage that is tolerant to colder water (128-cell stage at 5.9°C in 72 hours). The majority of spring chinook redds were constructed in October, giving the embryos six weeks to two months to develop into a cold-water tolerant stage.

It is assumed that little to no growth occurs in New River for YOY steelhead during the winter months. Snorkel observations of juveniles during periods of water temperatures below 7°C showed little activity of YOY steelhead, although larger 1+ steelhead were observed to be lurking near the bottom of pools. However, P. Zedonis (pers. comm., 1990) observed Trinity River juvenile steelhead to be actively feeding during winter nighttime hours. The limited winter growth in juvenile steelhead observed in New River may be attributed to the low feeding rates, low metabolic rates, and the lower production of aquatic insects that coincides with the cold water temperatures. Rearing steelhead appeared active in summer, but thermal stress may have affected the growth rate during the times when temperatures exceeded a daily minimum of 20.0°C. Temperatures were in excess of 20°C for 42 consecutive days in July and August, 1992.

Flows

The flow information presented herein is not strictly comparable to the USGS record, since the USGS gage was located 10.2 km up-river from our gage. The difference in drainage areas between the two gages is approximately 26% (448 vs. 605 km^2).

The New River average monthly stream flows for FY 1992 (October 1, 1991 to September 30, 1992) included the lowest recorded since the project began in 1988 (Figure 5). The annual peak flow of 89.4 cms (3160 cfs) was recorded by use of the crest gage at rkm 3.3 in March, 1992. Average annual peak flows for the nine years of USGS record, not including the extreme flood of December, 1964, were 195.2 cms (6900 cfs). Average minimum flows were 0.65 cms (23 cfs). In FY 1992, minimum summer flows were 0.42 cms (14.8 cfs) in mid-September, which was lower than the previous lowest recorded flow of 0.51 cms (18 cfs) in October, 1961.

Habitat Evaluations

Index Reaches

Only three YOY chinook juveniles were observed during index surveys in 1992. One chinook was seen in a corner pool along with ten YOY steelhead and three steelhead parr. The other two chinook were in a lateral-scour pool along with 79 YOY steelhead and 36 steelhead parr. No other juvenile chinook were seen during index surveys.

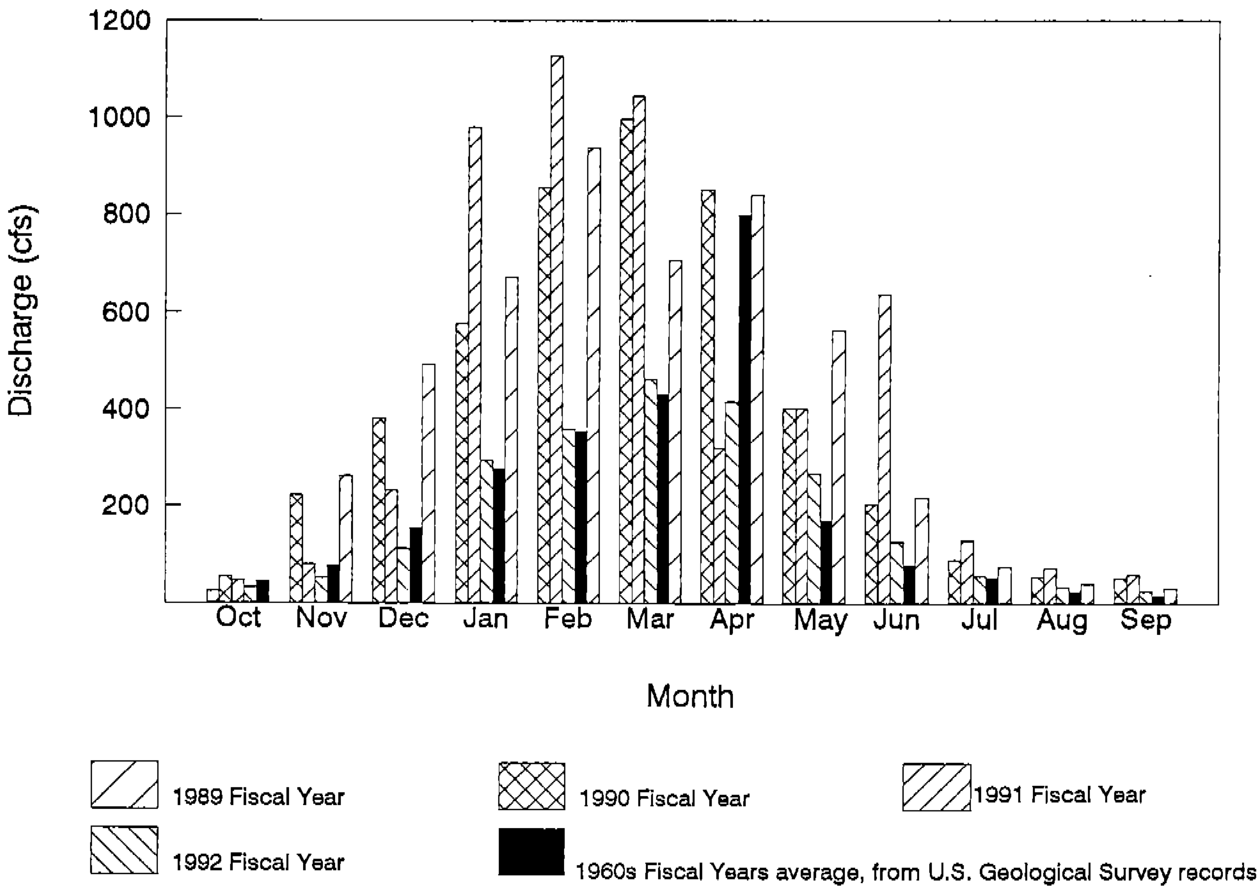

Figure 5. Average monthly flows in cubic feet per second (cfs) New River, during Fiscal Years (FY) 1989-92, and FY 1960-69.

Static densities of 1+ steelhead throughout all 14 index sites over the three years may reflect the carrying capacity of the system during recent drought years. Emigration of 1+ steelhead from the New River drainage appeared to end in early July, while remaining parr rear through the summer, fall and winter and emigrate as 2+ steelhead in the next spring. It appears that, unlike the YOY steelhead, the number of 1+ steelhead is independent of the number of adults returning to the drainage for at least the recent drought years.

All fish densities are expressed as number of fish per cubic meter (fish/m^3). Densities were calculated by volume, rather than area, since juvenile salmonids were dispersed throughout the water column, and comparisons were made across habitat types of varying depths.

Multi-variate analyses (two factor analysis of variance) were performed between habitat types and between years for each group of indices (main-stem, East Fork, Virgin, and Slide creeks). Significant differences mentioned below represent a level of significance of P less than 0.05. The following figures are intended to compare mean fish densities between years only within each group of index reaches. Mean fish densities are not necessarily comparable between groups, since all groups do not represent the same size of stream.

Differences of fish densities between habitat types may likely reflect individual and/or species preferences for: feeding sites, cover, territories, and water velocities. By the time of index surveys in late July, YOY steelhead were large enough (estimated average fork length 60 mm) to be feeding in moderate velocities. All sizes of juvenile steelhead were observed especially in riffles, runs, pocket water, and heads of pools.

Main-stem New River

Eight index sites in this group represent 10 habitat types, covering a total of 3028 m length of main-stem channel (Figure 2).

YOY steelhead

Results of combined densities by year (1990-92) (Figure 6) are displayed along with mean densities calculated between habitat types by year and by habitat type (Figures 7 and 8).

Significant differences were derived for the observed YOY steelhead densities between habitat types for the combined years for the main-stem New River. Mean densities ranged from a low of 0.02 in mid-channel pools to a high of 0.80 in side-channels. Densities of YOY were the highest in side-channels, low gradient riffles, runs, and pocket-waters (Figure 7). Densities were lowest in large pools such as mid-channel and corner-pools. The majority of juveniles within pools were observed in the head and tail-out areas while in the deep pool area, only a few small schools of YOY were observed. Significant differences were also determined for the combined YOY steelhead densities compared by year from a low of 0.25 observed in 1991 to a high of 0.37 observed in 1992 (Figure 5). The high densities of YOY observed in 1992 were most likely due to the large return of summer steelhead (702 adults) in 1991. The contributions by fall and winter steelhead spawners are unknown.

1+ steelhead

Mean densities were calculated between habitat types by year (Figure 9) along with combined densities by year (1990-92) (Figure 10) and by habitat type (Figure 11).

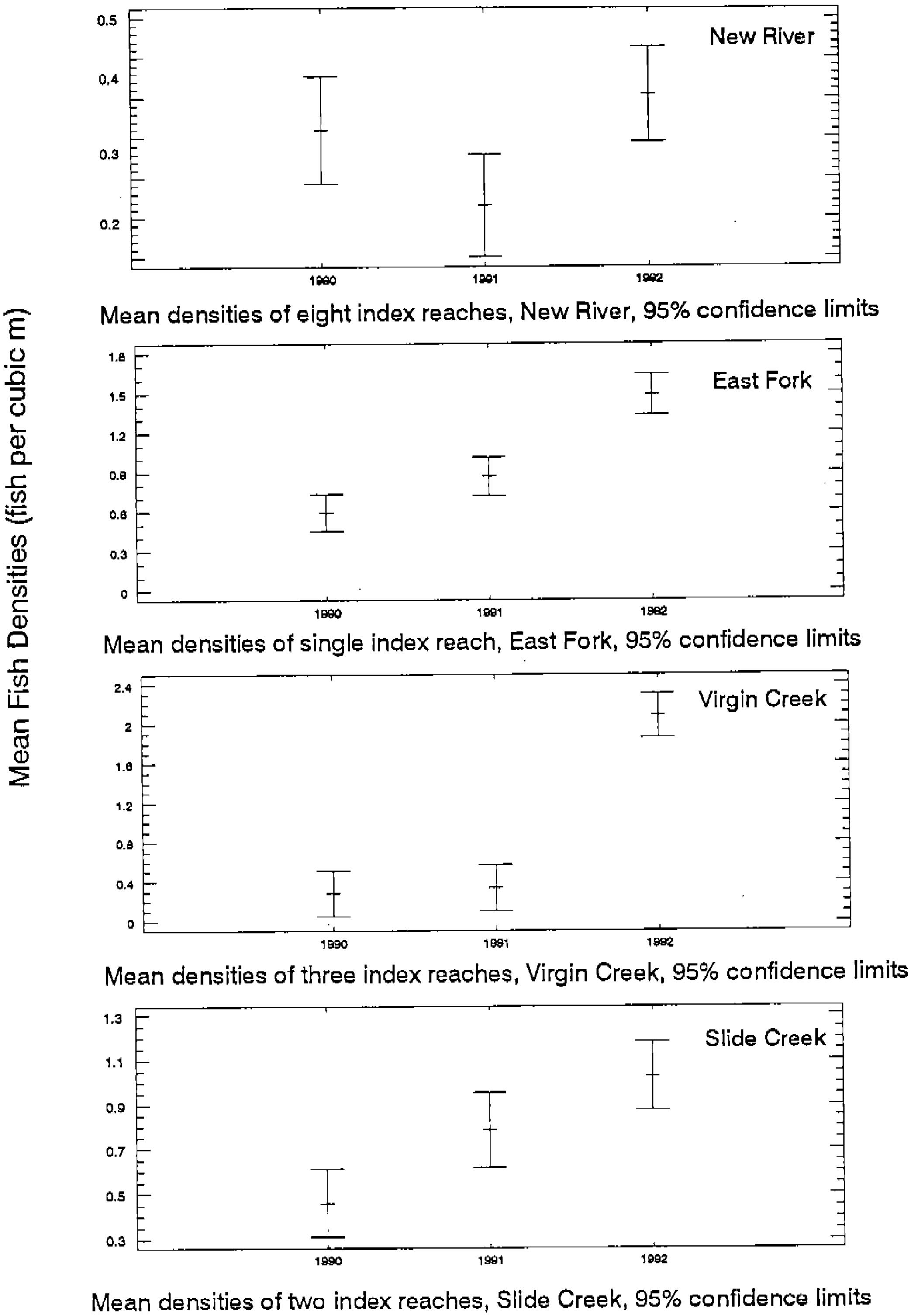

Figure 6. Steelhead young-of-year mean densities (fish/m^3) at index reaches in New River, East Fork, Virgin Creek and Slide Creek, during 1990-92.

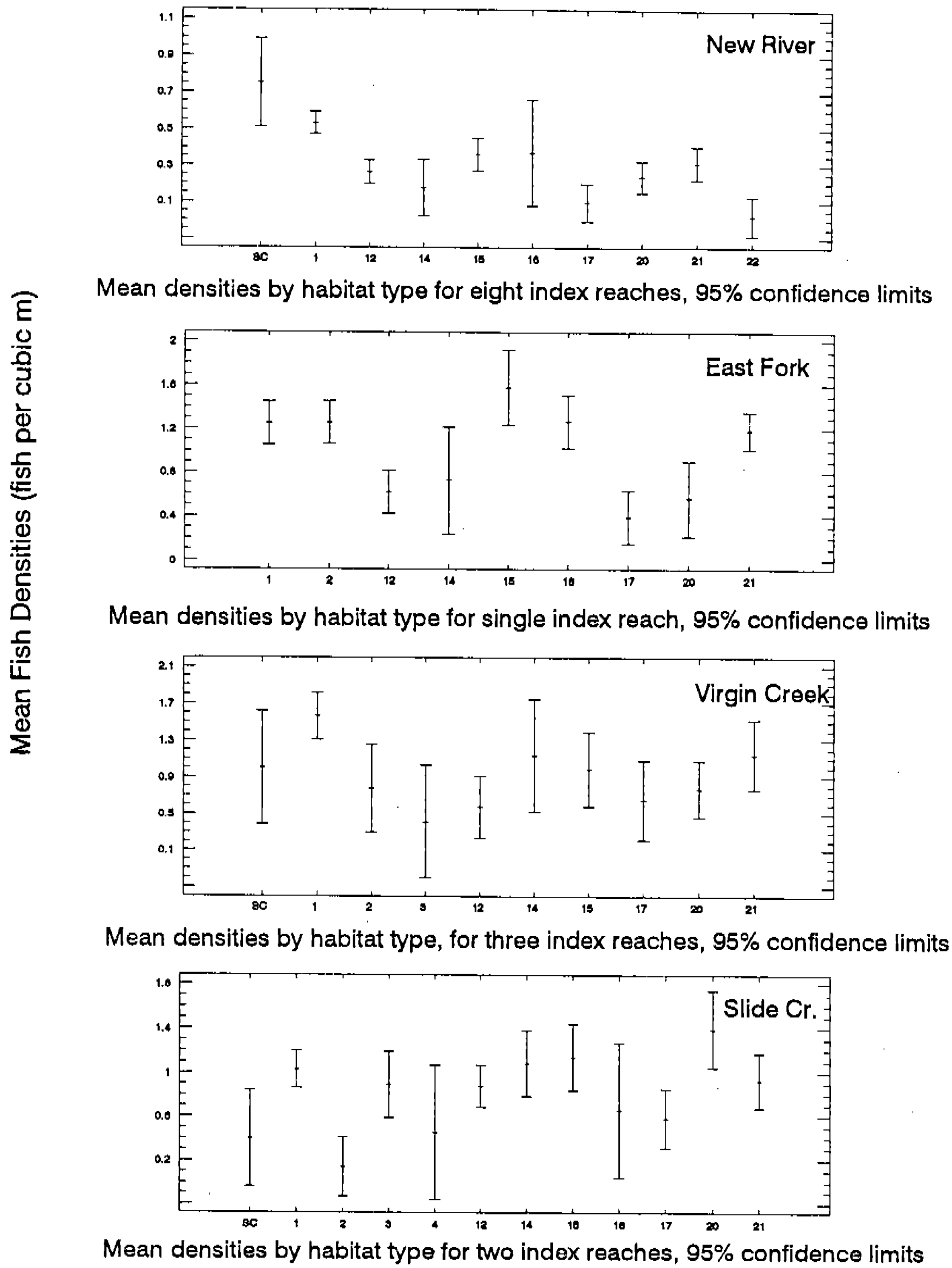

Figure 7. Steelhead young-of-year mean densities (fish/m^3) at index reaches, by habitat types, 1992.

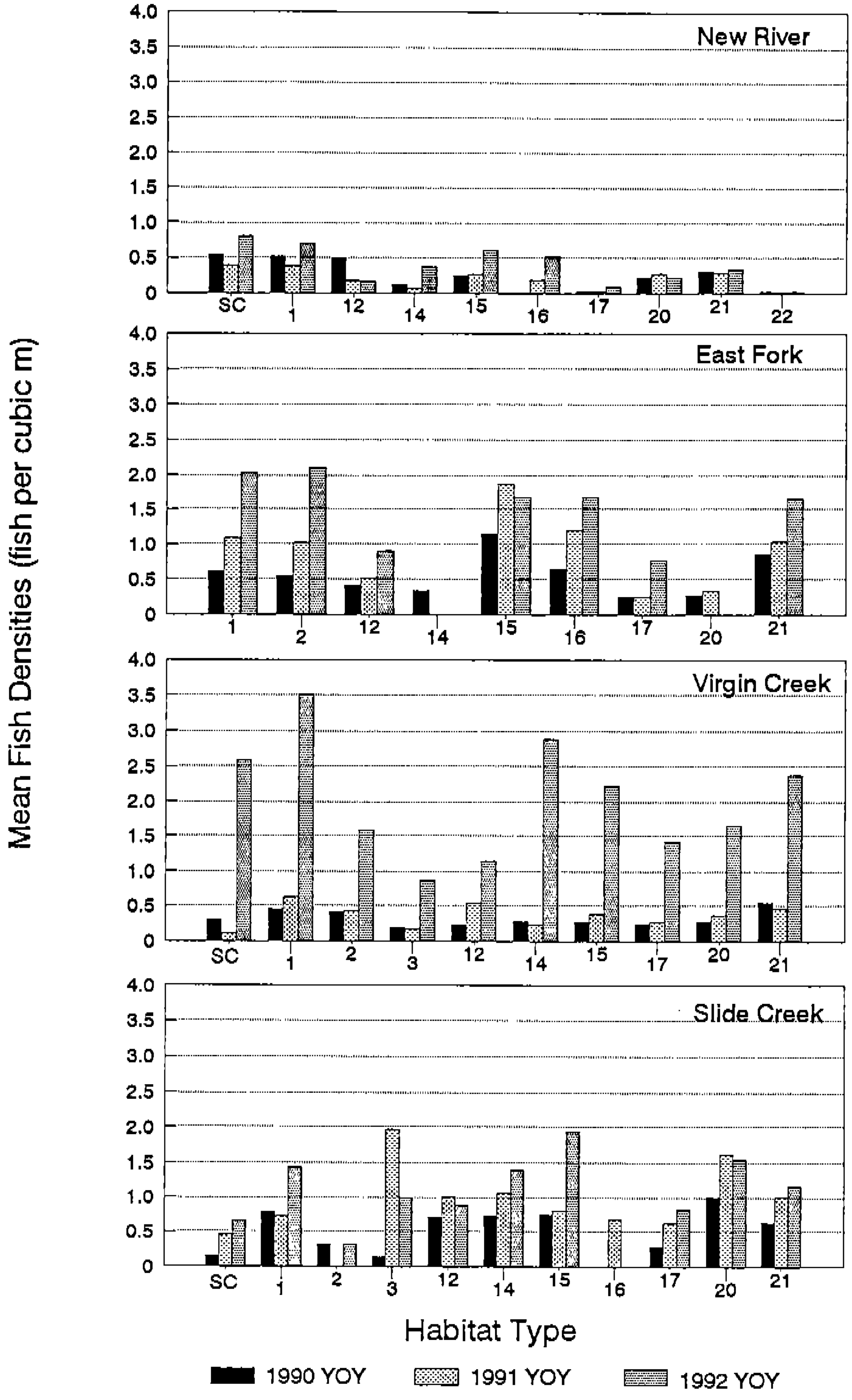

Figure 8. Steelhead young-of-year (YOY) mean densities (fish/m^3) at index reaches, by habitat types, 1990-92.

Significant differences were determined for the observed 1+ steelhead in the main-stem New River between habitat types. Mean densities ranged from a low of 0.04 in mid-channel pools to a high of 0.41 observed in runs. Low densities of 1+ steelhead were observed in glides, mid-channel pools, and corner-pools while higher densities were observed in low-gradient riffles, runs, pocket-water, and lateral-scour-boulder and bedrock pools (Figure 11). No significant differences in 1+ steelhead densities were observed between years (1990-92). Mean densities ranged from a low 0.14 in 1990 and 1992 to a high of 0.15 in 1991.

Habitat types generally remained static from 1990, 1991, and 1992. Notable exceptions were indices 3-2 and 4-0 where placer miners had altered the flat-water habitat types by "punching holes" in the gravel streambeds to create small pools and nearby spoil-piles, making differentiation of habitat types difficult. High winter and spring flows usually move gravels and may somewhat restore disturbed streambeds to previous conditions.

East Fork

This group contains only one index site that includes nine habitat types and covers 295 m length of channel (Figure 2).

YOY steelhead

Mean densities were calculated for combined densities by year (1990-92) (Figure 6) and by habitat type (Figure 7) along with habitat types by year (Figure 8).

Significant differences were observed between habitat types for YOY steelhead for the combined years (1990-92). Mean densities ranged from a low of 0.4 in mid-channel pools to a high of 1.6 in runs (Figure 7). Significant differences were also observed for combined densities for all habitat types between years with YOY steelhead mean densities ranging from a low of 0.59 in 1990 to a high of 1.48 observed in 1992.

1+ steelhead

Mean densities were calculated between habitat types by year (Figure 9) along with combined densities by year (1990-92) (Figure 7) and by habitat type (Figure 11).

There were no significant differences in the combined mean densities by year or between habitat types. Mean densities of 1+ steelhead ranged from a low of 0.06 in a glide to a high of 0.35 in the runs (Figure 11). Observed mean densities of 1+ steelhead were the lowest in glides and pocket-water and the highest in run and step-run habitat types. Mean densities for the combined habitat types compared by year ranged from a low of 0.15 in 1990 to a high of 0.21 in 1992 (Figure 7).

Habitat type changes were minimal among the three years. The glide observed in 1990 was retyped as pocket-water due to the movement of boulders. A lateral-scour-boulder pool was changed to a mid-channel pool due to additional scour extending the pool size.

As observed on the main-stem New River, 1+ steelhead densities by year seem to be static. This may also reflect a carrying capacity during the recent three drought years.

Virgin Creek

This group has three index sites that represent 10 habitat types, covering a total of 543 m length of channel (Figure 2).

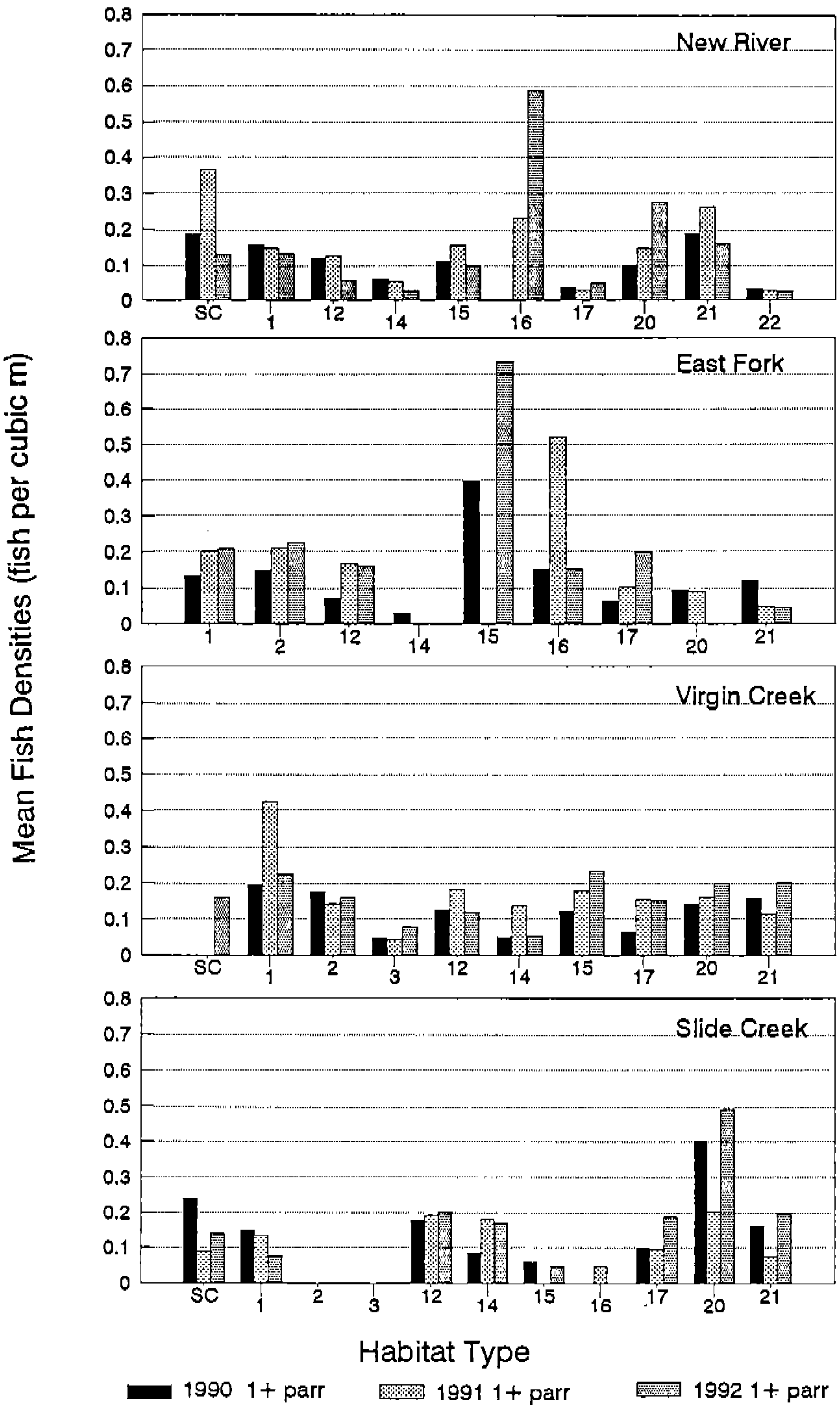

Figure 9. Steelhead (1+) parr mean densities (fish/m^3) at index reaches, by habitat types, 1990-92.

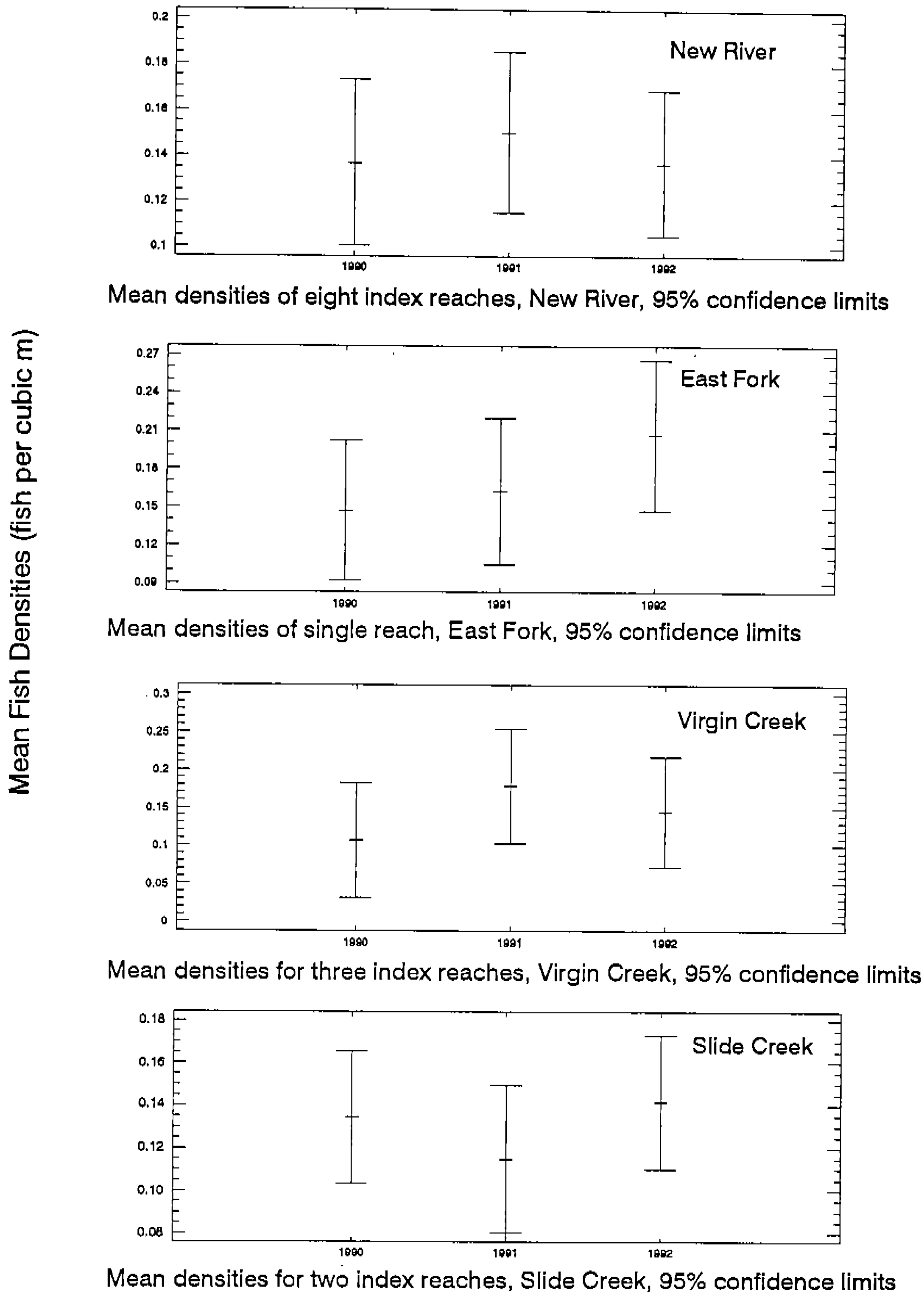

Figure 10. Steelhead (1+) parr mean densities (fish/m^3) at index reaches, 1990-92.

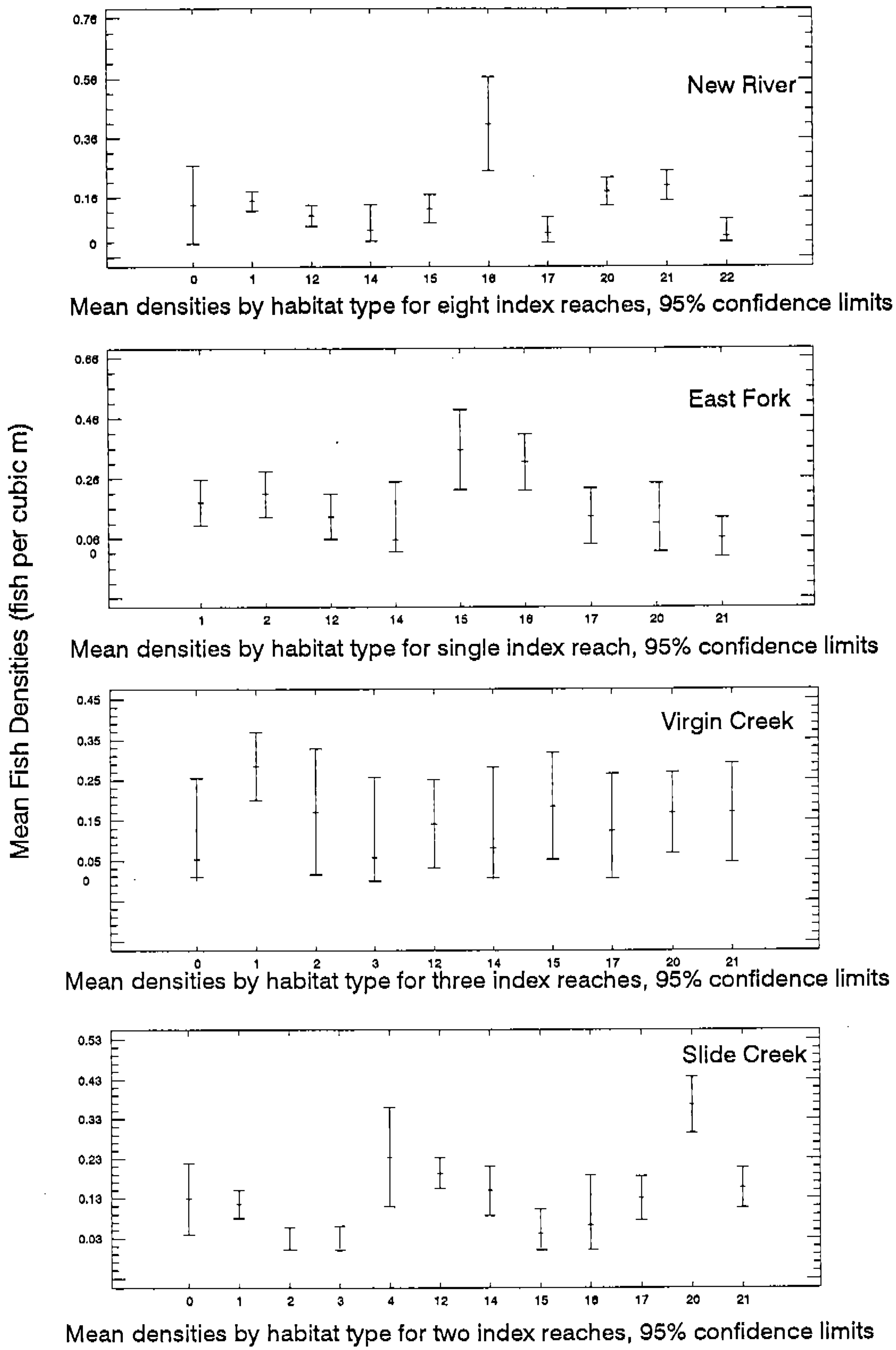

Figure 11. Steelhead (1+) parr mean densities (fish/m^3) at index reaches, by habitat types during 1992.

YOY steelhead

Mean densities were calculated for combined densities by year (1990-92) (Figure 6) and by habitat type (Figure 7) along with habitat types by year (Figure 8).

Significant differences were observed between years for YOY steelhead for the combined habitat types with a low mean density of 0.28 observed in 1990 to a high mean density of 2.01 observed in 1992 (Figure 7). Relatively high densities in 1992 may reflect a high number of spawners the previous winter. No significant differences were observed between habitat types. Mean densities between habitat types ranged from a low of 0.41 in cascades to a high of 1.56 observed in low-gradient riffles (Figure 7). Densities of YOY steelhead were lowest in the cascade, lateral-scour-bedrock pools, and mid-channel pools with highest densities observed in low-gradient riffles, glides, pocket-water and runs.

1+ steelhead

Mean densities were calculated between habitat types by year (Figure 9) along with combined densities by year (1990-92) (Figure 7) and by habitat type (Figure 11).

There were no significant differences in the combined mean densities by year or between habitat types. Mean densities of 1+ steelhead ranged from a low of 0.05 in a small side channel to a high of 0.28 in the low-gradient riffles (Figure 11). Observed mean densities of 1+ steelhead were the lowest in the side channel, cascades, and glide habitat types and the highest in low-gradient riffles, runs, and high-gradient riffles habitat types. Mean densities for the combined habitat types compared by year ranged from a low of 0.11 in 1990 to a high of 0.18 in 1991 (Figure 7).

Habitat type changes were recorded for index 7-1 (Fawn Creek area) where dredge mining had greatly altered the streambed in both 1991 and 1992. However, use of the habitat by 1+ steelhead did not change substantially. Also, a new lateral-scour-bedrock pool was formed from additional scour along a bedrock ledge. A rock slide was also observed at index 7-2 in 1991 which may change the habitat sequence after subsequent high water.

Slide Creek

This group has two index sites that represent 12 habitat types, covering a total of 420 m length of channel (Figure 2).

YOY steelhead

Mean densities were calculated for combined densities by year (1990-92) (Figure 6) and by habitat type (Figure 7) along with habitat types by year (Figure 8).

Significant differences were observed between years for YOY steelhead for the combined habitat types with a low mean density of 0.50 observed in 1990 to a high mean density of 1.07 observed in 1992. Significant differences were observed between habitat types (Figure 6). Mean densities between habitat types ranged from a low of 0.13 in high-gradient riffles to a high of 1.39 observed in lateral-scour-boulder pools (Figure 7). Densities of YOY steelhead were lowest in the high-gradient riffles, side-channels, and mid-channel pools with highest densities observed in lateral-scour-boulder pools, runs, glides, and low-gradient riffles.

1+ steelhead

Mean densities were calculated between habitat types by year (Figure 9) along with combined densities and 95% confidence interval by year (1990-92) (Figure 7) and by habitat type (Figure 11).

There were no significant differences in the combined mean densities by years. Mean densities for the combined habitat types by year ranged from a low of 0.12 in 1991 to a high of 0.14 in 1992 (Figure 7). Mean densities of 1+ steelhead ranged from a low of 0.00 in cascades and high-gradient riffles to a high of 0.37 in lateral-scour-boulder pools (Figure 11). Observed mean densities of 1+ steelhead were also low in the high-gradient riffles, and glide, and high in secondary channel and lateral-scour-bedrock pools.

No changes were detected in habitat types at the Slide Creek index reach from 1990 to 1992.

Population Trends

Summer Steelhead and Spring Chinook Adult Counts

A total of 272 summer steelhead and 18 spring chinook, including 15 jacks, were observed from September 15 to 23, 1992 (Table 1). This was the lowest annual count since the study began in 1988, and is close to another low abundance year, when an estimate of 250 steelhead was made in 1981 by CDFG (Table 2). Apparently no estimate was made that year for chinook.

In 1992, various pools located from rkm 1.6 to 3.2 were surveyed periodically from May 26 through August. Only adult steelhead were seen until August 11, when two small-sized chinook adults were seen at rkm 1.9. Juvenile chinook or adults have not been observed in the tributaries to New River; therefore only the main-stem was searched.

No other agency counted summer steelhead in New River in 1992. Discussions of poaching, mining, possible migration barriers, and steelhead counts by other agencies are presented in previous Progress Reports for New River, (USFWS 1990, 1991).

Spring and Fall Chinook Redd Counts

Results of redd surveys are reported here for both fall 1991 and 1992, since adult counts of chinook occurred in September each year while subsequent redd surveys were conducted for several weeks following. Redd surveys were conducted in mid-October, throughout November, and into early December, 1992. No redds were observed in October. Three redds (possibly spring chinook, based on timing of their appearance) were seen before November 10. Redd surveys in previous years have indicated that early November is an approximate separation time between fall and spring chinook, based on timing of redds and condition of spawners. Another seven redds, presumed to be fall chinook, were seen after November 10. Locations of redds are presented in Figure 12.

Table 1. Counts of adult summer steelhead and spring chinook in New River, CA, based on direct observation surveys conducted during September 1989 - 1992.

Location	1989		1990		1991		1992	
	Spring Chinook	Summer Steelhead	Spring Chinook	Summer Steelhead	Spring Chinook	Summer Steelhead	Spring Chinook	Summer Steelhead
VIRGIN CREEK Soldier Ck. to Four Mile Ck.	0	10	0	10	0	40	0	0
Four Mile Ck. to Confluence Pool	0	5	0	2	0	7	0	2
SLIDE CREEK N.F. Eagle Ck. to Mouth of Eagle Ck.	0	7	0	20	0	8	0	0
Mouth of Eagle Ck. to Confluence Pool	0	14	0	18	0	6	0	0
EAST FORK Mouth of South Fork to Lucky Lukes PMC	No Survey	No Survey	0	8	0	3	0	0
Lucky Lukes PMC to Mouth of East Fork	No Survey	No Survey	0	2	0	0	0	0
NEW RIVER Confluence Pool to Barron Creek	0	104	1	31	0	74	0	44
Barron Creek to East Fork Confluence	1	116	0	18	0	82	0	0
East Fork Confluence to Footbridge Area	5	177	0	50	0	93	0	73
Footbridge Area to Denny Campground	1	73	3	46	0	167	1	65
Denny Campground to Panther Creek	3	50	0	17	0	16	0	12
Panther Creek to Bell Flat (Five Waters)	1	23	2	60	1	109	8	52
Bell Flat to Mouth of New River	6	108	7	61	1	97	9	24
TOTAL	17	*687	13	343	2	702	**18	272

* count includes 32 half-pounders.
** 15 chinook believed to be jacks.

Table 2. Preliminary summer steelhead populations in northern California from 1980 - 1992, () = estimated, NS = No Survey, ND = No Data, (Gerstung pers. comm., 1992).

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

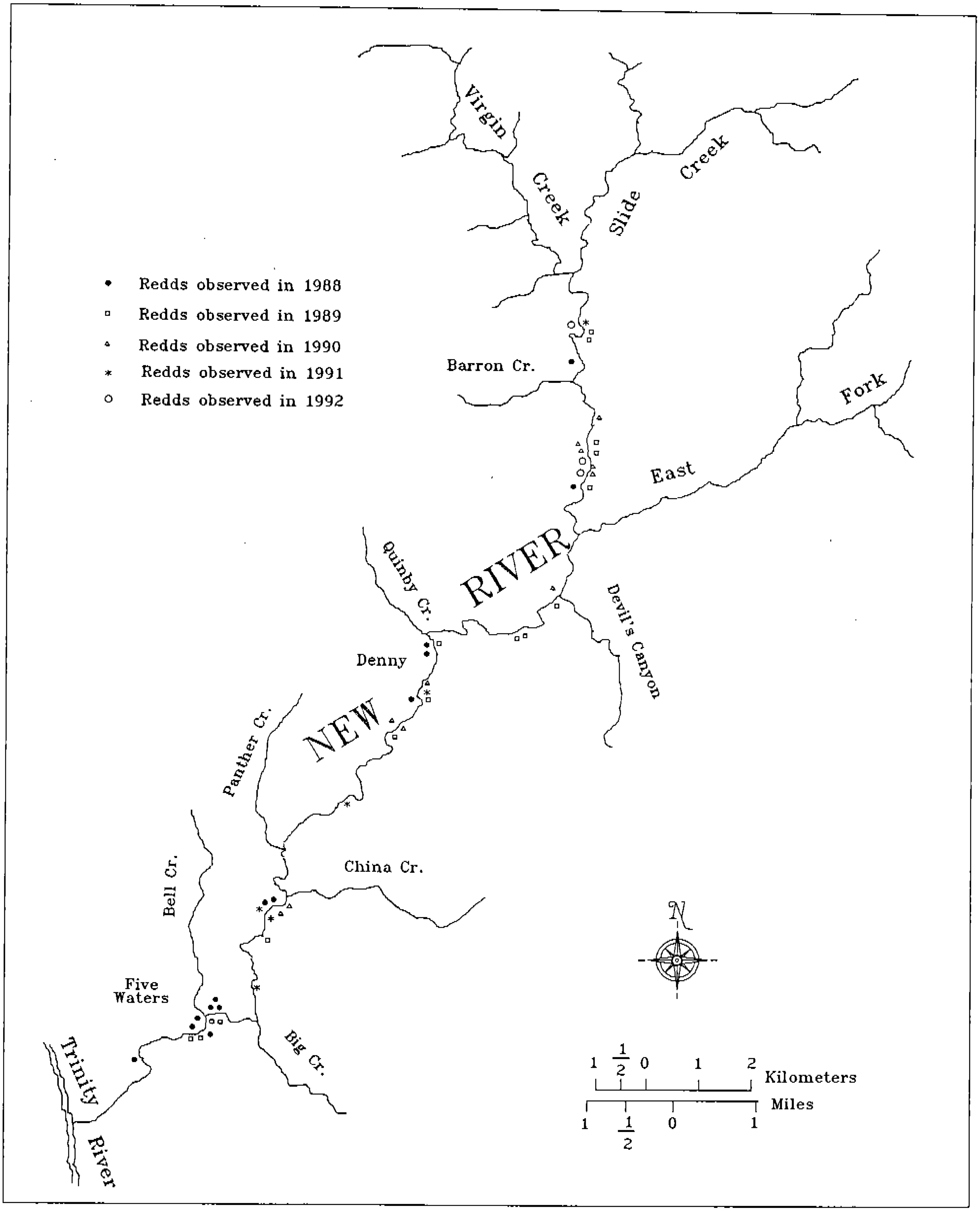

Figure 12. Locations of spring chinook redds observed in New River, CA from 1988-92.

Three redd surveys were conducted in fall, 1991, on the main-stem New River. In summary, only six redds were seen from October 22 to November 6, 1991 on the main-stem New River. Fall chinook redds were not seen in a subsequent survey in mid-November. These results were presented in the FY91 Progress Report. In the Trinity River, spring chinook spawning occurs from early September through mid-November. Spawning counts peak in late September to early October while fall chinook carcasses were first observed in early October, with their numbers peaking in early to mid-November (M. Zuspan, pers. comm., 1991). Trinity Fish Hatchery operators spawn spring chinook before October 13-18 and fall chinook after October 9 to November 1, depending on the timing and numbers of salmon returning to the hatchery (G. Ramsden, pers. comm., 1993). Numbers of fall chinook captured by a resistance-board weir, in late October through late November, 1992, will be reported in the Progress Report for FY93.

The total of six spring chinook redds observed in the main-stem New River was the lowest number of redds recorded since the project's beginning in 1988 (Figure 12). In addition, summer and autumn flows during 1992 were the lowest, and summer temperatures the highest, since the project began. Numbers of adults in New River were probably not limited by the cascade at rkm 1.1, since at least 25 chinook adults were seen above there during low flows in late October, 1992. This partial barrier was suspected of limiting chinook migration during 1991 (FY91 Progress Report, USFWS, 1992), but new evidence suggests that it may not hinder upstream migration.

Although three chinook adults and 15 jacks were seen in September, 1992, only three redds were seen before November 10. Another seven redds were seen in three subsequent surveys through December 4, and these later redds are considered fall chinook.

There have not been good correlations between chinook adult counts in September and subsequent number of redds for any of the four previous years. Possible reasons for the lack of correlation include: fish that may have eluded observers in September; fish that may have entered New River between mid-September surveys and spawning; and fish that may have died before spawning as a result of poaching or temperature stress (particularly during the recent drought years).

In 1988, nine adult chinook and two jacks were seen before November 12, and 16 redds were observed before November 10 in partial surveys that covered only 10.4 km. In 1989, 34 adult chinook were counted in September, and only 13 redds were observed before November 10, with one more redd seen during the following month of surveys. Only 13 adult chinooks were counted in September, 1990, and 12 redds were seen by November 10, with one redd seen in a survey in late November. In 1991, only two adult chinook were counted in September, while six redds were seen by November 10. No redds were seen in a later survey in mid-November, 1991.

Juvenile Trapping

Downstream migrant trapping occurred from March 30 to April 16, and May 7 to July 15, 1992 by use of a screw trap at rkm 3.7. The screw trap was destroyed when the moorings broke and it washed down-river during an unseasonable rain-on-snow storm on April 16-17. Flows increased overnight from 15.7 to 74.2 cms. A frame trap was not used at this time because experience with that type of trap in previous years was unsatisfactory at those flows. The screw trap was replaced on May 7, and operated until flows became too low in mid-July (Figure 13). Emigration rates declined after early July each year. Between 17% and 56% of the total stream flow was sampled by the screw trap over the 44 nights of trapping. A frame net was fished after July 20 to attempt to capture emigrating juveniles during

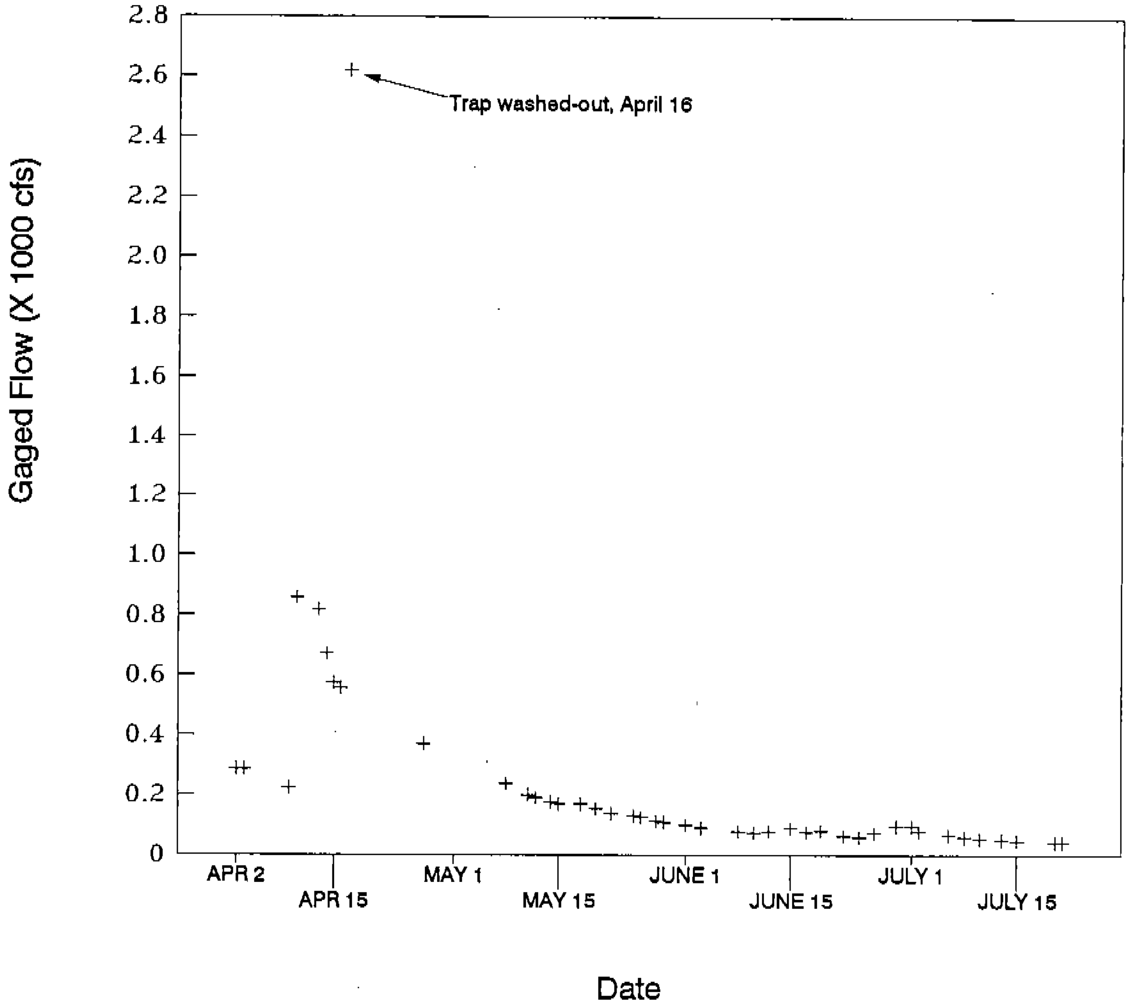

Figure 13. New River flows in cubic feet per second (cfs) during juvenile salmonid trapping, 1992.

periods of extremely low flows, but was discontinued because salmonids were not captured. Total captures for the 1992 trapping season were 121 YOY chinook, five age 1+ chinook, 2,499 YOY steelhead, 2,037 steelhead parr, and 793 steelhead smolts (Table 3). Estimates of total number of emigrating juvenile salmonids are given as the expansions of numbers captured (Figures 14, 15, 16, and 17). Note these are only calculated indices of production.

Daily estimates of emigrating salmonids calculated by species by age class were compared with the three previous trapping seasons. The discontinuous trapping period in 1992 resulted in data gaps (Figures 14, 15, 16, and 17). Peak emigrations of steelhead parr and smolts may have occurred during the 21 nights when the trap was not operated.

Chinook

Total season estimates for YOY chinook indices were 800, which was 42% of the previous year and only 22 and 25% of 1989 and 1990 respectively (Figure 14). Season estimates were not comparable for older chinook, since only four age 1+ chinook were trapped in 1991, and none of this age class were trapped in 1989 and 1990.

The first YOY chinook was captured on May 8, and the peak emigration was in June. The majority of YOY chinook had left the system by late June. The few numbers of chinook trapped during the time of year when many more were observed in previous years probably reflects the low number of spawners in the fall and winter of 1991. It is unknown if the remaining YOY chinook wintered in New River and left the system as 1+, or emigrated during high winter flows. Only 3 YOY chinook were observed during index surveys in late July, 1992, compared to 114 in 1990 and 114 in 1991.

Only five 1+ chinook were captured in the 1992 trapping season, (fork length range 92 - 112 mm). The first 1+ chinook was captured on April 3 and the last was captured on April 16. Peak emigration of chinook smolts likely occurred before trapping began. Low numbers of this age class observed in the screw traps and during snorkeling in both 1991 and 1992 suggests this is not a common life strategy in New River.

Histograms showing chinook fork lengths for 1989, 1990, 1991 and 1992, display the sizes of fish passing through the trap location (Figure 18). The mean fork length for juvenile chinook in 1989 was 72 mm (n = 424, SD = 10.3), 1990 was 66 mm (n = 708, SD = 9.4), 1991 was 69 mm (n = 565, SD = 10.9), and 1992 was 74 mm. The larger chinook in the 1991 and 1992 histograms are the 1+ chinook contribution.

YOY steelhead

The first YOY steelhead (length 45 mm) was caught on May 12. Very few YOY steelhead emigrated during late April in 1992, so that count is least affected by the interruption in trapping.

Total season estimates for emigrating YOY steelhead were far more in 1992 than previous years: 780% more than 1991, 670% more than 1990, and 1500% more than 1989 (Figure 15). Catch of this age class was apparently not affected by the hiatus in trapping, since few if any fish were caught before May 7 in each of the four trapping seasons. Several reasons likely explain the differences in total estimates between years: numbers of spawners in the previous winter, stability of flows during incubation, and perhaps overall volume of rearing habitat available. September counts of adult steelhead (Table 1) do not include any (uncounted) fall or winter fish, but generally correspond to total estimates of emigrating YOY steelhead during the following spring and summer.

Table 3. Summary of screw trap and late-season frame trap catches at New River, CA, 1989-92. YOY=young of year

	1989					1990					1991					1992				
Month	Steelhead			Chinook		Steelhead			Chinook		Steelhead			Chinook		Steelhead			Chinook	
	yoy	parr	smolt	yoy	1+	yoy	parr	smolt	yoy	1+	yoy	parr	smolt	yoy	1	yoy	parr	smolt	yoy	1+
March											0	20	47	0	1					
April	0	67	3	4	0	1	4,669	1,349	25	0	0	390	234	1	1	0	1,423	446	0	5
May	2	662	173	55	0	31	645	231	341	0	1	551	256	105	2	741	529	337	53	0
June	140	364	22	375	0	297	50	7	350	0	221	157	17	420	0	911	41	8	67	0
July	46	6	2	61	0	201	29	3	106	0	1	2	0	10	0	847	44	2	1	0
August						0	0	0	0	0	1	0	0	1	0					
September						28	4	0	0	0	15	9	0	0	0					
October						6	0	0	0	0	1	0	1	0	0					
November						9	0	0	0	0										
Total	188	1,099	200	425	0	573	5,397	1,590	822	0	240	1,129	555	537	4	2,499	2,037	793	121	5

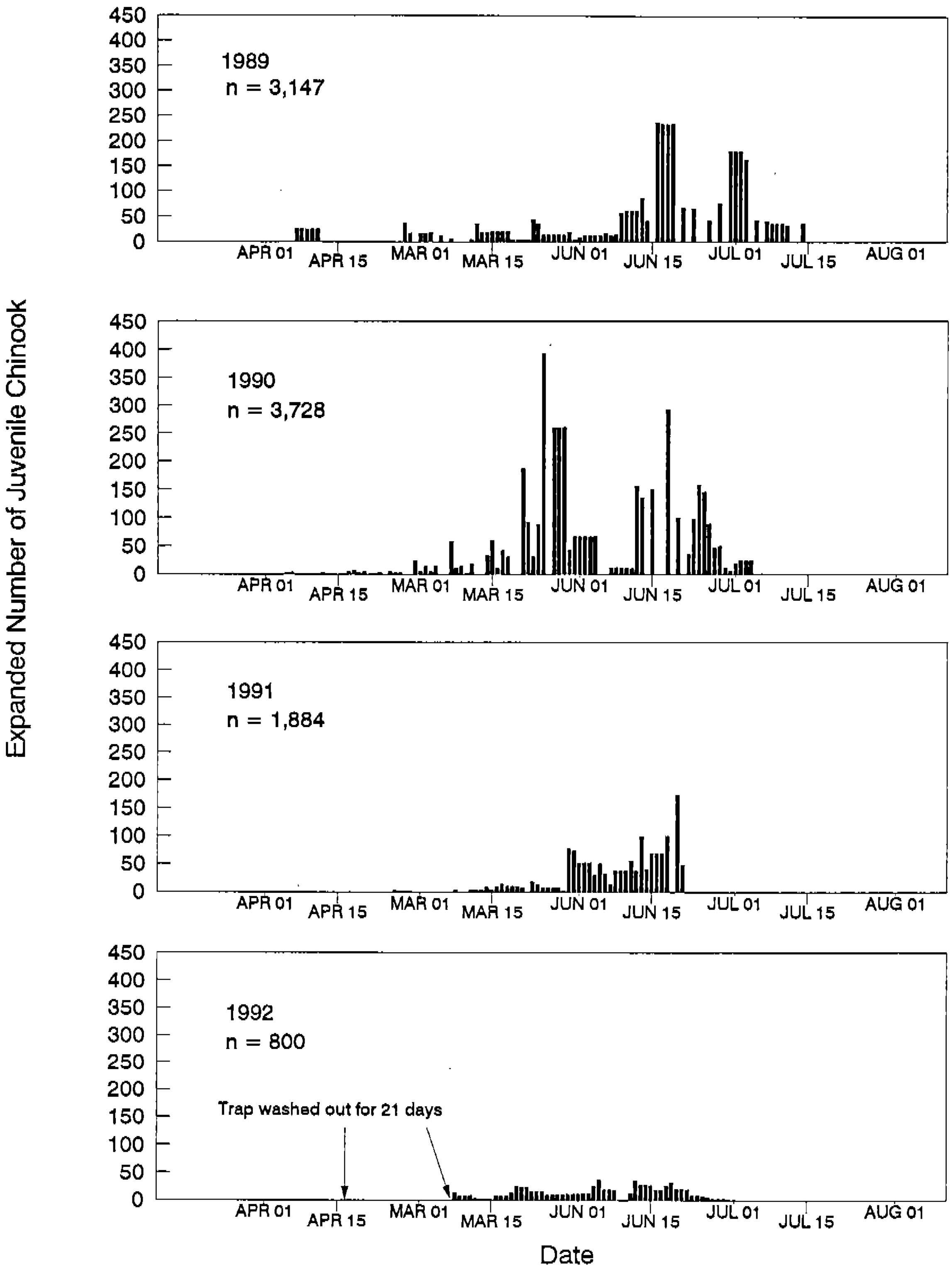

Figure 14. Juvenile chinook expanded daily emigrant estimate, based on New River screw trap catches, 1989-92.

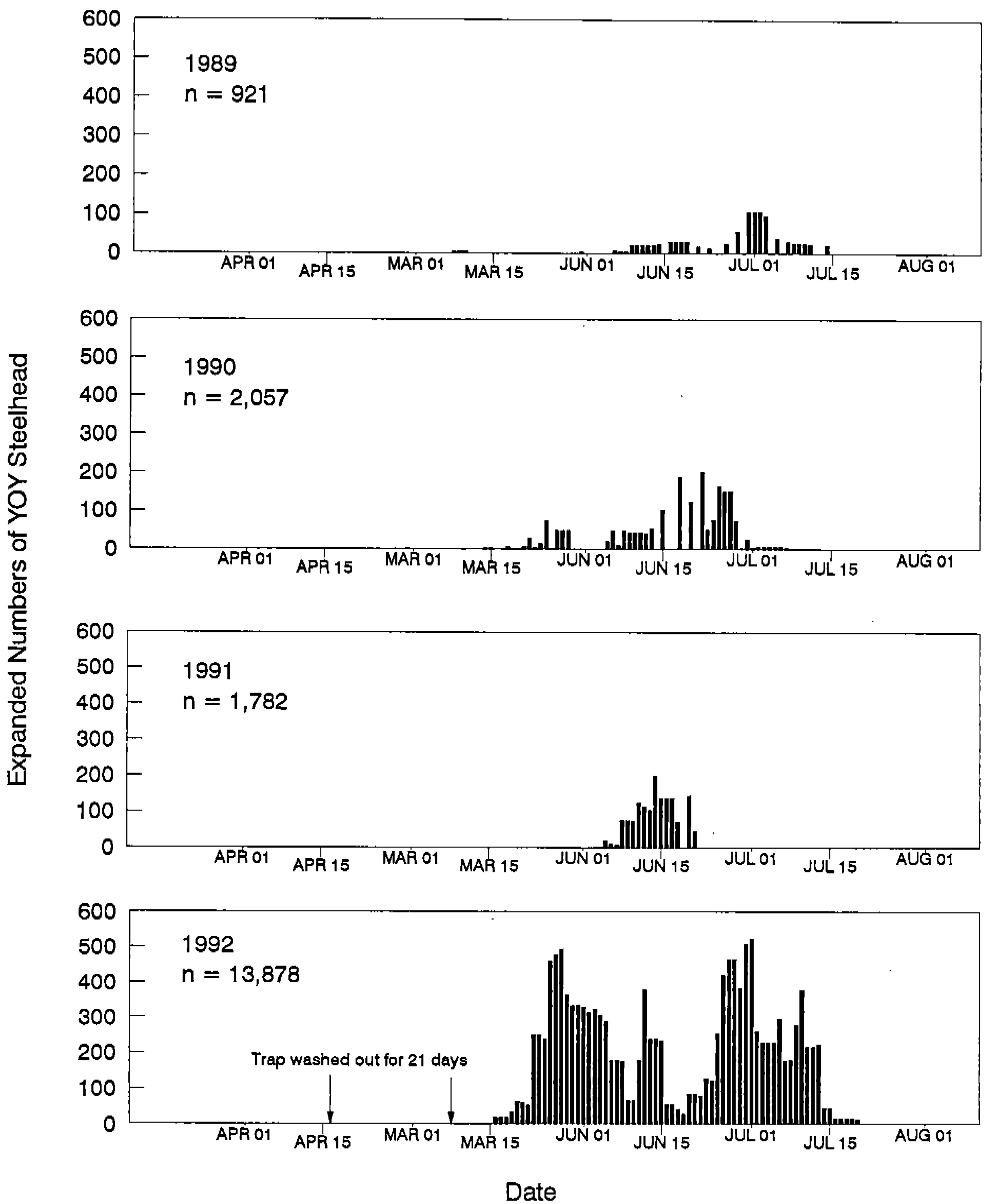

Figure 15. Steelhead young-of-year expanded daily emigrant estimate, based on New River screw trap catches, 1989-92.

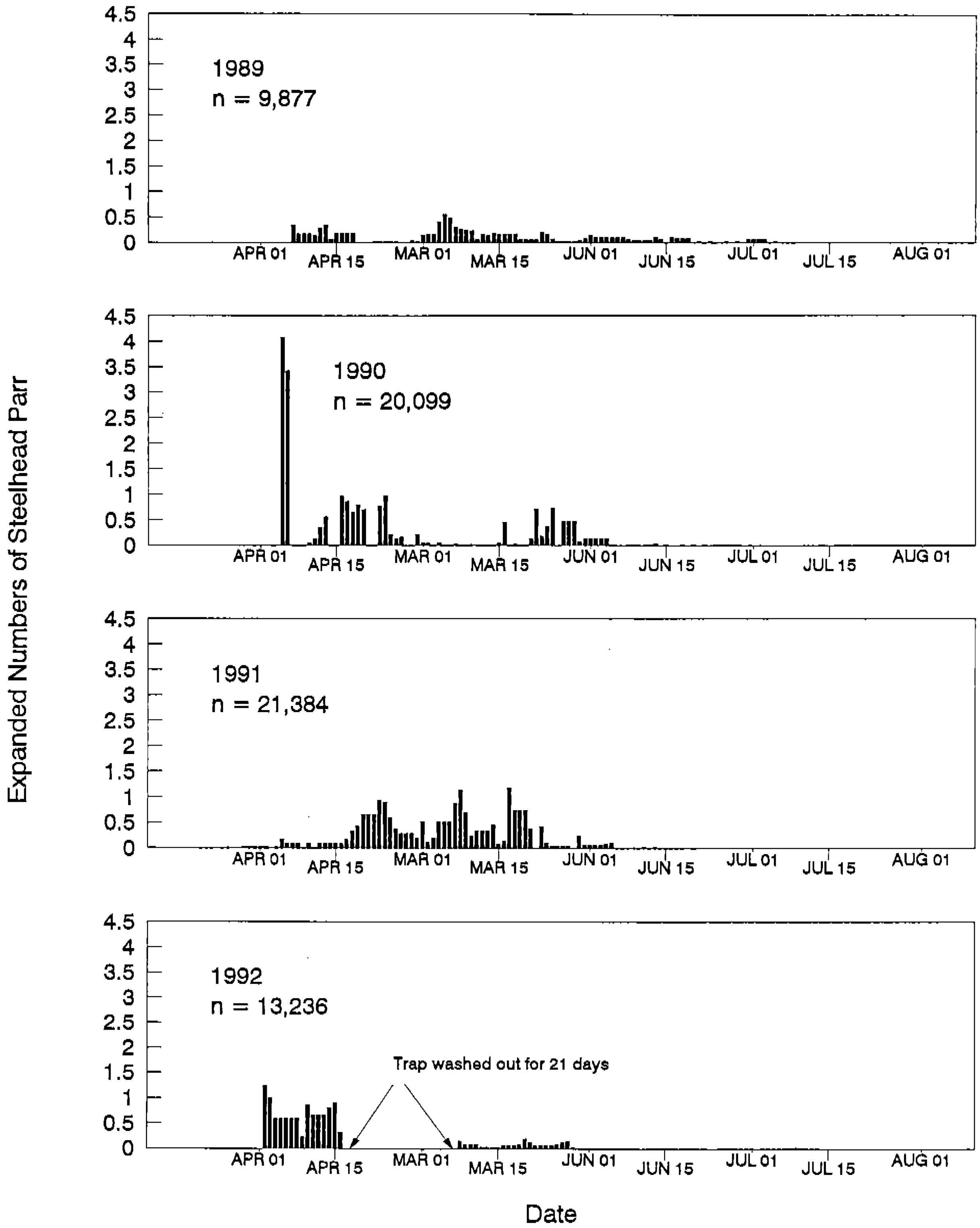

Figure 16. Steelhead parr expanded daily emigrant estimate, based on New River screw trap catches, 1989-92.

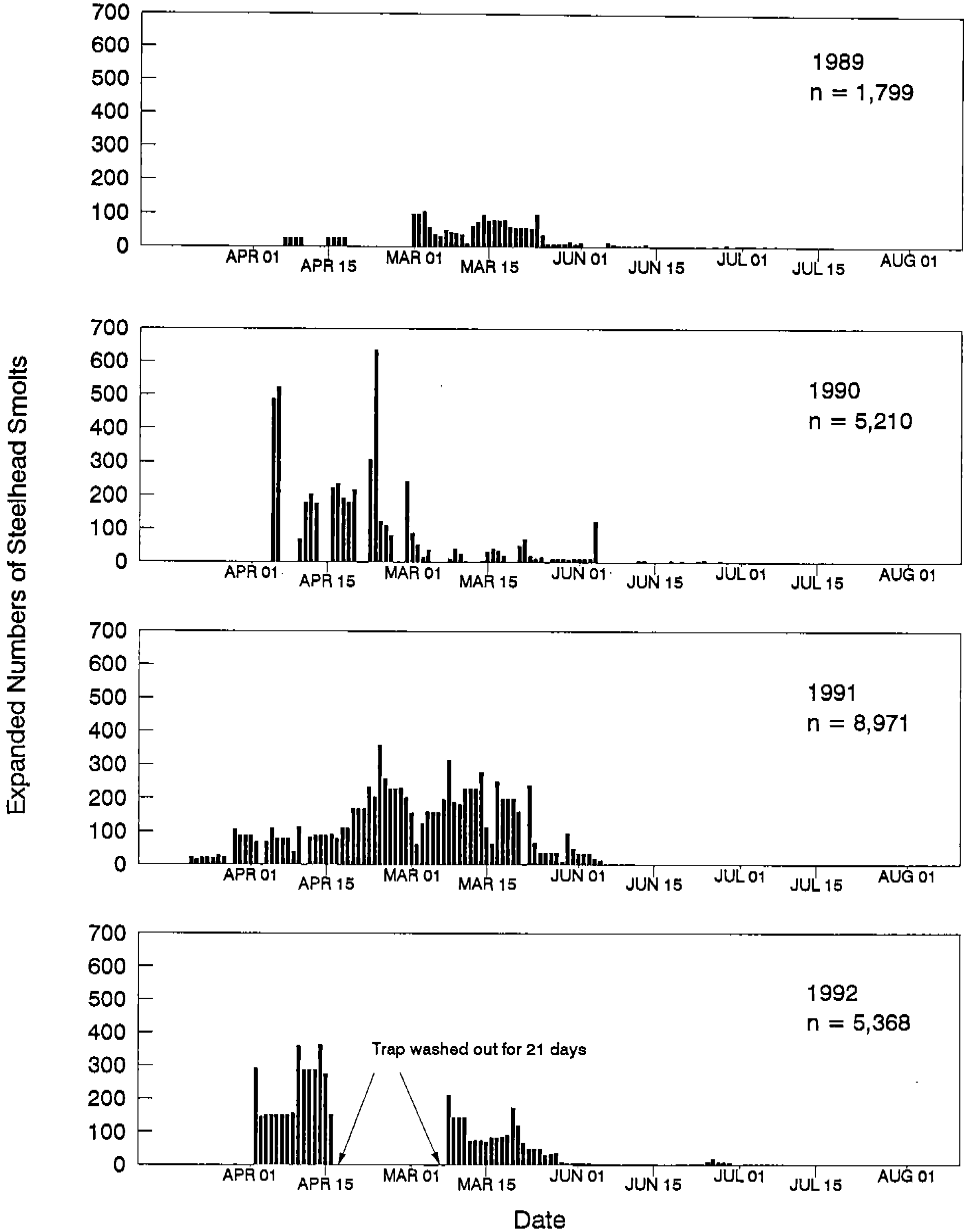

Figure 17. Steelhead smolt expanded daily emigrant estimate, based on New River screw trap catches, 1989-92.

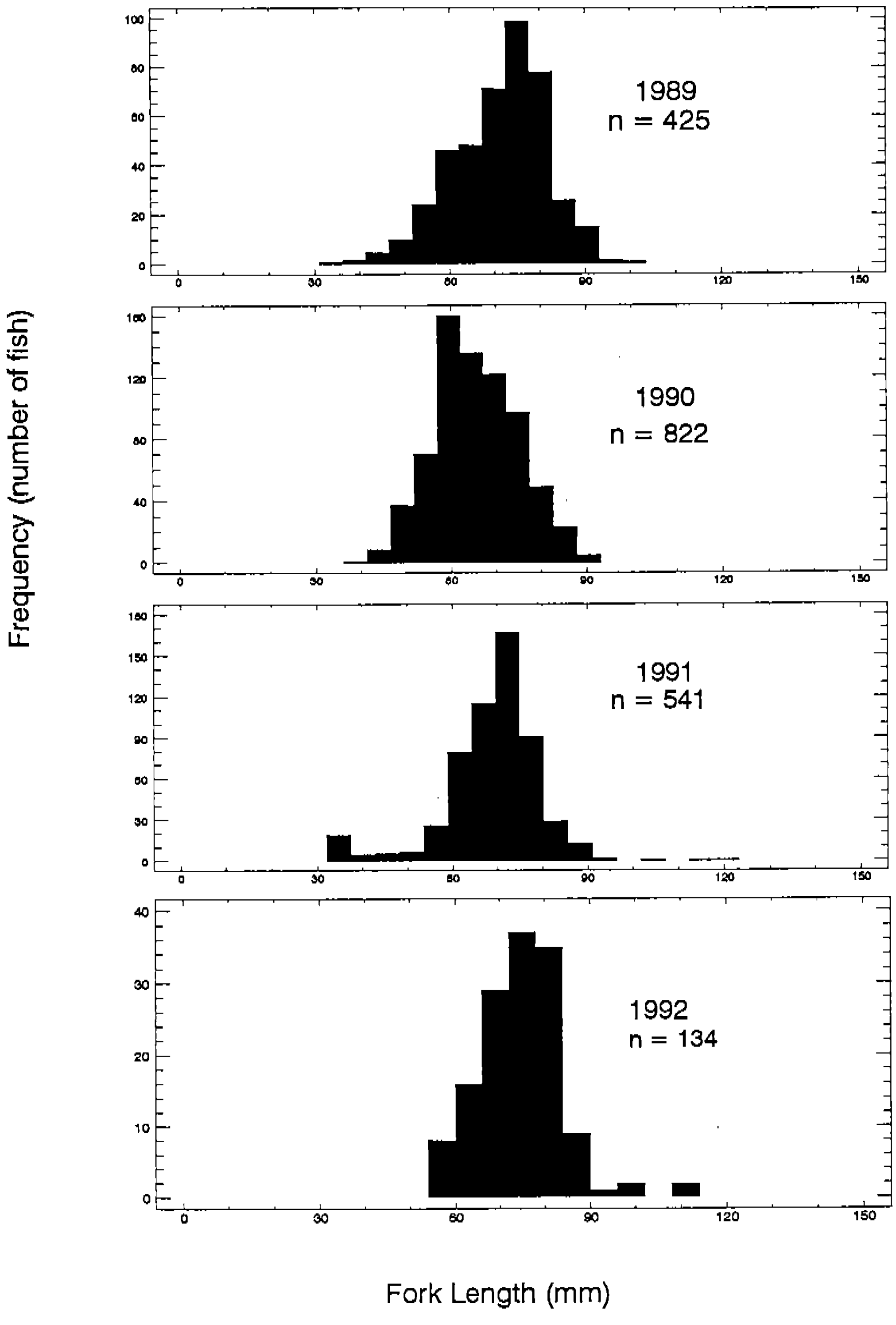

Figure 18. Juvenile chinook length-frequency histograms, based on New River screw trap catches, 1989-92.

The overall volume of year-round rearing habitat was not measured but summer habitat volume may be inferred from measured sites at the 14 index reaches. These volumes were relatively low during all the drought years, with the lowest volume in 1992. A lower volume of rearing habitat would be expected to effect a displacement of the smallest fish (YOY steelhead) downstream by competitive and predatory salmonids. A lower volume may also provide less edge-water habitats within constrained reaches, which dominate the main-stem of New River. Salmonids that have just emerged from natal gravel prefer quiet edges for several weeks. Volumetric comparisons between years for index reaches will be presented in the 1993 Progress Report.

Steelhead parr and smolts

Peak emigration of steelhead smolts and parr appeared to be well underway by early April and dwindled to very few by early July (Figures 16 and 17). Steelhead emigration halted by mid-July. The large numbers of parr and smolts caught in the first week of trapping in 1992 suggests that trapping operations may have begun too late to collect most of the emigration.

Total season estimates of emigrating steelhead parr and smolts were also affected by the trap not operating for 21 nights during their emigration period. An unknown number of steelhead parr and smolts emigrated during that period.

Steelhead length frequency histograms for April, May, June and July are displayed in Figure 19. Mean fork lengths and 95% confidence intervals are shown in Figure 20. Mean fork lengths for YOY steelhead ranged from 51 mm (Julian week 19) to 56 mm (Julian week 28), 1+ steelhead ranged from 93 mm (Julian week 14) to 131 mm (Julian week 28), and 2+ steelhead ranged from 170 mm (Julian week 14) to 229 mm (Julian week 25).

The length/displacement relationship was determined for both 1992 juvenile steelhead and chinook (Figures 21, 22). Slopes were determined for the log transformed linear regressions for juvenile steelhead (2.9) and juvenile chinook (2.8). According to Castleberry et al. (1991), a slope above 3.0 indicates that fish are in better condition, and become heavier for a given length as they grow. Since smolts are included in the steelhead regressions a lower value is expected because steelhead undergoing smoltification are predominantly leaner fish. These slopes are comparable to data from the 1991 trapping season, when juvenile steelhead data showed a slope of 2.9 and chinook data were 3.1.

The overall condition of juvenile salmonids was rated as excellent during trapping operations. Mortality rates were negligible (less than 0.1%) from trap operations. No external diseases were observed, although puncture wounds, possibly attributable to birds, were observed on numerous YOY steelhead and chinook.

Ages of scales taken from juvenile steelhead were determined only for the sizes of fish that were of indeterminate age class, in order to place every fish into an appropriate category, i.e. YOY, parr, and smolt. The separate and disparate age classes of fish captured in the trap, arranged by fork lengths, are graphically depicted in Figure 19. For example, the graph for May shows a distinct group of small sized fish, YOY steelhead, and two overlapping groups of larger fish. Ages of fish were determined for about 50 fish with fork lengths ranging from 130 to 155 mm.

Most adult steelhead returning to New River show two years of growth in fresh-water, according to unpublished scale analyses from FY 1993.

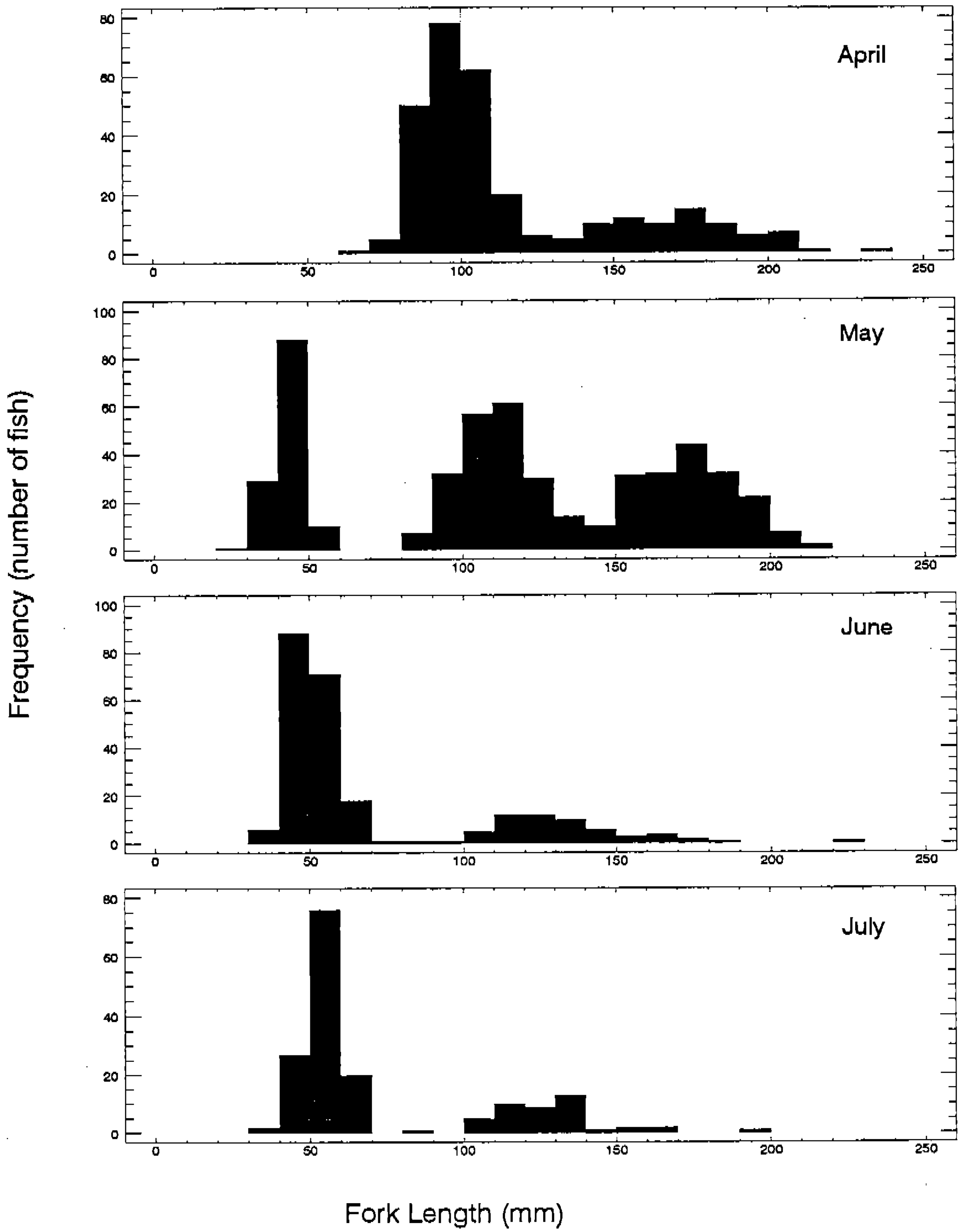

Figure 19. Juvenile steelhead length-frequency histograms, based on New River screw trap catches, 1992.

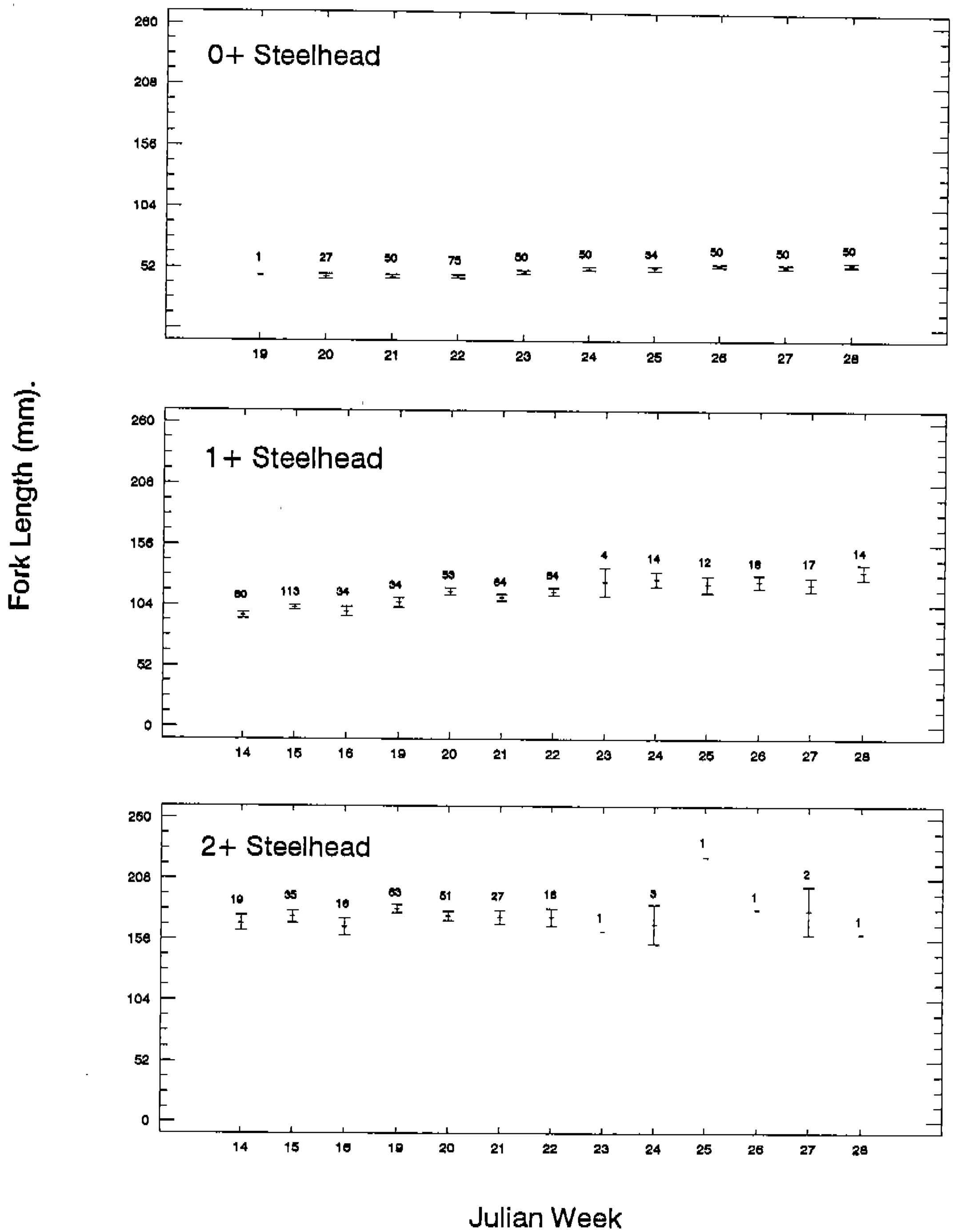

Figure 20. Average steelhead fork lengths, catch by Julian week, based on New River screw trap catches, 1992. Superscripted numbers are the sample size for each week. (See appendix C for list of Julian weeks and calendar dates.)

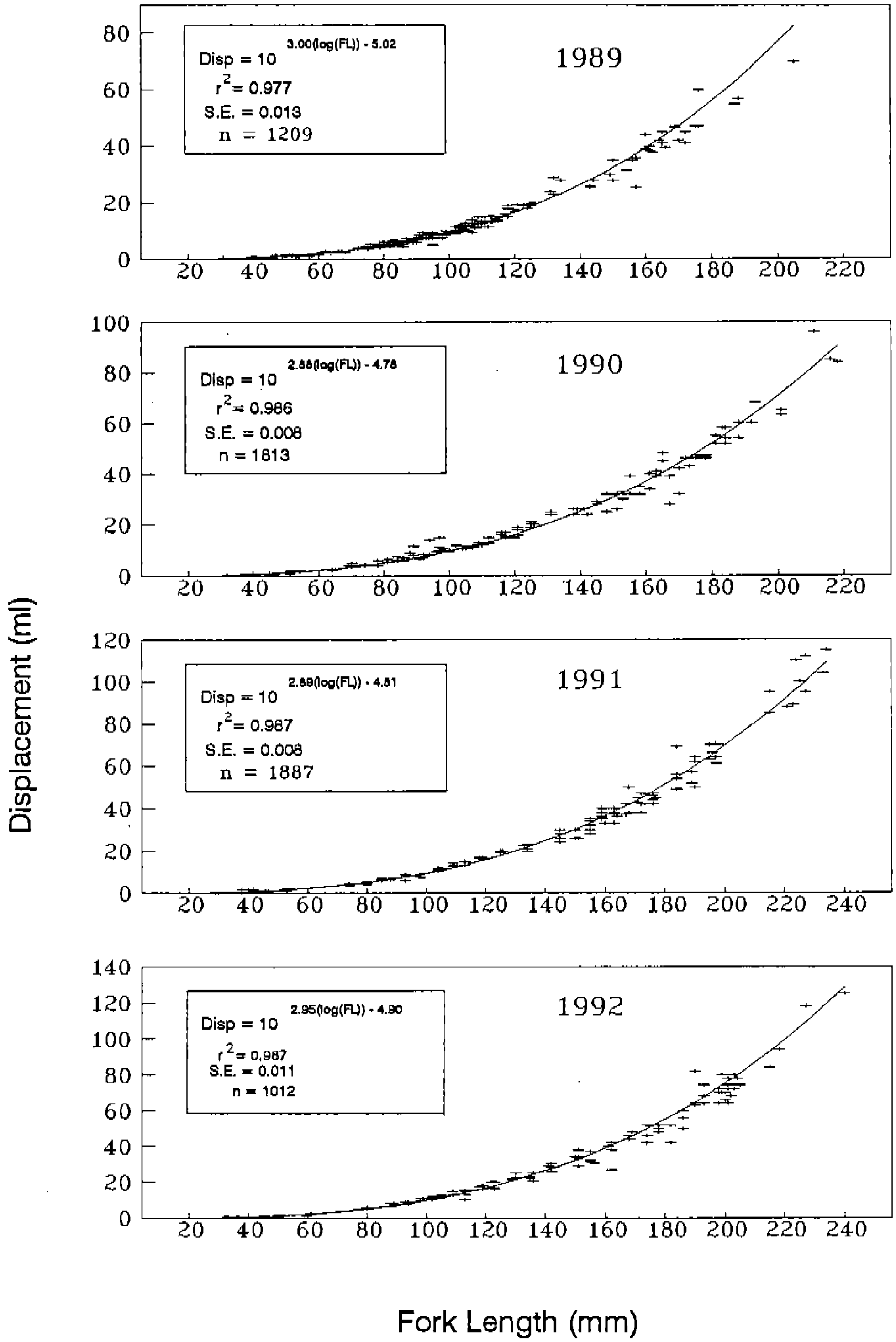

Figure 21. Juvenile steelhead length-displacement relationships observed at New River during 1989-92.

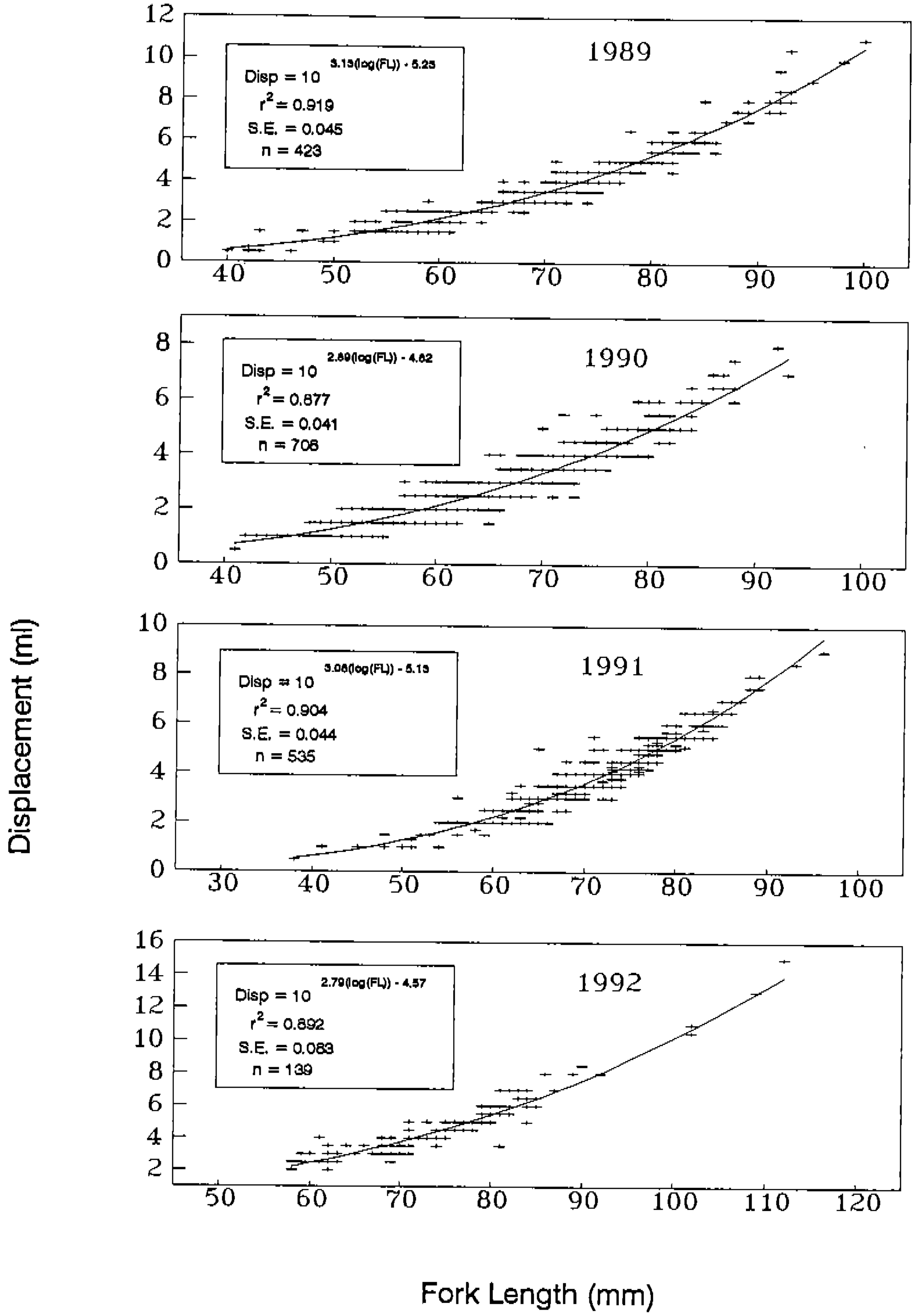

Figure 22. Juvenile chinook length-displacement relationships, observed at New River during 1989-92.

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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
SC	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 (Bawl)	
8	Trench/Chute (TRC)	Channel cross sections typically U-shaped with bedrock or coarse-grained bottom flanked by bedrock walls. Current velocities are swift and the direction of flow is uniform. May be pool-like.
9	Plunge Pool (PLP)	Found where stream passes over a complete or nearly complete channel obstruction and drops steeply into the streambed below, scouring out a depression; often large and deep. Substrate size is highly variable.
10	Lateral-Scour Pool formed by Log (LsL)	Formed by flow impinging against one streambank 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 (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. List of Julian weeks and calendar dates.

Julian week	Calendar date start	end	Julian week	Calendar date start	end
01	Jan 01	Jan 07	27	Jul 02	Jul 08
02	Jan 08	Jan 14	28	Jul 09	Jul 15
03	Jan 15	Jan 21	29	Jul 16	Jul 22
04	Jan 22	Jan 28	30	Jul 23	Jul 29
05	Jan 29	Feb 04	31	Jul 30	Aug 05
06	Feb 05	Feb 11	32	Aug 06	Aug 12
07	Feb 12	Feb 18	33	Aug 13	Aug 19
08	Feb 19	Feb 25	34	Aug 20	Aug 26
09	Feb 26	Mar 04	35	Aug 27	Sep 02
10	Mar 05	Mar 11	36	Sep 03	Sep 09
11	Mar 12	Mar 18	37	Sep 10	Sep 16
12	Mar 19	Mar 25	38	Sep 17	Sep 23
13	Mar 26	Apr 01	39	Sep 24	Sep 30
14	Apr 02	Apr 08	40	Oct 01	Oct 07
15	Apr 09	Apr 15	41	Oct 08	Oct 14
16	Apr 16	Apr 22	42	Oct 15	Oct 21
17	Apr 23	Apr 29	43	Oct 22	Oct 28
18	Apr 30	May 06	44	Oct 29	Nov 04
19	May 07	May 13	45	Nov 05	Nov 11
20	May 14	May 20	46	Nov 12	Nov 18
21	May 21	May 27	47	Nov 19	Nov 25
22	May 28	Jun 03	48	Nov 26	Dec 02
23	Jun 04	Jun 10	49	Dec 03	Dec 09
24	Jun 11	Jun 17	50	Dec 10	Dec 16
25	Jun 18	Jun 24	51	Dec 17	Dec 23
26	Jun 25	Jul 01	52	Dec 24	Dec 31