Progress Report for
Investigations on New River

FY 1991

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ABSTRACT

Continued decline of anadromous fish stocks in the Trinity River and its major tributaries has aroused concern in the basin and promoted 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 (Service) has been funded by the Trinity River Restoration Program for fisheries investigations in New River from 1988 to the present. Initial surveys of New River determined that the spring chinook run was dangerously low and the presence of the fall run chinook was unconfirmed. Summer steelhead surveys determined that New River supports one of the largest runs in California with counts exceeding 700 adults in 1991. Numbers of adult winter steelhead spawners is unknown, but will become evident in 1992/1993 when the resistance board weir is installed in the lower river. Spring chinook redd counts ranged from 16 in 1988 to 6 in 1991. Partial barriers to chinook immigration appear to limit distribution of spawners, these barriers will be investigated in summer 1992. Habitat summaries of the East Fork of New River, Slide Creek, Eagle Creek and Virgin Creek were completed. The East Fork was identified as a non-chinook stream due to the stream gradient ranging from 2.5 to 4.5%. Virgin and Slide creeks provide both chinook spawning and rearing habitat, although chinook have not been observed in these drainages. The second summer of juvenile rearing index surveys was also completed. Significant differences were observed between years for yoy chinook in the mainstem. Numerous juvenile chinook were observed in New River during August, September, and October of 1991. Significant differences were observed for yoy and 1+ steelhead (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 densities were observed in mid channel pools, corner pools, and glides. Summer index assessments will be repeated in 1992 to compare with data collected in the summer of 1990 and 1991. Downstream migrant trapping operations were used to determine the emigration period for juvenile salmon (May - July) and steelhead (March - July) to aid in management strategies to protect the native stocks. A small percentage (%) of juvenile chinook were observed to over-winter. Temperature and discharge has been continuously monitored throughout the investigation; flows ranged from 22 to 2,700 cfs and mean daily temperatures ranged from 0.6 to 23.6 °C (33.1 to 74.5°F) in 1991.

INTRODUCTION

The Trinity River Basin has experienced substantial declines in anadromous fish runs in recent years. Natural causes such as droughts and floods, as well as development associated with population growth, have contributed to a reduction 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 populations to historic levels in the Trinity River proper and significant tributaries.

New River, a major tributary to the Trinity River, is currently being investigated. New River is a nearly pristine watershed and is virtually untouched by logging. It has shown a substantial recovery from the high water event during December 1964, when heavy sediment loads were deposited in the streambed. Habitat for juvenile and adult salmonids is not severely degraded and does not appear to be fully utilized. New River appears to be a suitable index tributary to monitor changes in salmonid populations that are not associated directly with instream habitat improvement projects or watershed rehabilitation programs. New River has one of the largest summer steelhead populations in California and a remnant population of spring chinook salmon. According to the California Department of Fish and Game (CDFG), the total number of wild summer steelhead in California ranges from 1500 to 4000 fish and the number of wild spring chinook are less than 1000 fish. The potential for listing these species as threatened or endangered in California under state and/or federal endangered species laws is increasing with the continued decline of these populations.

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 stock enhancement potential for chinook salmon in the basin. In 1989, the project has broadened its scope 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 outmigrants. Additional information on spawning runs will be acquired after the installation and operation of a resistance weir in the fall of 1992. Recommendations to enhance stock production will be proposed following the project's completion in 1994.

STUDY AREA

Description

New River is one of the major tributaries to the Trinity River and is located 70.2 river kilometers (rkm) upstream of the confluence of the Klamath and Trinity Rivers.

Access to the majority of the river is limited due to inclusion in the Trinity Alps Wilderness Area, steep canyon walls, and areas of private ownership. Main access roads to New River are Highway 299 and the Denny road at Hawkins Bar. The Denny road parallels the river for approximately 27 kilometers (km) along the steep canyon walls. Access to the river is via private land until the public campground areas near Denny (rkm 18.5). After Denny, the road continues back into USFS land for about 5 km where it branches into short routes that end at the New River, Jim Jam, and East Fork trailheads. All access thereafter is nonmotorized.

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 concentrated human population (population 25 - 50). The U.S. Forest Service has jurisdiction over the majority of land in the area.

Salmonid species of the basin are spring chinook salmon (Oncorhynchus tshawytscha), rainbow trout (O. mykiss), and summer and winter steelhead (O. mykiss). Fall chinook runs were thought to occur in the basin; however, their existence has not been confirmed. Approximately 80.5+ km of the New River drainage is accessible to adult steelhead and provides excellent nursery areas for the juveniles. Investigations are presently being conducted to evaluate the spring chinook and steelhead populations and their habitat use in the drainage. Other known fish species of the drainage include speckled dace (Rhynichthys osculus), Klamath small scale sucker (Catostomus rimiculus), and the Pacific lamprey (Lampetera tridentata).

History

The Denny area of the New River drainage was extensively gold mined in the mid to late 1900'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 endured until the early 1900's, then the last town, Old Denny, was abandoned in 1920 (USFS 1989).

Numbers of steelhead in the early 1900's are unknown, but local residents claim that the population was so large that streams and pools were "so black with fish you couldn't see the stream bottom". Fish stocking occurred for steelhead in the 1930's and 40's, coho salmon (O. kisutch) in 1968, and chinook salmon in 1979 (Table 1). There is no present evidence or record of coho salmon returns to the basin.

Table 1. Stocking history of the New River drainage.

Date	Species	Size	Number	Hatchery
1932	Rainbow Trout	Unknown	15,000	Unknown
1933	Rainbow Trout	Unknown	15,000	Unknown
1933	Steelhead	Unknown	5,000	Unknown
08-03-38	Steelhead	43/oz.	30,300	Prairie Creek
07-27-39	Steelhead	44/oz.	50,200	Prairie Creek
07-17-41	Steelhead	41/oz.	30,340	Mt. Shasta
07-21-42	Steelhead	42/oz.	24,320	Mt. Shasta
1968	Coho	16/oz.	72,000	Trinity
10-30-79	Spring Chinook	9.2/lb.	1,380	Trinity
10-31-79	Spring Chinook	9.0/lb.	1,800	Trinity

The flood of 1964 had a dramatic effect on the instream habitat of the mainstem New River. After the flood event, there was a lack of pools and streamside canopy, which elevated water temperatures and, subsequently, degraded the remaining habitat. Thomas (pers. comm.) stated, " New River was like a sidewalk from the confluence of Virgin and Slide Creeks to the mouth".

In 1980, New River was declared as one of the National Wild and Scenic Rivers. The Trinity Alps was designated as a wilderness area in 1984. Close to 68 percent of the New River watershed is within the wilderness boundaries and moderate recreational use occurs in the summer months when average air temperatures are between 29 and 35 degrees Celsius (°C) daily and -4 to 7°C nightly.

Channel Morphology/Geology/Hydrology

New River is a fifth order stream that flows in a southwesterly direction through deeply incised, "V" shaped canyons. Elevation increases from 213 meters (m) at the mouth to 1,646 m in the headwaters. Channel morphology consists of an average stream width of 9 m, average depth of 1.1 m, with some pools as deep as 5.5 - 6.1 m. Stream gradient averages 1.2 % and the pool to riffle ratio is 20:50 (Freese and Tayler 1979). The primary sources of instream fish cover are boulders, bedrock ledges, pool depth, and surface turbulence. Instream woody material, as well as vegetative canopy, is lacking throughout most of the river. The upslope overstory vegetation consists of douglas fir, maple, digger pine, madrone, and California black oak. Understory riparian vegetation includes herbaceous shrubs, alders, and willows.

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 constitute the remaining 20%. Predominant rock formations of the area are of the Rattlesnake Creek Plate type. Tectonic mixing is suspected in this unit due to the highly variable rock compositions. The Ironside Mountain Batholith contains the lower reaches of the river and the western side of the drainage up into the headwaters. This area is underlain by hornblende diorite which is known to be highly erosive (Young 1978).

Boulder and bedrock banks are common throughout the system and bank slopes vary from 25 to 100 degrees. Bank degradation is minimal but is present where logging or burning has occurred. Pools, bank slides, and recently dredged (mined) areas contain most of the fine sediment and siltation found in the drainage. Compaction is relatively slight.

New River, predominantly a rain influenced basin, drains a total area of 448 square kilometers and can be characterized as "flashy". Current average annual precipitation is 102-127 cm. The heaviest precipitation normally occurs between December and April with peak discharge normally in February or March. The United States Geological Survey (USGS) recorded a peak discharge of 45,000 cfs on December 22, 1964; however, annual high flows have averaged 1,000 to 1,125 cfs in January, February, and March of 1989 and 1990. Low flows have been as low as 18 cfs (October 1961), but have averaged 24 to 72 cfs in August, September, and October of 1989, 1990, and 1991. The USGS period of record is 1961 - 1965 (USGS 1970).

MATERIALS AND METHODS

Stream Physical Measurements

Water Temperature Monitoring

A Ryan Instruments TempMentor temperature recorder (Model #RTM) was used to monitor stream temperature at 2 hour intervals beginning Aug 21, 1988. The TempMentor was anchored with a cement casing to prevent it from dislodging during storm flow conditions. This casing also camouflaged the recorder to preclude disturbance. The tempmentor was placed at rkm 3.5. Temperature data was downloaded onto RTM software and maximum, minimum, and average daily temperatures were calculated for water years (October 1 - September 30) 1989, 1990, and 1991.

Discharge

A staff gaging station was constructed at rkm 3.3 by use of a staff gage with anchor straps and bolts. A river crest gage (1" polyethylene tubing) was attached to the gage with the bottom end submerged in the water. Fine burnt cork shavings are placed inside the tubing and washed down to the meniscus. The raising and lowering of the water level leaves a cork resins on the inside tubing indicating the peak flow height. The gage/discharge relationship established in 1990 (Shaw et al. 1991) was used to determine the discharge for the varying gage heights throughout the investigation.

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

X = gage height, Y = discharge

The relationship was confirmed at a variety of flows by use of a Scientific Instruments, Inc. Price AA Current Meter. Flows were taken across a transect line (rkm 3.5) at 1.5 meter intervals and at the recommended depths for the calculation of total stream discharge.

Stream Classification

Channel Typing

Channel typing, using methods by Rosgen (1985) was continued for Virgin Creek, East Fork, Slide Creek, and Eagle Creek. Channel typing was based on channel gradient, sinuosity, width/depth ratio, dominant particle size of bed and bank materials, entrenchment of channel and confinement of channel in valley; and landform features and soil stability and soil stability such as low river terraces and fine textured banks (Appendix A).

Habitat typing

Habitat typing, using methods presented by Bisson et al. 1982 (modified by McCain et al. 1990) was completed for Virgin Creek (mouth to Soldier Creek, rkm 8.6), Slide Creek (mouth to Eagle Creek, rkm 4.5), Eagle Creek (to rkm, 1.4), and East Fork (mouth to Cabin Creek, rkm 11). Habitat types were identified by the observers using the Pacific Southwest Region Habitat Field Guide (USFS) based on 24 habitat unit types (Appendix B).

The surveyed creeks, with the exception of the lower 3.1 rkm of East Fork, are within the Trinity Alps Wilderness Area. All access was gained by use of USFS trails.

Mean length and width measurements were taken by using calibrated range finders (Ranging Inc. 620, 123X). A systematic approach was used to determine which habitat units were sampled for physical characteristics. At each change in channel type, units were tallied and every fifth unit of each specific habitat type was measured for mean depth, max depth, and depth at pool tail crest. Depth measurements were obtained by use of a telescoping leveling rod. Percent stream shade, percent pool instream cover, cover complexity, percent substrate composition, percent embeddedness, percent exposed substrate, time, temperature, and comments were also recorded. Every third unit of infrequent habitat types were sampled to reduce the likelihood of not being represented among measured units. Snorkel counts of juvenile salmonids were not conducted due to limited personnel and to allow time for other investigations on the river. Areas and volumes for the sampled reaches were calculated based the expansion of the 20 percent sampled.

Habitat Evaluations

Index Reaches

After assessing the habitat information collected from 1988 - 1990, permanent index reaches were established on the mainstem New River, East Fork, Slide Creek and Virgin Creek for long term monitoring of juvenile abundance and changes in habitat units.

Methods used to determine index reaches depended on the geomorphical characteristics, the proportional representation of primary habitat types, and the accessibility and the location of tributaries. As a result, eight index reaches and six sub-index areas were developed in the New River system (Figure 1). Six sections are located within B1(3)and C1(3) channel types, and eight are in B2 (4) and B3 (4) channel types. Flagging, spray paint and metal tags tacked to trees were used to mark the index reaches and identify separation points between habitat units. Index sections were snorkeled 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 the index area. Total numbers of fish, classified by species and age class, were tallied at upstream ends of individual units. Snorkelers proceeded upstream in this fashion until they reached the upper end of the index section. 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 limited and was practiced only in instances where each diver could clearly see both banks. For this method, both divers snorkeled the chosen unit and counted all fish observed. Teams then compared counts to determine their accuracy. Electroshocking calibration was not an option due to the rugged terrain, large deep pools, and time limitations. Divers recorded their degree of confidence (% of fish observed) to gain an idea of the reliability of count. After the entire index section was snorkeled, physical measurements were taken at designated transect points (downstream end, 1/4, 1/2, 3/4, upstream end) for each unit within the index reach. Stream widths were measured with a rangefinder at each transect point and depths were measured with a metric stadia rod across each transect from the right bank edge, 1/4, 1/2, 3/4, and the left bank edge. Maximum depths and mean unit lengths were also recorded. Additional information obtained included: percent total cover, dominant/subdominant cover (bank, small woody material, large woody material, terrestrial vegetation, surface turbulence, boulders, bedrock ledges and depth), and dominant/subdominant substrate; bedrock, boulder (>30cm), cobble (8-30cm), gravel (.5-8cm), sand (1mm-.5cm), and fines (ssc,<1mm). Average densities (fish/m^3) for habitat types were determined for yoy, 1+, and 2+ steelhead in the mainstem New River, Virgin Creek, Slide Creek, and the East Fork. Average densities were also determined for juvenile chinook remaining in the mainstem New River. Densities were calculated by volume since the yoy steelhead and chinook along with the 1+ and 2+ steelhead were dispersed throughout the habitat units during the summer months. Multivariate analysis was used to determine significant differences between years and habitat types for fish densities.

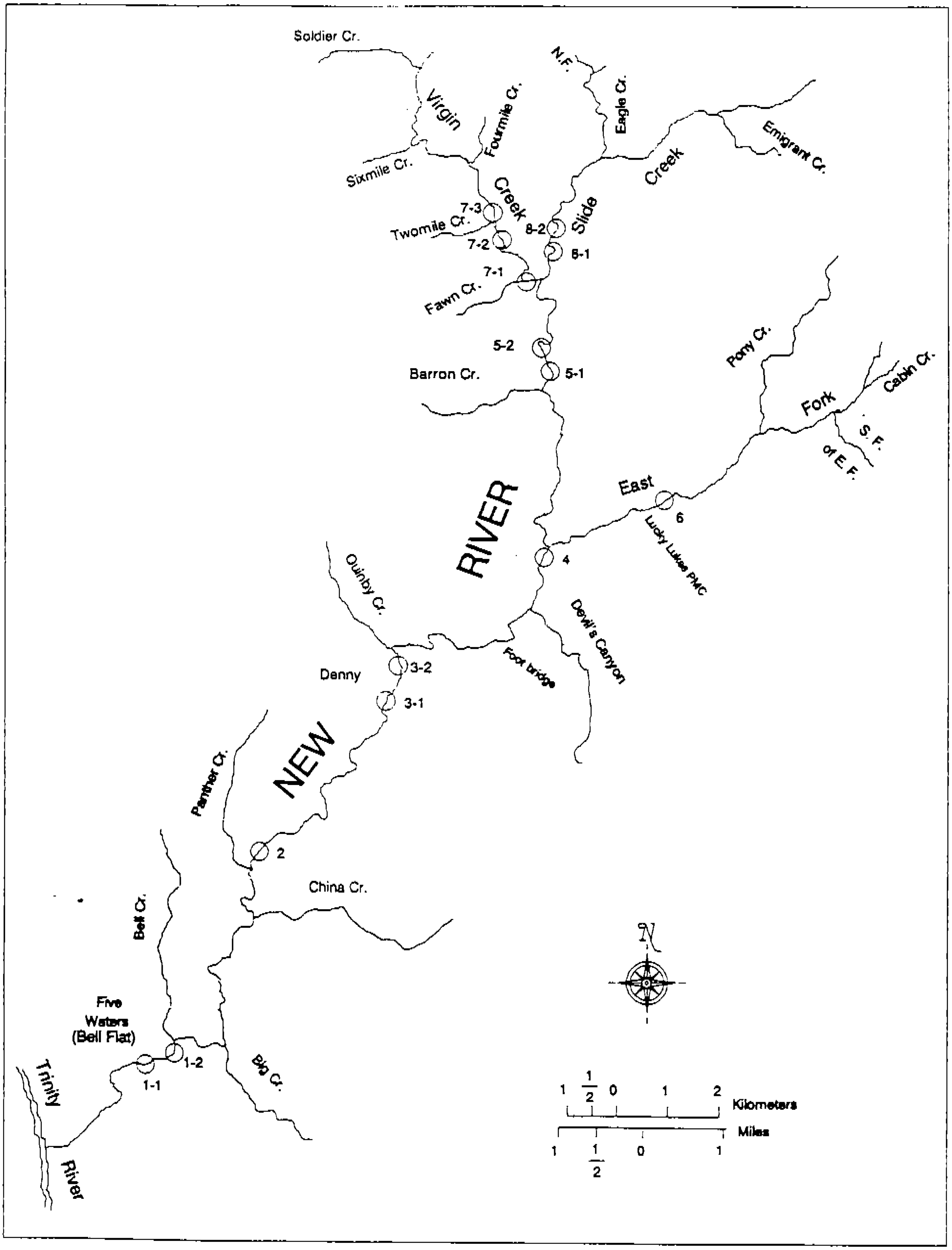

Figure 1. Juvenile salmonid index reach locations.

Population Trends

Summer Steelhead and Spring Chinook Counts

Two summer steelhead and spring chinook adult surveys were completed in 1991 to determine if adults continue to enter the New River drainage after July. The first survey was completed on the mainstem New River from the confluence of Virgin and Slide creeks to the mouth of New River in conjunction with the U.S. Forest Service (Redwood Science Lab) from July 8 - July 11, 1991. From September 4 - September 12, 1991 the mainstem of New River, 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) were surveyed with the assistance of the USFS (Shasta/Trinity) biologists. All habitat units within these sections were snorkeled. Numbers of summer steelhead and spring chinook along with their location and habitat type were recorded.

Spring Chinook Redd Counts

Three redd surveys were conducted on the mainstem New River from the confluence of Virgin and Slide to the mouth of New River. The surveys were completed on biweekly basis from October 22 to November 20, 1991. Habitat unit type, location in unit, 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 - 30cm, small cobble 8 - 15cm, large gravel 3.5 - 8cm, small gravel 0.5 - 3.5cm, and fines (ssc) < 0.5cm) were recorded at each redd location. The age of redds were categorized as code 1 (fresh, rocks bright; little or no algal growth on rocks; mound well developed), code 2 (2 weeks to one month old, rocks somewhat brighter than surrounding rocks; algal growth has dulled brightness of rocks in redd; mound may be slightly flattened), and code 3 (greater than 1 month, rocks dull and cannot be distinguished from surrounding rocks; identification of redd by pit and mound only).

Juvenile Trapping

A rotary screw trap (Figure 2) and frame net trap were again used in 1991 for the capture of emigrating juvenile salmonids. The rotary trap is comprised of a fiberglass spiral vane enclosed in a funnel-shaped aluminum pipe ring and galvanized hardware cloth enclosure. An aluminum pipe though the focus of the opening provides a spinning medium. Two aluminum encased styrofoam pontoons support the funnel and livebox as well as providing floatation and a walkway. The plywood cross braces along the front and rear of the trap allowed a working medium and an access to the live box. The trap's circular opening has a diameter of 2.44 meters and is capable of operating up to a depth of 1.22 meters. Water that passes though the trap opening and against the spiral vane causes the funnel to spin along its axis. All fish entering the trap are sectioned off from the river and passed through the auger into a holding box at the rear of the structure. Small-sized floating debris are removed from the live box by use of a perforated drum located at the rear of the live box. The drum is turned by use of a gear connected to the spiral vane. The floating debris are forced against the drum and passed out of the live box into the stream at the rear of the trap. Flows were taken at the right, center, and left side of the trap mouth 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 discharge sampled was then estimated by correlating the river discharge and the flow sampled by the trap. Assuming fish were equally distributed across the trap location (8 - 13 meters), numbers of fish passing through the site were extrapolated from the capture rate and percent discharge sampled.

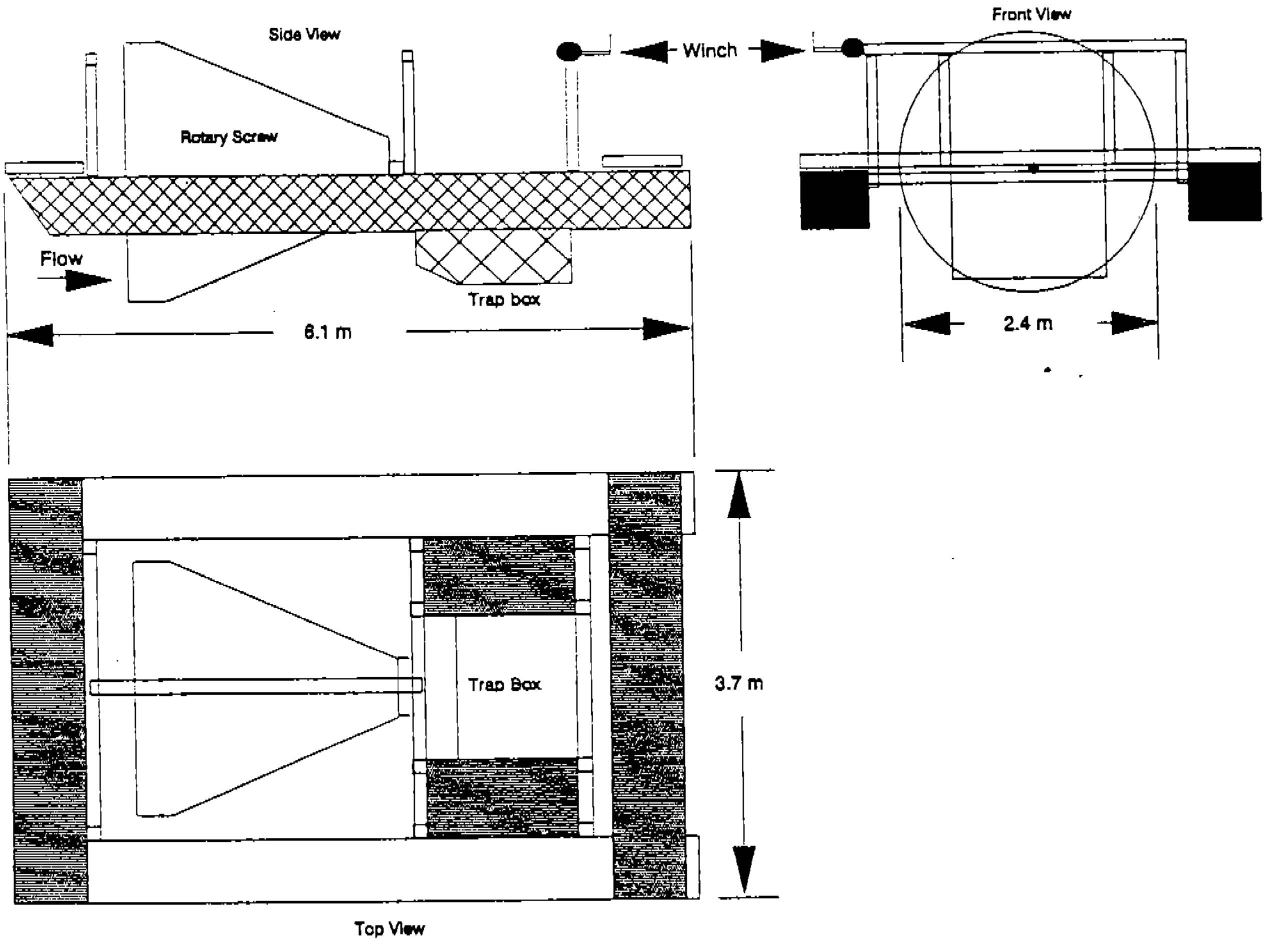

Figure 2. Views of the rotary screw trap used on New River.

On days not sampled, numbers of outmigrants were estimated using the average catch rates and discharge sampled prior and following the non trapping periods. The same trapping location (rkm 3.75) has been utilized since the later half of 1989.

When the New River discharge fell below 35 cfs (beginning on August 28) the rotary screw trap became inoperable, a frame net trap (1.5 x 3 meter opening) was then utilized. Flows were also taken at the trap mouth to determine percent discharge sampled and numbers of fish outmigrating were extrapolated similarly to the rotary trap.

The trapping season for 1991 was March 20 - October 22, 1991. All fish captured after a nights fishing were separated into species, young-of-year (yoy), parr, and smolt then tallied. Lengths and displacements were taken from random samples of up to 50 fish of each salmonid species and age class. Scales were taken from up to 25 juvenile steelhead to determine the proportion of yoy, yearlings, and 2+ aged fish. Fish were also examined externally for any symptoms of diseases and parasites.

Peak outmigration 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 steelhead yoy, parr, and smolts passing through the trap location were calculated for the 1989, 1990, and 1991 trapping seasons. Juvenile length displacement relationships were derived by using log transformed linear regression analyses. Length frequency histograms, average length at date, and length at age relationships were derived for juvenile chinook and steelhead for the trapping season.

RESULTS AND DISCUSSION

Stream Physical Measurements

Water Temperature Monitoring

Mean daily water temperatures were calculated for the 1991 water year (wy) (October 1, 1990 - September 30, 1991). Mean daily water temperatures ranged from a low of 0.7 °C (33.2 °F) in late December to a high of 23.6 °C (74.5 °F) in late July (Figure 3).

Drought conditions observed in 1991 influenced water temperatures during summer and winter months. Reduced snow pack, rainfall, and runoff in the summer (July - September) contributed to water temperature increases beyond that noted in other years; although, summer temperatures remained within the range for successful juvenile steelhead and chinook production (adult holding and rearing). Both juvenile and adult steelhead and chinook were observed to congregate near cool water tributaries during the summer snorkel surveys. Temperatures from July through September were again above the threshold (3.3 - 13.3°C) for the successful upstream migration of spring chinook (Reiser and Bjornn 1979), although deep pools and cool water tributaries are located throughout the drainage and provide some holding habitat for adult spring chinook and summer steelhead.

Degradation to the watershed's riparian and upslope vegetation by poor logging, mining, and grazing practices could potentially increase the temperature of the cool water tributaries causing an increase of the summer temperatures of New River beyond the tolerant range for the migrating and holding adult summer steelhead and spring chinook.

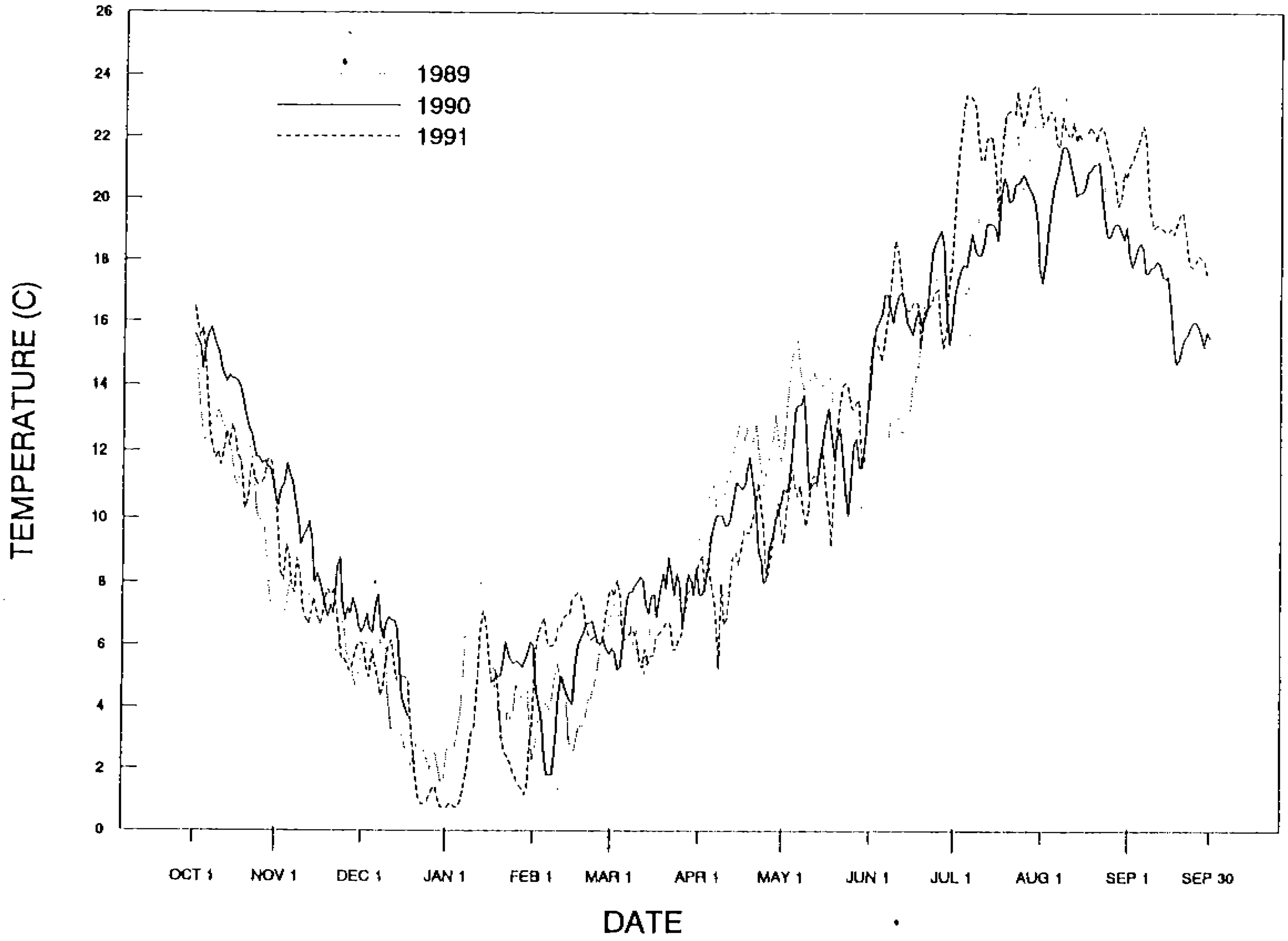

Figure 3. New River water temperatures for water years 1989, 1990, and 1991.

Low water temperatures during winter do not appear to be a problem in this system. 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 in 42.5°C in 72 hours). The majority of spring chinook redds were constructed in October giving the embryos two months to develop into a cold water tolerant stage.

Discharge

The New River average monthly discharge for 1991 (October 1, 1990 - September 30, 1991) was the lowest recorded since the projects beginning in 1988. Average monthly discharges for the 1989, 1990, 1991, and the USGS 1960's surveys (USGS 1970) are presented in Figure 4. A peak discharge of 2,700 cfs was recorded by use of the crest gage at rkm 3.3 in February 1991. Summer flows ranged from 97 cfs in June to 23 cfs in September. Peak flow for the New River drainage recorded by the USGS on December 22, 1964 was 45,000 cfs (USGS 1970).

Stream Classification

East Fork of New River

Study Site

The East Fork flows in a south to southwest direction, its banks are fairly steep sided and the stream is well shaded due to overhanging trees. Overstory vegetation includes Douglas fir, incense cedar, western white pine, alder, maple, madrone, black oak, and redbud. The East Fork stream temperatures remain below 18 °C during the summer due to the stream canopy and shading by steep sided banks. Scars are still present from the Jim Jam Fire in 1952 in the lower 2 rkms. Three major tributaries (South Fork, Pony Creek, and Cabin Creek) were observed on the East Fork that seem to support small populations of juvenile steelhead/rainbow trout (RBT). Caddis fly larvae, dragonfly larvae, mayfly larvae, and stonefly larvae and drift forage appear to be abundant. Spring chinook have not been recorded or observed in the East Fork drainage. The stream gradient (2.5 - 4.5%), lack of abundant spawning beds, and the limited holding pools may be factors deterring the chinook from using the drainage. Access to the East Fork was gained by use of the USFS East Fork (Pony Butts) Trail which begins at rkm 3.1 (bridge crossing, Trinity Alps Wilderness Area) and follows the creek to the Cabin Creek confluence.

Channel Typing

The East Fork of New River was channel typed from the mouth to the confluence of Cabin Creek (rkm 10.9). Twelve channel type changes were observed. B1 (8350 m, 76.4%), B2 (761 m, 7.0%), and A2 (1817 m, 16.6%) dominated the study area, which reflect the channel entrenchment and confinement. Elevation increases from 510 m at the mouth to 830 m at the Cabin Creek confluence. Channel materials were dominated by large cobble and small boulders (Table 2).

Habitat Typing

Habitat typing of the East Fork began in August of 1989 and was completed to the confluence of Cabin Creek in August of 1990 (Table 3). Beyond this point, the river becomes bedrock dominated and constricted, although juvenile

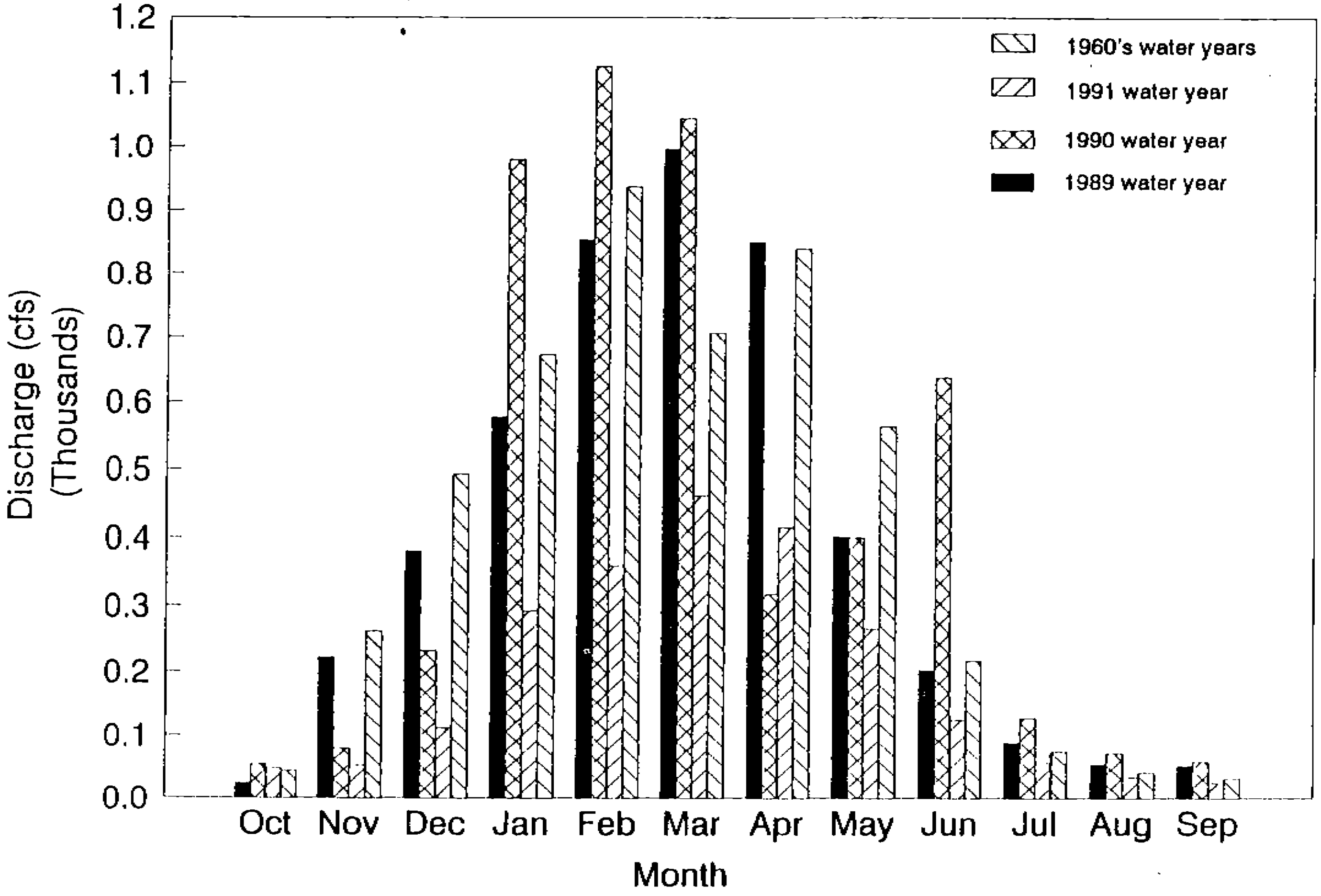

Figure 4. Average monthly discharge for water years 1989, 1990, 1991, and average 1960's (excluding 1964 flood).

Table 2. East Fork substrate summary (n.s. = not sampled).

Habitat Type	Acronym	Units Observed	Mean % Fines	Mean % Sand	Mean % Gravel	Mean % Cobble	Mean % Boulder	Mean % Bedrock	Mean % Pool Cover	Mean % Shade	Mean Exposed Substrate	Mean Substrate Embeddedness
1	LGR	108	0.0	5.4	21.9	46.0	25.5	1.3	n.s.	43.9	16.3	13
2	HGR	81	0.0	1.8	13.2	35.4	47.9	1.8	n.s.	62.7	17.3	18
3	CAS	65	0.1	3.7	8.1	27.3	39.2	21.5	n.s.	36.7	18.3	3
5	BwBo	3	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
8	TRC	1	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
9	PLP	33	0.0	5.0	8.6	21.4	35.0	30.0	33.0	18.0	5.2	7
12	LaBk	82	1.1	10.5	23.0	30.3	24.7	10.3	13.0	44.0	4.9	20
13	DPL	1	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
14	GLD	10	2.5	7.5	30.0	47.5	12.5	0.0	n.s.	62.5	4.0	13
15	RUN	38	0.0	5.0	17.9	33.6	32.1	11.4	n.s.	59.2	3.9	14
16	SRN	24	0.3	7.6	17.1	32.1	25.0	17.9	n.s.	59.3	8.6	24
17	MCP	45	1.4	16.9	18.3	23.9	26.1	13.3	18.8	34.4	2.3	21
18	EGW	6	5.0	40.0	40.0	10.0	5.0	0.0	n.s.	80.0	0.0	20
19	CCP	2	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
20	LaBo	83	2.1	14.7	18.8	27.7	35.3	1.5	20.2	43.8	6.7	21
21	POW	67	1.2	8.8	20.7	34.0	33.0	2.33	n.s.	47.5	17.3	18
22	CRP	2	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
23	STP	3	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
24	BRS	5	0.0	0.0	0.0	5.0	5.0	90.0	n.s.	30.0	10.0	0.0

Table 3. East Fork habitat summary (n.s. = not sampled).

Habitat Type	Acronym	Units Observed	Mean Length (m)	Mean Width (m)	Total Length (m)	Mean Depth (m)	Mean Maximum Depth (m)	Mean Area (m^2)	Estimated Total Area (m^2)	Estimated Volume (m^3)
1	LGR	8	9.7	6.9	77.8	0.2	0.4	68.8	550.7	110.2
2	HGR	13	9.9	5.2	128.0	0.2	0.5	49.4	641.9	128.3
3	CAS	13	13.0	5.6	169.1	0.3	0.8	77.9	1013.0	303.9
8	TRC	3	10.1	4.5	30.4	n.s.	n.s.	45.4	136.1	n.s.
9	PLP	1	10.6	7.0	10.6	n.s.	n.s.	74.2	74.2	n.s.
12	LsBk	14	19.8	6.8	277.0	0.7	1.5	140.4	1965.6	1418.2
14	GLD	2	14.1	6.0	28.1	n.s.	n.s.	90.9	181.8	n.s.
15	RUN	7	12.1	4.7	85.0	0.4	0.6	58.9	412.0	164.8
16	STR	3	27.8	5.3	83.3	n.s.	n.s.	148.5	445.4	n.s.
17	MCP	11	25.4	8.2	279.0	0.7	1.4	208.4	2292.5	1586.9
18	EGW	2	6.1	3.7	12.1	n.s.	n.s.	21.8	43.6	n.s.
20	LsBo	3	13.9	7.7	41.8	0.4	1.2	111.0	333.0	133.1
21	POW	9	13.0	6.2	117.0	0.3	0.6	84.4	759.9	225.4
22	CRP	1	18.6	12.0	18.6	n.s.	n.s.	223.2	223.2	n.s.
TOTAL					1,357.80				9,070.90	4,067.80

steelhead/RBT were observed upstream. A total of 653 habitat units (10,928.8 m) were observed in the mainstem of East Fork. Dominant habitat types observed were LGR (low gradient riffle, 20%), HGR (high gradient riffle, 10%), LsBk (lateral scour bedrock, 13%), LsBo (lateral scour boulder, 11%), and POW (pocket water, 12%) (Figure 5). Due to the confinement of the stream, side channels are limited. A total of 54 units measuring 583.5 meters were observed in sidechannels. Instream pool cover was fairly high ranging from 13 to 33%. The total surface area for the mainstem East Fork, excluding sidechannels was estimated to be 73,104.9 m^2. The volume at summer low flow, excluding side channels and 12 units (mean depths not taken) was 26,415.4 m^3 (Table 3). A potential barrier was observed at rkm 3.1 caused by a large boulder cluster. The cluster appears formidable, but adult summer steelhead were observed above indicating it is not a barrier to steelhead. Suction dredge mining is prevalent in the lower East Fork from the mouth to rkm 3.0 (upstream of the USFS East Fork trail crossing). Many of the units below the bridge crossing (rkm 2.5) were suction dredge influenced. To what extent the active mining impacts juvenile steelhead and upstream migrating adult summer steelhead is unknown. Large tailing areas, sand and silt covered pool bottoms, and poor water visibility was observed below these sites. During recent low years of precipitation, a reduction in flushing flows and the accumulation of sand and silt in the tailout of the pools could potentially have a negative influence on the survival of steelhead eggs. Average pool embeddedness below the dredging sites for MCP (mid channel pool) was 42% (n = 2) and 32% for LsBk (n = 7). The percent embeddedness above the dredging activities was 13% for LsBo (n = 13), 17% for MCP (n = 6), and 20% for LsBk (n = 14).

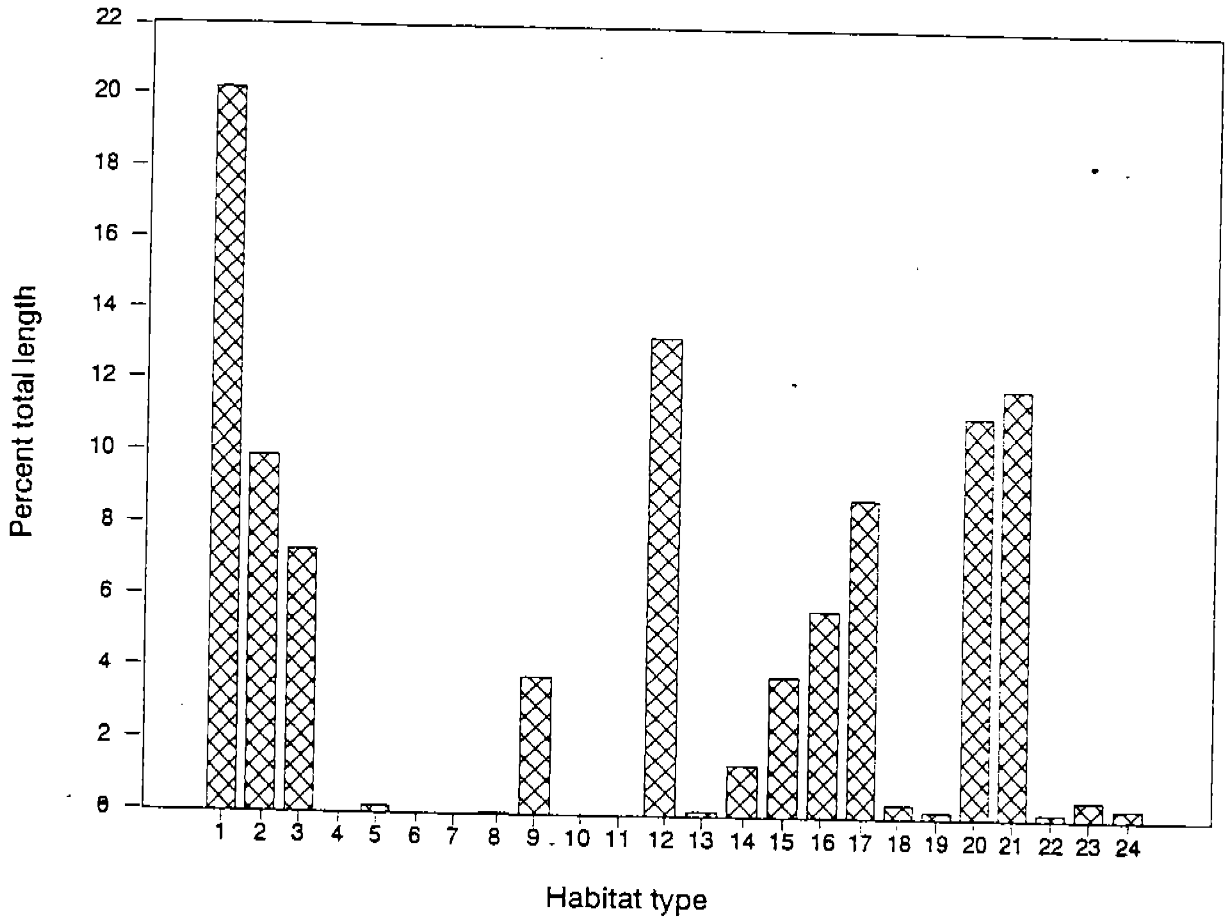

Figure 5. East Fork of New River habitat types and percent total length.

Virgin Creek

Study Site

Virgin Creek flows in a southeast direction and its banks are steep sided and well shaded. Overstory vegetation consists of Douglas fir, alder, madrone, black oak, and cedar. Habitat conditions for both juvenile and adult salmonids are rated as excellent. Pools and high quality spawning habitat are abundant. Virgin Creek is located within the Trinity Alps Wilderness Area. Access is gained by use of the USFS New River trail which follows the creek on the easterly side. Access points are limited to historic mining camps and the river crossing adjacent to the Soldier Creek confluence.

Channel Typing

Virgin Creek was channel typed from the confluence of Virgin and Slide Creeks to the confluence of Soldier Creek (8.5 rkm). Virgin Creek was divided into six reaches based on changes in channel types. Elevation increased from 610 m at the mouth to 756 m at the Soldier Creek confluence. Channel material consisted of small boulders, bedrock, gravel, and cobble (Table 4). Stream gradient ranged from 1.7 to 1.9%. Dominant channel types recorded were B1 (37%), B3 (28%), B2 (30%), and B1-1 (6%). Stream banks were stable except for a few slides which contribute gravel.

Habitat Typing

Habitat typing commenced in August 1989 during low summer flows and was completed to the Soldier Creek confluence in July 1991. A total of 446 habitat unit types (8,533 m) were measured in the mainstem Virgin Creek Dominant habitat types observed were LsBk (23.9%), LGR (19.4%), MCP (14%), LsBo (10.5%), and POW (8.9%) (Figure 6). Side channels were limited with only 54 habitat unit types observed totalling 774 m. The total surface area for the mainstem Virgin Creek, excluding side channels was estimated to be 69,162.6 m^2. The estimated volume at low summer flows, excluding side channels and 7 units (mean depth not taken) was 35,784.5 m^3 (Table 5).

Woody material was lacking in Virgin Creek with only one Lslog (lateral scour log formed pool). Apparently, the stable stream banks and the high flushing flow in the winter and spring months denude the stream of woody material. Mean percent pool instream cover ranged from 15 to 18.5% with dominant cover types of boulders, bubble curtains, and bedrock ledges. No barriers were observed in the study area. Numerous deep pools were observed in Virgin Creek. Average maximum depth for MCP (1.7 m), LsBo (0.9 m), and LsBk (1.3 m) indicated abundant adult holding habitat.

Suction dredge mining was observed in the Fawn Creek area rkm 0.4. Large dredge holes and tailings were common making habitat typing difficult in the shallow, low gradient areas. During low flow years, the aggregation of these tailings in shallow areas may decrease the amount and quality of suitable spawning areas.

Slide Creek

Study Area

Slide Creek flows in a southwesterly direction. Overstory vegetation consists of Douglas fir, alder, black oak, madrone, and cedar. Habitat conditions for both adults and juveniles are rated as excellent from the mouth to the confluence of Eagle Creek. Above Eagle Creek, the river becomes bedrock dominated and discharge dramatically decreases. Slide Creek is within the Trinity Alps Wilderness Area and access is gained by use of the USFS New River trail which branches at the confluence of Virgin and Slide

Table 4. Virgin Creek substrate summary (n.s. = not sampled).

Habitat Type	Acronym	Units Observed	Mean % Fines	Mean % Sand	Mean % Gravel	Mean % Cobble	Mean % Boulder	Mean % Bedrock	Mean % Pool Cover	Mean % Shade	Mean Exposed Substrate	Mean Substrate Embeddedness
1	LGR	96	0.0	3.0	18.9	44.4	32.8	1.0	n.s.	40.7	26.6	9
2	HGR	50	0.0	1.0	11.0	28.0	58.5	1.5	n.s.	48.0	29.5	2
3	CAS	20	0.0	1.3	8.8	26.3	50.0	13.8	n.s.	50.0	21.3	6
5	BwBo	1	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
8	TRC	2	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
9	PLP	2	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
10	Lslog	1	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
12	LsBk	85	1.2	12.1	30.9	28.1	18.4	6.2	15.5	43.2	0.9	15
14	GLD	14	1.7	7.3	45.0	40.0	6.0	0.0	n.s.	51.7	2.0	8
15	RUN	37	0.0	8.8	22.5	44.4	23.8	0.6	n.s.	51.4	4.8	9
16	STR	9	0.0	15.0	35.0	45.0	5.0	0.0	n.s.	95.0	5.0	10
17	MCP	28	2.0	22.0	31.0	16.0	17.0	12.0	17.4	65.0	1.0	24
18	EGW	5	10.0	30.0	30.0	30.0	0.0	0.0	n.s.	70.0	5.0	35
20	LsBo	58	1.1	11.8	26.8	32.3	23.6	4.5	18.5	33.6	4.6	17
21	POW	42	0.0	5.7	17.9	29.3	42.1	5.0	n.s.	37.1	11.4	6
23	STP	1	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

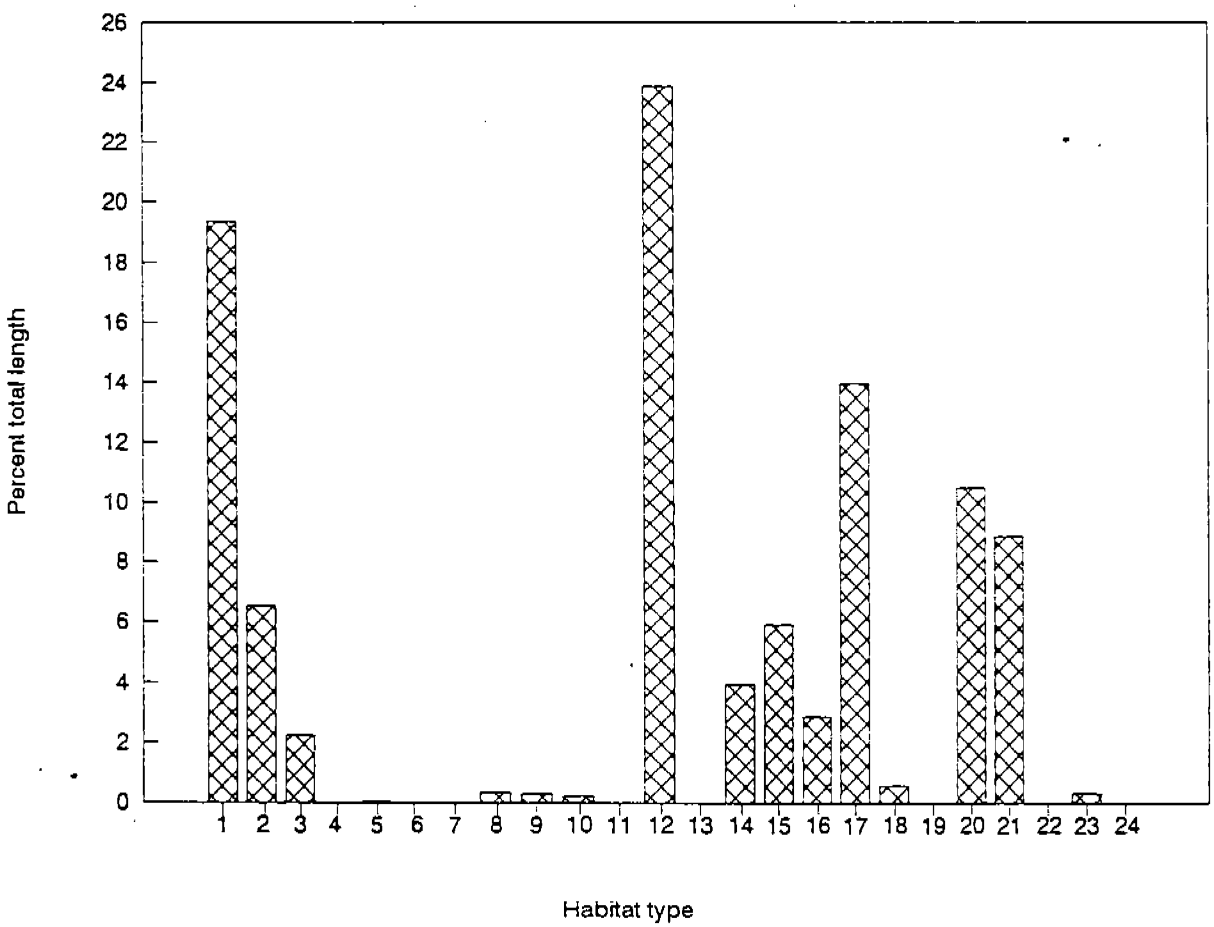

Figure 6. Virgin Creek habitat types and percent total length.

Table 5. Virgin Creek habitat summary (n.s. = not sampled).

Habitat	Acronym	Units Observed	Mean Length (m)	Mean Width (m)	Total Length (m)	Mean Depth (m)	Mean Maximum Depth (m)	Mean Area (m^2)	Estimated Total Area (m^2)	Estimated Volume (m^3)
1	LGR	96	17.3	7.7	1660.8	0.3	0.5	146.7	14086.4	3781.4
2	HGR	50	11.2	7.6	561.2	0.3	0.4	90.1	4502.3	1254.5
3	CAS	20	9.6	7.1	192.0	0.3	0.7	71.1	1421.0	443.6
5	BwBO	1	5.2	5.1	5.2	n.s.	n.s.	26.5	26.5	n.s.
8	TRC	2	15.3	7.0	30.5	n.s.	n.s.	106.8	213.6	n.s.
9	PLP	2	13.7	6.9	27.3	n.s.	n.s.	94.0	188.0	n.s.
10	Lslog	1	20.0	8.2	20.0	n.s.	n.s.	164.0	164.0	n.s.
12	LsBk	85	24.1	7.5	2049.1	0.8	1.3	188.3	16003.2	12760.0
14	GLD	14	24.2	9.1	338.8	0.4	0.6	229.1	3207.7	1173.2
15	RUN	37	13.7	5.5	507.4	0.4	0.6	76.4	2827.9	1007.9
16	STR	9	27.5	5.5	247.4	0.3	0.5	150.7	1356.4	406.9
17	MCP	28	42.8	8.9	1199.3	0.8	1.7	384.0	10751.8	8521.9
18	EGW	5	9.7	3.9	48.5	0.2	0.2	37.5	187.7	37.5
20	LsBo	58	15.6	8.2	903.0	0.5	0.9	129.2	7490.7	3789.8
21	POW	42	18.1	8.4	761.8	0.4	0.8	155.6	6534.4	2610.8
23	STP	1	29.0	7.0	29.0	n.s.	n.s.	203.0	203.0	n.s.
TOTAL					8,581.30				69,162.60	35,784.50

Creek. The creek is accessible at numerous points from the trail that follows the north bank. Aquatic insects are abundant with stonefly, dragonfly, mayfly, caddis fly larvae, and drift insects throughout the study area. Winter steelhead are believed to use the drainage and adult summer steelhead have been observed. No spring chinook have been recorded or observed to use Slide Creek, but suitable holding pools and spawning gravels do exist.

Channel Typing

Slide Creek was surveyed from the mouth to the confluence of Eagle Creek (rkm 4.4) and was divided into seven reaches based on changes of channel types. The dominate channel types observed were B3 (2,082 m, 47%), B2 (944 m, 21%), B1 (881 m, 20%), B1-1 (332 m, 8%), and A3 (160 m, (4%). The elevation of Slide Creek increases from 610 m at the mouth to 732 m at the Eagle Creek confluence with a gradient of 2.8%. The dominant channel materials (Table 6) consisted of gravel, cobble, small boulders,sand, and bedrock.

Habitat Typing

Habitat typing of Slide Creek was completed from the mouth to the confluence of Eagle Creek in August 1989. A total of 228 habitat units (4,399 m) were measured in the mainstem Slide Creek. Dominant habitat types observed were LGR (26%), LsBk (18%), MCP (13%), and POW (9%) (Figure 7). Side channels in Slide Creek measured 364 meters. The estimated area for the mainstem

Table 6. Slide Creek substrate summary (n.s. = not sampled).

Habitat Type	Acronym	Units Observed	Mean % Fines	Mean % Sand	Mean % Gravel	Mean % Cobble	Mean % Boulder	Mean % Bedrock	Mean % Pool Cover	Mean % Shade	Mean Exposed Substrate	Mean Substrate Embeddedness
1	LGR	53	0.5	5.5	26.5	51.0	15.0	1.5	n.s.	51.0	15.5	19
2	HGR	27	0.0	1.0	16.0	61.0	18.0	4.0	n.s.	58.0	15.5	19
3	CAS	14	0.0	8.3	11.7	25.0	46.7	8.3	n.s.	33.3	30.0	5
8	TRC	2	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
9	PLP	9	5.0	17.5	20.0	15.0	30.0	12.5	42.5	57.5	2.5	13
12	LaBk	32	8.3	22.5	16.7	24.2	14.2	14.2	17.5	55.0	1.7	26
14	GLD	8	10.0	17.5	35.0	25.0	7.5	5.0	n.s.	40.0	1.0	35
15	RUN	17	0.0	12.5	35.0	35.0	11.3	6.3	n.s.	47.5	2.0	19
16	STR	8	2.5	7.5	17.5	52.5	20.0	0.0	n.s.	70.0	17.5	18
17	MCP	19	8.8	28.8	11.3	16.3	8.8	26.3	17.0	38.8	4.3	28
18	EGW	7	7.5	20.0	30.0	40.0	2.5	0.0	n.s.	25.0	47.5	3
19	CCP	1	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
20	LaBo	17	1.7	11.7	20.0	33.3	33.3	0.0	25.0	60.0	5.0	20
21	POW	21	1.3	10.0	20.0	38.8	25.0	5.0	n.s.	51.3	20.0	20

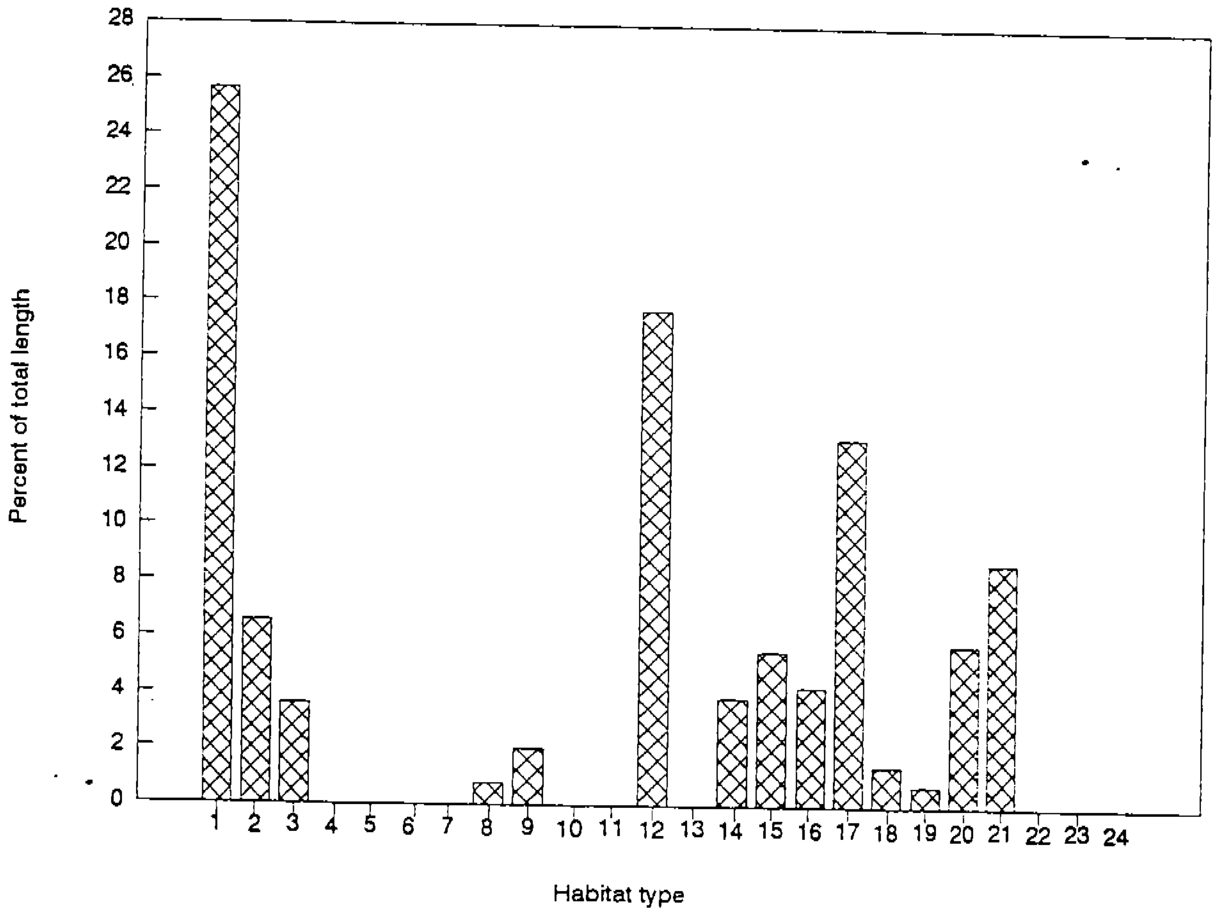

Figure 7. Slide Creek habitat types and percent total length.

excluding side channels totaled 32,200 m^2. The estimated volume during low summer flow, excluding 3 units (mean depth not taken) totaled 11,851 m^3 (Table 7).

Table 7. Slide Creek habitat summary (n.s. = not sampled).

Habitat Type	Acronym	Units Observed	Mean Length (m)	Mean Width (m)	Total Length (m)	Mean Depth (m)	Mean Maximum Depth (m)	Mean Area (m^2)	Estimated Total Area (m^2)	Estimated Volume (m^3)
1	LGR	8	9.7	6.9	77.8	0.2	0.4	68.8	550.7	110.2
2	HGR	13	9.9	5.2	128.0	0.2	0.5	49.4	641.9	128.3
3	CAS	13	13.0	5.6	169.1	0.3	0.8	77.9	1013.0	303.9
8	TRC	3	10.1	4.5	30.4	n.s.	n.s.	45.4	136.1	n.s.
9	PLP	1	10.6	7.0	10.6	n.s.	n.s.	74.2	74.2	n.s.
12	LsBk	14	19.8	6.8	277.0	0.7	1.5	140.4	1965.6	1418.2
14	GLD	2	14.1	6.0	28.1	n.s.	n.s.	90.9	181.8	n.s.
15	RUN	7	12.1	4.7	85.0	0.4	0.6	58.9	412.0	164.8
16	STR	3	27.8	5.3	83.3	n.s.	n.s.	148.5	445.4	n.s.
17	MCP	11	25.4	8.2	279.0	0.7	1.4	208.4	2292.5	1586.9
18	EGW	2	6.1	3.7	12.1	n.s.	n.s.	21.8	43.6	n.s.
20	LsBo	3	13.9	7.7	41.8	0.4	1.2	111.0	333.0	133.1
21	POW	9	13.0	6.2	117.0	0.3	0.6	84.4	759.9	225.4
22	CRP	1	18.6	12.0	18.6	n.s.	n.s.	223.2	223.2	n.s.
	TOTAL				1,357.80				9,070.90	4,067.80

Eagle Creek

Study Site

Eagle Creek is a relatively large tributary to Slide Creek and flows in a south west direction within the Trinity Alps Wilderness Area. Eagle Creek supports a population of summer steelhead September with counts of 7 in 1989, 20 in 1990, and 8 in 1991. Eagle Creek was surveyed from the mouth to rkm 1.3 during August 1989. Impacts from fire and logging [redacted] are minimal in the drainage, although, suction dredge mining was observed in the upper reaches near the North Fork confluence during September 1991 summer steelhead adult surveys. Access to the creek is gained by use of the USFS New River trail which follows Slide Creek then forks off along the Eagle Creek drainage.

Adult and juvenile habitat is considered excellent. Aquatic insects were abundant and juvenile steelhead were numerous.

Channel Typing

Eagle Creek was surveyed from the mouth to rkm 1.3. Channel B1-1 dominated the reach due to the presence of bedrock banks, ~~and the~~ shallow entrenchment and moderate confinement (Table 8). The elevation of Eagle creek ranged from 732 m at the mouth to 756 m at the end of the survey.

Habitat Typing

Due to time limitations, Eagle Creek was only surveyed from the mouth to rkm 1.3. A total of 88 habitat unit types (1,346 m) and 9 side channel units (79 m) were recorded for the Eagle Creek survey area. Dominant habitat types observed were MCP (279 m, 21%), LsBk (277 m, 20%), CAS (169 m, 13%), and HGR (128 m, 9%) (Figure 8). Pools were of good quality and numerous with average maximum depth for MCP (1.4 m), LsBo (1.2 m), and LsBk (1.5 m). Total surface area for the survey was 9,070.9 m^2 and the volume was estimated at 4,067.8 m^3 (Table 9).

Table 8. Eagle Creek substrate summary (n.s. = not sampled).

Habitat Type	Acronym	Units Observed	Mean % Fines	Mean % Sand	Mean % Gravel	Mean % Cobble	Mean % Boulder	Mean % Bedrock	Mean % Pool Cover	Mean % Shade	Mean Exposed Substrate	Mean Substrate Embeddedness
1	LGR	8	0.0	5.0	27.5	45.0	15.0	7.5	n.s.	100	20	18
2	HGR	13	0.0	2.5	20.0	52.5	17.5	7.5	n.s.	80.0	22.5	20
3	CAS	13	0.0	5.0	12.5	27.5	27.5	27.5	n.s.	72.5	30.0	8
8	TRC	3	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
9	PLP	1	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
12	LsBk	14	3.3	13.3	23.3	30.0	15.0	15.0	17.0	81.7	1.0	18
14	GLD	2	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
15	RUN	7	0.0	10.0	15.0	20.0	25.0	30.0	n.s.	85.0	2.0	25
16	STR	3	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
17	MCP	11	2.5	17.5	22.5	15.0	7.5	35.0	25.0	62.5	10.0	25
18	EGW	2	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
20	LsBo	3	5.0	10.0	15.0	30.0	15.0	25.0	n.s.	70.0	20.0	20
21	POW	9	2.5	5.0	15.0	42.5	30.0	5.0	n.s.	60.0	15.0	20
22	CRP	1	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.

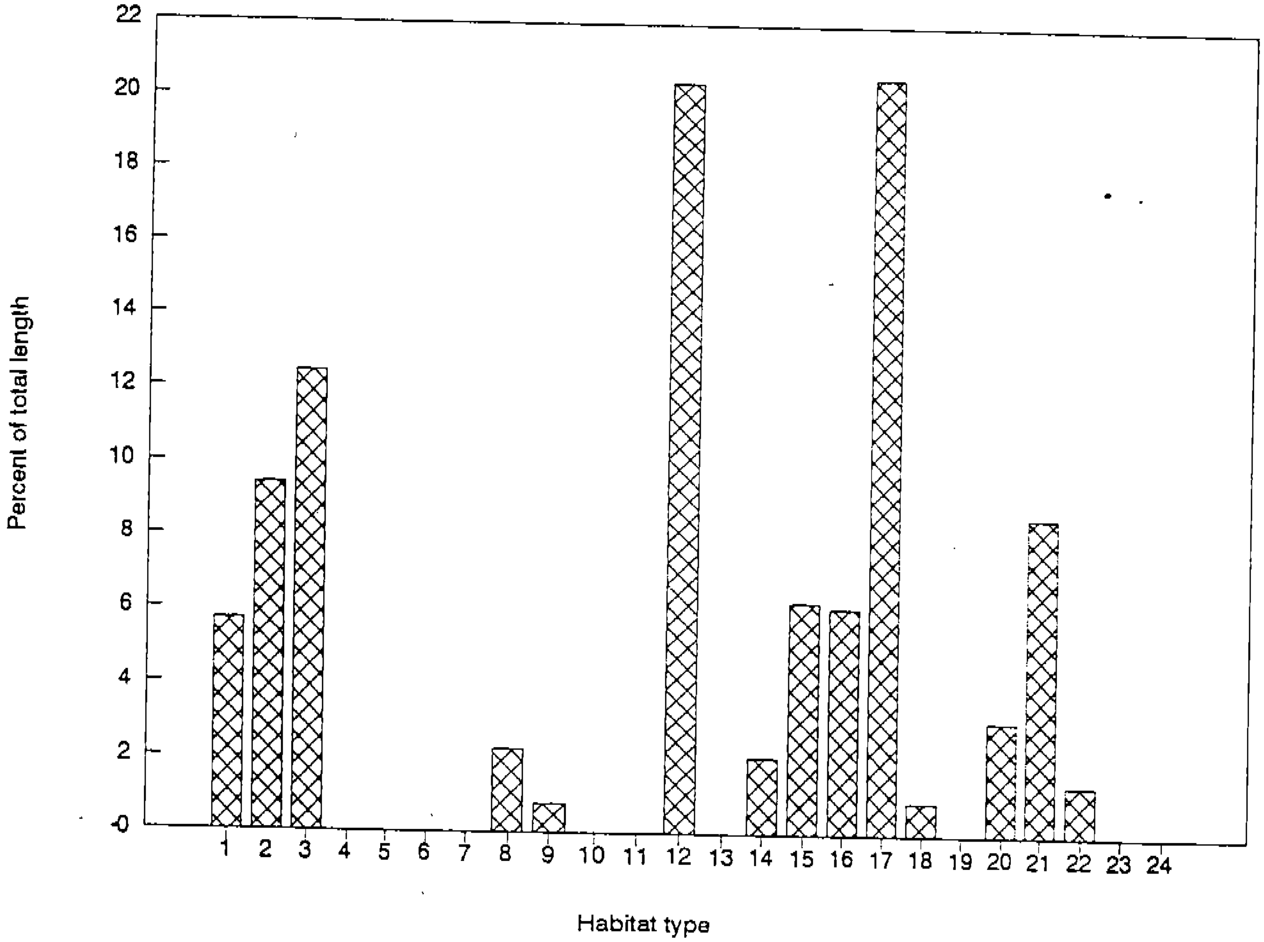

Figure 8. Eagle Creek habitat type and percent total length.

Table 9. Eagle Creek habitat summary (n.s. = not sampled).

Habitat Type	Acronym	Units Observed	Mean Length (m)	Mean Width (m)	Total Length (m)	Mean Depth (m)	Mean Maximum Depth (m)	Mean Area (m^2)	Estimated Total Area (m^2)	Estimated Volume (m^3)
1	LGR	8	9.7	6.9	77.8	0.2	0.4	68.8	550.7	110.2
2	HGR	13	9.9	5.2	128.0	0.2	0.5	49.4	641.9	128.3
3	CAS	13	13.0	5.6	169.1	0.3	0.8	77.9	1013.0	303.9
8	TRC	3	10.1	4.5	30.4	n.s.	n.s.	45.4	136.1	n.s.
9	PLP	1	10.6	7.0	10.6	n.s.	n.s.	74.2	74.2	n.s.
12	LaBk	14	19.8	6.8	277.0	0.7	1.5	140.4	1965.6	1418.2
14	GLD	2	14.1	6.0	28.1	n.s.	n.s.	90.9	181.8	n.s.
15	RUN	7	12.1	4.7	85.0	0.4	0.6	58.9	412.0	164.8
16	STR	3	27.8	5.3	83.3	n.s.	n.s.	148.5	445.4	n.s.
17	MCP	11	25.4	8.2	279.0	0.7	1.4	208.4	2292.5	1586.9
18	EGW	2	6.1	3.7	12.1	n.s.	n.s.	21.8	43.6	n.s.
20	LaBo	3	13.9	7.7	41.8	0.4	1.2	111.0	333.0	133.1
21	POW	9	13.0	6.2	117.0	0.3	0.6	84.4	759.9	225.4
22	CRP	1	18.6	12.0	18.6	n.s.	n.s.	223.2	223.2	n.s.
TOTAL					1,357.80				9,070.90	4,067.80

Habitat Evaluations

Index Reaches

The original proposal (Task 1b) indicated index reaches would be monitored seasonally, however spot surveys in the fall of 1989, and the spring of 1990 and 1991 produced few yoy, 1+, and 2+ steelhead. During the spring survey, as few as five juvenile steelhead were observed in large pool and pocket water habitat types when steelhead parr and smolts were undergoing their peak outmigration.

Low stream temperatures during spring and fall appear to be limiting the number of juvenile steelhead and chinook observed during daylight hours. Temperatures during the spring snorkel counts remained below 14°C (57°F) and fall temperatures remained below 6°C (43°F). 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 were half the number of fish present and temperatures below 9°C (48°F) less than 20% of the fish present were observed.

It was determined that in order to establish a long term, representative juvenile monitoring program, summer was the most suitable time. Stream temperatures are above 16°C (Figure 3) therefore a greater percentage of juveniles should be in the water column. Additionally, discharge is fairly stable, at or near low summer flows, and juvenile steelhead and chinook have nearly completed emigrating from the drainage.

Mainstem New River

Average densities (fish/m^3) were calculated for the five index reaches on the mainstem New River (Figure 9). Significant differences were observed between habitat types for both yoy and 1+ steelhead, but no significant differences for yoy and 1+ steelhead were observed between years. Yoy steelhead densities were highest in LGR, LsBk, POW, LsBo, and RUN. The lowest yoy densities were observed in MCP, CRP, and GLD habitat types. The 1+ steelhead densities were highest in side channels, LGR, STR, POW, LsBk, and LsBo. Significant differences were not observed for 2+ steelhead by either habitat or by year. The 2+ steelhead densities were low in the summer since the majority emigrated as smolts in the spring. The highest densities of 2+ steelhead were observed in side channels, LGR, and LsBk habitat units. Significant differences were observed between years for yoy chinook, but significant differences were not observed between habitat types (Table 10). A higher density of yoy chinook were observed in the summer of 1991. Numerous juvenile chinook were observed in the drainage during adult surveys in September and the redd survey in November 1991. Juvenile chinook were observed to be feeding with the steelhead yoy and 1+ juveniles. A total of 4 chinook 1+ were captured in the downstream migrant trap in the spring of 1991 indicating some juvenile chinook winter in New River and leave the system as 1+ smolts.

The juvenile abundance trends observed for the mainstem New River will give a reasonable baseline for comparison in the future. Densities greatly deviating from the observations may give a strong indication if the population levels are increasing or decreasing.

Habitat units remained fairly static from 1990 to 1991. Changes in habitat types within index reaches were recorded for Index 1-2 where a glide changed into a small LsBk pool, and in Index 3-2 where a run changed into a LsBk pool.

East Fork of New River

Mean densities (fish/m^3) of yoy, 1+, and 2+ steelhead were determined for the East Fork and are presented in Figure 10. No juvenile chinook were observed in the drainage. The highest yoy steelhead densities were observed in LGR, RUN, and POW habitat types with lowest densities were observed in GLD, MCP, and LsBo habitat types. Observed densities of 1+ steelhead were highest in LGR, CAS, RUN, and STR habitat types. Low densities for steelhead 1+ were observed in MCP and GLD habitat types. Significant differences were observed for yoy steelhead for years and habitat types with higher densities observed in 1991 (Table 11). Significant differences were not observed between habitat types or years for 1+ and 2+ steelhead.

Habitat type changes were minimal between the two seasons. The glide observed in 1990 was changed to pocket water due to the movement of boulders. Steelhead 2+ were again in very few numbers due to time of year when the majority of fish have outmigrated as smolts.

Virgin Creek

Mean densities for the combined sub indices were determined for steelhead yoy, 1+, and 2+ (Figures 11). Juvenile chinook were not observed in the drainage. No significant differences in fish densities (fish/m^3) were observed for yoy, 1+, and 2+ steelhead densities (Table 12). The LGR, LsBk, MCP, and POW constitute the highest densities for the steelhead yoy and 1+. Steelhead 2+ were observed in only few numbers.

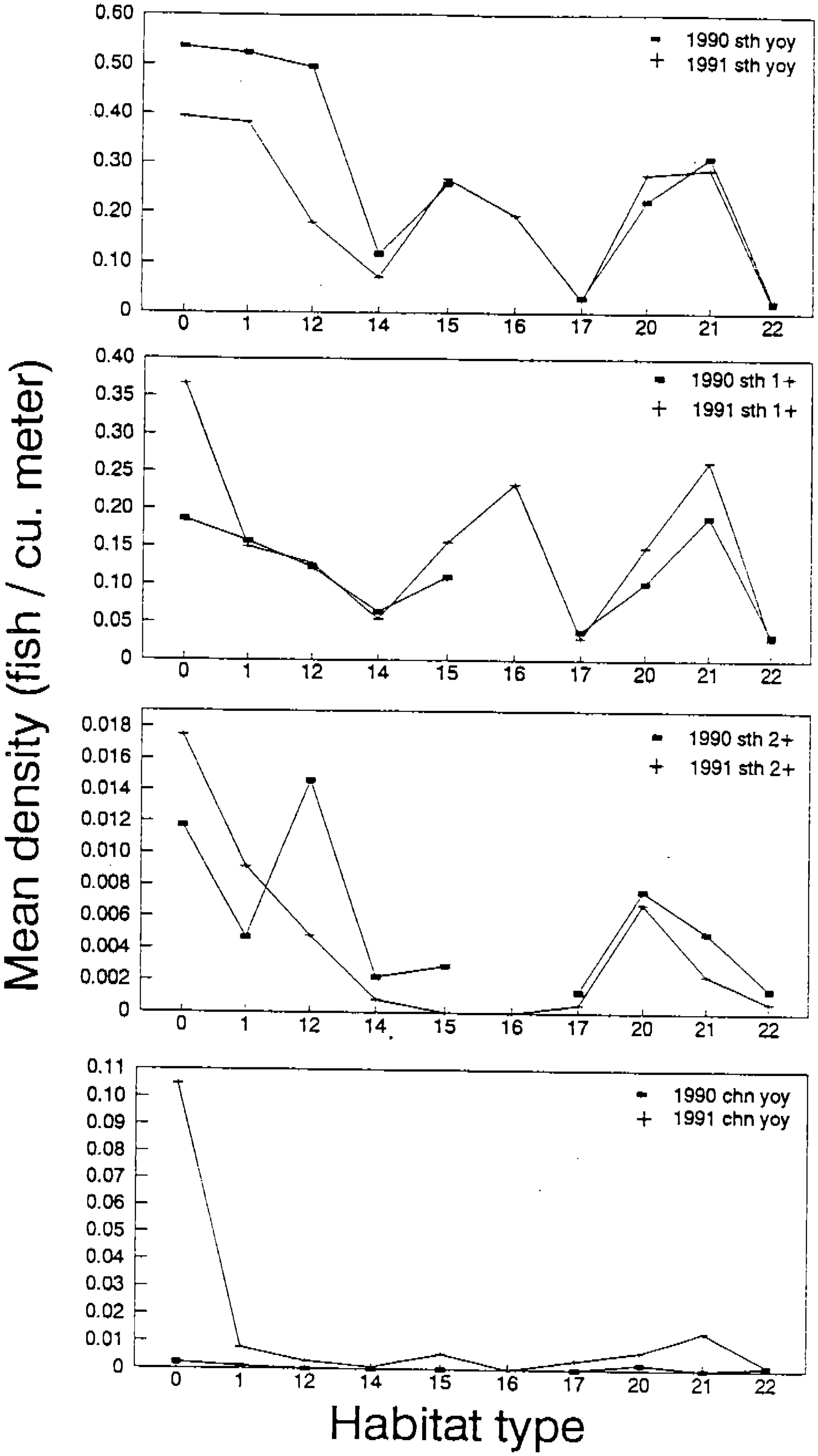

Figure 9. Mainstem New River mean observed steelhead (yoy, 1+, and 2+) and yoy chinook fish densities (fish / cu. meter).

Table 10. Multivariate analysis of combined index reaches of the mainstem New River.

Source of Variation	Degrees of Freedom	Mean Square	F-ratio	P[a]
<u>yoy Steelhead</u> ($fish/m^3$) **Year**	1	0.2825	3.359	0.0695
Habitat Type	8	0.3143	3.738	**0.0007**
Residual	112	0.0841		
<u>1+ Steelhead</u> ($fish/m^3$) **Year**	1	0.0077	0.447	0.5124
Habitat Type	8	0.0438	2.553	**0.0136**
Residual	112	0.0172		
<u>2+ Steelhead</u> ($fish/m^3$) **Year**	1	0.00008985	0.467	0.5029
Habitat Type	8	0.00015656	0.815	0.5912
Residual	112	0.00019220		
<u>yoy Chinook</u> ($fish/m^3$) **Year**	1	0.00080898	13.749	**0.0003**
Habitat Type	8	0.00005134	0.872	0.5420
Residual	112	0.00005884		

[a] $p < 0.05$ indicates a significant difference between years and/or habitat types.

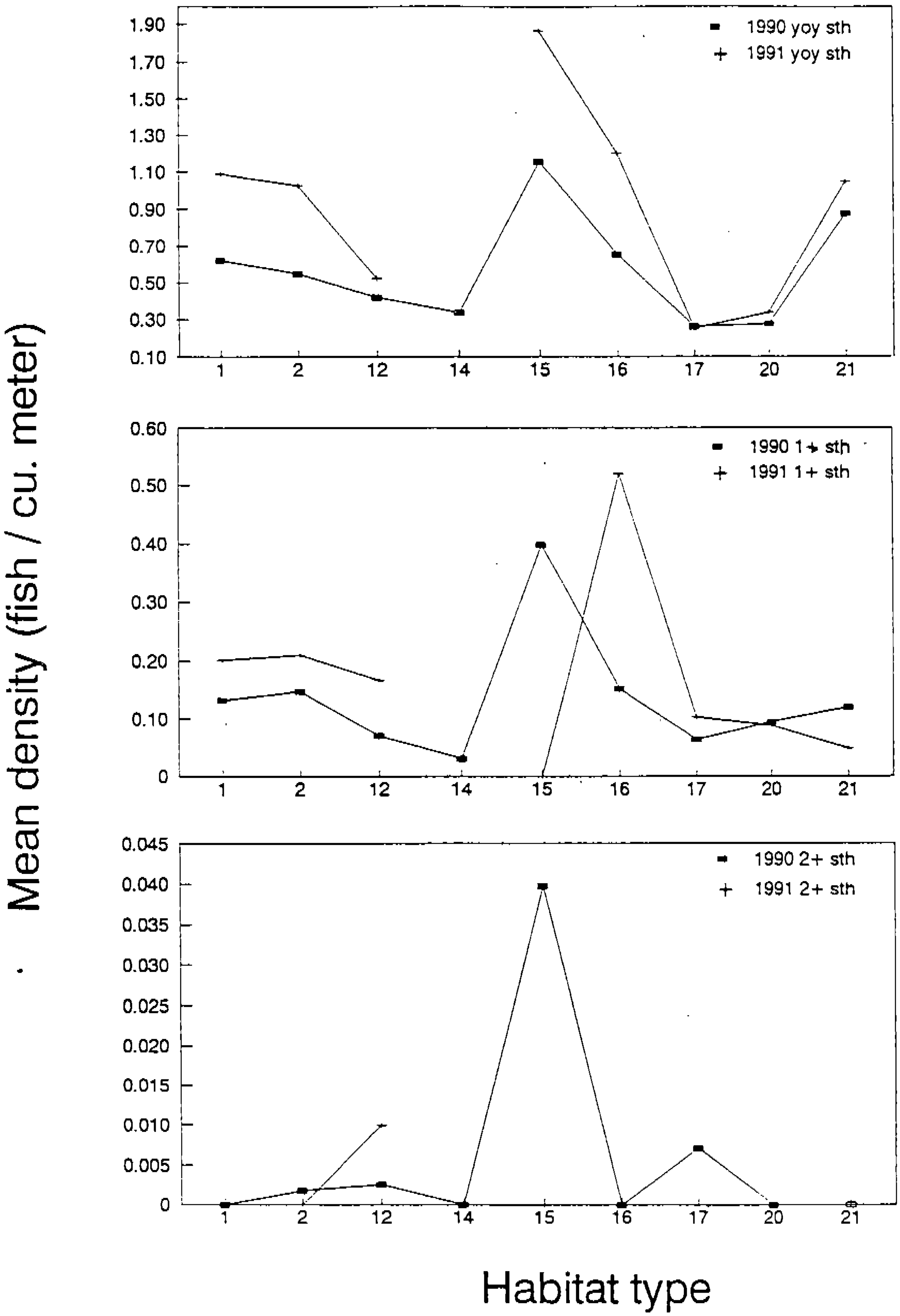

Figure 10. East Fork mean observed steelhead (yoy, 1+, and 2+) densities (fish / cu. meter).

Table 11. Multivariate analysis of index reaches on East Fork.

Source of Variation	Degrees of Freedom	Mean Square	F-ratio	p[a]
yoy Steelhead ($fish/m^3$) Year	1	0.5387	8.274	**0.0110**
Habitat Type	8	0.3407	5.234	**0.0024**
Residual	16	0.0651		
1+ Steelhead ($fish/m^3$) **Year**	1	0.0017	0.128	0.7287
Habitat Type	8	0.0180	1.352	0.2886
Residual	16	0.0133		
2+ Steelhead ($fish/m^3$) **Year**	1	0.00004155	0.774	0.4012
Habitat Type	8	0.00009707	1.809	0.1489
Residual	16	0.00005366		

[a] $p < 0.05$ indicates a significant difference between years and/or habitat types.

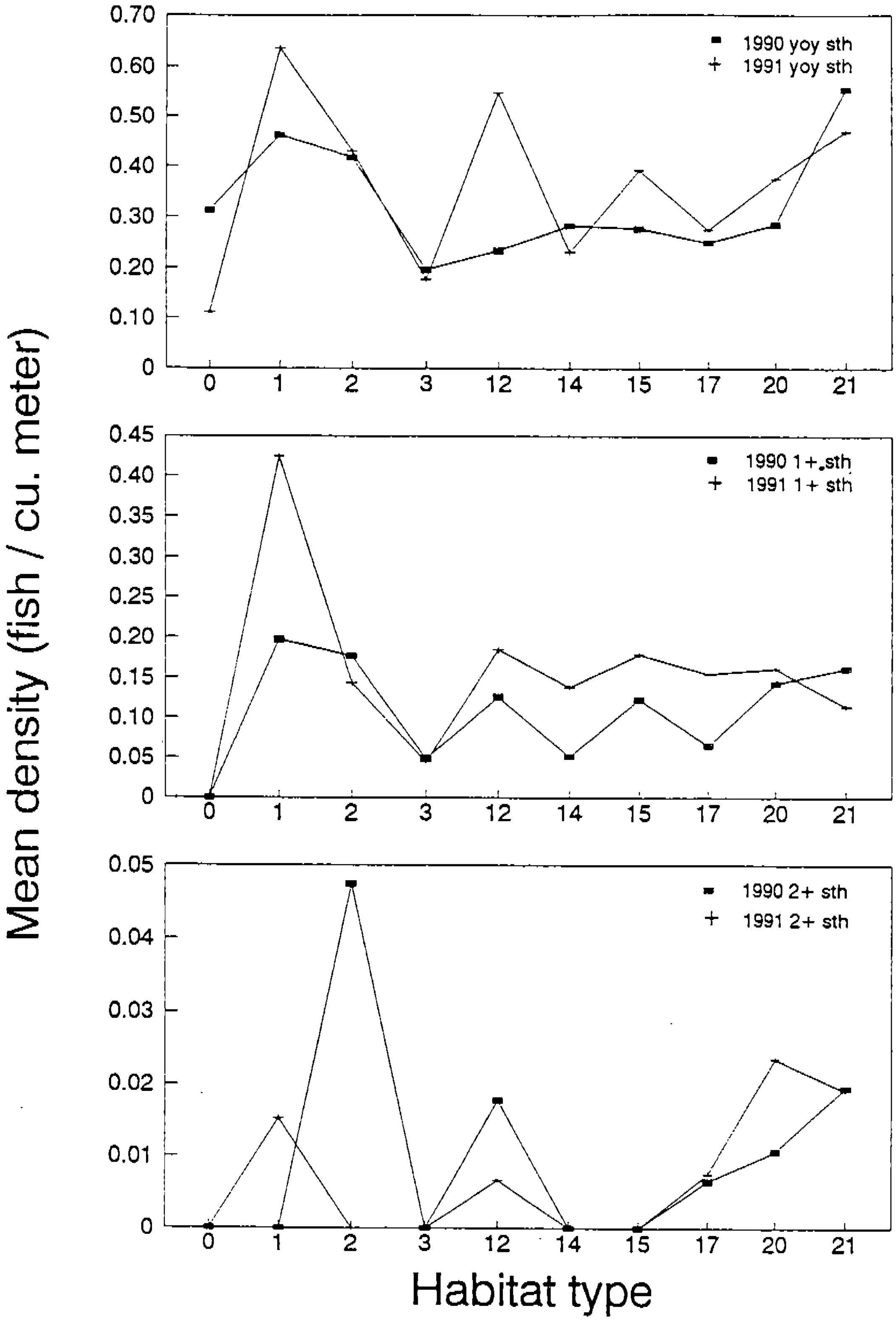

Figure 11. Virgin Creek mean observed steelhead (yoy, 1+, and 2+) densities (fish / cu. meter).

Table 12. Multivariate analysis of combined index reaches on Virgin Creek.

Source of Variation	Degrees of Freedom	Mean Square	F-ratio	p[a]
yoy Steelhead ($fish/m^3$) **Year**	1	0.0853	0.908	0.3569
Habitat Type	9	0.0787	0.838	0.5867
Residual	37	0.0940		
1+ Steelhead ($fish/m^3$) **Year**	1	0.0607	0.667	0.4280
Habitat Type	9	0.0399	0.439	0.9050
Residual	37	0.0910		
2+ Steelhead ($fish/m^3$) **Year**	1	0.00003377	0.079	0.7829
Habitat Type	9	0.00037592	0.882	0.5502
Residual	37	0.00042645		

[a] $p < 0.05$ indicates a significant difference between years and/or habitat types.

Habitat changes were recorded for Sub-index 7-1 (Fawn Creek area) where suction dredge mining altered the stream bottom changing a LGR and RUN into POW. A rock slide was also observed at Sub-index 7-2 in 1991 which may change the habitat sequence in the summer of 1992.

Slide Creek

Mean densities for the combined sub indices were determined for steelhead yoy, 1+, and 2+ (Figure 12). Significant differences were not observed for habitat types and years for yoy steelhead (fish / m^3) and 2+ steelhead (fish / m^3). A significant difference was observed between habitat types for 1+ steelhead but no differences were observed between years (Table 13). Steelhead yoy were most abundant in LsBk, MCP, and POW and steelhead 1+ were most abundant in sidechannels, LsBk, and LsBo habitat types.

Habitat types were fairly constant from 1990 to 1991 except a riffle and run area was combined into a steprun (STR, #16) in 1991. The 1990 and 1991 mean densities again followed the same trends, but further information will be needed due to changes in habitat types experienced in 1991.

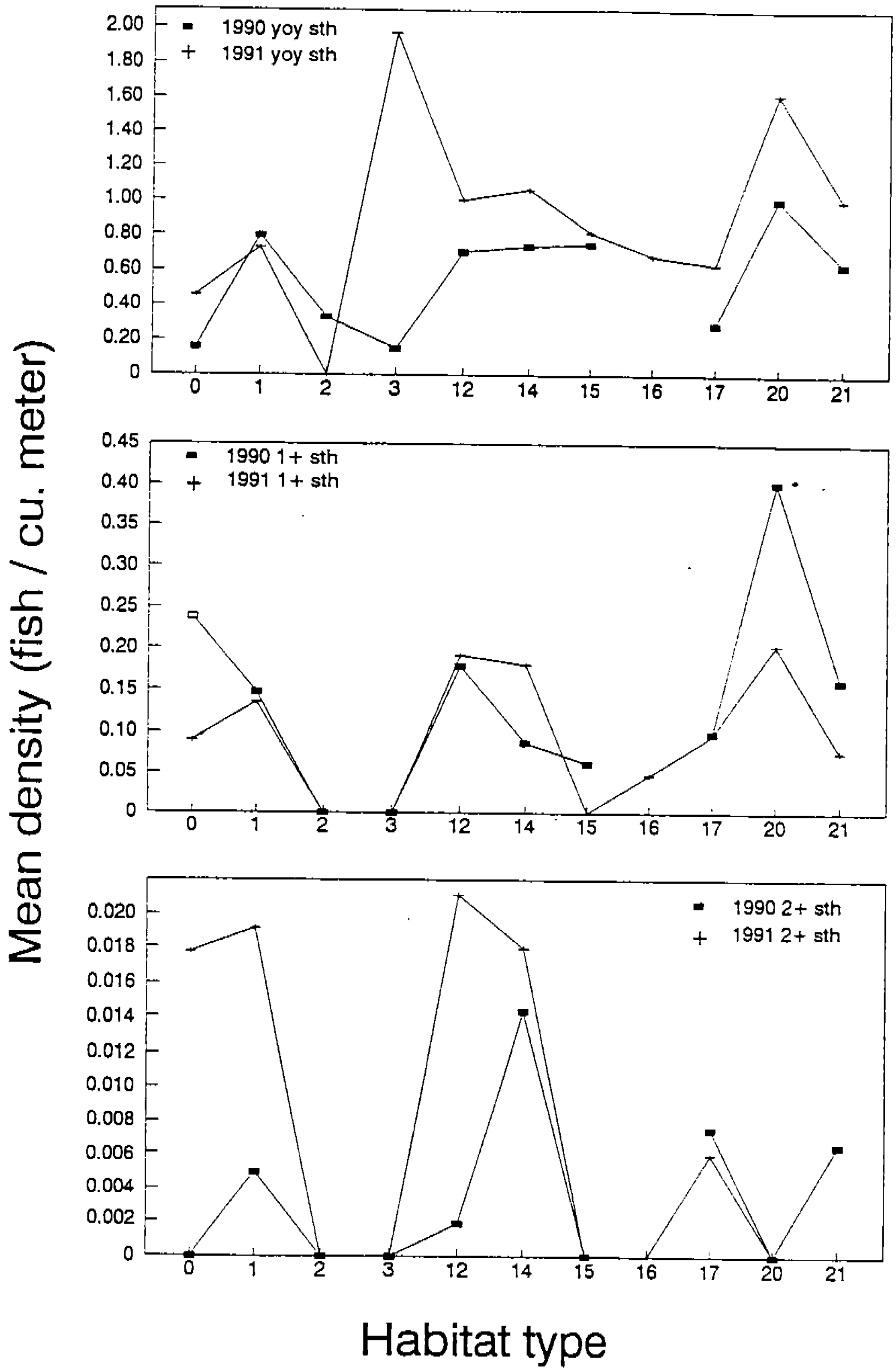

Figure 12. Slide Creek mean observed steelhead (yoy, 1+, and 2+) densities (fish / cu. meter).

Table 13. Multivariate analysis of combined index reaches on Slide Creek.

Source of Variation	Degrees of Freedom	Mean Square	F-ratio	p[a]
yoy Steelhead (fish/m^3) Year	1	0.7166	3.697	0.0660
Habitat Type	10	0.2744	1.416	0.2302
Residual	25	0.1938		
1+ Steelhead (fish/m^3) **Year**	1	0.0032	0.403	0.5378
Habitat Type	10	0.0228	2.876	**0.0156**
Residual	25	0.0079		
2+ Steelhead (fish/m^3) **Year**	1	0.0003850	2.262	0.1451
Habitat Type	10	0.0001138	0.669	0.7420
Residual	25	0.0001702		

[a] $p < 0.05$ indicates a significant difference between years and/or habitat types.

Barriers

A potential partial barrier to migrating chinook adults was observed at rkm 1.1 on the mainstem New River. This falls has little effect on the upstream migration of summer steelhead, but a dead adult spring chinook was observed in the pool below the falls during July. The California Department of Fish and Game, Trinity River Fish Habitat Shop, Lewiston, CA investigated the site in the summer of 1991. The CDFG advised that the blasting below the falls to create a suitable plunge pool would benefit the upstream migration of chinook, but they recommend no action since some chinook are passing the falls. Another partial barrier for chinook was observed on the mainstem New River 0.6 rkm downstream from the confluence of Virgin and Slide Creeks. This falls is a 1.1 meters bedrock plunge which could deter the passage of spring chinook during the low summer flows. No chinook redds have been observed above this falls. A large boulder cluster was observed at rkm 3.3 on the East Fork of New River. This cluster does not seem to be a complete barrier to summer steelhead, but low numbers of summer steelhead were observed in the East Fork in the summer of 1990 and 1991 (10 fish and 3 fish). The upper East Fork barrier approximately 400 m upstream from the mouth of Cabin Creek described by Thomas (1973) was observed in 1991. The falls is approximately 2 meters high with a 1.5 meter plunge pool. We do not believe this to be a barrier to summer steelhead even at low flows.

The complete log barrier reported by Coburn in 1984 on Virgin Creek (between Six Mile and Soldier Creek) does not exist at this time. A partial barrier located at rkm 1.1 on Eagle Creek (tributary to Slide Creek), was reported by Michelle (1984) and was observed in 1990. This falls is approximately 3 meters with a plunge pool of 2 meters. Although we suspect this to be a

Is this Mitchell (1984) spelling? see page 55 complete barrier at very low flows, 14 adult summer steelhead were observed approximately 400 m upstream in the confluence pool of Eagle and North Fork Creeks. No other barriers were observed at this time.

Population Trends

Summer Steelhead Adult Counts

Two snorkel surveys for summer steelhead and spring chinook were completed by the Service this year to determine if adults continue to enter the New River drainage after July. The first survey was completed on the mainstem New River from the confluence of Virgin and Slide Creeks to the mouth of New River. This survey was done in a cooperative effort with the U.S. Forest Service (Redwood Science Lab, Arcata, CA). A total of 427 summer steelhead and 2 spring chinook were observed from July 8 - July 11, 1991. From August 5 - August 9, 1991, California Department of Fish and Game (CDFG) contracted Dave Rogers and Dick Woods to also survey New River. They observed 443 adult summer steelhead. Due to access problems, their survey was limited from the confluence of Virgin and Slide Creeks to 3.2 kilometers upstream of the mouth of New River (Bell Flat area). Spot snorkel surveys during the time period indicated few adults were in the lower river. From September 4 - September 12, 1991 the mainstem of New River, Virgin Creek (Soldier Creek confluence to the mouth), Virgin Creek (Soldier Creek confluence to the mouth), Eagle Creek Slide Creek (Eagle Creek confluence to the mouth), and East Fork of New River (South Fork confluence to the mouth) was surveyed and 702 adult summer steelhead were seen (Table 15). U.S. Forest Service biologists (Shasta/Trinity National Forest, Big Bar) assisted in this adult snorkel count.

Apparently adult summer steelhead are still entering the drainage after early August. The 443 adults observed by CDFG in August coincide with the USFWS and USFS counts in early July (427 fish), although there was an potential increase of 34 fish (18 in lower 2 miles and an additional 16 fish not observed in July. The apparently significant increase in fish numbers during mid to late August could be attributed to a late summer steelhead run. Everest 1973, also reported a early and late run in the Rogue River, Oregon where adult summer steelhead entered the river in May, June and July, followed by a large run of "half-pounders' in August, and a late run of adults in August, September and October. The late run steelhead should be considered as summer steelhead in the New River system although the separation of run timing was unknown to still occur in California (Moyle pers. comm.). In Bluff Creek (Klamath River tributary), an early and late run were also observed (Gerstung pers. comm.). This information suggests that July and August counts may not reflect the true run size of summer steelhead in some streams which was also noted by Dunn (1981).

The total of 702 adult summer steelhead is the largest count for the New River drainage recorded to date. The CDFG preliminary population estimates for northern California streams placed New River as the second largest summer steelhead producer with North Fork, Trinity as the largest population (Table 15). The increase in numbers may be attributed to a higher ocean survival and a decrease of poaching from squatters in the watershed affiliated with ~~the~~ U.S. Forest Service ~~eradication~~ efforts. Due to the CDFG counts occurring too early in the season, past counts may be low. Poaching in the New River watershed is still a matter of great concern. It is unknown how many adults are illegally harvested in the New River drainage. Pipe bomb fragments were observed in August 1991 at the confluence of Virgin and Slide Creeks (Dick Woods pers. comm.) where large schools (60 - 150 fish) have been observed to hold during summer and early fall months. Mining in the upper reaches (above East Fork) was discontinued in 1991, yet unauthorized suction dredge mining was observed in the Eagle Creek drainage on September 5, 1991

law enforcement

in the vicinity of the North Fork. The number# of adult summer steelhead ~~adults~~ in Eagle Creek in 1991 (8 fish) was down from 1990 (20 fish) compared to Virgin Creek with 12 fish in 1990 and 47 fish in 1991 and the mainstem with 283 adults observed in 1990 and 638 in 1991. The decrease of fish numbers in the Eagle Creek drainage may denote the illegal harvest of summer steelhead.

Table 14. Locations of observed spring chinook and summer steelhead July and September 1991.

Location	07/08/91 - 07/11/91		09/04/91 - 09/12/91	
	Spring Chinook	Summer Steelhead	Spring Chinook	Summer Steelhead
Virgin Creek Soldier Creek to Four Mile Creek	No Survey		0	40
Four Mile Creek to Confluence Pool	No Survey		0	7
Slide Creek N.F. Eagle Creek to Mouth of Eagle Creek	No Survey		0	8
Mouth of Eagle Creek to Confluence Pool	No Survey		0	6
East Fork Mouth of South Fork to Mouth of East Fork	No Survey		0	3
Lucky Lukes PMC to Mouth of East Fork	No Survey		0	0
New River Confluence Pool to Barron Creek	0	81	0	74
Barron Creek to East Fork Confluence	0	49	0	82
East Fork Confluence to Footbridge Area	0	169	0	93
Footbridge Area to Denny Campground	0	28	0	167
Denny Campground to Panther Creek	0	9	0	16
Panther Creek to Bell Flat	2	73	1	109
Bell Flat to mouth of New River	0	18	1	97
Total	2	427	2	702

Table 16. Preliminary summer steelhead populations in northern California from 1980 - 1991, () = estimated (Gerstung pers. comm.) .

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

Spring Chinook Salmon Adult and Redd Counts

Spring chinook adults were counted during July and September in the mainstem New River (Table 14). No juvenile chinook or adults have been observed in the tributaries to New River; therefore all emphasis was focused on the mainstem. Only 2 adult spring chinook were observed in July and again in September during the mask and snorkel surveys. It is unknown if the chinook adults are residing in the mainstem Trinity during the majority of the summer or if they are eluding direct observation by taking cover under bubble curtains or large boulder clusters. One adult spring chinook mortality was observed in the July adult survey below the falls at rkm 1.1. It is unknown if the adult chinook mortality was due to the partial barrier. Three redd surveys were conducted in 1991 on the mainstem New River. The initial survey was conducted from October 22 - 24 from the confluence of Virgin and Slide Creeks to the mouth of New River. Only two redds were observed, both located between Panther Creek and Bell Creek (Figure 13). The second survey was conducted from November 4 - 6 on the mainstem New River. Four new redds (fresh) were observed. No new redds were observed during the third survey from November 19 - 20.

In the Trinity River, spring chinook spawning occurs from early September through mid-November. Their numbers peak in late September to early October while fall chinook carcasses were first observed in early October, their numbers peak in early to mid-November (Zuspan pers. comm.). Trinity Hatchery spawns spring chinook between September 1 and October 13 and fall chinook between October 9 and December 17 (Hassler pers. comm.). It is still unknown if fall chinook are still using the New River drainage. The redds observed in early November were completed and the females were no longer present indicating the redds were one to two weeks old. We considered these as spring chinook redds.

The total of 6 spring chinook redds observed in the mainstem New River is the lowest number of redds recorded since the project's beginning in 1988 (16 redds). It is unknown how many fish are necessary to maintain a viable population of spring chinook in the New River drainage. Genetically, to maintain good genetic variation in a gene pool and decrease the chance of inbreeding depression, at least 50 adults (short term) and 500 adults (long term) are suggested (Franklin 1980). Hydraulic mining activities and complete water diversions during the gold rush may have greatly impacted the population for many years. Personal communication with local residences imply large runs were once again present in the 1950's. Thomas (pers. comm.) mentioned that in the mid 1950's the lower pools in New River were abundant with adult spring chinook. The flood of December 1964 (45,000 cfs) and resulting sediment deposition in the stream channel that accompanied the flood probably impacted the runs for many years due to lack of suitable adult holding habitat. There now appears to be sufficient holding areas for spring chinook beyond the numbers currently returning.

Juvenile Trapping

1991 Juvenile Trapping

Downstream migrant trapping occurred from March 21 through October 22, 1991, by use of a rotary screw trap (Figure 2) and a frame net trap during periods of extreme low discharge. Total capture for the 1991 trapping season was 537 chinook yoy, 4 chinook 1+, 240 steelhead yoy, 1129 steelhead parr, and 555 steelhead smolts (Table 16). The first steelhead yoy (mean length 27 mm) was observed on May 3, 1991 and the first chinook yoy was observed on April 18, 1991 in a frame net trap located at rkm 25.7 (upstream from the mouth of East Fork). Chinook 1+ were captured for the first time since the trapping began in 1989. Only four chinook 1+ were captured in the 1991 trapping season

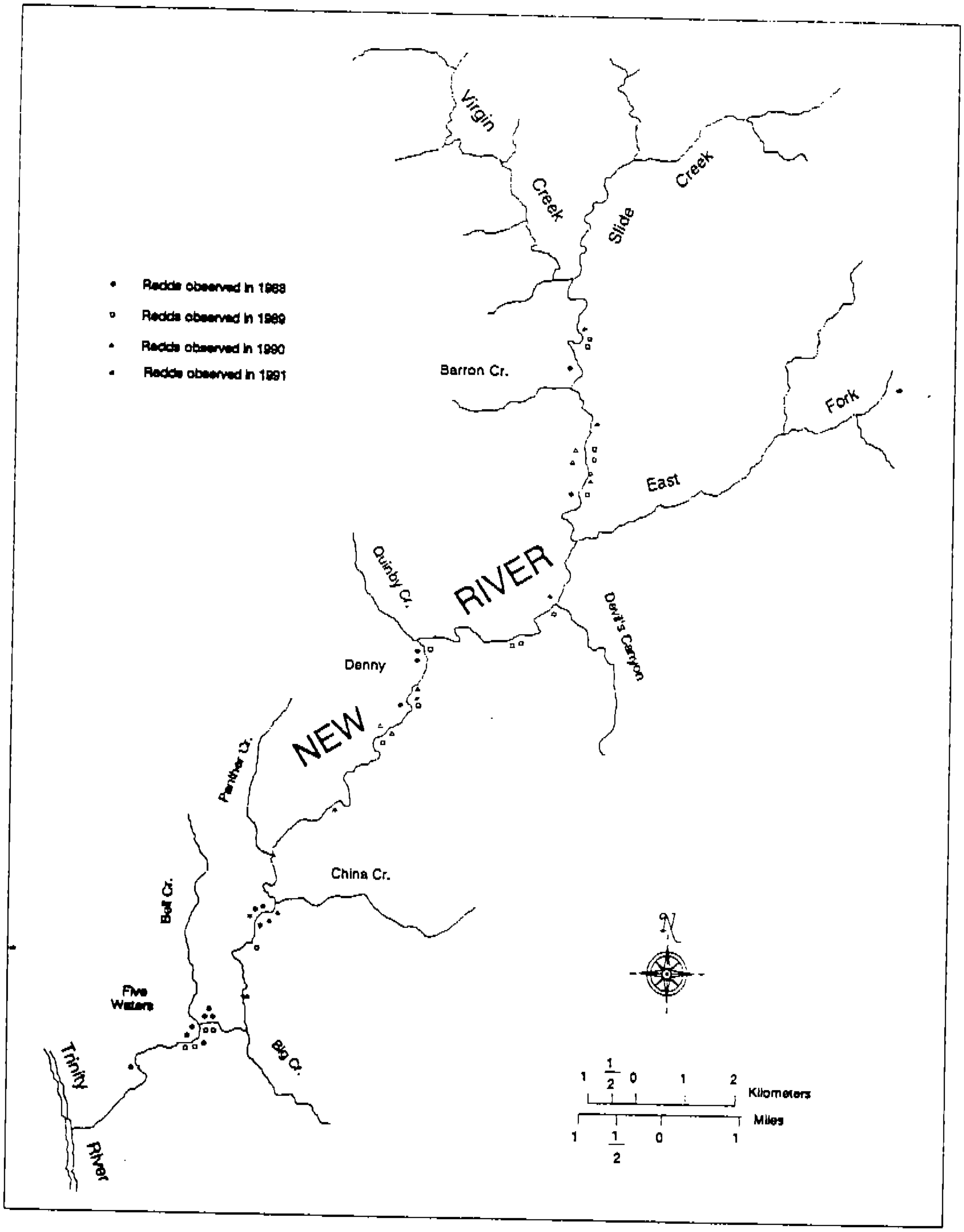

Figure 13. Locations of chinook redds observed in New River in fall 1988, 1989, 1990, and 1991.

Table 16. Rotary screw trap and late year frame trap summary for 1989,1990, and 1991 trapping seasons.

Month	1989					1990					1991				
	Steelhead			Chinook		Steelhead			Chinook		Steelhead			Chinook	
	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
May	2	662	173	55	0	31	645	231	341	0	1	331	256	105	2
June	140	364	22	375	0	297	50	7	330	0	221	157	17	420	0
July	46	6	2	61	0	201	29	3	106	0	1	2	0	10	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	325	425	0	573	5,397	1,590	822	0	240	1,129	555	537	4

(fork length 96 - 121 mm). Total number of 1989, 1990, and 1991 emigrated chinook, steelhead yoy, parr, and smolts are given as the expansions of numbers captured by nights fished and discharge sampled (Figures 14, 15, 16, and 17). The first chinook 1+ was captured on March 29 and the last was captured on May 15. The first chinook yoy entered the screw trap at rkm 3.75 on April 26 (38 mm) and the peak emigration was in June. The majority of chinook yoy had left the system by the middle of June. During September, numerous chinook yoy were still residing in the river as high as rkm 28. It is unknown if the remaining chinook yoy wintered in New River and left the system as 1+ or outmigrated during high winter discharge. Peak emigration for steelhead parr and smolts occurred during late April and the month of May. Steelhead smolts were virtually out of the system by the middle of June. Steelhead smolts made up 28 % of the rotary screw trap catch in 1991 and 20 % of the catch in 1990. Steelhead parr comprised 72 % of the catch in 1991 and 72 % of the catch in 1990. The similar life history strategies observed in 1990 and 1991 display how the majority of juvenile steelhead leave the New River system as parr. In late July, steelhead outmigration comes to a halt when stream flow and habitat has stabilized. In Blue Creek (lower Klamath River tributary), 71 % of the trapped and sampled juvenile steelhead were parr indicating a similar life history pattern. (USFWS files). Scale information to be gathered from returning adults captured in the proposed resistance weir (fall 1992) will determine if the steelhead parr are residing in freshwater (Trinity/Klamath) for an additional year or are entering the estuary/ocean as 1+ smolts.

Biological Data

Steelhead length frequency histograms for March, April, May and June are displayed in Figure 18. The distinctive modes observed in April, May, and June depict steelhead yoy, 1+, and 2+ aged fish. Juvenile scale samples collected in 1991 were analyzed and also showed the distinct breaks between age classes. Mean fork lengths and 95% confidence intervals are displayed in Figure 24. Mean fork lengths for steelhead yoy ranged from 27mm (Julian week 18) to 82mm (Julian week 40), steelhead 1+ ranged from 89mm (Julian week 12) to 126mm (Julian week 38), and steelhead 2+ ranged from 172mm (Julian week 12) to 139mm (Julian week 41).

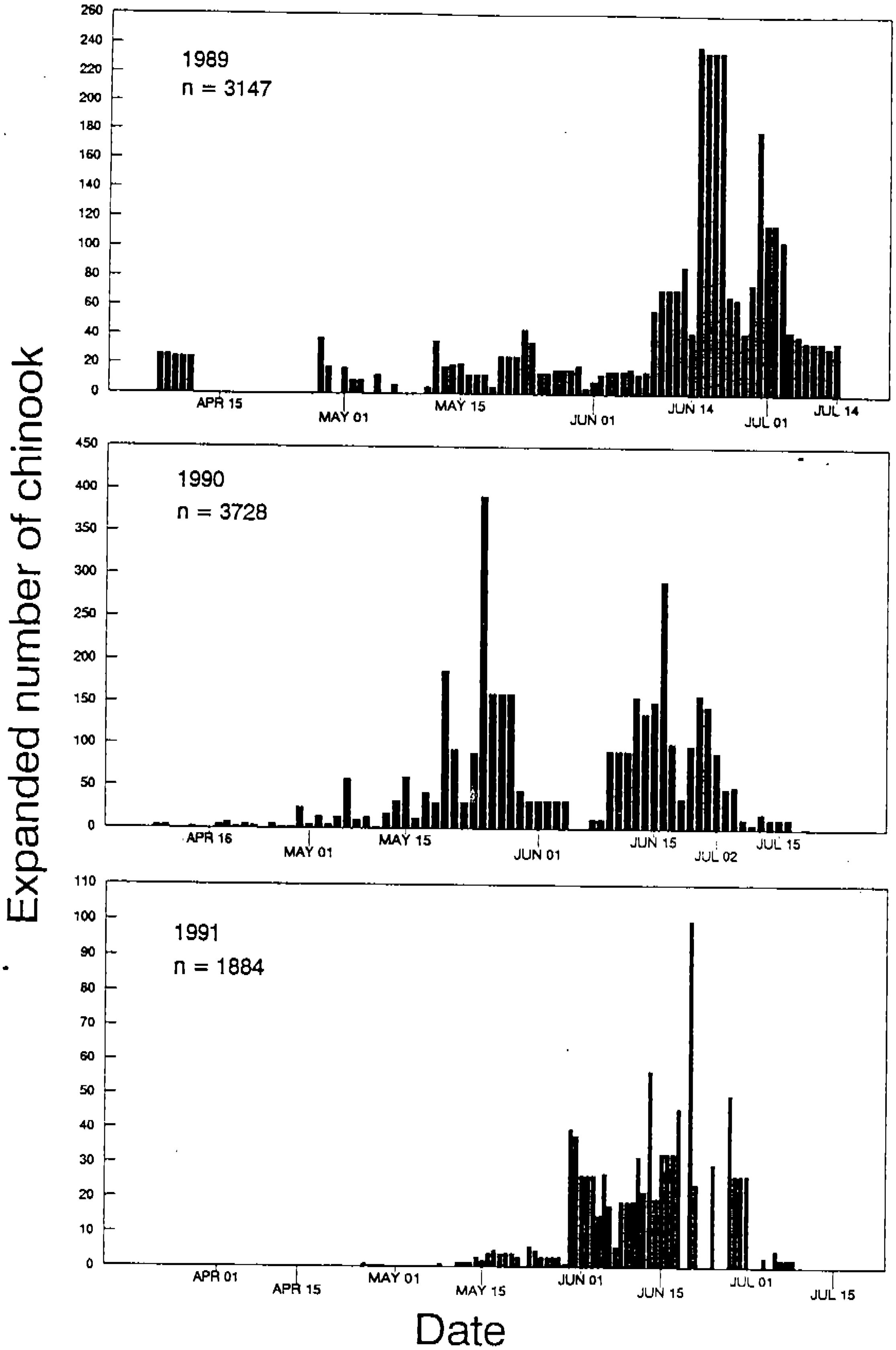

Figure 14. Juvenile chinook expanded daily outmigrant estimate (1989, 1990, and 1991).

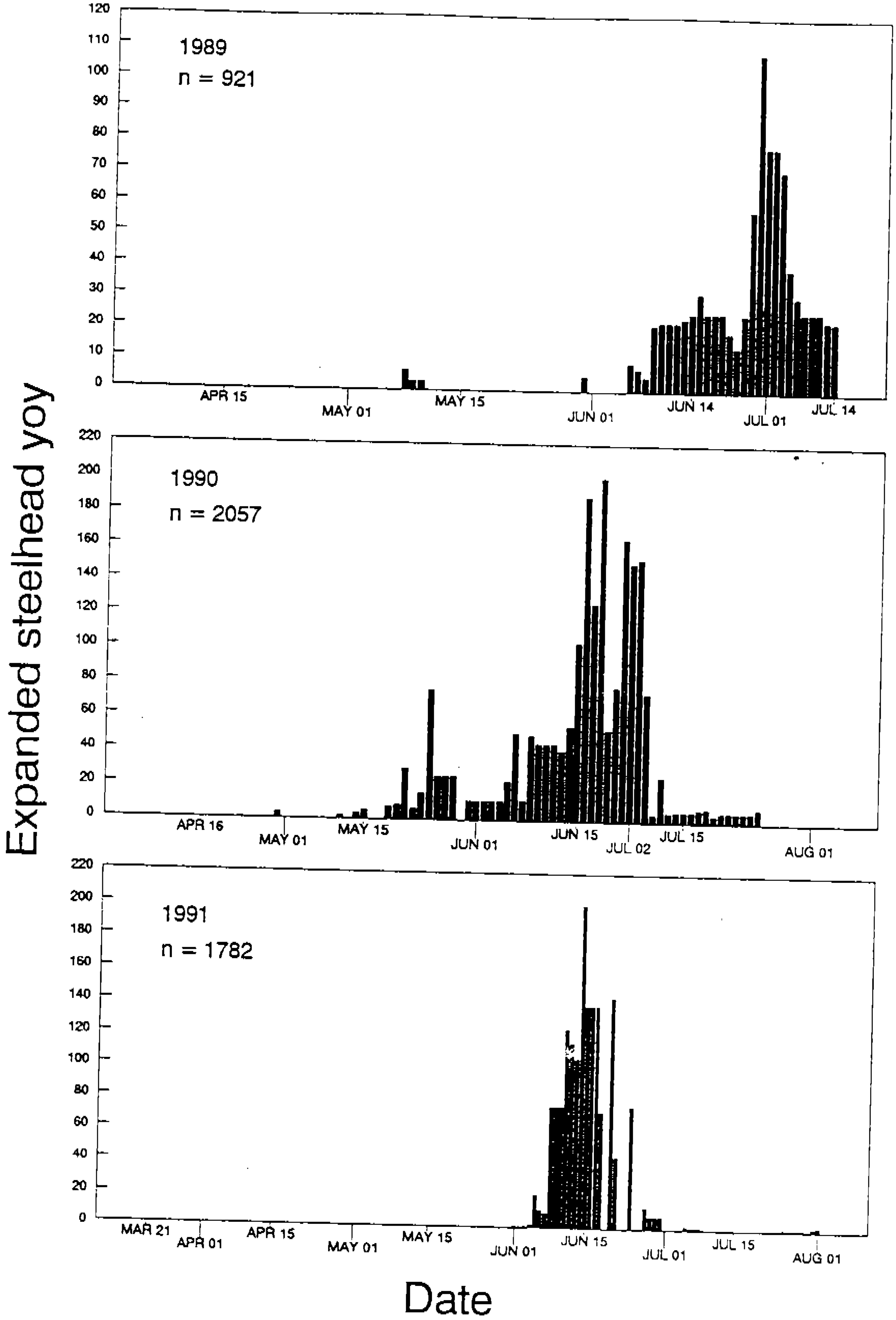

Figure 15. Steelhead yoy expanded daily outmigrant estimate (1989, 1990, and 1991).

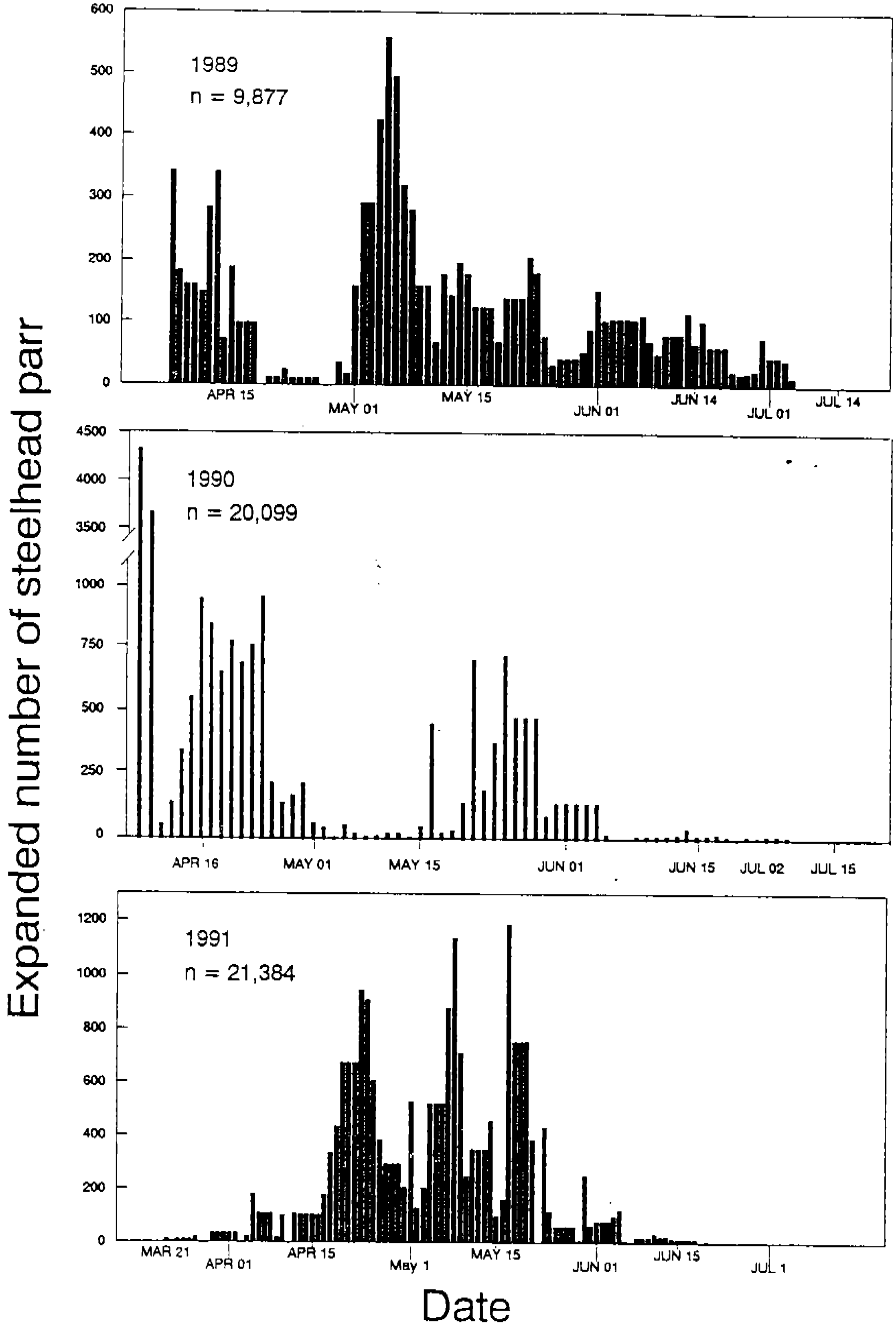

Figure 16. Steelhead parr expanded daily outmigrant estimate (1989, 1990, and 1991).

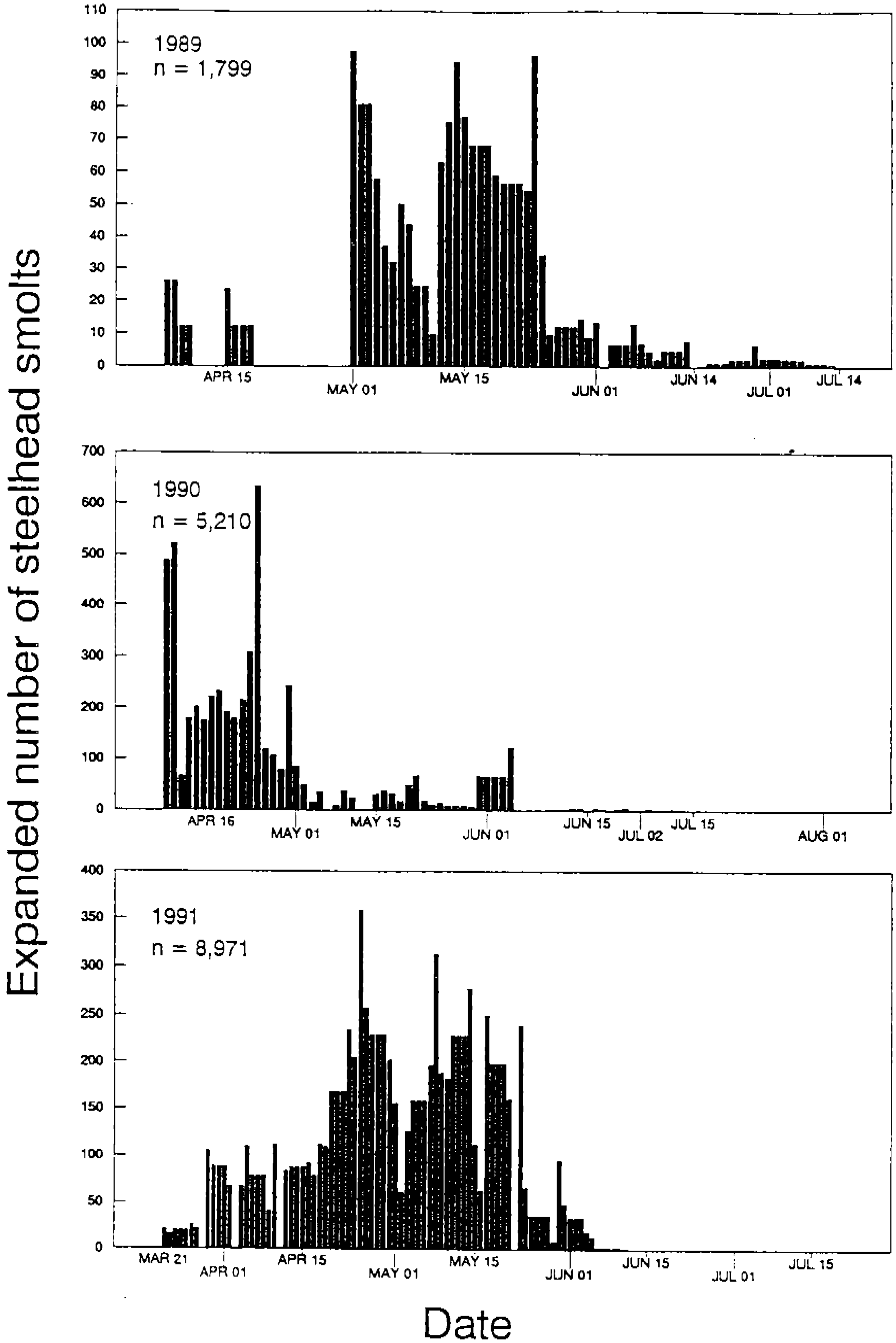

Figure 17. Steelhead smolt expanded daily outmigrant estimate (1989, 1990, 1991).

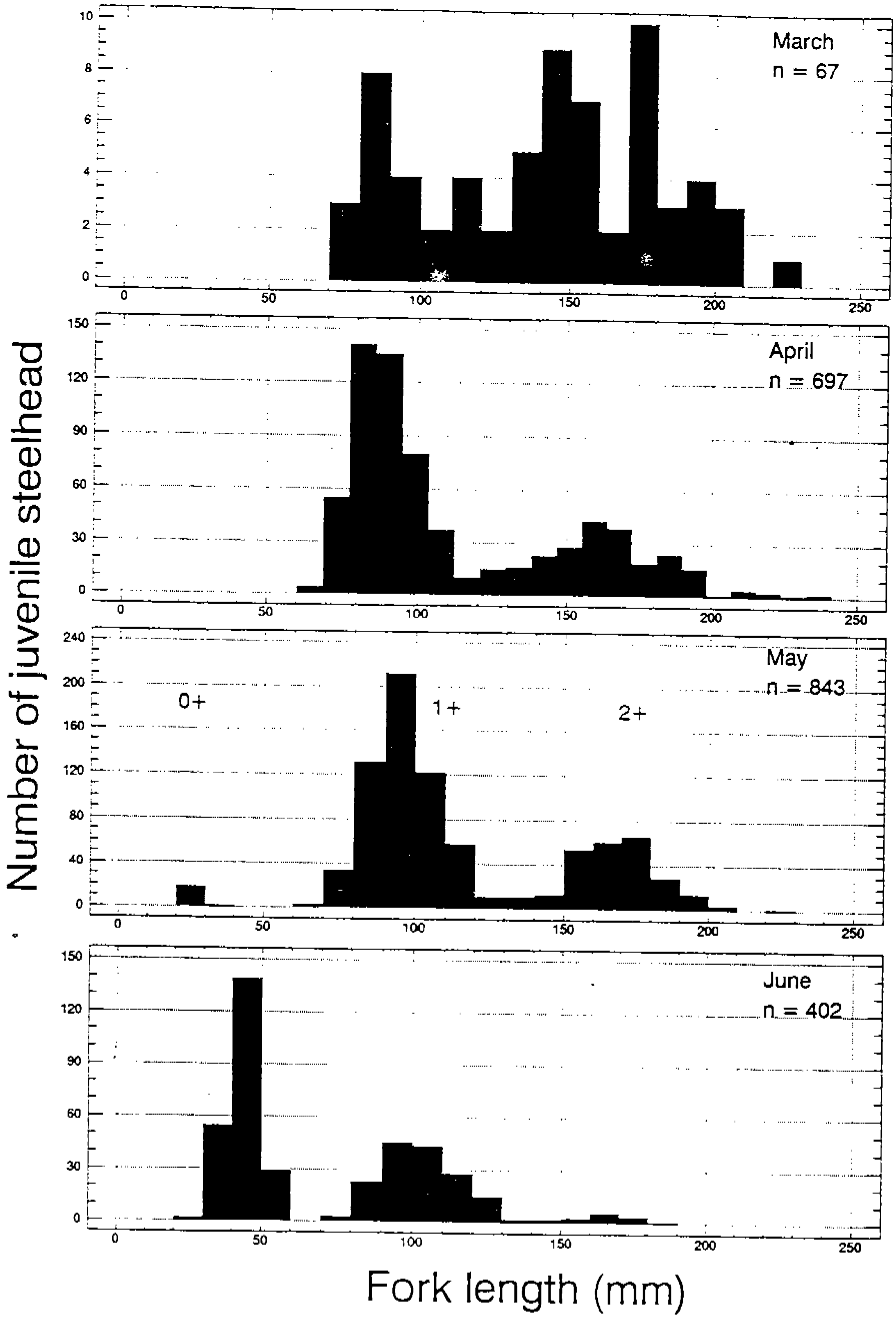

Figure 18. 1991 juvenile steelhead length frequency histograms.

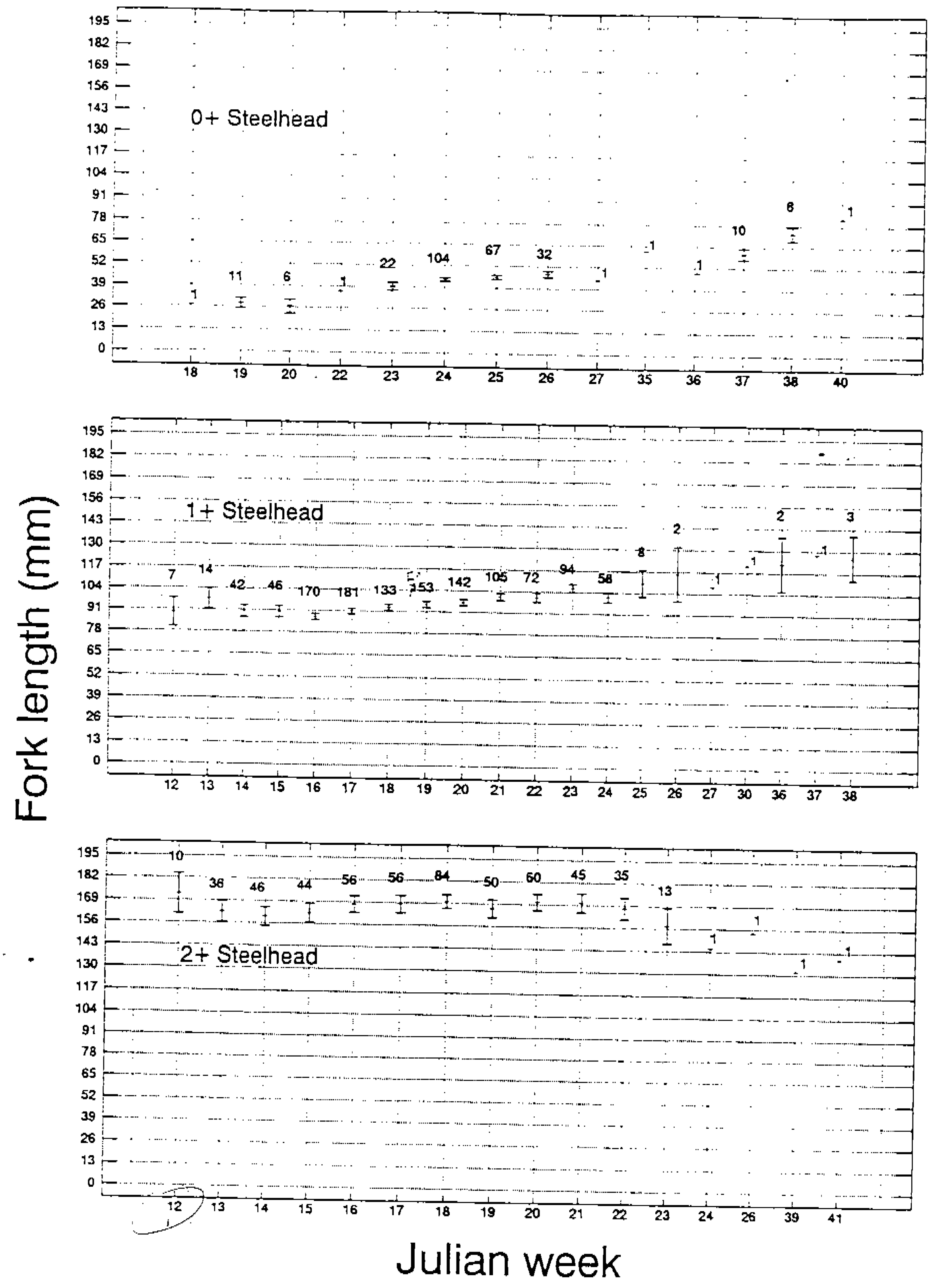

Figure 19. 1991 steelhead 0+, 1+, and 2+ fork length mean and 95%. confidence interval (Julian scale, Appendix 3).

It is apparent that little to no growth occurs for yoy steelhead during the winter months. Snorkel observations of juveniles during periods of cold water temperatures (<7°C) showed little activity of yoy steelhead although larger 1+ steelhead were observed to be lurking near the bottom of pools. Zedonis (pers. comm.) observed juvenile steelhead in the winter to be actively feeding during nighttime hours. The limited growth in juvenile steelhead observed in New River may be attributed to the low metabolic rate in fish and the suspected lower production of aquatic insects that coincides with the cold water temperatures.

Histograms showing chinook fork lengths for 1989, 1990, and 1991 display the sizes passing through the trap location (Figure 20). The mean fork length for juvenile chinook in 1989 was 71.7mm (n = 424, standard deviation (SD) = 10.3), 1990 was 65.5mm (n = 708, SD = 9.4), and 1991 was 69.0mm (n = 565, SD = 10.9). The larger chinook in the 1991 histogram are the 1+ chinook contribution.

The length displacement relationship was determined for both 1991 juvenile steelhead and chinook (Figure 21). Slopes were determined for the log transformed linear regressions for juvenile steelhead (2.9) and juvenile chinook (3.1). According to Castleberry et al. (1991), a slope above 3.0 indicates that fish become heavier for a given length as they grow. Since smolts are included in the steelhead regressions a lower value is expected since steelhead undergoing smoltification are predominantly a leaner fish.

The overall condition of juvenile salmonids were rated as excellent. No external diseases were observed, although puncture wounds from birds were observed on numerous yoy steelhead and chinook.

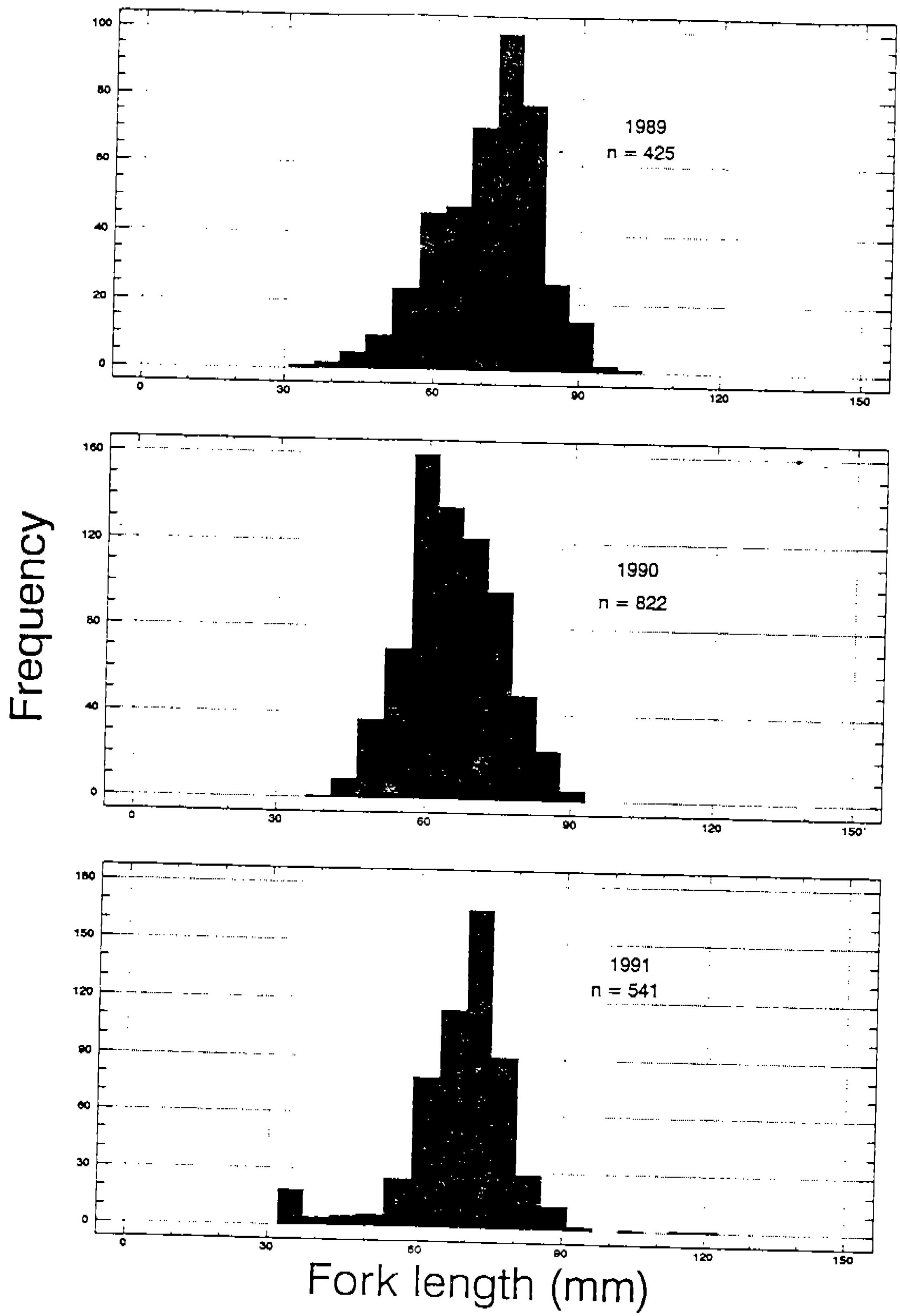

Figure 20. 1989, 1990, and 1991 juvenile chinook length frequency histograms.

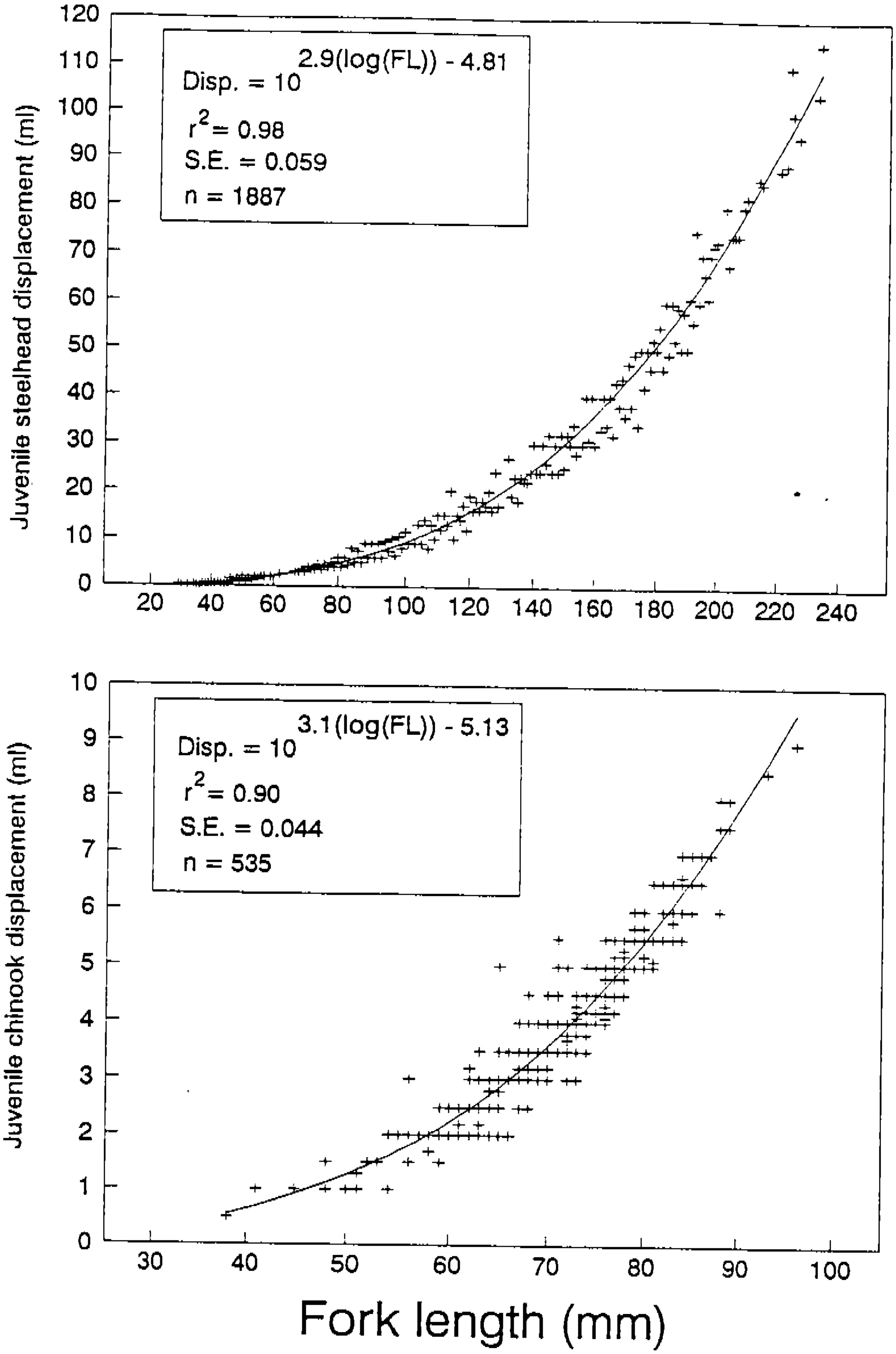

Figure 21. 1991 juvenile steelhead and chinook length displacement relationships.

Summary

New River's 1991 adult summer steelhead count of 702 fish was the largest run recorded to date and one of the largest runs in California. Runs of 687 and 343 fish occurred in 1989 and 1990, respectively. The USFS removal of squatters in the upper drainage along with proposed fishing regulations limiting fishing below the East Fork of New River will act as a protective measure to the returning steelhead populations. More than eighty kilometers of quality steelhead spawning and rearing habitat are available. Numbers of winter steelhead using the drainage are uncertain, however the number of winter steelhead adults will be estimated when the proposed resistance board weir is constructed and operated beginning in the fall of 1992.

The total of 6 spring chinook redds recorded in the mainstem New River is the lowest since counts began in 1988. Estimates of potentially available chinook spawning habitat in the mainstem New River suggest that a range from 1442 to 2351 spawning chinook pairs could be accommodated (Shaw et al. 1991). Both Virgin and Slide Creeks have high quality spawning gravel and holding pools which would also support populations of chinook. The waterfall located at rkm 1.1 may be limiting chinook entering the New River drainage. One adult spring chinook mortality was observed in July of 1991 below the falls. The falls 0.6 rkm below the confluence of Virgin and Slide Creeks may also limit chinook from entering the creeks. No juvenile chinook have been observed in either Virgin ~~and~~ Slide Creeks.

Stream temperatures have continued to increase in the summer and decrease in the winter possibly due to the continued drought. Mean temperatures ranged from a high of 23°C in late July to a low of 0.7°C in December. The high temperatures are within the tolerance zone for steelhead and extreme temperatures are sustained for only short periods during the late afternoons. The effects of elevated temperatures on the migration of spring chinook and summer steelhead are uncertain. Numerous deep pools, cold tributaries and seeps are present throughout the drainage to provide thermal refuge for holding adults.

The discharge of 23 cfs in September of 1991 is the lowest since the project began in October 1988. The placement of chinook redds during low discharge periods may result in poor reproductive success since scour is likely during high discharge periods. Outmigrating juvenile salmonids were not observed during these low flow periods.

Stream classification was completed for the East Fork of New River from the mouth to the Cabin Creek confluence with the B1 channel type predominant, indicating a moderate gradient (2.5 - 4%). The East Fork is not considered a chinook tributary due to the gradient and the lack of suitable chinook spawning gravel in the lower reaches. It is unknown why the summer steelhead population in the East Fork is low, since the upper drainage along with the South Fork and Pony Creeks are inhabited by steelhead. The dominant habitat types for East Fork were LGR, LsBk, LsBo, and POW. Suction dredge mining was prevalent in the lower East Fork from the trail bridge downstream to the mouth. Impacts to juvenile and adult populations by dredging are uncertain.

The stream channel classification for Virgin Creek included B1, B3, B2, and B1-1 indicating a variety of habitat configurations. Excellent holding pools, rearing habitat, and spawning habitat are located throughout the creek with LsBk, LGR, MCP, LsBo, and POW dominating the habitat types. The summer steelhead counts in Virgin Creek are larger than other tributaries of New River which reflects the pristine condition. Chinook have not been observed in Virgin Creek although the habitat would support them. The falls located 0.6 rkms below the confluence of Virgin and Slide Creeks may deter the passage of chinook upstream.

The stream channel classification for Slide Creek was also diverse with B3, B2, B1, B1-1, and B3 channel types located in the lower 1.4 kilometers. The stream gradient of 2.8% indicates primarily steelhead habitat although numerous deep pools (LsBk 18% and MCP 13%) are located in the lower river (Eagle Creek confluence to the mouth) and could accommodate some holding adult chinook. Juvenile rearing habitat does not appear limited. Slide Creek's flow is much less upstream of the Eagle Creek confluence. Adult summer and winter steelhead use the upper Slide Creek with the increase in discharge during the fall and winter months.

Significant differences in densities (fish/m^3) were not observed between years for yoy, 1+, and 2+ steelhead in the mainstem New River, however differences were observed between habitat types for both yoy and 1+ steelhead. These differences may be attributed to the low densities of yoy and 1+ steelhead observed in mid channel pools and glides while higher densities were observed in low gradient riffles, lateral scour bedrock pools, lateral scour boulder pools, and pocket water. The significantly higher densities of chinook yoy observed in the mainstem New River in 1991 correspond with the fall snorkel observations and outmigrant trapping in the spring indicating many juvenile chinook are remaining in the system beyond July. Significant differences were determined for yoy steelhead in the East Fork for both habitat types and years. The reason for higher densities of yoy steelhead in 1991 is not known. Adult summer steelhead surveys for the East Fork did not begin until 1990 (10 adults) and the contribution rate of the winter race is unknown. No significant differences were observed for yoy, 1+, and 2+ steelhead in Virgin creek for either habitat types or years indicating a stable population. Significant differences were observed for 1+ steelhead between habitat types in Slide Creek, although significant differences were not observed between years for yoy, 1+, and 2+ steelhead.

The 1992 index studies will repeat the density measurements made in 1990 and 1991. Long term monitoring of the index reaches will determine if the population of steelhead and chinook are increasing or decreasing. Population trends observed in the New River could be used for comparison with other Trinity River tributaries where restoration efforts have taken place to manipulate habitat.

Downstream migrant trapping over the last three years have placed the peak migration of juvenile chinook between June 1 and July 1 although in 1990 a relatively large group of chinook outmigrated in mid May. The peak emigration of steelhead parr and smolts occur in April and May, according to trapping during the period March 26 through October 22.

Emergence of chinook was estimated to occur in late February while steelhead emergence occurs in April and May. If suction dredge mining continues, investigations need to determine the emergence timing of summer and winter steelhead fry and if dredging impacts adult migration and holding patterns.

The operation of the proposed resistance weir will be used to determine winter steelhead numbers, age, and migration characteristics. It is unknown if the majority of juvenile steelhead, outmigrating as 1+ parr, smolt in the estuary or reside in the freshwater (Trinity/Klamath) for an additional year and leave the system as 2+ smolts. If the juveniles reside in freshwater for an additional year, such scale information would be an important reason to increase the Trinity/Klamath rearing flows.

Activities planned for 1992 and 1993 are to continue the downstream trapping of juvenile salmonids, monitoring of the permanent index reaches, assessment of the partial barriers, conduct adult and redd counts.

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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	

Stream Type	Gradient (%)	Dominant Particle Size of Channel Materials	Channel Entrenchment and Valley Confinement
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)	Gravelbed w/mixture of small cobble and sand.	Moderate entrenchment; slightly confined.
C4	0.1-0.5 (X=0.3)	Sandbed 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))	Sandbed w/mixture of silt and some gravel.	Deeply entrenched; unconfined.

Stream Type	Gradient (%)	Dominant Particle Size of Channel Materials	Channel Entrenchment Valley Confinement
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)	Sandbed 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.

HABITAT TYPE		DESCRIPTION
0	Dry Channel (DRY)	
1	Low Gradient Riffle (LGR)	Shallow reaches with swiftly flowing, turbulent water with some partially exposed substrate. Gradient <4%, substrate is usually cobble dominated.
2	High Gradient Riffle (HGR)	Steep reaches of moderately deep, swift, and very turbulent water. Amount of exposed substrate is relatively high. Gradient is >4%, and substrate is boulder dominated.
3	Cascade (CAS)	The steepest riffle habitat, consisting of alternating small waterfalls and shallow pools. Substrate is usually bedrock and boulders.
4	Secondary Channel Pool (SCP)	Pools formed outside of the average wetted channel width. During summer, these pools will dry up or have very little flow. Mainly associated with gravel bars and may contain sand and silt substrates.
5	Backwater Pool (BwBo) Boulder Formed	Found along channel margins and caused by eddies around obstructions such as boulders, rootwads, or woody debris. These pools are usually shallow and are dominated by fine grain substrates. Current velocities are quite low.
6	Backwater Pool (BwRw) Root Wad Formed	
7	Backwater Pool (BwL) Log Formed	
8	Trench/Chute (TRC)	Channel cross sections typically U-shaped with bedrock or coarse grained bottom flanked by bedrock walls. Current velocities are swift and the direction of flow is uniform. May be pool-like.
9	Plunge Pool (PLP)	Found where stream passes over a complete or nearly complete channel obstruction and drops steeply into the streambed below, scouring out a depression; often large and deep. Substrate size is highly variable.
10	Lateral Scour Pool (LsL) Log Formed	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 (LsRw) Root Wad Formed	
12	Lateral Scour Pool (LsBk) Bedrock Formed	
13	Dammed Pool (DPL)	Water impounded from a complete or nearly complete channel blockage (debris jams, rock landslides or beaver dams). Substrates tend toward smaller gravels and sand.
14	Glides (GLD)	A wide uniform channel bottom. Flow with low to moderate velocities, lacking pronounced turbulence. Substrate usually consists of cobble, gravel and sand.
15	Run (RUN)	Swiftly flowing reaches with little surface agitation and no major flow obstructions. Often appears as flooded riffles. Typical substrates are gravel, cobble and boulders.
16	Step Run (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) Boulder Formed	Formed by flow impinging against boulders that create a partial channel obstruction. The associated scour is confined to <60% of wetted channel width.
21	Pocket Water (POW)	A section of swift flowing stream containing numerous boulders or other large obstructions which create eddies or scour holes (pockets) behind the obstructions.
22	Corner Pool (CRP)	Lateral Scour Pools formed at a bend in the channel. These pools are common in

		lowland valley bottoms where stream banks consist of alluvium and lack hard obstructions.
23	Step Pool (STP)	A series of pools separated by short riffles or cascades. Generally found in high gradient, confined mountain streams dominated by boulder substrate.
24	Bedrock Sheet (BRS)	A thin sheet of water flowing over a smooth bedrock surface. Gradients are highly variable.

Appendix 1. List of Julian Weeks and their calender date equivalents.

Julian Week	Calender dates		Julian Week	Calender dates	
	Start	Finish		Start	Finish
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