KLAMATH RIVER FISHERIES ASSESSMENT PROGRAM

JUVENILE SALMONID MONITORING ON THE TRINITY AND KLAMATH RIVERS

Coastal California Fishery Resource Office

Arcata, California

Region 1

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JUVENILE SALMONID MONITORING ON THE TRINITY AND KLAMATH RIVERS

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

Greg H. Goldsmith

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TABLE OF CONTENTS

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ABSTRACT

This report marks the fourth year of juvenile salmonid outmigration monitoring on the mainstem Klamath and Trinity rivers, and the third year of monitoring utilizing rotary screw traps. CCFRO initiated the use of rotary traps in the Klamath Basin in 1989.

Trapping in 1991 at the Klamath River site near Orleans, CA began in March and continued into December utilizing a single rotary trap. A single trap was also utilized at the Trinity River site near Willow Creek, CA and was operated from February into November. The trapping season was divided into "spring" and "fall" trapping periods which coincide with hatchery chinook release strategies and corresponding outmigration peaks.

The Klamath River trap was located at river kilometer (rkm) 80, 16.1 rkm downstream of the town of Orleans. This trap operated for 102 nights, from April 02, 1991 to December 20, 1991. The catch included 4,468 chinook salmon Oncorhynchus tshawytscha, of which 344 (7.7%) were adipose (AD) fin-clipped indicating coded wire tag (CWT) implantation. Iron Gate Hatchery (IGH) released fall chinook salmon fingerlings in late May 1991 and yearlings in mid November 1991. Yearling chinook were also released in October from several salmonid rearing project sites on tributary streams to the Klamath River. The peak of chinook emigration occurred during the week from June 30, 1991 to July 6, 1991. During the fall sampling period, the peak occurred during the week of December 1-7, 1991 following yearling releases.

The relative hatchery contribution estimate to the chinook population sampled in the Klamath River trap was 69.7% for the entire trapping season. The spring trapping period was comprised of 81.1% hatchery chinook, while the fall period contained 57.5% hatchery chinook stocks. Initial migration rates ranged from 7.1 to 37.7 rkm per day for hatchery reared chinook salmon. The abundance index for chinook salmon for the entire trapping season totalled 359,183. Additionally, the trap captured 238 steelhead O. mykiss, and 44 coho salmon O. kisutch. The steelhead catch in the spring trapping period included 52.1% of the total steelhead captured, and the coho catch in the spring was dominated by hatchery smolts.

The Trinity River trap was located 6 km downstream of the town of Willow Creek, at rkm 34. The trap was operated for 155 nights, from February 13, 1991 to November 22, 1991. Chinook catch totalled 24,737, including 1,807 ad-clips (7.30%). The spring trapping period on the Trinity River included 19,599 (79.2%) of the total chinook captured. Trinity River Hatchery (TRH) released spring chinook salmon in late May 1991, and released both spring and fall chinook yearlings in early October 1991. Also captured were chinook salmon of natural origin which were marked AD-CWT by CDFG upstream of our trapping operation. Peak weekly chinook catch occurred from June 30 to July 6. Catch effort was high throughout June, and the period of high catch effort coincided with the capture of TRH chinook fingerlings. During the fall period, A lesser peak in catch effort occurred from October 13 through 19 following the release of chinook yearlings from TRH.

Hatchery chinook salmon comprised 46.9% of the sampled population in the Trinity River trap for the season. The spring trapping included 34.5% hatchery chinook, while the fall trapping contained 92.4% hatchery chinook. Initial migration rates for hatchery chinook ranged from 18.0 to 48.0 rkm per day. The abundance index estimate of chinook salmon for the entire trapping season totalled 542,828. Trap efficiency estimates were attained using mark and recapture groups of chinook salmon, with estimates ranging from 0.3% to 5.6% efficiency.

The trap also captured 1,235 steelhead and 224 coho salmon during the entire trapping season. Steelhead catch for the spring period accounted for 91.8% of the total steelhead captured. More than 99% of all coho were captured during the spring trapping period.

INTRODUCTION

The Klamath River system is the second largest river system in California, draining an area of approximately 26,000 square kilometers (km^2), and 14,400 km^2 in Oregon. The Trinity River is the largest tributary to the Klamath River, draining approximately 7,690 km^2 in California. Two dams, Iron Gate Dam on the Klamath River and Lewiston Dam on the Trinity River, are the upper limits of anadromous fish migration in the basin. Two fish hatcheries, Iron Gate Hatchery (IGH) on the Klamath River and Trinity River Hatchery (TRH), were constructed to mitigate for losses of anadromous fish habitat upstream of Iron Gate and Lewiston dams. The anadromous fish stocks of the Klamath River and the Trinity River represent an extremely important part of California's salmon populations. The drastic decline of these stocks in recent years has raised concerns regarding the conservation of chinook salmon, coho salmon, and steelhead trout.

In 1984, Congress established the Trinity River Basin Fish and Wildlife Restoration Act (P.L. 98-541) which provided a means for restoration of anadromous fish stocks to pre-impoundment levels. One of the goals developed was the restoration of anadromous salmonid stocks to the Trinity River below Lewiston Dam. Monitoring the responses of juvenile salmonid populations to the restoration efforts was initiated to evaluate the restoration efforts as the work proceeded.

In 1986, the Klamath River Basin Conservation Area Fishery Restoration Program (P.L. 99-552) was initiated to restore the anadromous fish stocks of the Klamath River basin, and to offset the effects of dams, floods, timber harvest, mining, and other detrimental impacts (Klamath River Basin Fisheries Task Force, 1991). One of the main goals of the program is to restore anadromous fish stocks to viable levels by the year 2006. Habitat restoration measures play a major role in this process and are being implemented to enhance the populations of juvenile and adult salmonids.

Until recently, most fishery investigations in the Basin have been focused primarily on adult returns, due to the concerns regarding harvest allocation and escapement goals. The monitoring of outmigrating juvenile salmonid populations focuses more on the effects of habitat availability and suitability on production success and permits examination of the success of the restoration efforts. The assessment of juvenile production also excludes the little understood variables existing in the ocean environment.

Intermittent juvenile salmonid investigations have been conducted in the Klamath River Basin by Coastal California Fishery Resource Office (CCFRO) since 1981 (USFWS, 1981, 1982). In 1988, a substantial monitoring effort was undertaken in both the mainstem Klamath and Trinity rivers utilizing fyke nets, and in 1989, the use of rotary screw traps was initiated at both locations.

METHODS

Trapping Sites

The Klamath River trap was located at river kilometer (rkm) 80, 16 rkm downstream of the town of Orleans, CA (Figure 1). The site on the Klamath River was chosen after utilizing several nearby sites in previous trapping years. The new location provides a more laminar river flow and adequate depth for the trap to operate with a margin for normal river stage fluctuation. The site also allowed for continued trapping at high river discharge levels, and provided good access for crews and equipment. Access was available through the Big Bar River Access maintained by the U.S. Forest Service.

The Trinity River trap was located at rkm 34, 6 rkm downstream of the town of Willow Creek, CA (Figure 1). During the first three years of collecting juvenile trapping data on the Trinity River, several sites were utilized. In January 1991, CCFRO personnel located what was perceived to be an excellent trapping site adjacent to the Riverdale R.V. Park. The site is in a run/glide habitat between two large pools, and affords good year-round flow characteristics, along with good access to the trap.

Trap Design and Operation

The trap design includes a set of 6.1 m long aluminum pontoons that support the 2.44 m diameter rotary screw or 'cone' (Figure 2). The cone spins to overcome drag and consequently traps any fish traveling downstream through the water that turns it. The cone is covered with 0.64 cm galvanized wire mesh to allow for water passage while retaining fish. The fish were held in an aluminum live box at the rear of the screw until a sampling crew arrived. When not in use, the cone and live box can be lifted clear of the water with winches. The trap was anchored into position in the river with 0.64 cm diameter aircraft cable and secured to large trees upstream. A 4.88 m extension constructed of steel pipe was used to push the trap out from the bank. The extension allowed for adjustment of the distance from shore to compensate for changes in river stage and velocity. The trap was normally operated in fast water to obtain adequate turning velocity. Trapping typically began with lowering the screw into the water on Monday, and checking the trap daily until it was raised from the water on Friday. During the peak of the trapping season, the trap was operated seven days per week to ensure that hatchery releases were captured as soon as they reached the trap.

Biological Sampling Procedures

Only salmonids that are actively migrating downstream were expected to be caught, since the trap mouth faces upstream, and the trap was located in fast-moving water. Trap sampling consisted of catch effort and biological data. Fish were collected in the live box by the trap and retained in the box until crews arrived for sampling procedures. Fish were placed in plastic buckets and anaesthetized with Tricaine methanesulfonate (MS-222). The fish were identified to species, and the salmonid species were enumerated and classified to a development stage of sac-fry, fry, parr, smolt, or adult. A random sample of up to 30 salmonids of each species were measured to fork length (f.l.) in millimeters (mm) and volumetric displacement in milliliters (ml). Volume was substituted for weight to aid in sampling and to alleviate stress on the fish. Condition equations were constructed utilizing fish length and volume. As a measure of condition, volumetric displacement was measured and regressed on fork length. The estimate of ordinary least-squares regression parameters was used. This is a more accurate method of examining the length-weight relationship of fish populations than using Fulton's condition factor (K)(Cone, 1989). Up to 30 steelhead each were measured from the parr and smolt development stage to obtain a representative sample size of the distinct developmental stages present. Scale samples were collected from a subsample of all captured salmonids for age-class identification and for future use in determining hatchery or natural origin.

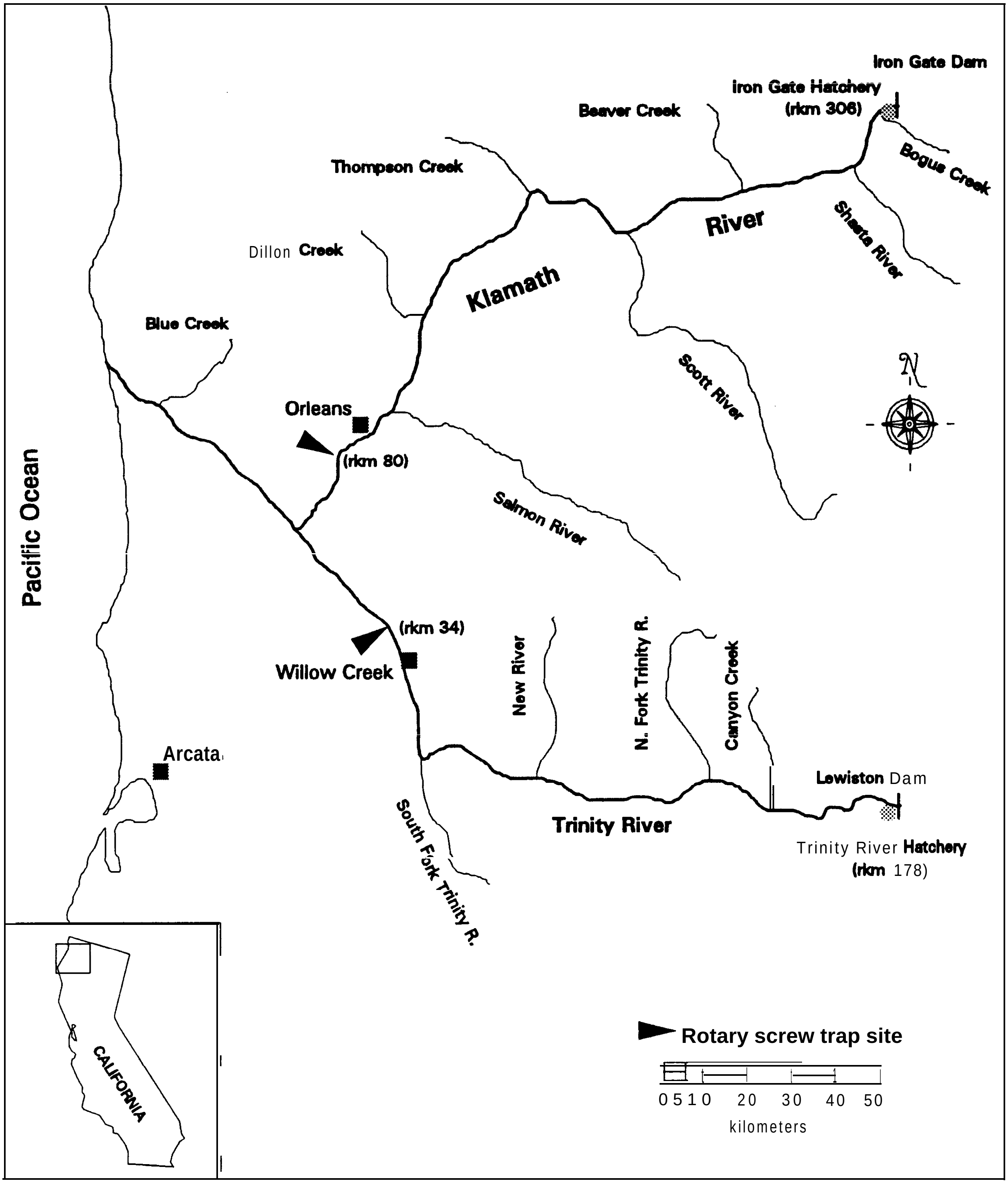


Figure 1. Location of rotary trapping sites, Klamath and Trinity rivers, 1991.

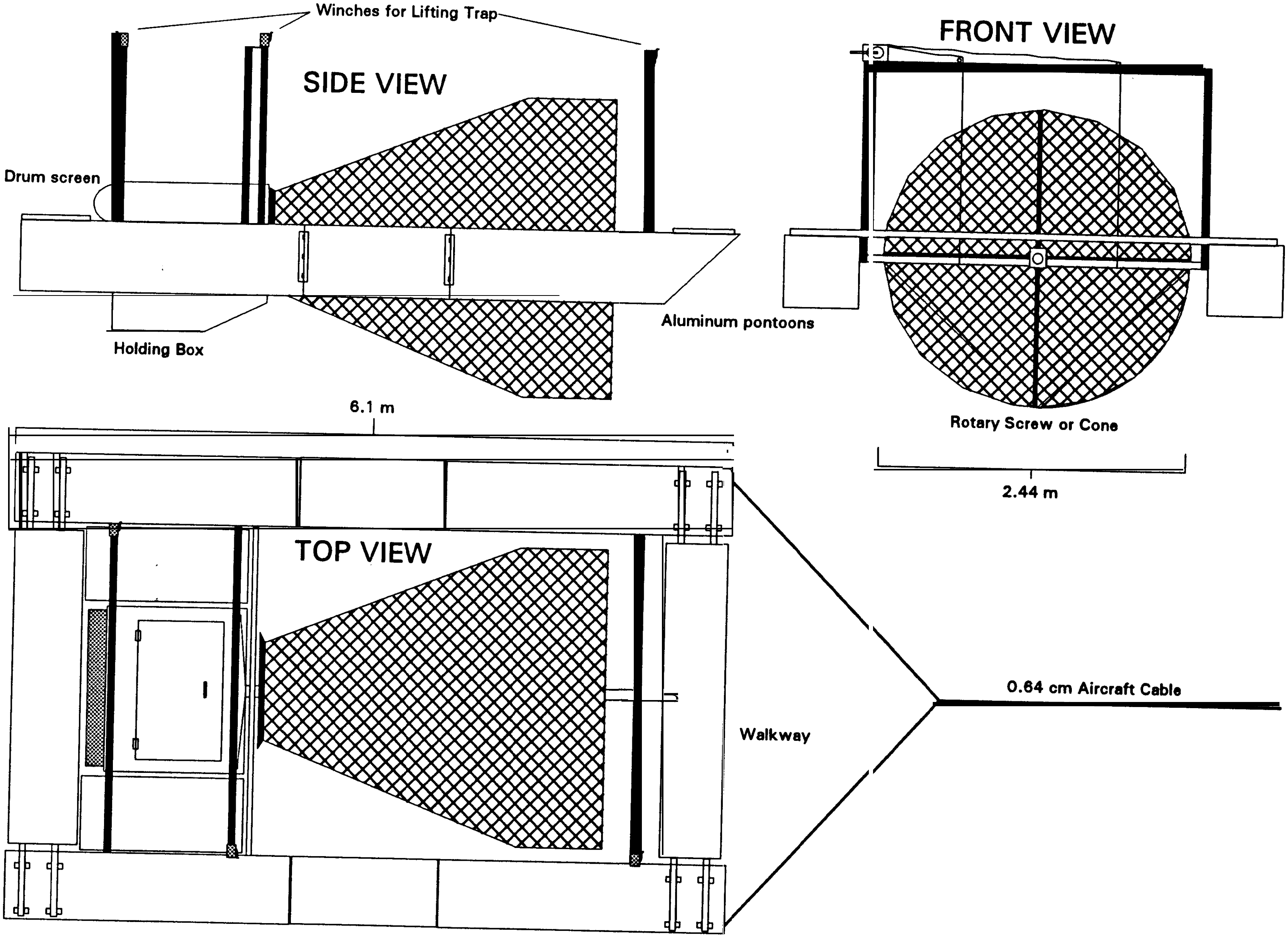


Figure 2. Schematic of the rotary screw trap design depicting key components and dimensions.

All chinook and coho salmon were examined for an adipose fin clip (ad-clip) indicating coded wire tag (CWT) implantation. In addition, all steelhead were examined for combination adipose and ventral fin clips and/or dorsal fin erosion. A daily subsample of ad-clip chinook and coho were collected for CWT retrieval to assist in obtaining information pertaining to migration timing, abundance indexes, and hatchery/wild contribution estimates. The tags were extracted from the fish with the aid of a magnetic field detector manufactured by Northwest Marine Technology, Inc. Tags were read using a dissection microscope at 42X magnification.

Origin (hatchery or natural) of non-clipped steelhead and coho salmon, was determined by the presence or absence of eroded fins.

Fish were also noted if they had obvious external damage to skin and fins from disease, predation, or if they were found moribund in the trap. Sampled fish were revived in plastic buckets containing fresh water, and released below the trap. All fish in excess of the number required for biological sampling were examined for fin clips and released.

The presence of other species was also noted and unidentified fish were preserved in a formalin solution and returned to the lab for taxonomic identification.

Flow and Temperature Measurements

Water flow was measured through the trap opening using a General Oceanics Inc. Model 2030R digital flow meter. Daily water velocities were measured at positions 0.61, 1.22, and 1.83 m across the front of the rotary trap opening and at two depths for each position (0.2 and 0.8 of the depth of the trap opening at each of the three stations). Using the calibration curve of average velocity values provided with the flow meter and the area for each station, the flow was calculated in cubic feet per second entering the trap for that day. The area sampled based on the depth of the trap opening was entered into the calculation to account for times when the trap had to be operated at less than normal depth due to conditions such as shallow placement, high flows, etc. River flow information was obtained from the U.S. Geological Survey, Water Resource Division. This information was acquired from gage stations at Orleans (rkm 94.7) on the Klamath River and Hoopa (rkm 19.8) on the Trinity River. These gaging stations were assumed to have no major differences in discharge from the trap locations. The trap revolutions were recorded for three minutes to be used as an indicator of flow for the purpose of deciding if the trap could operate without sustaining damage.

Water temperature data was collected using Ryan Tempmentor^{tm} thermographs which were attached to the trap live boxes at both trap sites. The temperature was recorded every two hours for the extent of the season. Individual temperature readings were averaged to produce a daily mean temperature. A daily water temperature was taken with a handheld thermometer as a backup precaution.

Emigration Trends

Catch per unit effort (CPUE) data was collected and analyzed on a daily basis. Emigration trends at both trap locations were examined on a weekly basis using a total weekly catch (TWC) estimate. When traps operated for less than seven days per week, TWC was estimated by dividing weekly catch by the number of days sampled, and expanding by a factor of seven. This technique was used to standardize catch effort on a weekly basis. Current hatchery release practices consist of two major chinook releases; fingerlings released in late May, and yearlings released in early October. The two distinct release periods are the basis for dividing the trap season into spring and fall periods.

Hatchery and Natural Stock Contribution Estimate

Chinook and Coho Salmon

A subsample of trapped ad-clipped chinook and coho were retained to utilize the extracted CWTs in determining the hatchery and natural stock composition of the population. The ad-clipped fish collected were categorized as recovered tags, lost tags, and no tags. If no tag was detected initially, the head of the ad-clipped fish was placed in a solution of 56.7 g potassium hydroxide per liter of water and heated to dissolve the tissue around the tag. A magnet was then stirred through the resulting mixture to recover the tag. If a tag still was not recovered, the fish was considered a no tag. A lost tag was defined as an ad-clip fish having a registered tag using the magnetic field detector, which was subsequently lost during the tag removal process. Lost tags were also placed in potassium hydroxide solution to dissolve the tissue around a tag that may not have been strongly magnetized. The no tags (or shed tags) are represented in the calculations of hatchery and natural stock estimate as poor tags.

Each CWT code was expanded to account for lost tags, ad-clipped fish in the trap catch that were not retained, and fish that escaped without being examined for clips. The expansion factor (E) was calculated on a daily basis using the following equation:

E = {(C OVER MS)(AD OVER H)(T OVER TR)}
where:

C = Catch of chinook or coho
MS = Number of fish examined for ad-clips
AD = Number of observed ad-clipped fish
H = Number of heads collected from ad-clipped fish
T = Number of heads collected containing tags
TR = Number of tags recovered

The estimate of hatchery chinook and coho salmon in trap catches was determined using CWT recoveries and a production multiplier (P.M.) associated with each tag code. The P.M. accounts for unmarked production represented by each tag code as follows:

P.M. = {r+r SUB p+r SUB nm} OVER r
where:

r = Number of CWT fish in release group
r_p = Number of fish in release group with an ad-clip only (poor tag)
r_{nm} = Number of unmarked fish in release group.

The number of expanded tags for each tag code was multiplied by the corresponding production multiplier to estimate the number of hatchery fish in the catch represented by each tag group. All untagged captures in excess of the estimated unmarked hatchery production were assumed to be of natural origin. The number of chinook recovered from natural stock CWT programs were not used in estimating contribution of natural chinook due to the lack of a P.M.

The hatchery and natural stock estimate assumes; accurate identification of ad-clipped fish, no differential mortality between tagged and untagged hatchery fish of the same release group, and that the reported numbers of tagged and untagged fish are accurate. The estimate does not account for ad-clips removed from the population at sites upstream. The Service conducts a similar trapping operation through the Trinity River Fishery Resource Office (TRFRO) in Weaverville, CA (Trinity River at rkm 132). The number of ad-clipped fish removed by the TRFRO trap operation is small compared to the number released and the effect on the estimate is assumed to be negligible.

Steelhead

The hatchery and natural stocks estimate for steelhead was based on the presence or absence of adipose-ventral fin combination clips and/or dorsal fin erosion. Steelhead from both hatcheries showed notable fin erosion. This characteristic seems typical of hatchery reared steelhead in this system, based on the information collected in 1989 and 1990. TRH steelhead were marked with an adipose clip and a left or right ventral fin clip for the 1+ and 2+ releases, respectively. Steelhead from IGH release groups were not fin clipped, and were identified by fin erosion only.

Migration Rate and Duration

Migration rates for hatchery chinook, coho, and steelhead release groups were determined from CWT and finclip recovery data. The initial migration rate was computed by dividing the distance (rkm) from the release site to the trap in kilometers by the number of days from release to the first capture in the trap. The mean migration rate (rkm/day) was determined by using all captures of a particular tag code or fin clip. The mean migration rate was weighted by the daily expansion for discharge sampled by the trap for the period from release to mean capture date. The duration of the migration was computed as the number of days between 10% and 90% dates of the total capture (Fish Passage Center, 1985). Because the natural stock CWT groups on the Trinity River were released over periods as long as three weeks per tag code (M. Zuspan, pers. comm, 1992), a range of migration rates was used based on the first and last release date for a particular tag code. The migration timing information of natural stocks is limited when compared to hatchery stocks that are released in a much shorter period of time.

Seining Efforts

Due to structural damage to the cone portion of the Klamath River trap, the trap was not operated from June 7 through June 17. To account for this gap in sampling, seining was used as a substitute for the trap to aid in recovering initial migration rate data for IGH ad-clip chinook. Seining was conducted on June 13 at locations adjacent to the Klamath River trap site utilizing a 45.7 m x 2.0 m (0.4 cm delta mesh) beach seine deployed from a boat.

Trap Efficiency

During 1991, mark-recapture trap efficiency tests were conducted at the Trinity River trap. Efficiency tests were not conducted at the Klamath River trap due to insufficient numbers of chinook captured and available for marking. Only chinook salmon were used to determine trap efficiency due to their abundance throughout the season. Attempts at efficiency tests were previously made using steelhead smolts, but unsatisfactory results were caused by inadequate holding conditions due primarily to the large size of the fish. The tests utilized the trap catches from one to three days of sampling effort. If the numbers from one day's catch were insufficient for carrying out the test the fish were held in the river overnight in a fine mesh cage. Two methods were utilized for marking fish; fin clipping in which the fish were given a slight clip to the upper lobe of the caudal fin, and dye-marking using Bismark Brown Y, a biological stain. A concentration of 20 mg Bismark Brown Y per liter of water was used for a period of 15 to 30 minutes. Marked fish were placed in large plastic barrels filled with fresh water. The water was aerated using a canister of compressed air attached to airstone bubblers and a regulator to control air flow. Water temperature in the barrels was monitored throughout the marking period. The fish were taken upstream by boat and released in the afternoon/evening in a location approximately one km upstream of the trap. The instream location used for release was a slow moving pool, which allowed for orientation after release. Two groups of 25 fish each were retained instream in 1.0 m x 1.0 m x 1.2 m cages with mesh sides to determine delayed mortality of both marked and unmarked controls. These groups were kept for two days after release of the marked fish to evaluate mortality levels. If the marked group sustained mortality in excess of the unmarked group, the percentage of differential marking mortality was applied to the marked releases when calculating efficiency. Conversely, if the unmarked control group sustained equal or higher mortality than the marked control after the two day period, then the differential mortality was assumed to be zero.

All chinook captured in the rotary trap after release of an efficiency test group were examined for marks. After three to four days, the fish dyed with Bismark Brown faded beyond recognition, and recapture could no longer be recorded. Trap efficiency was determined by dividing the number of marked fish recaptured by the number released and correcting for marking mortality.

Abundance Index

The abundance index is based on the proportion of river discharge (daily average) sampled by the trap. The daily index, by species, was calculated by dividing the number of each species captured by the proportion of stream discharge sampled. The weekly abundance index estimate was calculated by multiplying the sum of the daily index values by the proportion of days each trap sampled during that week. The index reflects relative changes in salmonid abundance between weeks during the trapping season, and between trapping years. This index is used to describe relative abundance, and is not intended to represent a population estimate. During the trapping season, the rotary traps were moved to keep the trap in an optimal trapping location with varying flow conditions. These adjustments were on the order of a few meters closer to, or farther from the bank. The use of the abundance index for comparisons between years assumes similar efforts.

Additional Studies

This year, CCFRO entered into a cooperative effort with the California-Nevada Fish Health Center (CA-NV FHC) involving disease monitoring of juvenile salmonids. Samples from the Trinity River trap were utilized by CA-NV FHC personnel to identify and quantify disease prevalence.

An effort was made to collect gill tissue samples from chinook smolts for analysis of gill ATPase levels indicative of the degree of smoltification of chinook captured by the trap. Fifteen samples were collected biweekly from each rotary trap during chinook emigration. The samples were analyzed by the staff of the National Marine Fisheries Service (NMFS) laboratory in Cook, Washington. This involved sacrificing juvenile chinook in order to collect gill tissue, and sending the tissue samples to the NMFS lab on dry ice.

Plankton net tows were made from the downstream end of the rotary traps to attempt capture of the egg and larval stage of green sturgeon, Acipenser medirostris. Tows were made using a plankton net with a 0.5 m diameter opening. The net was weighted and deployed near the bottom in swift current. After 10 minutes, the net was retrieved and the contents were examined.

RESULTS AND DISCUSSION

KLAMATH RIVER TRAPPING

The rotary screw trap was operated from April 2, 1991, to December 20, 1991, for a total of 102 nights trapping effort (Appendix A). The trap captured 4,468 chinook salmon over the entire trapping season. Of these, 344 chinook were ad-clipped. Also captured were 238 steelhead and 44 coho salmon.

Spring trapping included the period from April 2 through August 2, for a total of 58 nights (Appendix A). Capture during the spring period included 2,925 chinook, 72 of which were ad-clips. In addition, 124 steelhead and 32 coho were captured.

Trapping in the fall was initiated for the first time in 1991 to monitor the yearling chinook emigration. Trapping extended from September 19 through December 20, totalling 44 nights (Appendix A). The fall period catch consisted of 1,543 chinook, including 272 ad-clipped chinook. Also captured were 114 steelhead and 12 coho.

Chinook Salmon Monitoring

Chinook Emigration Monitoring

Chinook salmon were captured as soon as trapping began, with low numbers of natural young-of-year (yoy) through early June (Appendix A). On June 7, the trap sustained structural damage and trap operation ceased. The trap was reset on June 18 after repair of the screw. Promptly after replacing the trap, catches of chinook increased dramatically, coinciding with early captures of the fingerling release from IGH on May 28, 1991. The highest estimated chinook TWC (3,448) occurred during the week of June 30 to July 6 (Appendix B). The peak daily catch occurred on July 2, with a total of 691 chinook captured. On August 2 the trap was removed from operation due to negligible chinook catch.

The trap was placed back in operation at the same location on September 19. The daily chinook catches in the fall period began increasing in late October and peaked in early December, corresponding to the November release of chinook yearlings from IGH. The highest estimated TWC for the fall trapping period (844) occurred from December 1 through 7, with the peak daily catch of 220 chinook on December 10. Fall catches included yearling chinook releases from pond rearing project sites on Indian Creek, and Elk Creek, tributaries to the Klamath River, and yearling chinook released from IGH. The catch of chinook dropped considerably during the last week of trapping, December 15-21. The combination of minimal chinook catch and possibility of damage to the trap due to winter flow increases was the basis for terminating trapping on December 20, 1991.

Size and Condition

Of the 4,468 chinook captured, 1,441 were measured (32.3%). The length frequency of catches in April and May indicate large numbers of young-of-year (yoy) chinook in the range of 30-86 mm. The mean yoy chinook fork length for April was 41.7 mm. The length frequency data also indicate that yearling (1+) chinook, (f.l. 102-185 mm) were still present in the system during April and May (Figure 3). Scale samples were used for age determination to confirm the presence of 1+ chinook in the catch. Trapping data from 1989 and 1990 contained similar results in the capture of 1+ chinook from March through May(USFWS, 1991, 1992b). The trend of capturing a few 1+ chinook each spring trapping period suggests that these fish may be the lingering segment of the releases made during the fall of the previous year from IGH and the Klamath River rearing ponds. This has been confirmed by CWT data from yearling chinook released from IGH in fall 1991 and captured in the rotary trap in the spring of 1992 (USFWS, unpublished data).

The mean fork length of yoy chinook generally increased from April into mid-June when the trap was removed due to equipment damage. This was prior to the capture of hatchery chinook. The mean fork length of chinook fluctuated after the trap was reinstalled in late June and July, coinciding with the capture of IGH chinook. A substantially larger mean length was observed for this period, which would be expected with the influx of hatchery fish.

During the fall trapping period, mean length generally increased on a weekly basis progressing from 91.5 mm to 155.63 mm from October through December.

To assess condition, a length-volume relationship was established. Volume was substituted for weight to aid in sampling and to alleviate stress on the fish. Volumetric displacements of fish in water were assumed to be proportional to weight because most fish are neutrally buoyant in water (Anderson and Gutreuter, 1983). Displacements were measured from 1,318 of the chinook measured to fork length to assess condition, or fitness (Figure 4). The displacements were measured from the random sample of fish measured for fork length. The least-squares regression slope value of 2.94 is significantly lower ($P<0.05$) than previous values of 3.12 (1989) and 3.21 (1990) (USFWS, 1991, 1992b). A slope value of 3.0 indicates isometric growth with respect to girth and length. A slope value less than 3.0 indicates that fish are thinner for a given length as they grow (Anderson and Gutreuter, 1983). The slope value of 2.94 may indicate the presence of factors limiting growth such as physiological stress from smolting, competition, or disease.

Hatchery and Natural Stock Estimate

A total of 246 yoy chinook were captured in the trap prior to the first ad-clipped chinook capture which occurred on June 19. These fish were assumed to be of natural stock origin. None of the twelve 1+ chinook captured in April and May were ad-clipped, and no determination was made as to their origin. The fingerling chinook release from IGH occurred on May 28. Three CWT codes were utilized, and the fish averaged 179/lb. at release (Appendix C). Two of the tag codes were represented in the catch, with no captures occurring for the third tag code, 06-63-26. After the hatchery fingerling release, the subsequent capture of non-CWT chinook totalled 4,311. The 344 ad-clipped chinook were identified as releases from IGH and the Klamath River rearing ponds. Based on the tagging rate for the various CWT release groups, it is estimated that 3,178 of the 4,468 total chinook (71.2%) captured were of hatchery origin. The spring trapping period estimate contained 70.4% hatchery chinook, while the fall trapping included 84.6% hatchery chinook. Based on the above natural and hatchery percentages, the spring trapping catch included 2,057 hatchery chinook, and 865 natural chinook. The IGH fingerling tag code 06-01-02-01-05 accounted for 56.5% of the spring hatchery recoveries at the trap, while the 06-01-02-01-06 code made up the remaining 43.5% hatchery fish.

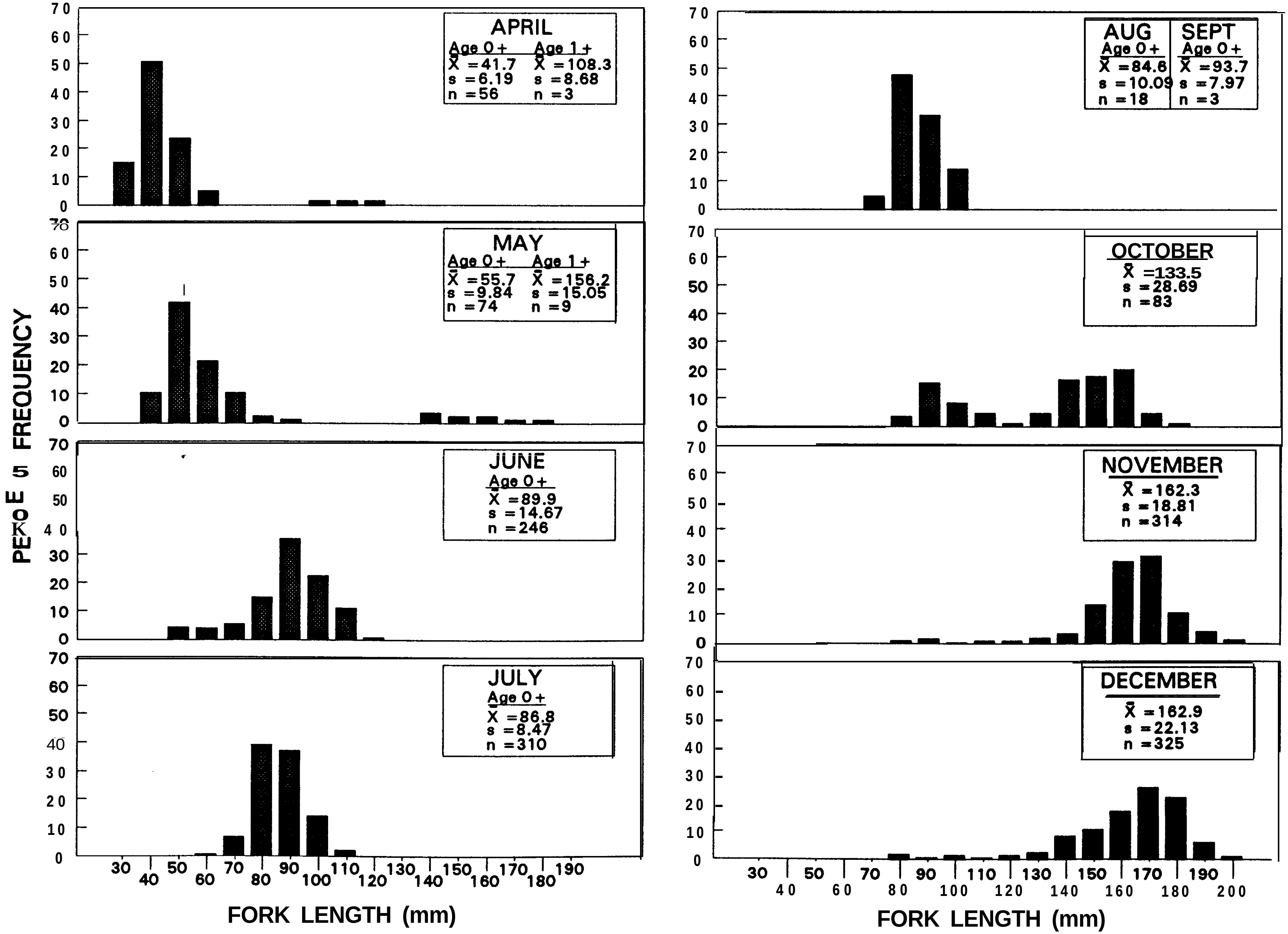


Figure 3. Percent length frequency of chinook salmon captured in the Klamath River rotary trap, 1991.

The results for the fall period were 1,305 hatchery and 238 natural chinook. The fall hatchery capture was comprised of 44% Indian Creek yearling chinook release, 38% Elk creek yearling chinook, and IGH yearling release groups made up the remaining 18% of the hatchery capture.

The abundance index for the spring trapping period accounted for 222,061 (80.1%) IGH fingerling chinook and 55,169 (19.9%) natural chinook. The index for the fall included 50,262 (61.3%) hatchery chinook, and 31,691 (38.7%) natural chinook.

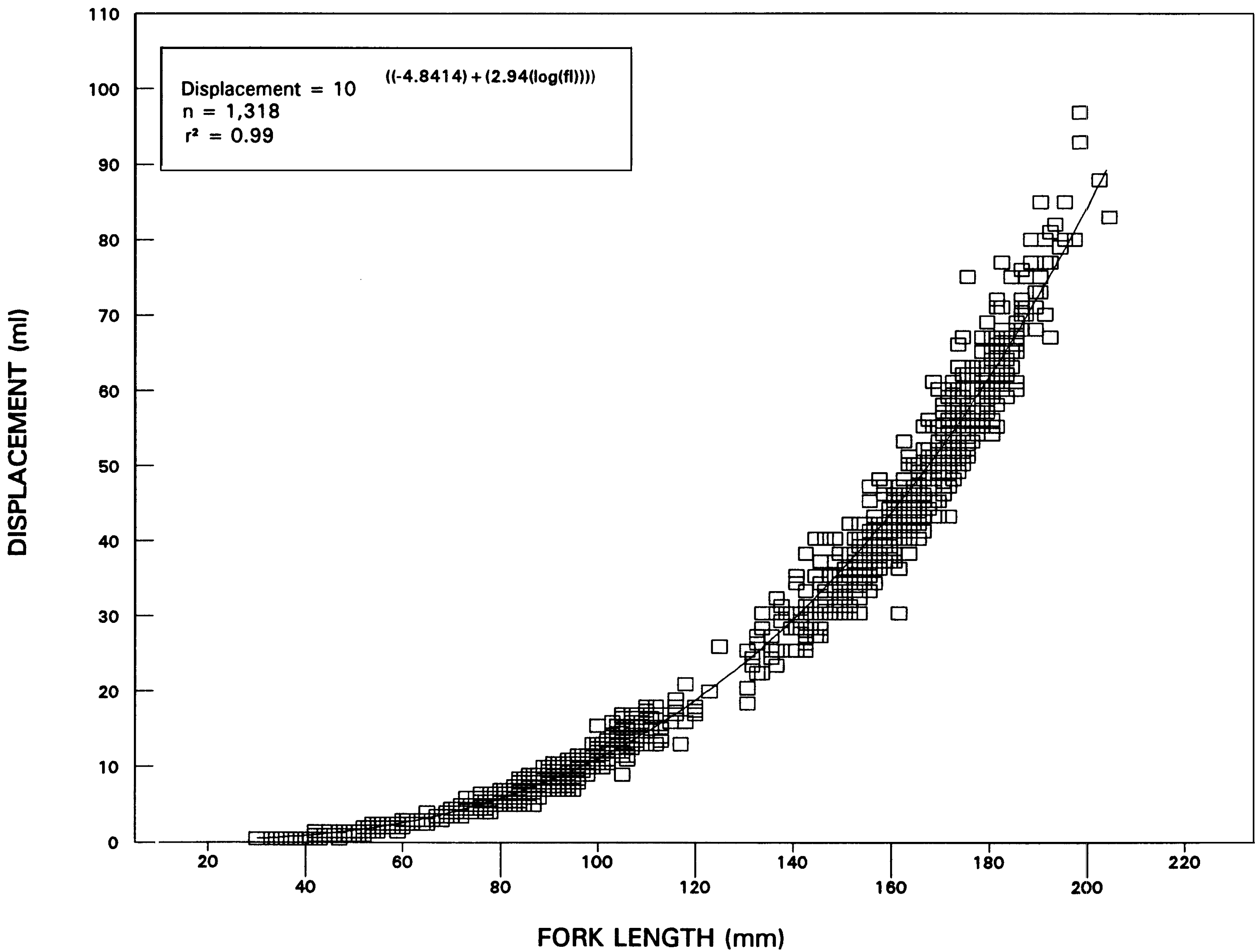


Figure 4. Klamath River chinook length - displacement relationship, 1991.

Migration Rate and Duration

The release of hatchery fingerling chinook from IGH occurred on May 28, 1991. The first ad-clip capture in the trap occurred on June 19, 22 days after release, constituting an initial migration rate of 10.3 rkm/day (Table 1). Only two of the three CWT groups were represented by the rotary trap catch. The mean migration rates for the 06-01-02-01-05 and 06-01-02-01-06 tag groups were 6.0 and 6.6 rkm per day using 43 and 33 recoveries, respectively. The 06-63-26 tag code was not accounted for in trap catches. This is probably due to the very small number of fish in this tag group (Appendix C).

Yearling chinook CWT were released from two Klamath River rearing pond sites on October 21, Elk Creek and Indian Creek. The Elk Creek chinook were first captured four days after release. The initial migration rate was 25.1 rkm/day, and the weighted mean was 2.7 rkm per day using 63 recoveries (Table 1). The Indian Creek chinook were also captured four days after release, for an initial migration rate of 26.5 rkm/day. The weighted mean migration rate for Indian Creek was 2.8 rkm/day using 73 recoveries. The release locations at Indian Creek and Elk Creek are 13.7 rkm and 10.3 rkm upstream from their confluences with the Klamath River, respectively (D. Alcorn, pers. comm, 1992). The last chinook CWT release of the year was made from IGH on November 15. The first recovery occurred six days after release for an initial migration rate of 37.7 rkm/day. The weighted mean migration rate was 9.8 rkm/day. A release of 11,070 chinook yearlings was made from Camp Creek utilizing natural stock chinook with left maxillary clips. None of these fish were identified by field personnel, because CCFRO staff had no knowledge of this release until after trapping had concluded.

The migration rates of releases in 1991 show a distinct difference between fingerling groups released in May, and the yearling chinook released in October and November (Table 1). Yearling chinook releases in the Klamath Basin had much higher initial migration rates than the fingerling release groups. The mean migration rates for the IGH fingerling releases were lower than the IGH yearling release, but higher than the pond reared yearlings from Indian and Elk creeks. The low mean migration rate for the Indian and Elk creek yearlings may be partially explained by the lower flow conditions during their period of emigration. The data from the 1990 trapping effort suggests similar migration rates for the IGH fingerling release.

Several benefits may be realized in conjunction with yearling releases. Release strategies can play an important role in protecting wild stocks of anadromous salmonids from increased competition for rearing habitat and food. Providing a temporal difference in hatchery chinook emigration also reduces the chance for lateral transfer of disease pathogens. The larger yearling release size may also increase survivability to adulthood.

Abundance Index

The chinook abundance index values before release of hatchery fish peaked in mid-May (2,394) and again in the week of June 2-8 (4,172) (Appendix A). The capture of hatchery fish in mid-June began an increase in abundance index values which peaked during the week of June 30 - July 6 at 138,425 (Figure 5). The index value for the entire spring trapping season totalled 277,230. The spring trapping abundance index of 277,230 is comparable to the chinook abundance index value from 1989 of 268,008 (USFWS, 1991).

The fall trapping period abundance index value peaked during the week of December 1-7. The fall index value of 81,953 is based on the capture of 1,543 chinook. Based on the 4,465 season chinook catch, the index estimates 359,183 chinook throughout the trapping season.

In 1990, an abundance index was not calculated due to the lack of consistent trap sampling (USFWS, 1992).

Table 1. Migration rate (rkm/day) and duration of Klamath River CWT chinook releases, 1991. IGH=Iron Gate Hatchery, #/lb=average number per pound, cfs=cubic feet per second, rkm=river kilometer

Tag Code	Release Location	Release Date	Size #/lb	Initial Rate (rkm/day)	Mean Rate (rkm/day)	10-90% duration (days)	[1/] Mean River Flow (cfs)	Number Sampled
6-1-2-1-5	IGH	05/28/91	150	8.1	6.0	15	3206	43
6-1-2-1-6	IGH	05/28/91	150	10.3	6.6	15	3327	33
06-63-26	IGH	05/28/91	150	none captured				0
06-63-24	Indian ck.	10/21/91	7	26.5	2.8	35	2085	73
06-63-27	Elk ck.	10/21/91	7	25.1	2.7	29	2053	63
06-57-03	IGH	11/15/91	8	37.7	9.8	22	3103	29

[1/]Mean river flow calculated from release date to mean capture date.

The trap was not operated during the week of June 9-15 due to trap damage, and no weekly abundance index could be generated for that time period or for the weeks beginning August 4 and ending September 14. The latter gap in sampling was due to excessive algae accumulating in the trap. This period also followed extremely low catches of salmonids and high water temperatures. The effect of the gaps in sampling on the abundance index was probably more critical due to the early gap caused by trap damage. This period was bounded by moderately high and increasing index values for chinook salmon. The gap during August and September was most likely a period of low chinook abundance based on the catch figures preceding and following the gap, and probably did not affect the estimate greatly.

Trap Efficiency

An attempt was made to trap chinook for an efficiency estimate using the rotary trap and an additional fyke net in a nearby location on June 25. This attempt did not capture the needed number of fish, and further attempts to estimate efficiency were abandoned. The Klamath River trap has not been able to produce daily catches of chinook large enough to conduct estimates of trap efficiency. A minimum of several hundred chinook are necessary and must be captured within a short time period to provide usable results and to avoid excessive holding conditions and stress related mortality.

Seining

On June 13, seine hauls were made at five sites directly upstream of the rotary trap site. Seining was conducted due to trap damage that rendered the trap temporarily inoperable. The primary objective was to capture chinook traveling through the trapping area from the IGH release, so that initial migration rates could be calculated. Five non clipped chinook were captured at site number one (mean length 61.6 mm, s=5.28). No ad-clipped chinook or other salmonids were captured in the seine. Although limited in effort, the seining conducted indicates that the IGH release groups had not reached the trap site by June 13.

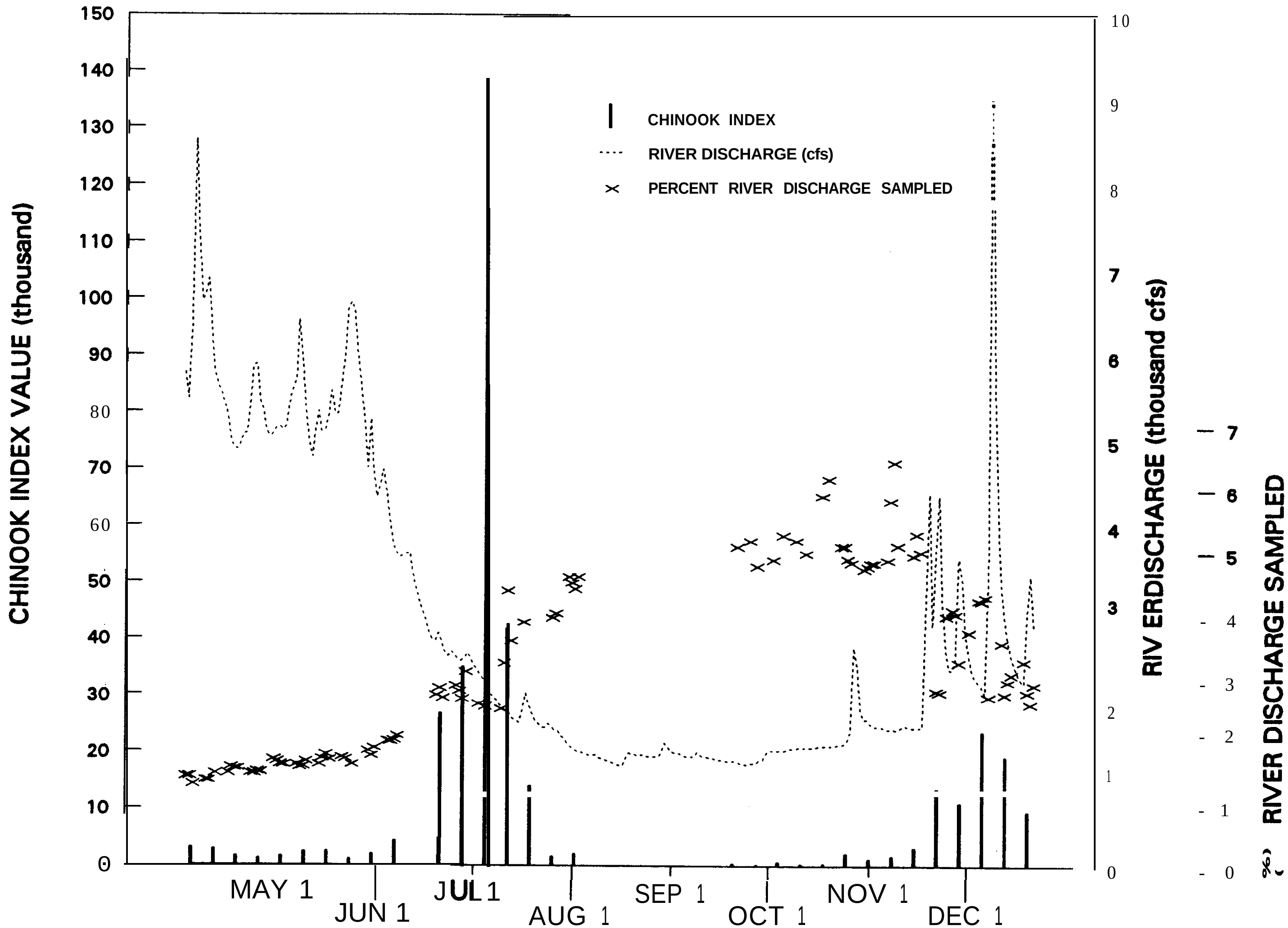


Figure 5. Weekly chinook abundance index values, river discharge, and percent (%) river discharge sampled, Klamath River rotary trap, 1991.

Steelhead Monitoring

Steelhead Emigration Monitoring

A total of 238 steelhead were captured during the trapping period. This included 31 yoy and 119 parr. The smolt catch was comprised of age 1+ and 2+ fish. Trap catches of steelhead were erratic in the spring trapping period, with the largest TWC estimate (58) occurring from June 16-22 (Appendix B). The fall trapping season produced more consistent results with highest catch for four weeks from November 17 to December 14. Highest TWC for the fall period occurred the week of December 8 to December 14 with an estimate of 47.

Size and Condition

A total of 235 steelhead were measured, representing several age classes. The length of yoy ranged from 41-84 mm, while the parr ranged from 67-179 mm (Figure 6). The fork length of steelhead smolts ranged from 112-266 mm. The mean fork length of steelhead fry was 60.6 mm. The mean fork length of steelhead parr was 97.4 mm, and the mean fork length of steelhead smolts was 186.3 mm.

Of the steelhead measured to fork length, 224 were also measured for displacement. A length-displacement relationship is presented using this information (Figure 7). The least squares regression slope value is 2.86. This is very similar to the slope value of 2.85 obtained in 1990 (USFWS, 1992b). The regression slope of 2.95 from 1989 suggests that steelhead were in superior condition during the 1989 trapping period (USFWS, 1991).

Hatchery and Natural Stock Estimate

IGH released 200,000 1+ steelhead. The release did not include any marked steelhead. All IGH releases were 1+ fish, and therefore all yoy were assumed to be of natural origin. A total of 11 steelhead smolts (12.5%) with distinct dorsal fin erosion indicating hatchery origin, were captured. The remaining 77 steelhead smolts in the catch were all of natural origin. The natural steelhead made up an estimated 95.4% (237) of the total steelhead catch. No hatchery steelhead were captured during the fall trapping. The 1989 trapping data estimated 79% natural steelhead (USFWS, 1991). In 1990, no estimate was made due to gaps in sampling (USFWS, 1992b). The estimates assume the ability to identify fin erosion on all individuals.

The steelhead abundance index (see following section) included 973 hatchery steelhead (5.2%) and 17,846 natural steelhead (94.8%) for the entire season.

Migration Rate and Duration

The IGH steelhead were released on May 5, 1991. The initial capture occurred on May 29, 24 days post release for an initial migration rate of 8.7 rkm per day. The 10% - 90% duration occurred May 19-21 for a mean migration rate of 4.7 rkm per day. The majority of captures occurred soon after the trap was repaired, indicating that some steelhead may have passed the trapping site undetected due to lack of trapping in early June, however, the seining results from June 13 did not produce any steelhead. The last trap capture of hatchery steelhead occurred on June 25. Migration rate calculations for steelhead were not attempted in previous year's trapping reports (USFWS, 1991, 1992b).

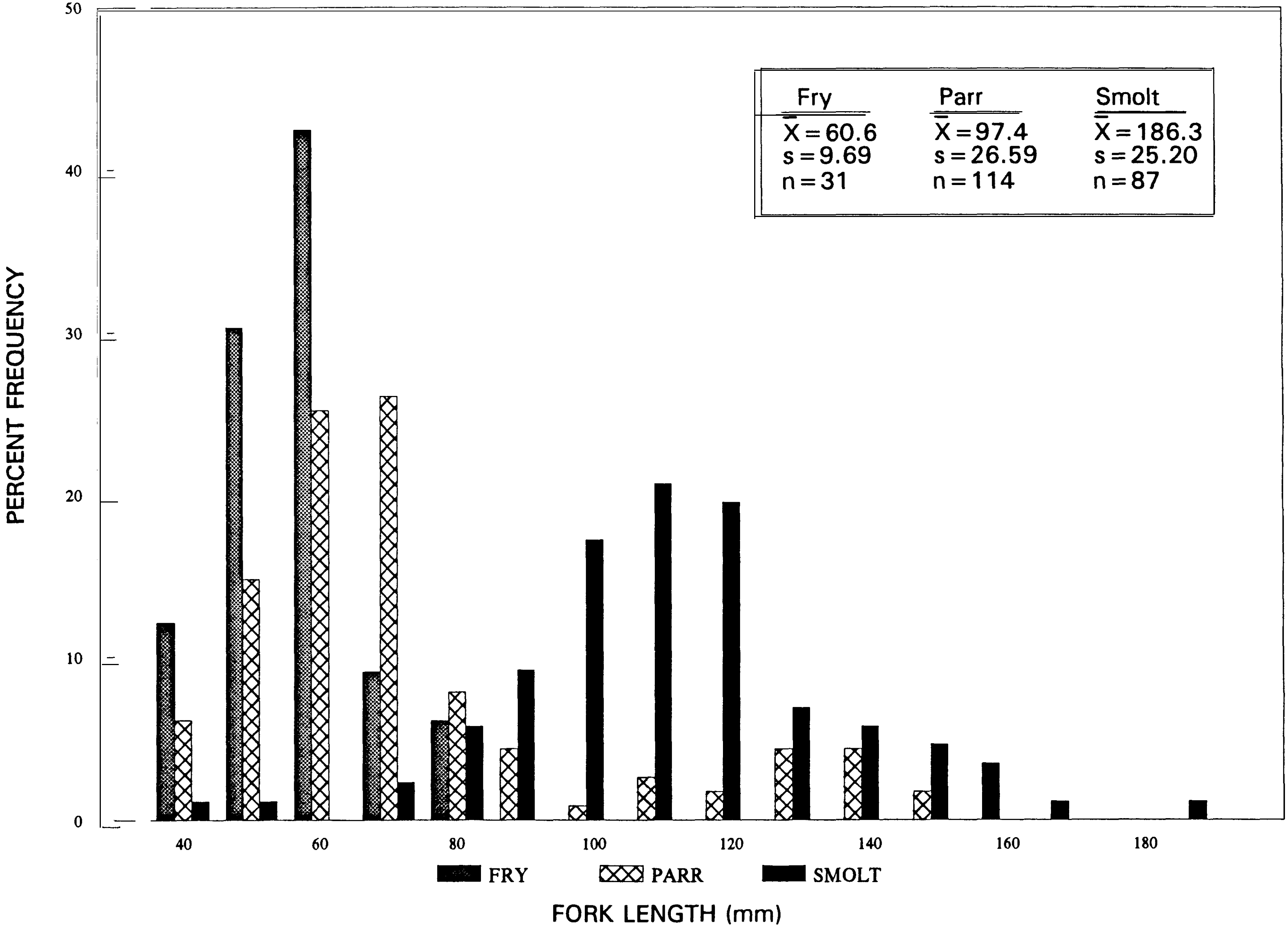


Figure 6. Percent length frequency of steelhead by developmental stage, Klamath River rotary trap, 1991.

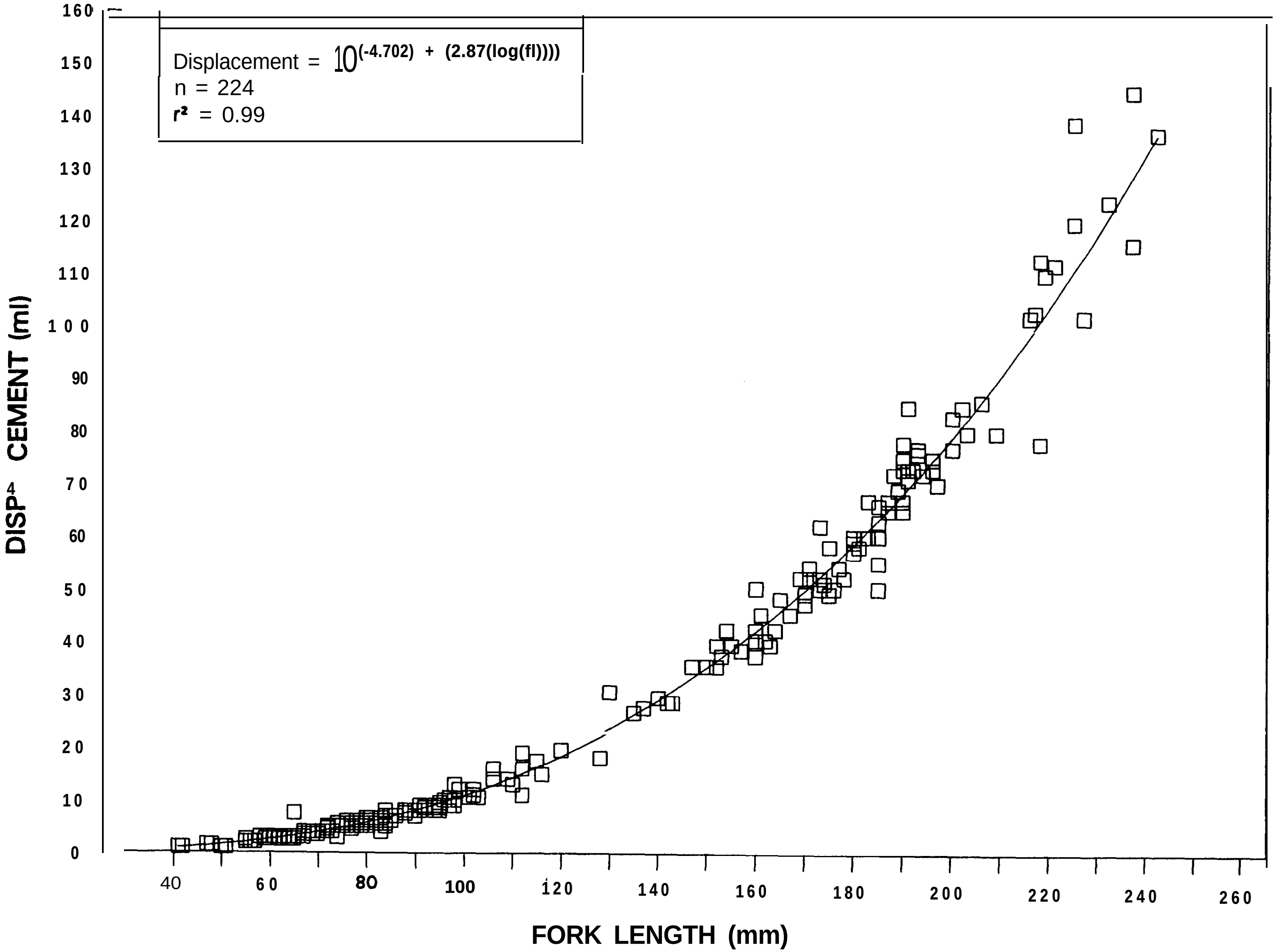


Figure 7. Klamath River steelhead length - displacement relationship, 1991.

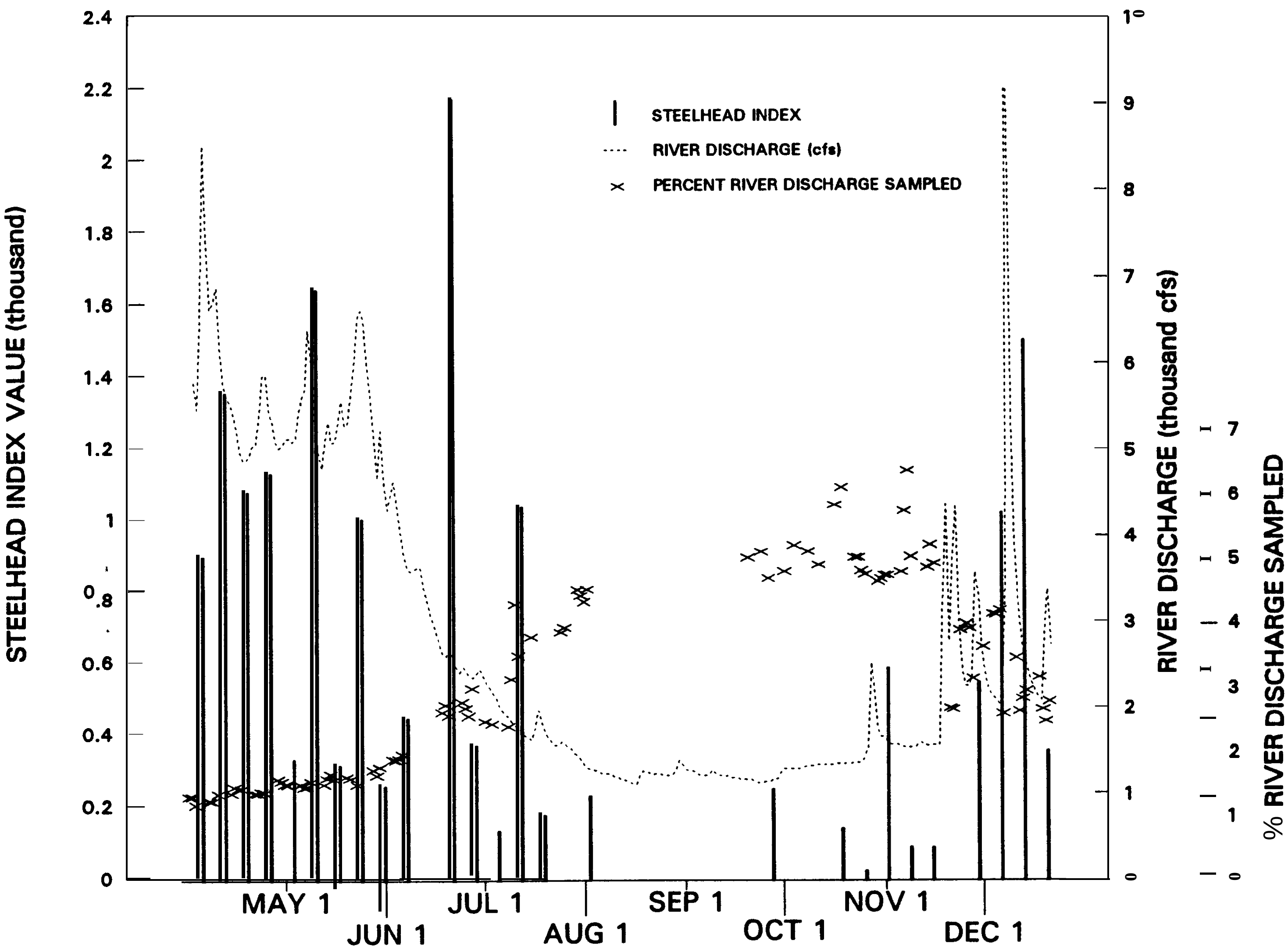


Figure 8. Weekly steelhead abundance index values, river discharge, and percent (%) river discharge sampled, Klamath River rotary trap, 1991.

Abundance Index

The index values for steelhead totalled 18,819 for all age classes during the weeks trapped (Appendix A). The value for 1+ and 2+ smolts was 6,486. The highest weekly abundance index value for all steelhead captured was 2,177 during the week of June 16-22 (Figure 8). During the period of high river discharge in the early part of the trapping season, steelhead abundance index values were high, as they were also in latter portion of the fall trapping. In past trapping seasons, the index has not been calculated for steelhead due to unforeseen gaps in sampling which occurred during probable peak migration periods. Provided that consistent trapping occurs in future years, abundance estimates can be compared to this estimate to assess relative abundance of steelhead.

Coho Salmon Monitoring

Coho Emigration Monitoring

A total of 44 juvenile coho salmon were captured throughout the trapping season, with 32 captured during the spring trapping period (Appendix A). Estimated TWC value for all developmental stages was highest (23) during the week of May 19 to 25 (Appendix B). The timing of the peak TWC for coho was similar to past trapping seasons, although capture of coho is sporadic throughout the season. A total of 12 coho were captured in the fall trapping period, all being 1+ individuals.

Size and Condition

Of the total coho captured, 27 were yoy and 17 were yearlings. The capture of yoy coho began in the last week of May, and continued with sporadic low catches throughout the season. Coho yoy (f.l. range 33-62 mm), parr (54-99 f.l.) and 1+ smolts (f.l. range 138-175 mm) showed a bimodal length frequency grouping (Figure 9). Of the 44 coho, 36 were measured to fork length, and 33 of those were measured for displacement (Figure 10). The least squares regression slope value for coho was 2.95. The slope value obtained in 1989 was 3.08 and the value in 1990 was 3.15 (USFWS, 1991, 1992b).

Hatchery and Natural Stock Estimate

Release of coho yearlings from IGH occurred on March 16. The release of 130,000 coho included 41,262 CWT fish, utilizing two tag codes (Appendix C). Three CWT coho were captured on May 24, representing both of the tag codes released. All coho released were 1+ smolts. All of the yoy coho captured (27 of the 44 total coho) were of natural origin. Based on the production multipliers of 4.95 and 5.82 for IGH coho CWT releases, all of the 14 non-clipped coho smolts can be attributed to IGH production. The hatchery component of total coho was 17 (39%). No hatchery coho were captured during the fall trapping. The natural component of total coho included only the 27 yoy (61% of total coho). The abundance index estimates 1,847 (43%) IGH and 2,428 (57%) natural coho throughout the trapping season.

Migration Rate and Duration

The three coho CWT recoveries occurred on May 24, 69 days after release for an initial and average migration rate of 3.3 rkm/day. Release of coho from IGH occurred 17 days previous to the beginning of trapping. It is possible that some of these fish moved past the trap site before trapping began. River flow between release and capture dates fluctuated between 4,460 and 8,540 cfs. One CWT coho captured in a juvenile seining project on the lower 54 rkm of the Klamath River indicated a migration rate of 4.5 rkm per day (USFWS, unpublished data). The migration rates observed, although based on very few recoveries, are very close to the rate observed during the 1990 trapping season (3.2 rkm, mean) (USFWS 1992b).

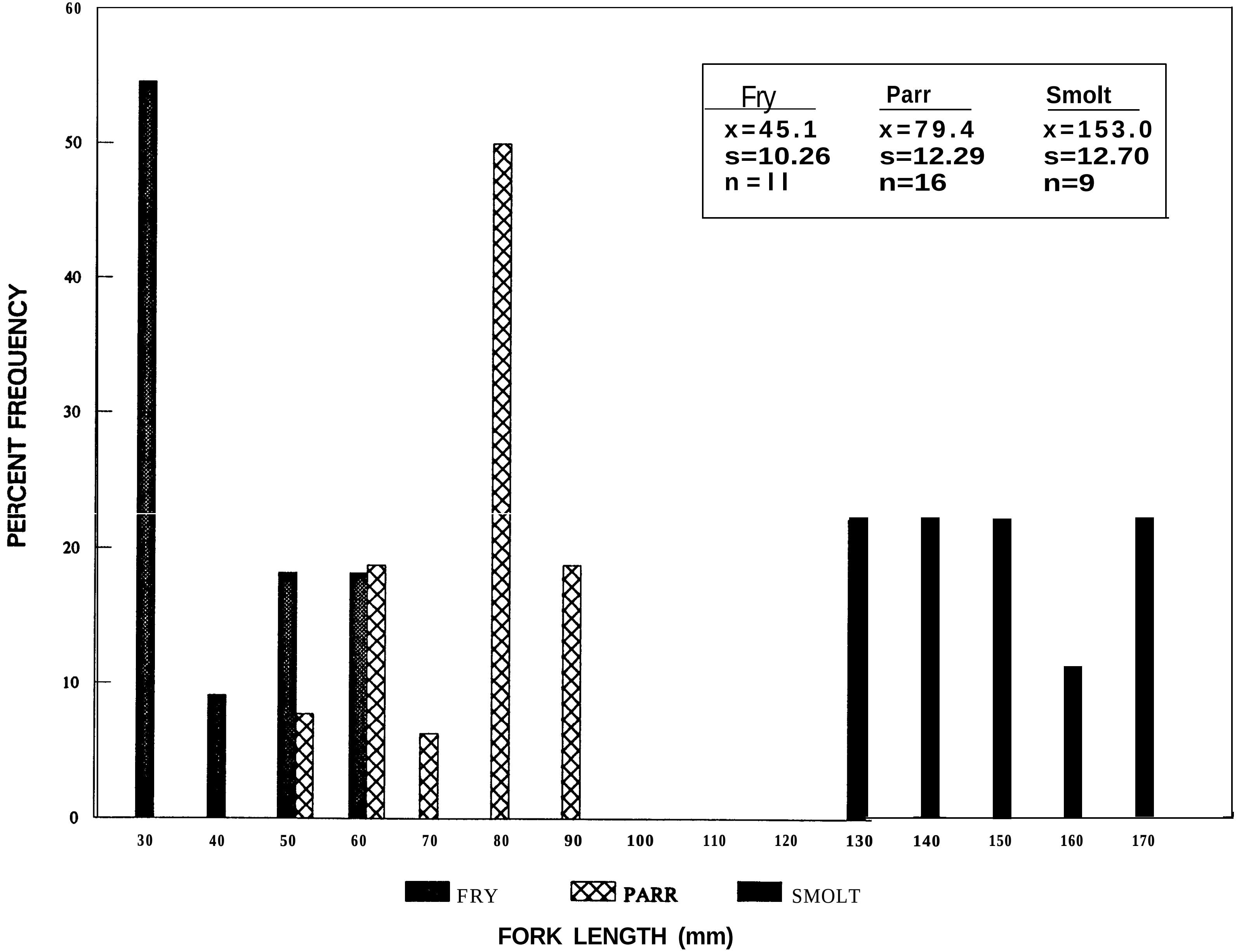


Figure 9. Percent length frequency of coho salmon by developmental stage, Klamath River rotary trap, 1991.

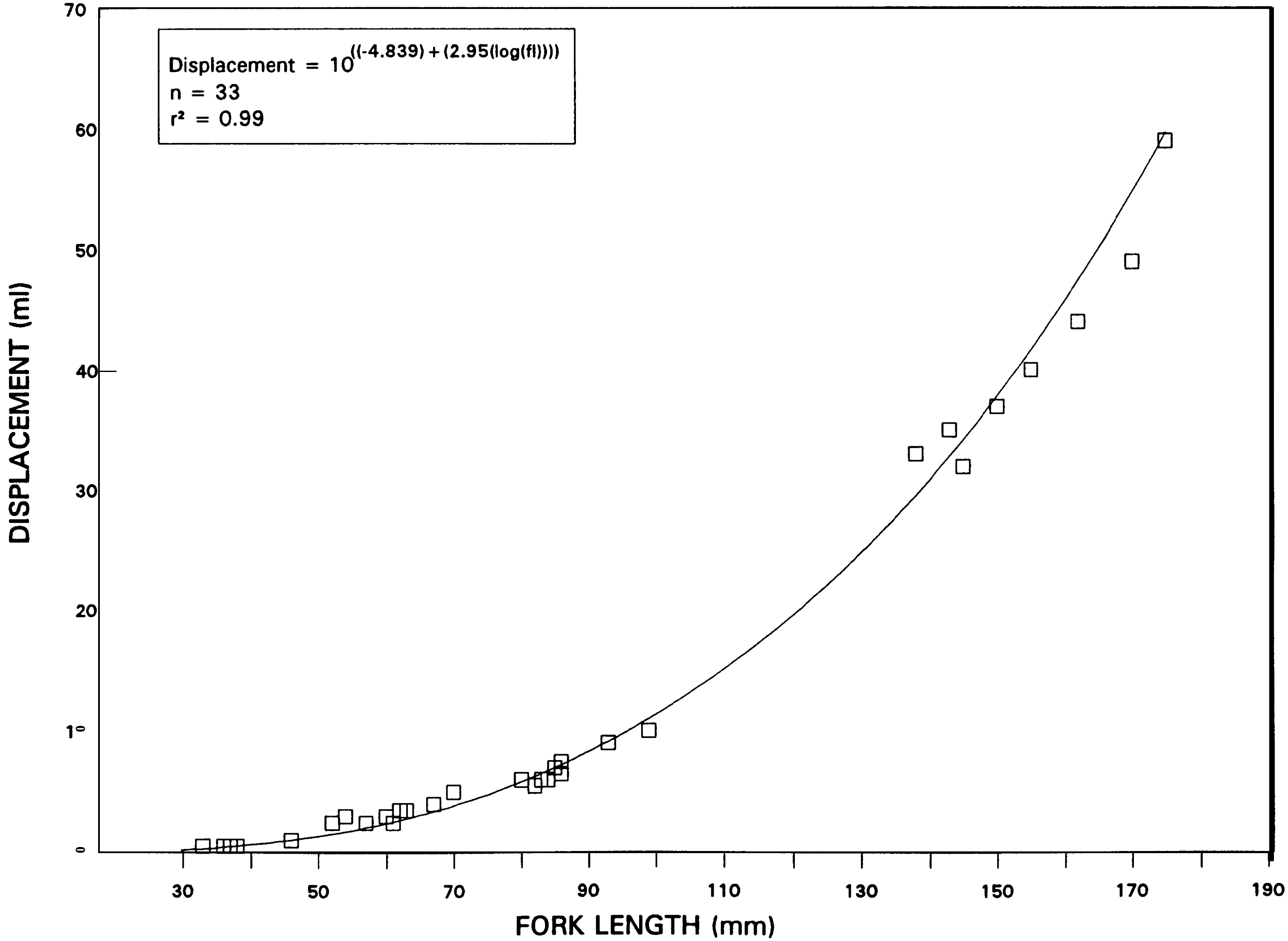


Figure 10. Klamath River coho length - displacement relationship, 1991.

Abundance Index

The coho abundance index estimate was 4,275 for the weeks that the trap operated (Appendix A). Weekly values peaked during the week of May 19-25 with an estimate of 1,488 total coho (Figure 11). The abundance index is designed to provide comparative analysis of yearly populations based on catches and proportion of river flow and time sampled. Results from 1989 and 1990 trapping efforts are not comparable due to large gaps in sample time in these data sets.

Flow and Water Temperature

Klamath River flow data was obtained from the USGS gaging station at Orleans (J Palmer, pers.comm, 1992). Highest flows encountered were 9,190 cfs on December 7, and 8,540 on April 6 (Figure 12). The trap was operated during these flow peaks without damage.

Water temperature was recorded every two hours from April 3 to December 20 and daily mean temperature was calculated from these data (Figure 12). A gap in sampling occurred from July 23 to September 19, the period that the trap was not operated due to negligible catches. This gap was supplemented partially by several temperature measurements recorded with a handheld thermometer at the trap location. The lowest daily mean temperature recorded was 4.9 C on December 15. The highest water temperatures at the trap site most likely occurred during the gap in sampling from late July to September. The highest recorded daily mean temperature was 24.5 C on July 5.

Other Species

Various non-salmonid fish species were captured in the rotary trap throughout the trapping season. This was the first year in which juvenile green sturgeon were captured. A total of six juvenile green sturgeon (total length range 27-59 mm) were captured on June 19 and 20. Plankton net tows were conducted for green sturgeon eggs and larvae from April 8 to June 28. The sampling produced various aquatic invertebrates, and one larval Cyprinid fish, but no green sturgeon were captured in the tows.

Ten moribund adult American shad were captured during July. At least two of the adult shad were unspawned. Numerous juvenile shad were captured from late September to mid-November. All non-salmonid species are listed in Table 2.

Additional Studies

Physiological studies were attempted involving the collection of gill tissue samples for monitoring of gill Na^+ - K^+ ATPase and Mg^{++} ATPase levels in chinook salmon smolts. The first 15 samples were ruined during shipment due to thawing of the tissue. We received data from 69 samples representing catches from May 29, June 07, July 10, and July 11. Some of the samples may have been contaminated by introduced esophageal tissue taken with the gill tissue. This tends to result in a lowering of ATPase levels, although many of the samples exhibited high values (W. Zaugg, pers. comm, 1992) . Further investigations of this type may prove useful in management decisions concerning fish fitness and saltwater readiness, such as release timing and strategy.

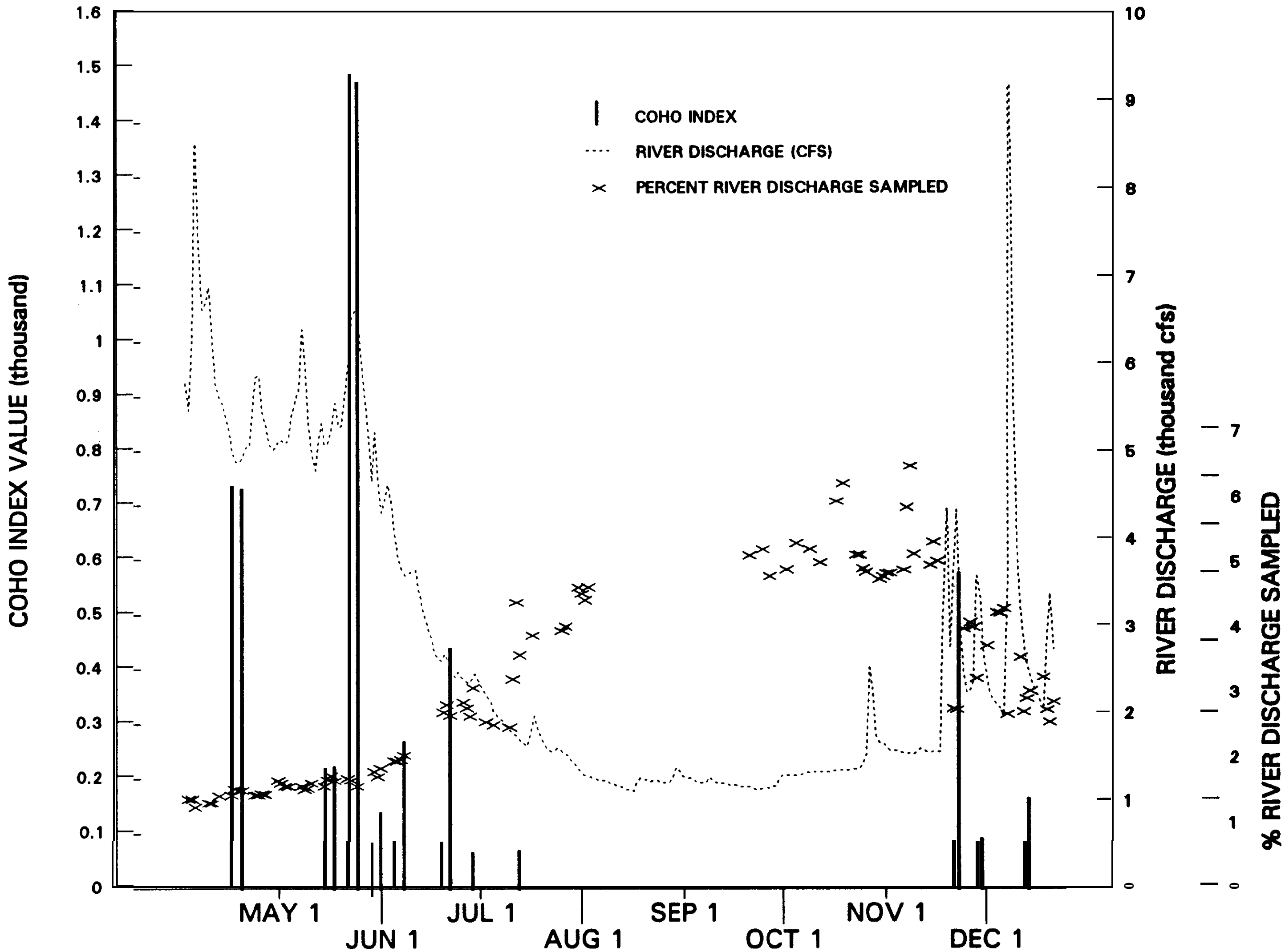
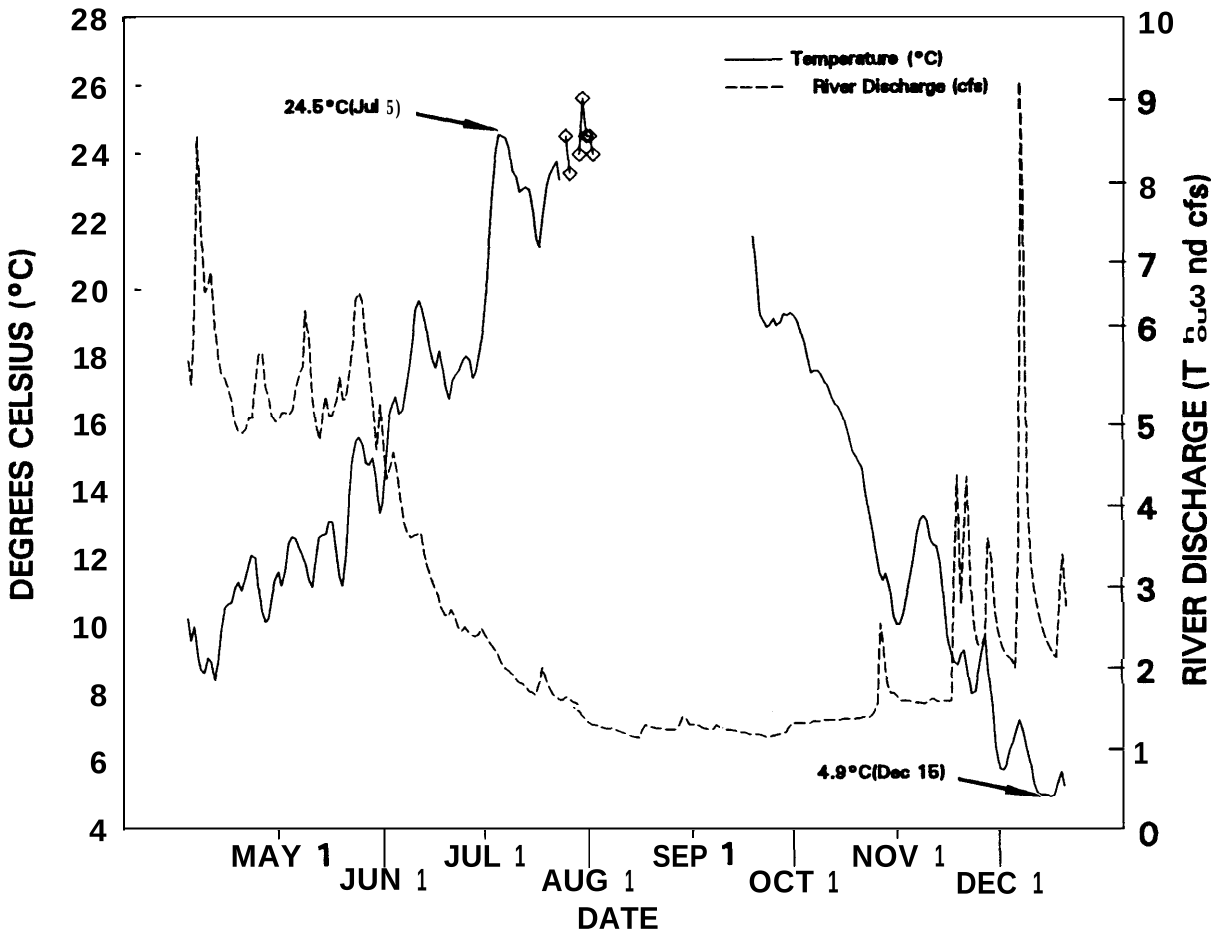


Figure 11. Weekly coho abundance index values, river discharge, and percent (%) river discharge sampled, Klamath River rotary trap, 1991.



◊ Denotes single readings taken with a handheld thermometer.

Figure 12. Daily average water temperature (°C) and river discharge (cfs), Klamath River rotary trap, 1991.

Table 2. Non-salmonid fish species listed in descending order of capture frequency, Klamath River rotary trap, 1991.

Common Name	Species
Klamath smallscale sucker	Catostomus rimiculus
Pacific lamprey	Entosphenus tridentatus
Speckled dace	Rhinichthys osculus
Threespine stickleback	Gasterosteus aculeatus
American shad	Alosa sapidissima
Yellow bullhead	Ictalurus natalis
Prickly sculpin	Cottus asper
Golden shiner	Notemigonus chrysoleucas
Green sturgeon	Acipenser medirostris
Green sunfish	Lepomis cyanellus
Fathead minnow	Pimephales promelas
Black crappie	Pomoxis nigromaculatus
Largemouth bass	Micropterus salmoides

TRINITY RIVER TRAPPING

The Trinity River rotary trap operated from February 13, 1991, to November 22, 1991, for a total of 155 nights (Appendix A). The trap captured 24,737 chinook salmon over the entire trapping season. Of these, 1,807 chinook were ad-clipped. Also captured during this time were 1,235 steelhead, and 224 coho salmon.

The spring trapping period, from February 13 to August 27, included 117 trapping nights (Appendix A). The chinook catch during the spring period totalled 19,599, including 990 ad-clips. The steelhead capture totalled 1,134, and 222 coho were also caught. On August 27, the trap sustained major structural damage due to fatigue of key components. Trapping ceased until September 19, when the trap was replaced in the river in the previous location.

During the fall trapping period, from September 19 to November 22, 38 nights of trapping effort were completed. The chinook catch totalled 5,138 including 817 ad-clips. The steelhead catch included 101 individuals. Only two coho were captured during this time. By November 22, the negligible chinook catch, and the anticipation of high flows which accompany winter storms, was the basis for terminating trapping.

Chinook Salmon Monitoring

Chinook Emigration Monitoring

The catch of chinook salmon in February yielded low numbers of primarily 1+ chinook, while March and April were dominated by yoy chinook. Daily catches increased dramatically in early June corresponding to the capture of fingerling chinook salmon released from TRH on May 28 (Appendix A). Catches peaked in mid-June with June 21 signifying the peak daily catch of 1,591 chinook. In July, catches began to drop, and this trend continued into mid-August, when trap failure occurred. The peak TWC estimate of 6,759 occurred during the week of June 16 to June 22 (Appendix B). Another slightly lower value of 6,738 was obtained for the week of June 30 to July 6.

After trap repair and reinstallation, the chinook catch increased and peaked again in mid-October corresponding to the October 8 release of chinook yearlings from TRH. The peak TWC of 2,904 for the fall period took place from October 13 to October 19.

Size and Condition

Fork length of 2,674 (10.8%) chinook juveniles was measured during the spring trapping period. The length frequency of the catch by month indicates a bimodal distribution during February and March (Figure 13). Yearling (1+) chinook predominated in these catches. The occurrence of a bimodal length frequency distribution has occurred annually since these juvenile investigations began in 1988 (USFWS, 1989, 1990). Trapping data from 1989 and 1990 indicates the presence of 1+ chinook as late as May in those years. None of the chinook yearlings were ad-clipped, and no attempt was made to identify their origin.

The mean fork lengths of yoy chinook increased consistently throughout the season. The low mean fork lengths of yoy chinook in February, March and April may be indicative of redds occurring upstream in close proximity to the trapping site. A substantial increase in mean fork length occurred in June in conjunction with the abundance of TRH fingerling releases. Another abrupt increase in fork length occurred in October coinciding with yearling chinook releases from TRH.

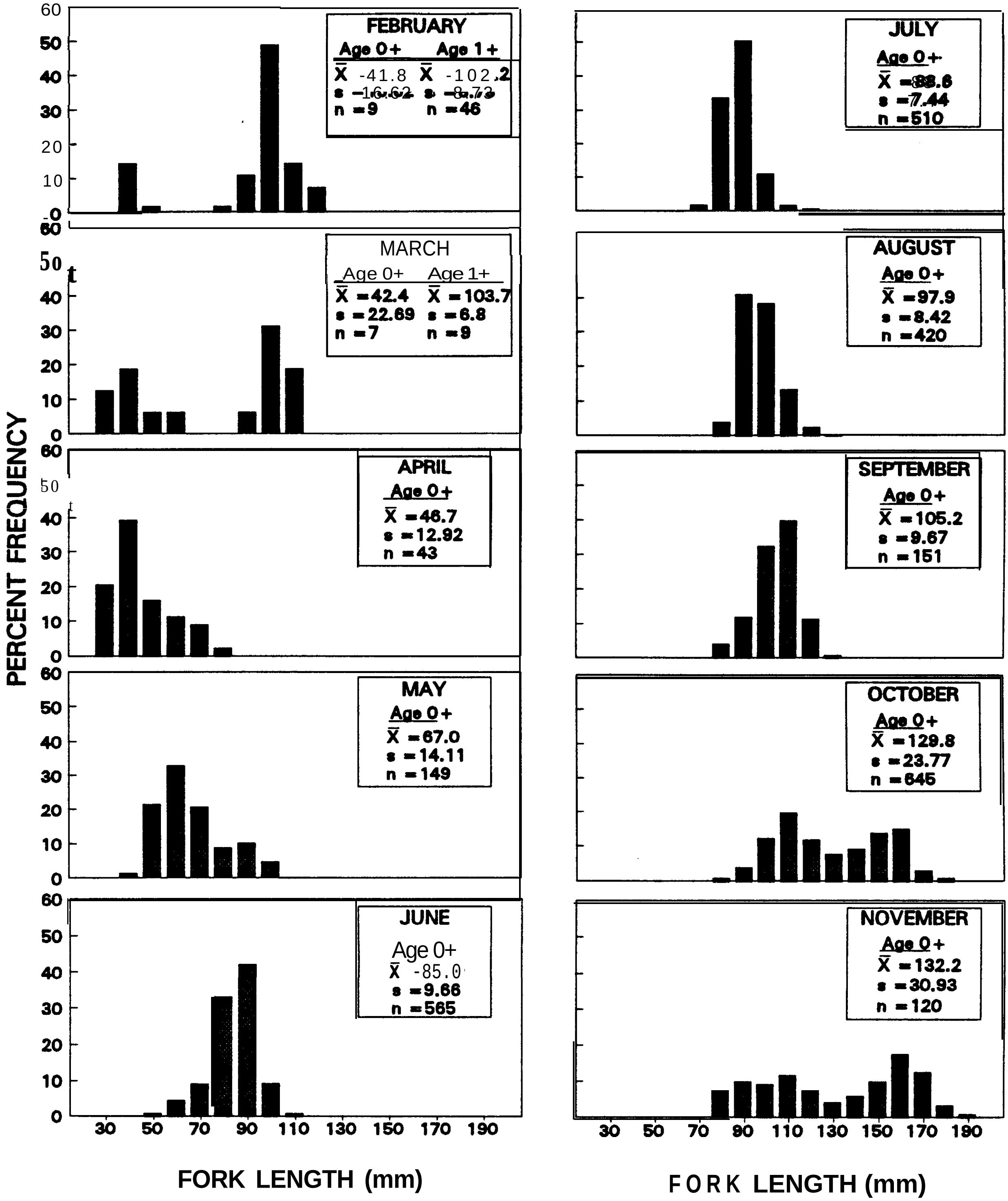


Figure 13. Percent length frequency of chinook salmon captured in the Trinity River rotary trap, 1991.

A total of 2,632 displacements were measured from the random sample of fish measured for length (Figure 14). The least-squares regression slope of the length-displacement regression was 2.91. The slope value from the 1989 chinook regression was 2.86 and 1990 value was 3.05 (USFWS, 1991, 1992b). The regression slopes from 1989, 1990 and 1991 were significantly different ($P<0.05$). Condition factor was used as an indicator of fish health along with visual cues such as fungal infection, lesions, fin condition, etc. The presence of fungal infection and obvious pre-trapped mortality was evident in the catches to some extent, although the yearlings observed in 1991 appeared to be in better condition from appraisal of external characteristics than those seen in 1990.

Hatchery and Natural Stock Estimate

A portion of the natural stock chinook captured were coded wire tagged by the Trinity Fisheries Investigations Project of the California Department of Fish and Game (CDFG) (Appendix C). The rotary trap captured these fish throughout the spring trapping season. The TRH fingerling release on May 28 was a volitional release consisting of only spring run chinook. After the TRH fingerling release, ad-clipped chinook from TRH and from the CDFG natural stocks tagging operation were both captured in substantial numbers. The natural component of the catch previous to capture of the TRH fingerling release consisted of 208 chinook yoy. This included one CWT chinook from the CDFG natural stocks tagging program. Of the 824 tags recovered during the spring trapping period, 319 (38.7%) were from the CDFG natural stocks tagging program, and the remaining 505 individuals were TRH fingerlings. The production multiplier for the TRH fingerling release group was 9.342 (Appendix C). The TRH catch component was estimated at 5,668 of the 19,390 total chinook captured for the period after the first recovery of TRH fingerlings. Assuming equal capture probability and equal mortality rates of marked and non-marked release groups, this corresponds to a 30.5% TRH component in the chinook catch for the spring trapping season. Of the remaining 18,401 unmarked chinook captured during the period following initial capture of the TRH release, 12,733 (69.5%) were estimated as natural chinook for the spring period.

The yearling release groups from TRH included both spring and fall chinook. There is no conspicuous difference in numbers of spring chinook yearling tags recovered versus fall chinook yearlings when compared to their release numbers. The 209 combined spring and fall CWT chinook recovered from the yearling release estimates a hatchery contribution of 4,748 chinook (92.4%) of the catch for the fall period. The estimate of no-clip chinook from TRH would be 100% using the corresponding production multipliers, however one tag recovery from the CDFG natural stocks tagging program occurred during this time, which expands to estimate 23 of the total ad-clip chinook not recovered to be of natural origin. Virtually all natural chinook have emigrated by this time.

The combined contribution estimate for the entire trapping season included 10,909 hatchery chinook (44.1%), and 13,828 natural chinook (55.9%).

The estimated hatchery component from the abundance index (see following section) was 239,387 for the entire trapping season. This includes 146,957 (30.2%) of the chinook captured during spring trapping and 56,104 (99.8%) during the fall period.

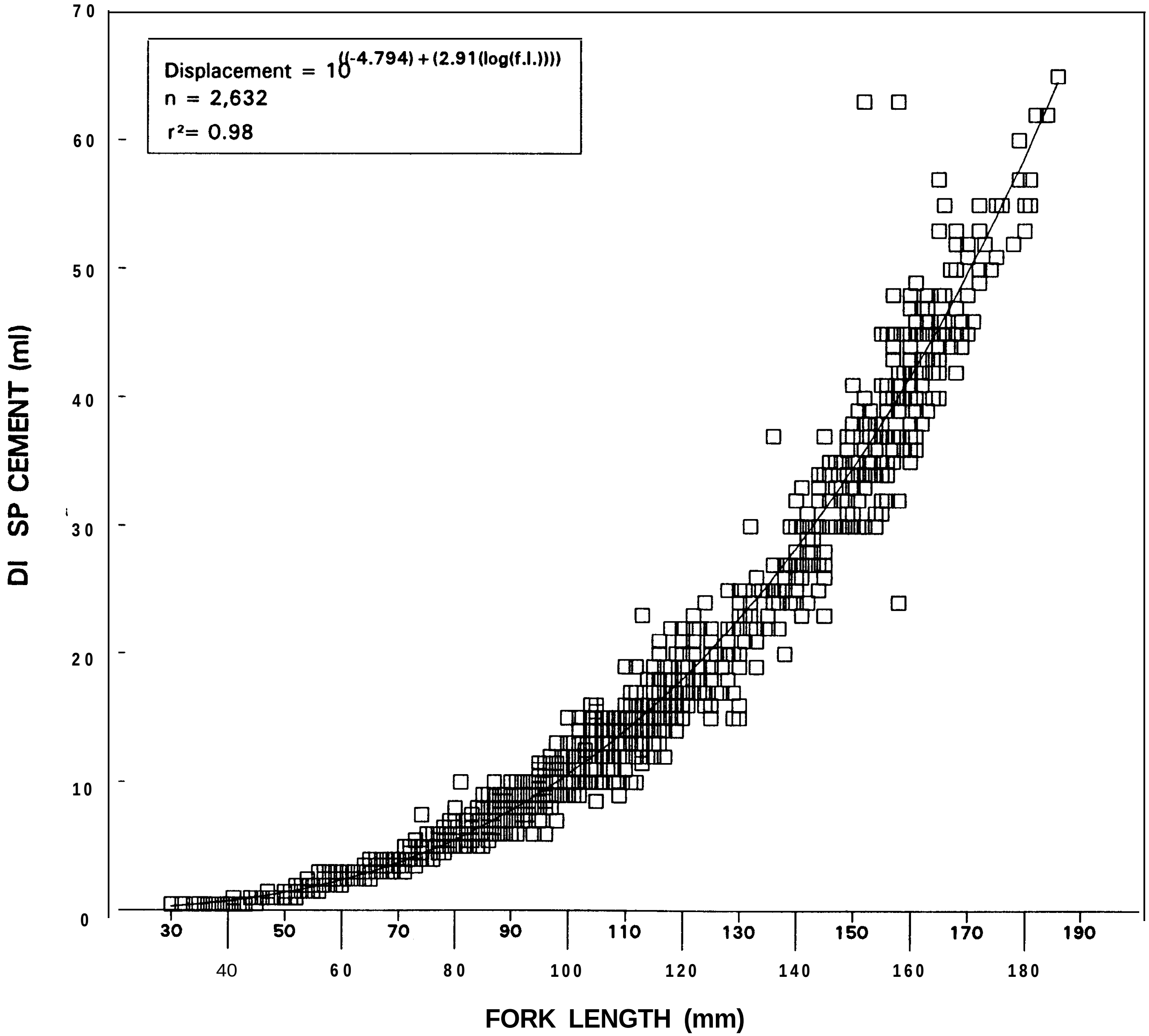


Figure 14. Trinity River chinook length - displacement relationship, 1991.

Migration Rate and Duration

The natural stocks CWT chinook were released by CDFG over extended periods of up to three weeks due to lack of capture of sufficient numbers of chinook in a shorter timespan. This precludes the comparison of initial and mean migration rates with those of the TRH releases. Ranges are given for the initial migration rates of natural stock chinook based on the first and last day of release for that tag code. The first ad-clip chinook capture occurred on May 15. The first recovery of the 06-01-08-01-13 tag code occurred previous to the last day of release of that tag code. This allows for an initial migration rate in excess of the minimum 14.4 rkm/day calculated using the first release date.

Initial capture of the TRH fingerling CWT release (06-01-04-01-03) was on June 5, 8 days after release, for an initial migration rate of 18.0 rkm/day (Table 3). Most of the natural stock chinook tag recoveries occurred during the early capture period of the TRH fingerling release group. It is possible that the natural fish may be "pulled along", migrating due to the sudden influx of large numbers of hatchery chinook immediately following release.

All three yearling release groups from TRH were recovered three days after release, for an initial migration rate of 48.0 rkm/day. The lowest mean migration rate of the yearling tag releases (24.1 rkm/day) was the fall chinook group (06-56-38). This may be due to the slightly larger size of the spring chinook at release. The weighted mean migration rates for the yearling chinook releases in October were much higher than the weighted mean rate of the fingerling release group in May (Table 3). Much of the reason for this may be due to the large size of the yearling releases. They are also more physiologically developed, having smolted more completely than the fingerling releases. This was evident from the amount of silvering in the skin, black fin tips, faint parr marks, etc.

The migration rates of TRH yearling chinook indicates their readiness to emigrate to the estuary/ocean. This rapid emigration, coupled with the estimate of very low natural chinook present in the system at this time, demonstrates that raising chinook to yearling size prior to release is beneficial to both the return success of these fish because of larger size at ocean entrance, and the natural stocks of chinook which otherwise would be competing for food and habitat are also benefitted.

The mean migration rate of TRH fingerlings was comparable to 1989 fingerling releases, although no yearling releases were monitored that year (USFWS, 1991). In 1990, all of the yearling releases showed high mean migration rates from 15.7 rkm/day to 42.8 rkm/day (USFWS, 1992b).

Abundance Index

Weekly abundance increased dramatically in early June and decreased through July (Figure 15). The peak weekly abundance index (108,295) occurred during the week of June 16-22 (Appendix A). The index value for the spring trapping period totalled 486,612 as compared to the 1989 value of 926,788 (USFWS, 1991). The total number of TRH chinook fingerlings released in 1989 and 1991 were 4,760,936, and 1,841,825, respectively. The low release number in 1991 would account for a much lower chinook abundance. There was also a difference in the trapping sites between 1989 and 1991 and its associated efficiency may also explain the disparity in abundance estimates. The 1990 abundance index for chinook totalled 56,500 (USFWS, 1992b), but the inconsistency of trapping and poor site location precludes comparison of that estimate to previous years. The likely continuation of trapping at the current site will allow for more comparable abundance index estimates.

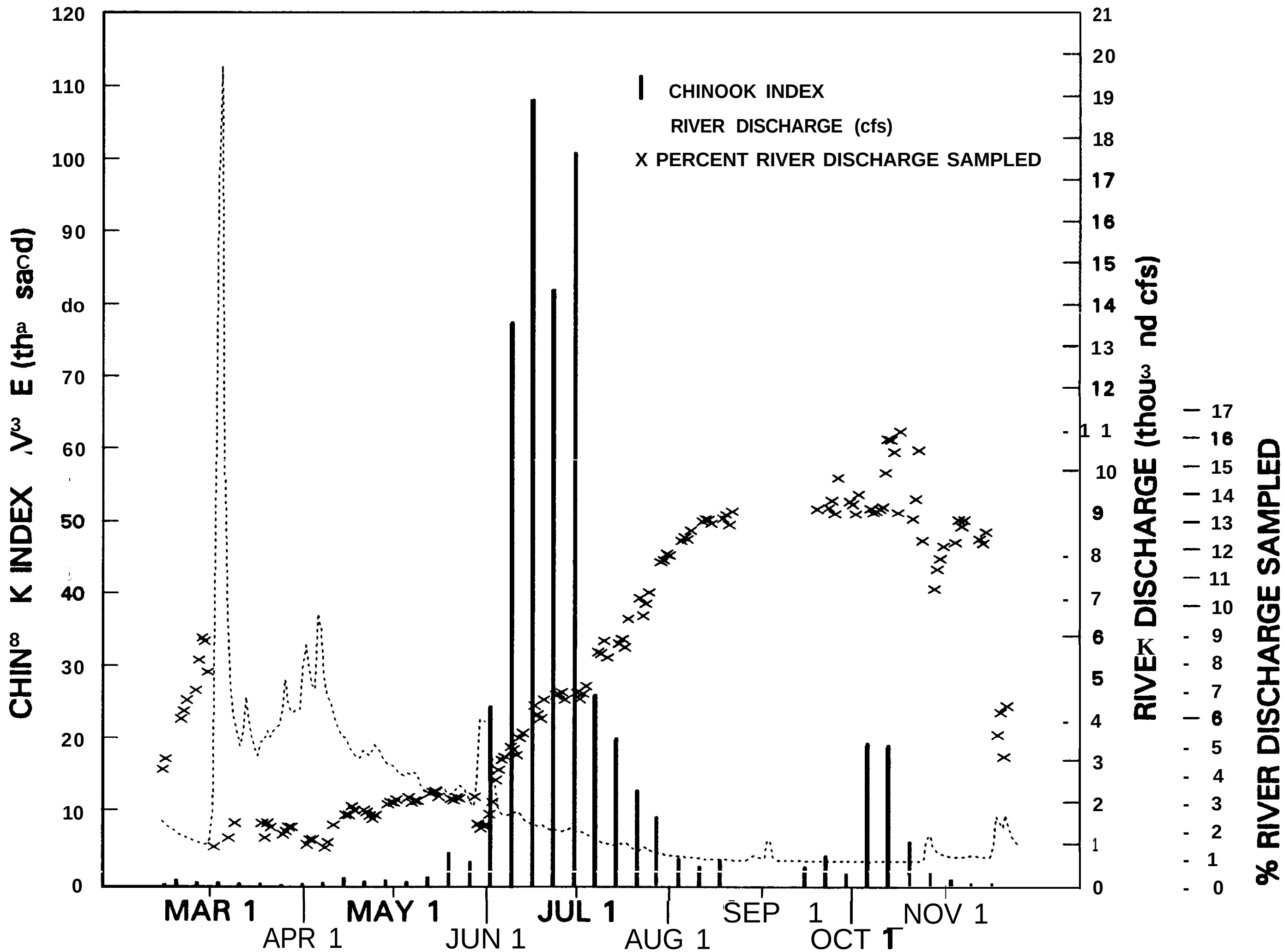


Figure 15. Weekly chinook abundance index values, river discharge, and percent (%) discharge sampled, Trinity River rotary trap, 1991.

Table 3. Migration rate and duration of Trinity River CWT chinook releases, 1991.

TRH=Trinity River Hatchery, #/lb=average number per pound, rkm=river kilometer, cfs=cubic feet per second

Tag Code	Release location	Release Date	Size #/lb	Initial Rate (rkm/day)	Mean Rate (rkm/day)	10-90% duration (days)	Mean River Flow (cfs)	Number Captured
6-1-4-1-3	TRH	05/28/91	72	18.0	7.8	51	1,601	505
6-1-8-1-12	Steel bridge	04/18/91 to 05/02/91	150	3.3 - 4.0	[2/]	[2/]	[2/]	42
6-1-8-1-13	Sky ranch	05/05/91 to 05/27/91	150	14.4	[2/]	[2/]	[2/]	133
6-1-8-1-14	Sky ranch	05/05/91 to 05/27/91	150	4.6 - 16.0	[2/]	[2/]	[2/]	144
06-56-36	TRH	10/08/91	10	48.0	24.7	6	513	40
06-56-38	TRH	10/09/91	11	48.0	24.1	12	513	117
06-56-40	TRH	10/08/91	10	48.0	30.2	13	514	52

[1/]Mean river flow calculated from release date to mean capture date.
[2/]Information was not available due to extended release periods.

Trap Efficiency

Mark-recapture efficiency testing was conducted on eight separate occasions throughout the season utilizing chinook salmon (Table 4). Fish were lightly anaesthetized with MS-222 and marked with a slight clip to the upper lobe of the caudal fin during all of the tests in the spring period. The fish used in the mark-recapture studies were obtained from the rotary trap catch with the exception of the first test which utilized fish that were seined from the trap vicinity. Seining was attempted when needed numbers of juvenile chinook were not available from the trap catches for marking. Numbers of chinook used for the release group varied from 117 to 1,009. It is possible that seined fish may not be representative of the trap catch since seining could capture fish not actively migrating, although the mean fork length (74.6 mm, n=25, s=11.80) of fish utilized from the seine capture was not significantly different ($P<0.05$) than those captured by the rotary trap during the same period (mean length 75.4 mm, n=36, s=16.56). Capturing significant numbers of chinook in the trap is the primary factor limiting the ability to conduct these tests, especially during the period before capture of hatchery chinook. Estimates ranged from 0.3% to 5.6% efficiency. The mean of the efficiency tests was 1.52% for the spring period in which tests were conducted, which encompassed May 30 to July 9. Release times varied from 1230 to 2100 hours, with the night releases consistently exhibiting higher trap efficiency estimates. During the fall trapping period, two efficiency tests were conducted. Bismark Brown Y dye was utilized in favor of fin clipping due to less handling stress on fish. Also, large numbers of fish could be marked in a relatively short period of time. Both of the fall period tests involved night release times, and efficiencies were estimated at 2.3% and 5.6%. These are higher than figures obtained during the spring period. The fall efficiency tests were conducted at very low flows (Table 4), and the chinook available for marking in the fall were larger, and had higher migration rates. The high migration rates, along with trap placement in swift current, may explain the higher efficiencies.

Efficiency is assumed to be variable with changes in flow and site characteristics. The flows during the efficiency tests ranged from 513 to 3,950 cfs. An estimate of chinook abundance using the mean efficiency values from the spring and fall trapping periods totals 1,289,408 and 130,076 respectively. Although the combined season estimate of 1,419,484 is much larger than the abundance index estimate of 542,828, several of the individual efficiency tests applied to the catch during that week are similar to abundance index values for the same week (Table 5). The weeks where estimates varied the greatest also had very low estimated trap efficiency. It would be helpful to have additional correlations of efficiency tests and abundance index values to help validate the abundance index for further use to estimate production.

Table 4. Trap efficiency test summary, Trinity River rotary trap, 1991.

Test #	Release Date	Time of Day	Mark Applied	Number Marked & Released	Number Recovered	% Mark Mortality	% Efficiency	River Flow
1	05/30/91	1500	caudal fin clip	95	1	0.0	1.1	3,950
2	06/11/91	1230	caudal fin clip	1,009	3	1.2	0.3	1,690
3	06/19/91	1645	caudal fin clip	852	22	0.0	2.6	1,380
4	06/27/91	1500	caudal fin clip	541	3	4.0	0.6	1,250
5	07/02/91	1430	caudal fin clip	465	14	0.0	3.0	1,240
6	07/09/91	2000	caudal fin clip	322	5	0.0	1.6	1,000
7	10/17/91	2000	Bismark Brown	346	8	0.0	2.3	513
8	10/23/91	1945	Bismark Brown	178	10	0.0	5.6	520

Table 5. Comparison of trap efficiency tests and abundance index values by week.

week	chinook catch	abundance index estimate	efficiency test estimate
May 26-Jun 1	42	3,098	3,818
Jun 9-15	3,159	77,574	1,053,000
Jun 16-22	3,862	108,295	148,538
Jun 23-29	3,138	82,129	523,000
Jun 30-Jul 6	3,878	100,961	129,266
Jul 7-13	1,231	26,152	76,937
Oct 13-19	2,489	19,164	108,217
Oct 20-26	456	5,928	8,143

Steelhead Monitoring

Steelhead Emigration Monitoring

Capture of steelhead began with primarily parr and natural smolts in February and March, with numbers of TRH steelhead increasing gradually from early April to a peak in mid-May (Appendix A). Steelhead fry (0+) catches occurred primarily through June and July. Steelhead catches totalled 1,134 for the spring trapping period. The highest TWC of 410 occurred during the week of May 12 to May 18 (Appendix B). The fall trapping period catch included 101 steelhead, composed exclusively of natural fish. Almost all of these individuals were 1+ parr and smolts, while only three were fry (0+). Fall TWC peaked from October 27 to November 2 with 56.

Size and Condition

Of the 1,134 steelhead captured during the spring portion of the trapping season, 1,093 (96.4%) were measured to fork length and displacement was measured for 1,038 (95.0%) of these. This data allowed us to obtain a condition appraisal comparable with similar information from other years (Figure 16). The least-squares regression slope value for all measured steelhead is 2.73. A length frequency graph (Figure 17) shows the three developmental classes observed. The trimodal length frequency shows probable age class separation between yoy, 1+, and 2+ steelhead. One "half-pounder" steelhead (fork length 489 mm) was also captured in the trap. The capture of half-pounders has occurred in past trapping seasons (USFWS, 1992b).

Hatchery and Natural Stock Estimate

All steelhead released from TRH were marked with fin clips. The 1+ (1990 brood year) groups were marked with a combination left ventral and adipose fin clip. The 2+ (1989 brood year) juveniles were given right ventral and adipose fin clips. During the spring trapping period, 498 (43.9%) of the 1,134 steelhead captured were of hatchery origin. The natural steelhead comprised the remaining 56.1% of the total steelhead catch for the spring trapping period. The TRH 1+ steelhead contributed 470 (94.5%) of the hatchery steelhead, and the remaining 28 (3.7%) were from the 2+ release group. This represents a 0.0485% capture of the 1+ steelhead, and a 0.0151% capture of the 2+ group based on hatchery release numbers of 969,600 and 185,571 for 1+ and 2+ steelhead, respectively. No hatchery steelhead were captured during the fall trapping period.

The abundance index estimate was 26,690 hatchery steelhead (43%) for the spring period, and since no hatchery steelhead were captured during the fall trapping, the index estimate of 1,681 is made up entirely of natural steelhead.

Migration Rate and Duration

The release of TRH steelhead occurred on March 18, with a volitional release technique allowing fish to leave the hatchery voluntarily. The initial capture of the 1+ yearlings occurred on March 22, four days after release, for an initial migration rate of 36.0 rkm/day. The initial capture of the 2+ yearling steelhead occurred on April 30, 43 days post release for an initial migration rate of 3.4 rkm/day. The capture of TRH 1+ steelhead continued until July 25, for a total duration of 95 days. The TRH 2+ steelhead captures occurred for 42 days, with the last capture taking place on June 11. The weighted mean migration rates were 2.9 rkm/day for 1+ steelhead and 2.3 rkm/day for 2+ steelhead. In 1989, TRH steelhead were not fin clipped, and in 1990, multiple releases occurred using the same fin clip, so average migration rate of steelhead was not calculated for either of the previous trapping years.

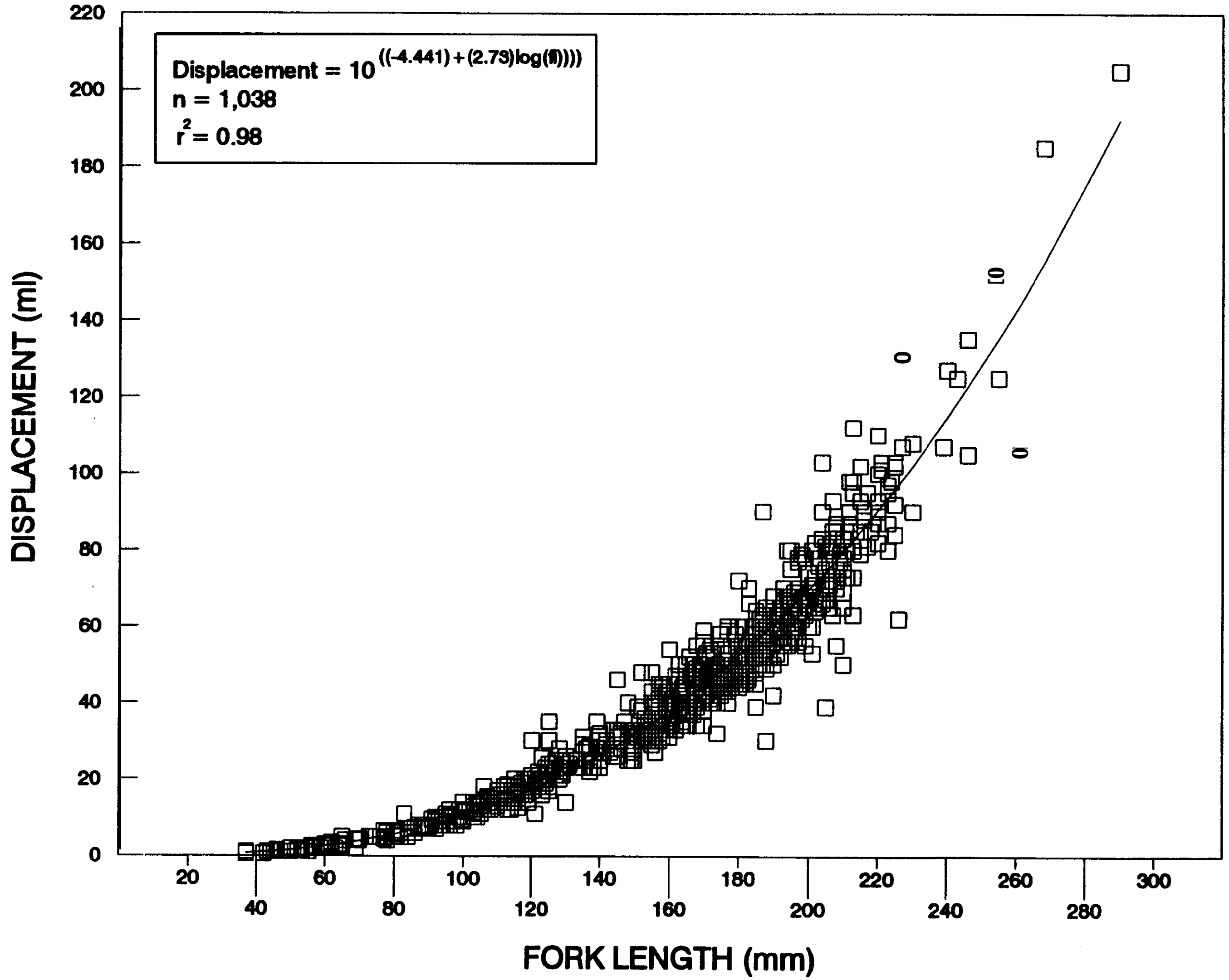


Figure 16. Trinity River steelhead length - displacement relationship, 1991.

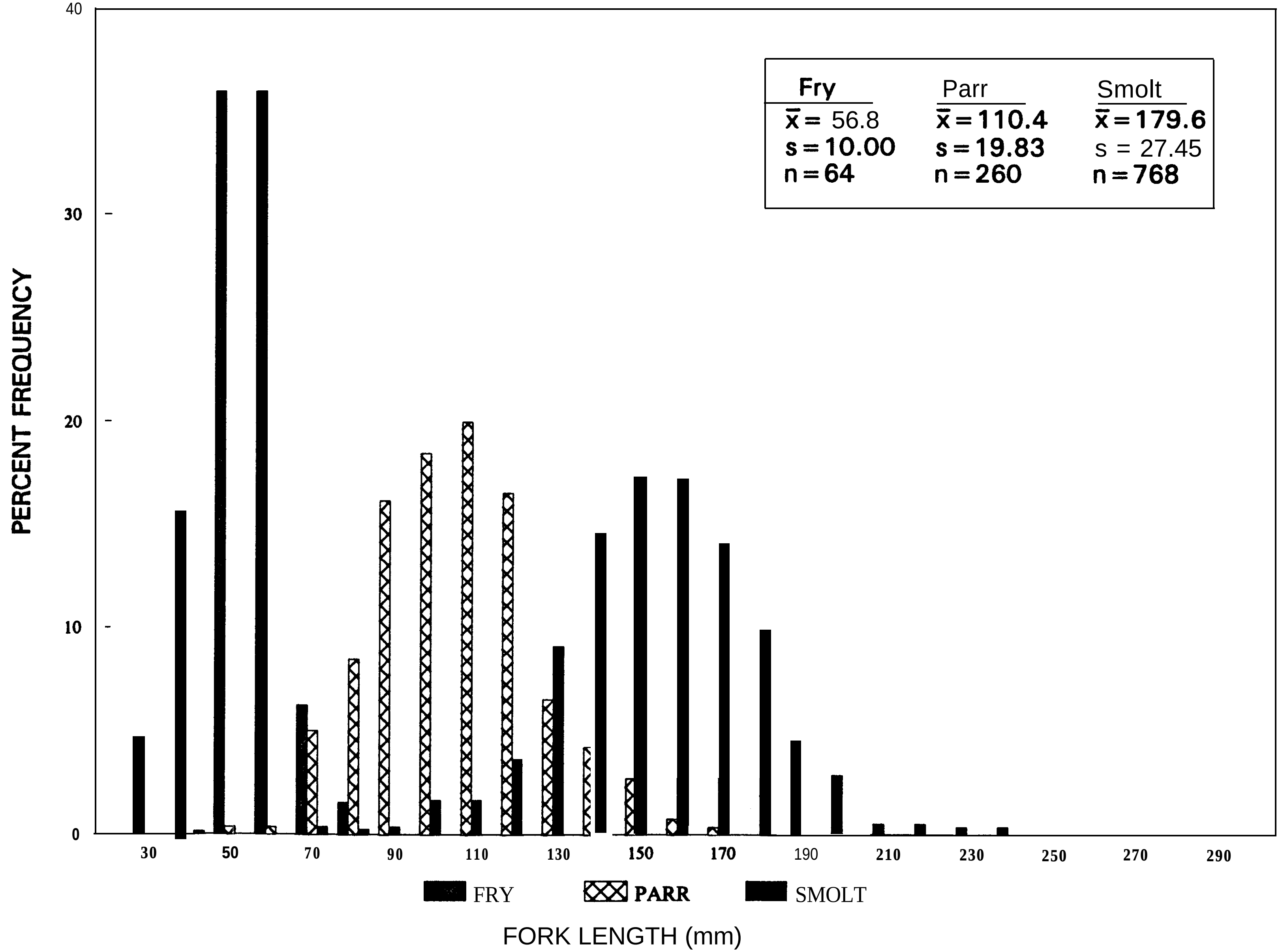


Figure 17. Percent length frequency of steelhead by developmental stage, Trinity River rotary trap, 1991.

Abundance Index

The spring index value for all developmental classes of steelhead totalled 62,120, compared with a value of 58,335 in 1990 (USFWS, 1991). The peak weekly abundance occurred during the week of May 12 to 18 with abundance estimates dropping quickly by July (Figure 18). Estimates of abundance were very low during the fall period. The fall trapping index for all steelhead amounted to 1,681, compared to the 1990 figure of 1,016 (USFWS, 1992b).

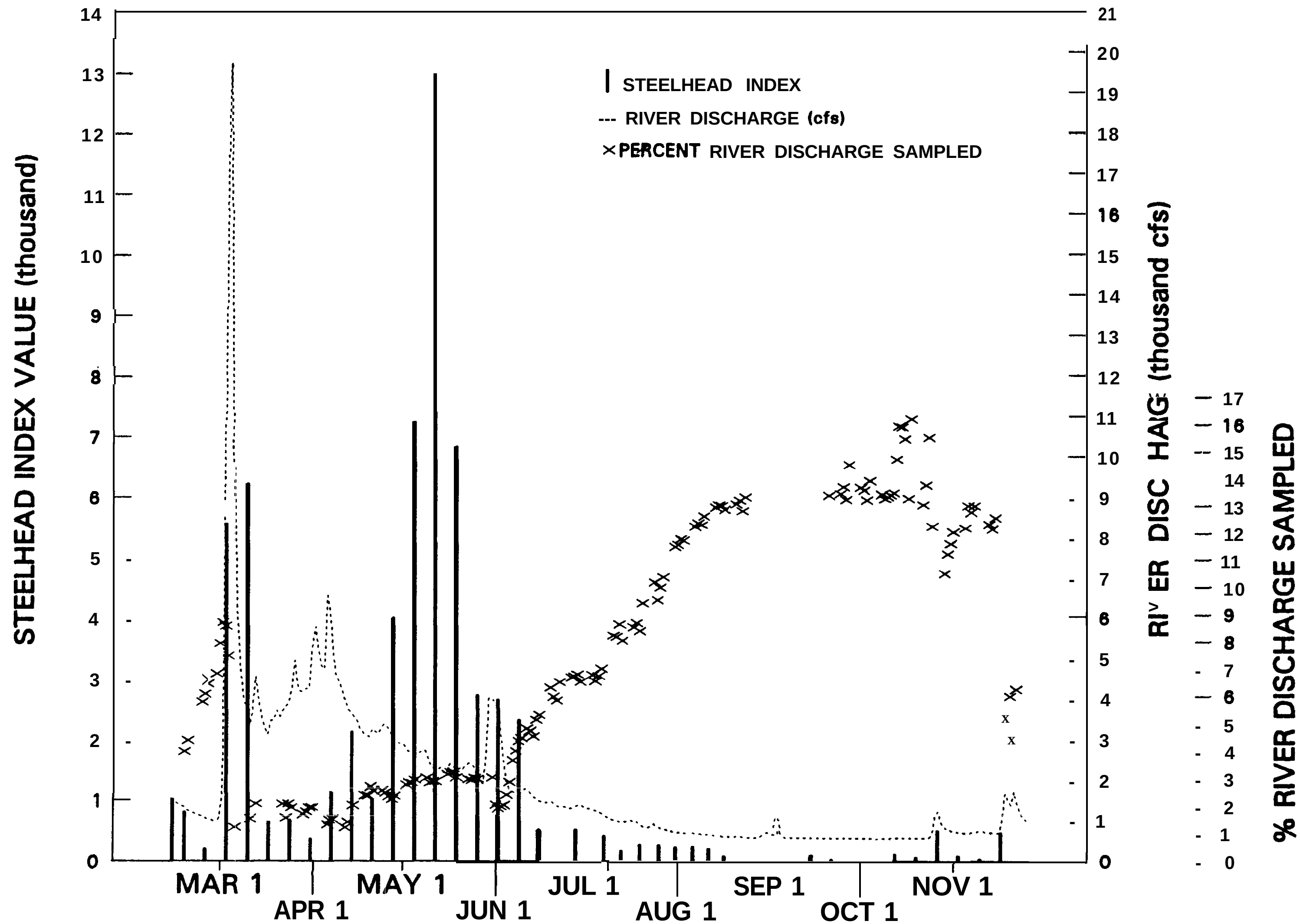


Figure 18. Weekly steelhead abundance index values, river discharge, and percent (%) river discharge sampled, Trinity River rotary trap, 1991.

Coho Salmon Monitoring

Coho Emigration Monitoring

The capture of coho salmon in the trap was composed of primarily 1+ natural and TRH yearling releases. Only 14 coho were captured during the months of February, March, and April. Catch numbers of 1+ coho began increasing in early May, and the trap captured a total of 145 1+ coho, all during the spring trapping period (Appendix A). The catch of coho yoy fry and parr made up the remaining 79 coho caught for the entire season. TWC of coho peaked during the week of May 19 to May 25 with an estimate of 79 (Appendix B). The majority of the spring coho catch occurred during May. Only two coho were captured in the fall period.

Size and Condition

Fork length was measured from all 224 coho captured. A bimodal length distribution occurred, with the capture of both coho 0+ (fry and parr) and large numbers of 1+ smolts (Figure 19). Displacements were measured for 205 (91.5%) of the coho measured. The slope value for the fork length-displacement regression for all coho was 2.69 (Figure 20). This value is slightly lower than the slope of 2.80 obtained in 1990 (USFWS, 1992b). This may be an indicator of the poor health condition of the TRH 1+ coho noted by CA-NV Fish Health Center staff (Foott and Walker, 1991).

Hatchery and Natural Stock Estimate

TRH coho were all released as 1+ fish on March 18 as a volitional release group (allowed to leave voluntarily), including 8.2% marked Ad-CWT. Identification was attempted on coho that were not tagged by associating dorsal fin erosion with hatchery origin. Assuming equal capture probability and survival of tagged and untagged coho, the four ad-clipped coho recoveries should have an untagged adjunct population of 49 TRH coho represented in the trap catch. The 53 hatchery coho made up 24% of the coho caught in the spring, and since only 2 natural coho were captured in the fall, a total of 24% of the coho were of hatchery origin throughout the season. Using such a low number of CWT recoveries may have introduced error in expanding for untagged fish. Since the catch of coho identified as untagged TRH yearlings was greater (115) than 49, this may indicate a possible failure to correctly identify untagged hatchery coho by observation of fin erosion alone, effectively overestimating the hatchery component. Given that the coho smolts identified as natural origin were captured during the same time period as the TRH smolts, the natural component of the smolt catch could be misidentified hatchery fish not having visible fin erosion. Another possibility for the low number of CWT recoveries is a higher mortality rate for the tagged coho in comparison to the untagged fish of the same release group.

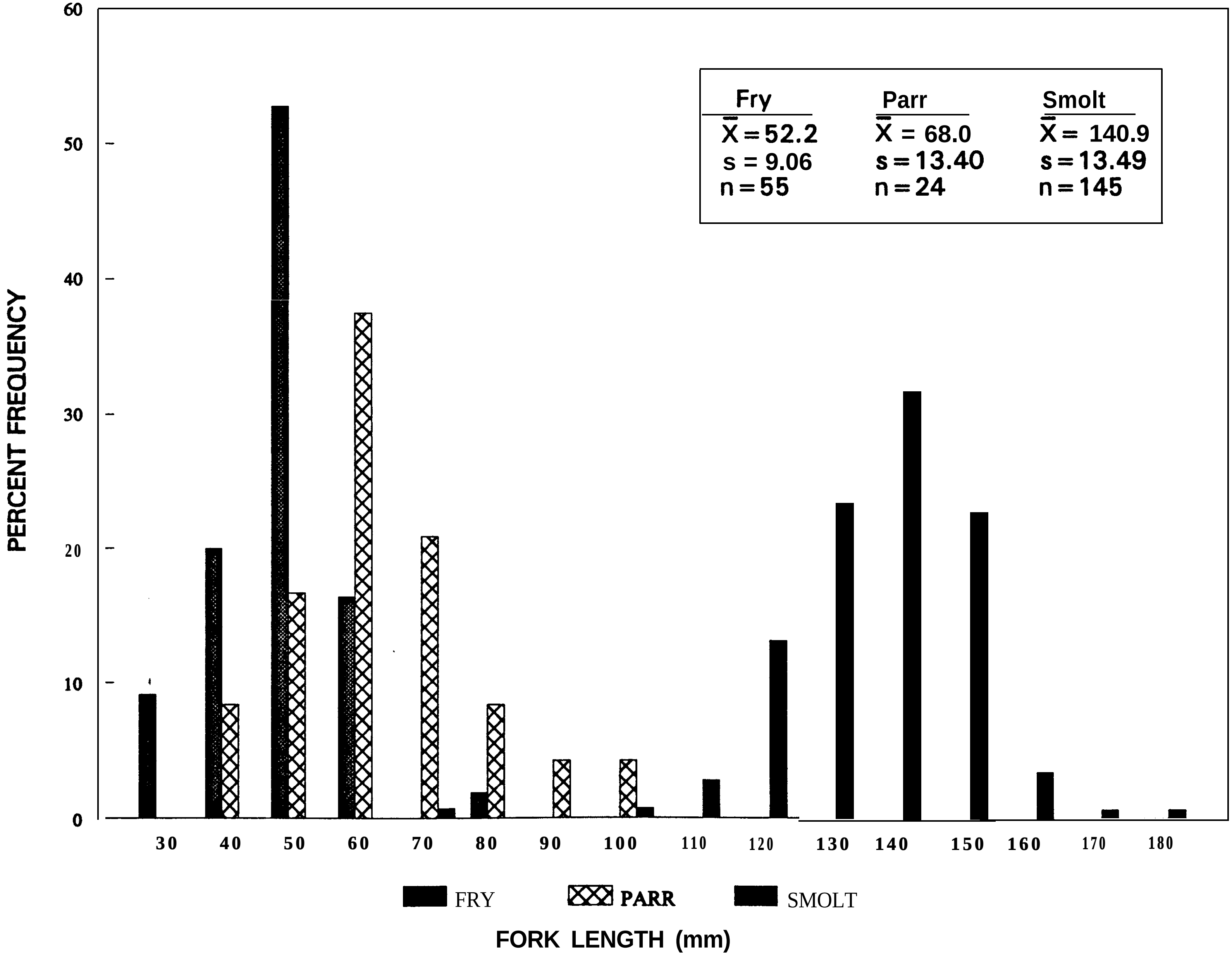


Figure 9. Percent length frequency of coho salmon by developmental stage, Trinity River rotary trap, 1991.

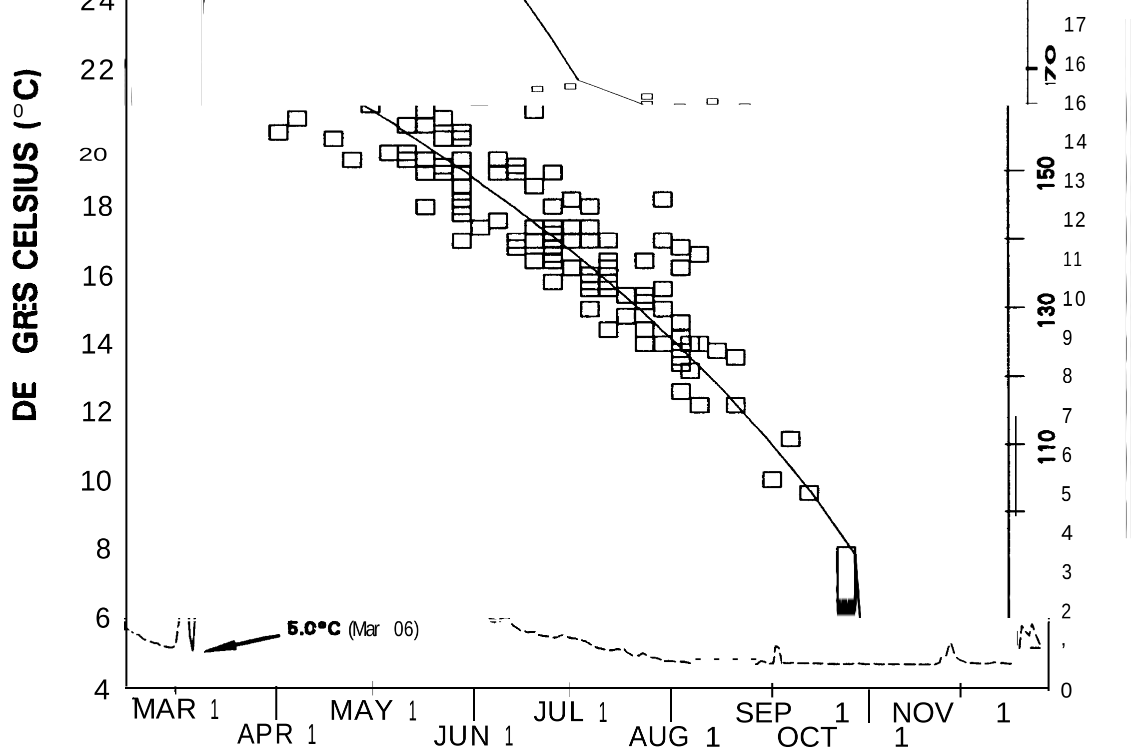


Figure 22. Daily average water temperature (°C) and river discharge (cfs), Trinity River rotary trap, 1991.

The hatchery/natural coho composition from the abundance index estimate was 6,967 hatchery coho (56.4%) for the spring period. This is higher than the hatchery/natural estimate from the actual catch due to the probable overestimation of non clipped coho smolts as hatchery fish. Hatchery coho were not estimated for in the abundance index during the fall trapping.

Migration Rate and Duration

Four ad-clipped 1+ coho were caught and recovered from the trap. The initial tag recovery occurred on March 22, four days after release, for an initial migration rate of 36.0 rkm/day. The next two recoveries occurred in late May, and the last recovery occurred on June 5. Several of the CWT coho were captured in the mainstem Klamath River and Klamath River estuary seining programs throughout May (USFWS, unpub. data). Three additional ad-clipped coho recovered in the same time period were no tags. The observations of the few coho recovered at the trap, along with the capture in the Klamath River estuary, suggests a high migration rate for coho yearlings. The capture of only four coded wire tagged coho gives us only minimal information regarding hatchery coho migration rates, therefore no mean migration rate was calculated for coho.

Abundance Index

The abundance index for all age classes of coho throughout the trapping season totalled 12,362 (Appendix A). The index for the spring period (12,315) made up 99.6% of the index for the entire season. The weekly values were highest for the four weeks from May 5 to June 1 (Figure 21). This corresponds to the highest catches of hatchery coho smolts throughout the entire season. The abundance index for 1990 was 17,925 for the spring trapping period (USFWS, 1992b). The value for total coho during the fall trapping period was only 47, suggesting extremely low abundance of coho during this time period.

Flow and Water Temperature

Flow data was obtained from the USGS gaging station at Hoopa (J. Palmer, pers. comm, 1992). High flows up to 19,700 cfs occurred in early March and within a few days had receded to lower levels (Figure 22). Flows were not a limiting factor to trap operation.

Water temperature was recorded every two hours from February 13 to November 25 (Figure 22). The lowest daily mean temperature recorded was 5.0 C on March 6. The highest recorded daily mean temperature was 25.5 C on July 5. A gap in water temperature monitoring occurred from August 8 to September 19 due to damage to trap equipment which necessitated removal of the trap containing the thermograph.

Other Species

Several species were captured in addition to the targeted salmonids. Seven chum salmon (O. keta) juveniles were captured from May 31 to July 17. Chum salmon appear to be uncommon in the Trinity

River. Anecdotal information exists about the occasional capture of adult chum salmon in the Native American gill net fishery in the Klamath River estuary (USFWS, 1982, 1992a).

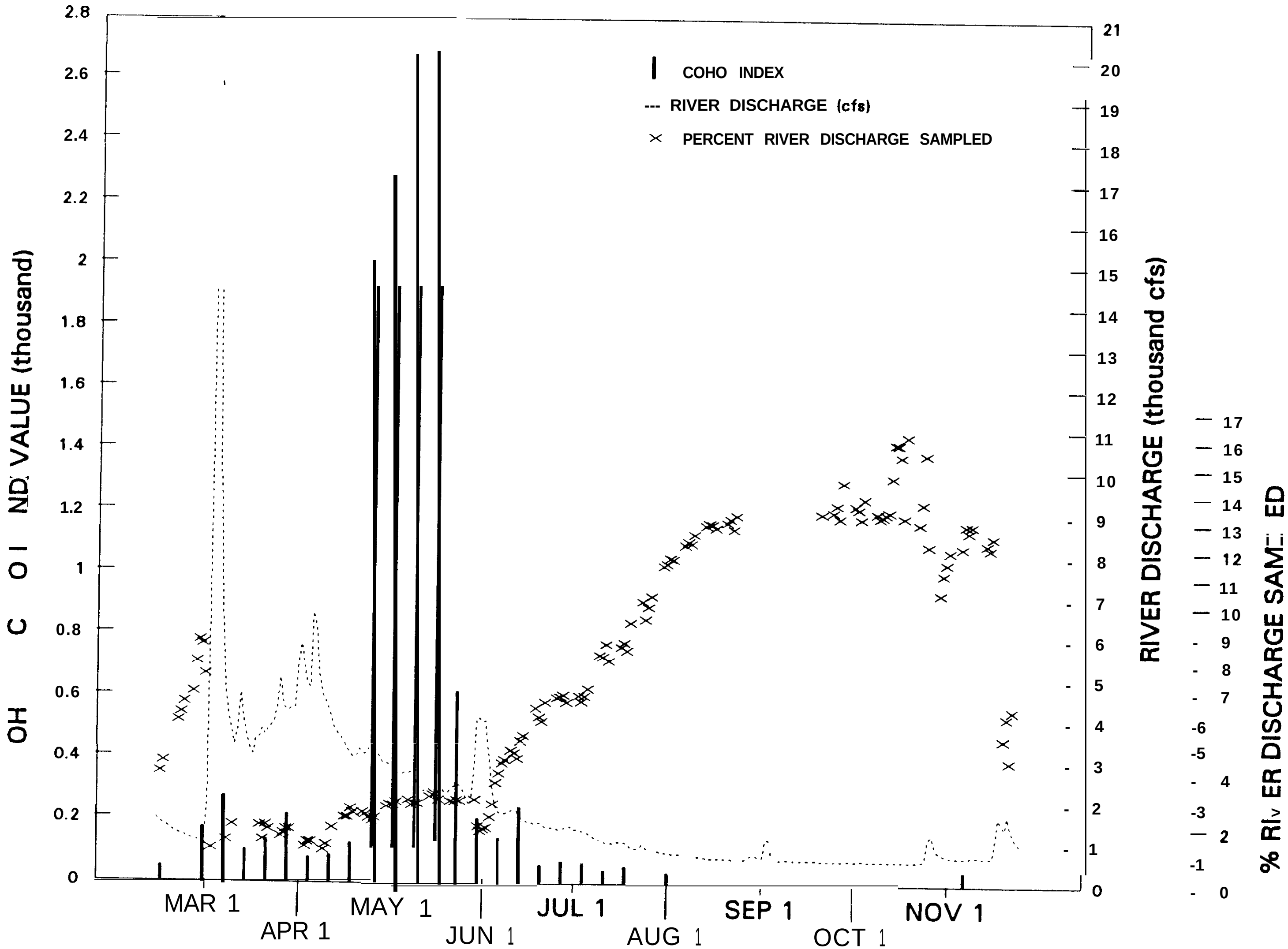


Figure 21. Weekly coho abundance index values, river discharge, and percent (%) river discharge sampled, Trinity River rotary trap, 1991.

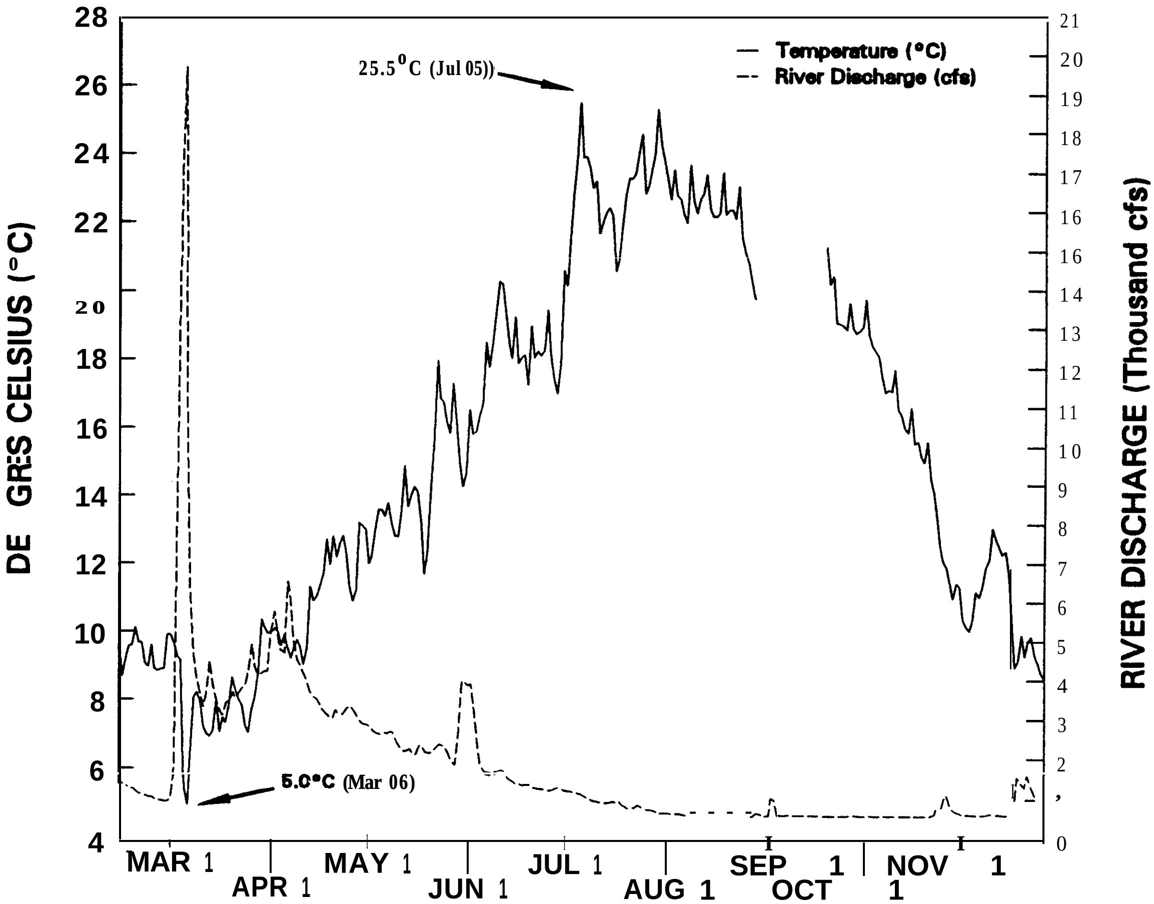


Figure 22. Daily average water temperature (°C) and river discharge (cfs), Trinity River rotary trap, 1991.

Juvenile chum salmon were also captured during 1989 and 1990 rotary trapping efforts (USFWS, 1991, 1992b). Other salmonids include three juvenile brown trout (Salmo trutta), commonly found in Lewiston Reservoir and in the upper Trinity River. Brown trout have been captured in previous trapping seasons (USFWS, 1991, 1992b). The trap also captured a post-spawned adult chinook salmon on November 19.

Also captured were six juvenile green sturgeon Acipenser medirostris (total length 79-120 mm), between July 16 and July 24. In 1989, green sturgeon juveniles were also captured in the Trinity River rotary trap (USFWS, 1991). Several other non-salmonid fish species were captured (Table 6).

Table 6. Non-salmonid fish species listed in order of capture frequency, Trinity River rotary trap, 1991.

Common Name	Species
American shad	Alosa sapidissima
Pacific lamprey	Entosphenus tridentatus
Klamath smallscale sucker	Catostomus rimiculus
Speckled dace	Rhinichthys osculus
Threespine stickleback	Gasterosteus aculeatus
Prickly sculpin	Cottus asper
Green sturgeon	Acipenser medirostris
Yellow bullhead	Ictalurus natalis
Green sunfish	Lepomis cyanellus

Additional Studies

Field work for the disease survey of salmonid populations in the Trinity River was conducted by Dr. J. Scott Foott and Robert Walker. This work involved coordinated sample collection between CCFRO and the California-Nevada Fish Health Center (CA-NV FHC). Samples of steelhead, and chinook and coho salmon were collected and transferred to CA-NV FHC personnel on site for identification of types and severity of diseases present. These findings are presented in another report (Foott and Walker, 1991).

RECOMMENDATIONS

The use of the rotary screw trap for juvenile salmonid monitoring has proven to be an advantageous method of field sampling throughout periods of high flows and the typically concurrent high debris load. The present trapping sites have proved suitable to be used in future trapping years, which will allow for valuable abundance index comparisons in the upcoming trap seasons. CCFRO recommends continuation of rotary trapping programs to obtain valuable salmonid emigration data on; length and age, migration rates and durations, hatchery and natural contribution rates, and to attempt to estimate trap efficiency, which would allow for developing population estimates of juvenile salmonids emigrating from each sub-basin. The use in 1991 of single traps at each location allowed us to have additional traps in a "back-up" capacity, ready for placement in case of trap failure, in comparison with 1990, when two traps were operated side by side.

The attempt to collect ATPase data from chinook salmon should be followed up with more detail in future years to hopefully gain valuable information on smoltification of hatchery releases and how that relates to migration rates. Quick emigration of hatchery chinook should reduce competition with natural chinook present in the system for food and habitat. In addition, the monitoring of migration rates would be enhanced by the release of hatchery chinook marked by size grouping with individual tag codes, allowing better study of the effect of size on migration rates. The use of volitional releases will undoubtedly have effects on migration rates, lowering the mean migration rate, and spreading the migration duration over a much longer time period. This is due to cases where fish linger for up to two weeks in the raceways until forced out (J. Bedell, pers. comm, 1992). The lack of marking of steelhead from IGH has limited the ability to distinguish those stocks from the natural population, preventing this project from ascertaining reliable information on migration rates and duration. The marking and subsequent recapture of natural chinook stocks in the Trinity River is an important part of understanding the natural salmonid populations in the basin. The information available on growth, migration rates, and mortality would be enhanced by using smaller groups of individual tag codes. This would allow for a shorter release period for a tag code, which would allow us to obtain more precision in our recovery data.

Although competition between hatchery and natural chinook stocks may be lessened through the use of yearling release of hatchery fish, there is an unknown impact on coho salmon and steelhead during the yearling emigration period that needs further investigation.

CCFRO has been contacted by the Service's National Ecology Research Center (NERC) in Fort Collins, Colorado to provide data for developing a population model of Trinity River outmigrating juvenile chinook salmon. Some cooperative efforts may be forthcoming involving CCFRO and NERC to aid in improving the chinook population model (S. Williamson, pers. comm, 1992). Estimating movement rates and mortality between sampling locations may prove valuable in the future for the development of the population model.

Although the trapping program has had some sampling gaps in 1991 due to trap failure, the gaps were much less critical than those existing in past years' data sets. In order to further lessen gaps in sampling, trap maintenance will need to be of increased importance, along with conservative placement of the trap during high flow situations.

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Appendix A. Weekly catch and related flow data, Klamath River rotary trap, 1991.

WEEK		TRAP NIGHTS	FLOW (CFS)	% FLOW SAMPLED	NO CLIP CHINOOK	AD CLIP CHINOOK	TOTAL CHINOOK	STEELHD FRY	STEELHD PARR	NATURAL STEELHD SMOLTS	HATCHERY STEELHD SMOLTS	TOTAL STEELHD	COHO FRY	COHO PARR	NO CLIP COHO SMOLTS	AD CLIP COHO SMOLTS	TOTAL COHO
MAR	31-APR 6	3	6535	1.28	16	0	16	0	4	1	0	5	0	0	0	0	0
APR	7-13	4	6467	1.32	20	0	20	1	a	1	0	10	0	0	0	0	0
	14-20	4	5136	1.44	12	0	12	0	a	1	0	9	6	0	0	0	6
	21-27	4	5437	1.39	a	0	a	0	9	0	0	9	0	0	0	0	0
	28-MAY 4	4	5101	1.55	13	0	13	0	1	2	0	3	0	0	0	0	0
MAY	5-11	4	5631	1.51	19	0	19	0	14	0	0	14	0	0	0	0	0
	12-18	4	5183	1.60	22	0	22	0	0	2	0	2	0	0	2	0	2
	19-25	4	5983	1.56	9	0	9	0	3	6	0	9	0	0	10	3	13
	26-JUN 1	3	5098	1.73	14	0	14	0	0	1	1	2	1	0	0	0	1
JUN	2-8	4	4079	1.93	46	0	46	1	1	3	0	5	1	1	1	0	3
	9-15	0	3380		TRAP NOT OPERATED DUE TO STRUCTURAL DAMAGE												
	16-22	3	2656	2.67	291	1	292	5	0	11	9	25	3	2	0	0	5
	23-29	4	2416	2.78	518	16	534	1	1	3	1	6	1	0	0	0	1
	30-JUL 6	2	2180	2.48	955	30	985	0	1	0	0	1	0	0	0	0	0
JUL	7-13	4	1806	3.35	774	24	798	10	5	2	0	17	0	1	0	0	1
	14-20	1	1754	3.82	69	1	70	1	0	0	0	1	0	0	0	0	0
	21-27	2	1574	3.92	17	0	17	0	0	0	0	0	0	0	0	0	0
	28-AUG 3	4	1366	4.48	50	0	50	6	0	0	0	6	0	0	0	0	0
AUG	4-10	0	1236														
	11-17	0	1159														
	la-24	0	1243														
	25-31	0	1281														
SEP	1-7	0	1241														
	a-14	0	1224														
	15-21	1	1173	5.05	2	0	2	0	0	0	0	0	0	0	0	0	0
	22-28	3	1157	4.87	1	0	1	0	2	2	0	4	0	0	0	0	0
	29-OCT 5	2	1293	5.03	8	0	8	0	0	0	0	0	0	0	0	0	0
OCT	6-12	2	1334	5.04	2	0	2	0	0	0	0	0	0	0	0	0	0
	13-19	2	1353	6.00	5	0	5	0	0	1	0	1	0	0	0	0	0
	20-26	4	1566	4.94	49	7	56	0	0	0	0	0	0	0	0	0	0
	27-NOV 2	4	1740	4.74	19	10	29	0	12	4	0	16	0	0	0	0	0
NOV	3-9	4	1557	5.52	23	24	47	0	2	1	0	3	0	0	0	0	0
	10-16	3	1576	5.03	33	33	66	0		1	0	2	0	0	0	0	0
	17-23	3	3406	3.11	123	24	147	0	15	4	0	19	0	7	0	0	7
	24-30	4	2697	3.70	167	49	216	0	9	3	0	12	0	1	1	0	2
DEC	l-7	4	3310	3.80	394	88	482	0	1	23	0	24	0	0	0	0	0
	8-14	4	3246	2.99	304	31	335	4	18	5	0	27	0	3	0	0	3
	15-21	4	2560	2.80	141	6	147	2	4	0	0	6	0	0	0	0	0
SPRING SUBTOTAL		58			2853	72	2925	25	55	33	11	124	12	4	13	3	32
FALL SUBTOTAL		44			1271	272	1543	6	64	44	0	114	0	11	1	0	12
TOTAL		102			4124	344	4468	31	119	77	11	238	12	15	14	3	44

Appendix A (continued). Weekly abundance index estimates, Klamath River rotary trap, 1991.

	WEEK	TRAP NIGHTS	NO CLIP CHINOOK	AD CLIP CHINOOK	TOTAL CHINOOK	STEELHD FRY	STEELHD PARR	NATURAL STEELHD SMOLTS	HATCHERY STEELHD SMOLTS	TOTAL STEELHD	COHO FRY	COHO PARR	NO CLIP COHO SMOLTS	AD CLIP COHO SMOLTS	TOTAL COHO
MAR	31-APR 6	3	2954	0	2954	0	726	177	0	903	0	0	0	0	0
APR	7-13	4	2672	0	2672	138	1085	138	0	1361	0	0	0	0	0
	14-20	4	1454	0	1454	0	963	121	0	1064	733	0	0	0	733
	21-27	4	1008	0	1008	0	1136	0	0	1136	0	0	0	0	0
	28-MAY 4	4	1488	0	1488	0	112	226	0	338	0	0	0	0	0
MAY	5-11	4	2200	0	2200	0	1649	0	0	1649	0	0	0	0	0
	12-18	4	2394	0	2394	0	0	219	0	219	0	0	224	0	224
	19-25	4	994	0	994	0	322	686	0	1008	0	0	1372	116	1372
	26-JUN 1	3	1876	0	1876	0	0	131	133	264	140	0	0	0	140
JUN	2-8	4	4172		4172	93	88	271	0	452	91	91	88	0	270
	9-15	0	TRAP NOT OPERATED DUE TO STRUCTURAL DAMAGE												
	16-22	3	25608	89	25697	434	0	966	777	2177	264	177	0	0	441
	23-29	4	32928	1026	33954	63	63	189	63	378	68	0	0	0	66
	30-JUL 6	2	134204	4221	138425	0	140	0	0	140	0	0	0	0	0
JUL	7-13	4	40425	1236	41661	625	296	123	0	1044	0	72	0	0	72
	14-20		12649	182	12831	182	0	0	0	182	0	0	0	0	0
	21-27	2	1502	0	1502	0	0	0	0	0	0	0	0	0	0
	28-AUG 3	4	1948	0	1948	236	0	0	0	236	0	0	0	0	0
AUG	4-10	0													
	11-17	0													
	18-24	0													
	25-31	0													
SEP	1-7	0													
	8-14	0													
	15-21		280	0	280	0	0	0	0	0	0	0	0	0	0
	22-28	3	49	0	49	0	91	163	0	254	0	0	0	0	0
	29-OCT 5	2	557	0	557	0	0	0	0	0	0	0	0	0	0
OCT	6-12	2	140	0	140	0	0	0	0	0	0	0	0	0	0
	13-19	2	294	0	294	0	0	147	0	147	0	0	0	0	0
	20-26	4	1745	256	2001	0	0	28	0	28	0	0	0	0	0
	27-NOV 2	4	704	371	1075	0	445	147	0	592	0	0	0	0	0
NOV	3-9	4	772	798	1570	0	67	28	0	95	0	0	0	0	0
	10-16	3	1524	1517	3041	0	47	47	0	94	0	0	0	0	0
	17-23	3	10278	2000	12278	0	1297	292	0	1589	0	579	0	0	579
	24-30	4	8425	2380	10805	0	422	131	0	553	0	47	47	0	94
DEC	1-7	4	18669	3850	22519	0	42	985	0	1027	0	0	0	0	0
	8-14	4	16381	1649	18030	238	971	298	0	1507	0	166	0	0	166
	15-21	4	8969	345	9314	131	231	0	0	362	0	0	0	0	0
SPRING SUBTOTAL		58	270476	6754	277230	1771	6580	3247	973	12571	1296	340	1654	116	3320
FALL SUBTOTAL		44	68787	13166	81953	369	3613	2266	0	6248	0	792	47	0	839
TOTAL		102	339263	19920	359163	2140	10193	5513	973	18819	1296	1132	1731		4159

Appendix A (continued). Weekly catch data, Trinity River rotary trap, 1991.

	WEEK	TRAP NIGHTS	RIVER FLOW (CFS)	96 Row SAMPLED	NO CLIP CHINOOK	AD CLIP CHINOOK	TOTAL CHINOOK	STEELHD FRY	STEELHD PARR	NATURAL STEELHD SMOLTS	HATCHERY STEELHD SMOLTS	TOTAL STEELHD	COHO FRY	COHO PARR	NO CLIP COHO SMOLTS	AD CLIP COHO SMOLTS	TOTAL COHO
FEB	10-16	2	1354	4.18	3	0	3	2	6	5	0	12	0	0	0	0	0
	17-23	3	1089	6.29	2%	0	20	4	10	7	0	21	0	0	0	0	0
	24-MAR 2	7	2280	7.90	37	0	37	0	6	8	1	15	0	3	0	0	3
MAR	3-Q	3	9299	1.39	3	0	3	0	13	21	0	34	0	0	0	0	0
	10-16	2	3566	2.08	2	0	2	0	22	15	0	37	1	0	0	0	1
	17-23	4	3593	1.91	4	0	4	0	6	0		7	0	0	2	1	3
	24-30	4	4287	1.83	2	0	2	0	4	2		7	0	0	1	0	1
	31 -APR 6	4	5456	1.43	3	0	3	0	1	2	0	3	0	0	1	0	1
APR	7-13	4	4167	1.54	5	0	5	0	1	2	10	13	1	0	1	0	2
	14-20	4	3197	2.49	16	0	16	0	13	2	15	30	1	0	0	0	1
	21-27	7	3150	2.39	16	0	16	0	3	10	12	25	2	0	0	0	2
	28-MAY 4	4	2734	2.83	12	0	12	0	6	6	53	65	0	0	2	0	2
MAY	5-11	4	2474	2.89	10	0	10	0	7	28	85	120	2	0	31	0	33
	12-18	4	2193	3.14	20	1	21	0	7	78	149	234	2	0	39	0	41
	19-25	4	2223	2.95	73	0	73	0	6	38	71	115	22	0	21	2	45
	26-JUN 1	4	3127	2.19	42	0	42		4	19	11	35	6	7	17	1	31
JUN	2-8	7	1973	3.60	962	74	1036	7	26	44	45	122	3	1	12	3	19
	9-16	6	1571	4.89	2923	236	3159	3	22	32	36	93	3	1	4	0	8
	16-22	4	1346	6.15	3643	219	3862	4	6	3	5	18	0	1	4	0	5
	23-29	4	1277	6.67	2985	153	3138	5	6	7	2	20	6	2	1	0	9
	30-JUL 6	4	1184	6.75	3727	151	3878	2	11	3	0	16	0	2	0	0	2
JUL	7-13	4	959	8.25	1204	27	1231	7		0	0	8	1	2	0	0	3
	14-M	4	896	8.75	977	37	1014	9	5	0	0	14	1	2	0	0	3
	21-27	4	785	10.00	697	33	730	8	3	3		15	1	0	1	0	2
	28 -AUG 3	4	670	11.62	565	30	595	5	4	6	0	15	1	1	1	0	3
AUG	4-10	4	618	12.36	242	9	251	2	8	7	0	17	0	0	0	0	0
	11-17	4	575	12.94	176	9	185	2	7	7	0	16	1	1	0	0	2
	18-24	4	555	13.07	240	11	251	0	3	4	0	7	0	0	0	0	0
	25-31	0	598														
SEP	1-7	0	696														
	8-14	0	538														
	15-21	1	520	13.37	44	4	48	0	2	0	0	2	0	0	0	0	0
	22-28	4	516	13.70	300	7	307	0	2	1	0	3	0	0	0	0	0
	29-oCT5	4	519	13.58	133	3	136	0	1	0	0	1	0	0	0	0	0
OCT	6-12	4	514	13.58	1260	232	1492	0	9	8	0	17	0	0	0	0	0
	13-19	6	512	15.32	2012	477	2489	0	11	5	0	16	0	1	0	0	1
	20-26	4	699	13.63	377	79	456	0	4	1	0	5	0	0	0	0	0
	27-NOV 2	4	719	11.34	94	5	99	0	17	17	0	34	0	0	0	0	0
NOV	3-9	4	636	12.72	61	8	69	2	3	2	0	7	0	0	0	0	0
	10-16	3	673	12.33	28	2	30	0	0	2	0	2	0	0	0	0	0
	17-23	4	1366	5.52	12	0	12	1	11	2	0	14	1	0	0	0	1
SPRING SUBTOTAL		117			18609	990	19599	61	216	359	498	1134	54	23	138	7	222
FALL SUBTOTAL		38			4321	817	5138	3	60	38	0	101	1	1	0	0	2
TOTAL		155			22930	1807	24737	64	276	397	498	1235	55	24	138	7	224

Appendix A (continued). Weekly abundance index estimates, Trinity Aver rotary trap, 1991.

WEEK	TRAP NIGHTS	NO CUP CHINOOK	AD CUP CHINOOK	ALL CHINOOK	STEELHD FRY	STEELHD PARR	NATURAL STEELHD SMOLTS	HATCHERY STEELHD SMOLTS	ALL STEELHD	COHO FRY	COHO PARR	NO CUP COHO SMOLTS	AD CUP COHO SMOLTS	TOTAL COHO
FEB 10-16	2	263	0	263	168	424	424	0	1016	0	0	0	0	0
17-23	3	744	0	744	159	380	264	0	803	0	0	0	0	0
24-MAR 2	7	484	0	484	0	79	109	11	199	0	44	0	0	44
MAR 3-Q	3	492	0	492	0	2198	3372	0	5570	0	0	0	0	0
10-16	2	336	0	336	0	3707	2527	0	6234	168	0	0	0	168
17-23	4	345	0	345	0	548	0	91	639	0	0	162	91	273
24-30	4	196	0	196	0	399	189	98	686	0	0	98	0	98
31 -APR 6	4	382	0	382	0	117	250	0	367	0	0	133	0	133
APR 7-13	4	494	0	494	0	88	173	870	1131	124	0	88	0	212
14-20	4	1110	0	1110	0	919	135	1062	2116	74	0	0	0	74
21-27	7	679	0	679	0	124	414	479	1017	63	0	0	0	83
26-MAY 4	4	744	0	744	0	371	369	3273	4013	0	0	123	0	123
MAY 6-11	4	606	0	606	0	422	1698	5128	7248	121	0	1685	0	2006
12-16	4	1108	54	1162	0	385	4330	8276	12991	112	0	2168	0	2280
19-25	4	4338	0	4338	0	357	2263	4218	6838	1300	0	1248	119	2667
26-JUN 1	4	3098	0	3098	86	298	1470	873	2727	473	639	1486	86	2684
JUN 2-8	7	22815	1747	24562	183	634	1245	1214	3276	71	42	420	78	611
Q-15	6	71790	5784	77574	78	555	790	884	2307	77	26	98	0	201
16-22	4	102121	6174	108295	112	168	86	142	608	0	30	110	0	140
23-29	4	78127	4002	82129	131	159	184	53	527	158	53	26	0	237
30-JUL 6	4	97053	3908	100961	51	287	79	0	417	0	51	0	0	51
JUL 7-13	4	25578	574	26152	149	21	0	0	170	21	42	0	0	63
14-20	4	19415	740	20155	180	98	0	0	278	21	37	0	0	68
21-27	4	12318	578	12896	144	53	51	18	266	18	0	18	0	36
28-AUG 3	4	8542	453	8995	75	60	91	0	226	16	16	16	0	48
AUG 4-10	4	3428	128	3556	28	114	98	0	240	0	0	0	0	0
11-17	4	2378	121	2499	26	95	95	0	216	14	14	0	0	28
18-24	4	3218	147	3365	0	40	54	0	94	0	0	0	0	0
25-31	0													
SEP I-7	0													
8-14	0													
15-21	1	2303	210	2513	0	105	0	0	105	0	0	0	0	0
22-28	4	3855	91	3946	0	26	12	0	38	0	0	0	0	0
29-OCT 5	4	1713	39	1752	0	12	0	0	12	0	0	0	0	0
OCT 6-12	4	16422	301 Q	19441	0	117	105	0	222	0	0	0	0	0
13-19	6	15483	3681	19164	0	88	37	0	125	0	8	0	0	8
20-26	4	4890	1038	5928	0	56	11	0	67	0	0	0	0	0
27-NOV 2	4	1479	81	1560	0	275	231	0	506	0	0	0	0	0
NOV 3-Q	4	837	110	947	28	42	28	0	98	0	0	0	0	0
10-16	3	632	37	569	0	0	37	0	37	0	0	0	0	0
17-23	4	396	0	396	39	376	56	0	471	39	0	0	0	39
SPRING SUBTOTAL	117	462202	24410	486612	1570	13100	20760	26690	62120	2851	994	8099	374	12318
FALL SUBTOTAL	38	47910	8306	56216	67	1097	517	0	1681		8	0	0	47
TOTAL	155	510112	32716	542828	1637	14197	21277	26690	63801	2890	1002	8099	374	12365

Appendix B. Total Weekly Catch (TWC) Estimates by species, Klamath and Trinity river rotary traps, 1991.

Klamath River rotary trap Total Weekly Catch estimates by species, 1991.

Week	Chinook captured	Chinook TWC	Steelhead captured	Steelhead TWC	Coho captured	Coho TWC
3/31 - 4/06	16	37	5	12	0	
4/07 - 4/13	20	35	10	18	0	0
4/14 - 4/20	12	21	9	16	6	11
4/21 - 4/27	8	14	9	16	0	0
4/28 - 5/04	13	23	3	5	0	0
5/05 - 5/11	19	33	14	25	0	0
5/12 - 5/18	22	39	2	5	2	4
5/19 - 5/25	9	16	9	16	13	23
5/26 - 6/01	14	33	2	5	1	2
6/02 - 6/08	46	81	5	9	3	5
6/16 - 6/22	292	681	25	58	5	12
6/23 - 6/29	534	935	6	11	1	2
6/30 - 7/06	985	3448	1	4	0	0
7/07 - 7/13	795	1397	17	30	1	2
7/14 - 7/20	70	490	1	7	0	0
7/21 - 7/27	17	60	0	0	0	0
7/28 - 8/03	50	88	6	11	0	00
9/15 - 9/21	2	14	0	0	0	0
9/22 - 9/28	1	2	4	9	0	0
9/29 - 10/05	8	28	0	0	0	0
10/06 - 10/12	2	7	0	0	0	0
10/13 - 10/19	5	18	1	4	0	0
10/20 - 10/26	56	98	0	0	0	0
10/27 - 11/02	29	51	16	28	0	0
11/03 - 11/09	47	82	3	5	0	0
11/10 - 11/16	66	154	2	5	0	0
11/17 - 11/23	147	343	19	44	7	16
11/24 - 11/30	216	378	12	21	2	4
12/01 - 12/07	482	844	24	42	0	50
12/08 - 12/14	335	586	27	47	3	5
12/15 - 12/21	147	257	6	11	0	0

Trinity River rotary trap total weekly catch estimates by species, 1991.

Week	Chinook captured	Chinook TWC	Steelhead captured	Steelhead TWC	Coho captured	Coho TWC
2/10 - 2/16	3	11	12	42	0	0
2/17 - 2/23	20	47	21	49	0	0
2/24 - 3/02	37	37	15	15	3	3
3/03 - 3/09	3	7	34	79	0	0
3/10 - 3/16	2	7	37	130	1	4
3/17 - 3/23	4	7	7	12	3	5
3/24 - 3/30	2	4	7	12	1	2
3/31 - 4/06	3	5	3	5	1	2
4/07 - 4/13	5	9	13	23	2	4
4/14 - 4/20	16	28	30	53	1	2
4/21 - 4/27	16	16	25	25	2	2
4/28 - 5/04	12	21	65	114	2	4
5/05 - 5/11	10	18	120	210	33	58
5/12 - 5/18	21	37	234	410	41	72
5/19 - 5/25	73	128	115	201	45	79
5/26 - 6/01	42	74	35	61	31	54
6/02 - 6/08	1036	1036	99	99	19	19
6/09 - 6/15	3158	3684	93	109	8	9
6/16 - 6/22	3862	6759	18	32	5	9
6/23 - 6/29	3138	5492	20	35	9	16
6/30 - 7/06	3850	6738	16	28	2	4
7/07 - 7/13	1231	2154	8	14	3	5
7/14 - 7/20	1014	1775	14	25	3	5
7/21 - 7/27	730	1278	15	26	2	4
7/28 - 8/03	595	1041	15	26	3	5
8/04 - 8/10	251	439	17	30	0	0
8/11 - 8/17	185	324	16	28	2	4
8/18 - 8/24	251	439	19	12	0	0
9/15 - 9/21	48	266	22	14	0	0
9/22 - 9/28	307	537	3	5	0	0
9/29 - 10/05	136	238	1	2	0	0
10/06 - 10/12	1492	2089	17	24	0	0
10/13 - 10/19	2489	2904	16	19	1	1
10/20 - 10/26	1385	798	5	9	0	0
10/27 - 11/02	99	173	32	56	0	0
11/03 - 11/09	69	121	7	12	0	0
11/10 - 11/16	30	70	2	5	0	0
11/17 - 11/23	12	21	14	25	1	2

Appendix C. Klamath River basin salmonid release information upstream of trapping operations, 1991.

Iron Gate Hatchery

species	race	brood year	tag code	#/pound average	# tagged	# poor tag	# not tagged	production multiplier	release site
coho		1989	06-63-20	16	23,051	2,849	88,144	4.947	
			06-63-23	16	18,805	2,324	88,255	5.816	
chinook	fall	1990	0601020105&	179	91,075	8,569	4,993,714	55.925	IGH
			0601020106&		95,629	8,998		1.094	IGH
			06-63-26		1,891	178		1.094	IGH
chinook	fall	1990	06-63-24	7	37,655	2,042	40,642	2.134	Indian ck
chinook	fall	1990	06-63-27	7	31,807	4,752		1.149	Elk ck
chinook	fall	1990	06-57-03	8	95,880	3,620	894,120	10.363	IGH

Trinity River Hatchery

species	race	brood year	tag code	#/pound avg.	# tagged	# poor tag	# not tagged	production multiplier	release site
coho		1989	06-56-601	11	51,088	551	576,651	12.298	TRH
chinook	spring	1990	0601040103	76	196,908	7,716	1,634,917	9.342	TRH
chinook	spring	1990	06-56-36&	10	46,086	2,328	505,623	12.022	TRH
		1990	06-56-40	10	48,553	5,909	505,623	11.535	TRH
chinook	fall	1990	06-56-38	11	103,040	8,243	540,870	6.329	TRH

CDFG - Natural Stocks Assessment

species	race	brood year	tag code	#/pound average	# tagged	# poor tag	# not tagged	production multiplier	release site
chinook	1/	1990	0601080112	227	19,090	495	2/	2/	Steelbridge
chinook	1/	1990	0601080113	151	26,741	383	2/	2/	Sky Ranch (day release)
chinook	1/	1990	0601080114	151	27,034	1,014	2/	2/	Sky Ranch (night release)

1/ These groups may include both Spring and Fall chinook.
2/ These fish are natural stocks, captured in-river. No untagged number or P.M. is available

(Data obtained from: Pacific States Marine Fisheries Commission, 1991)