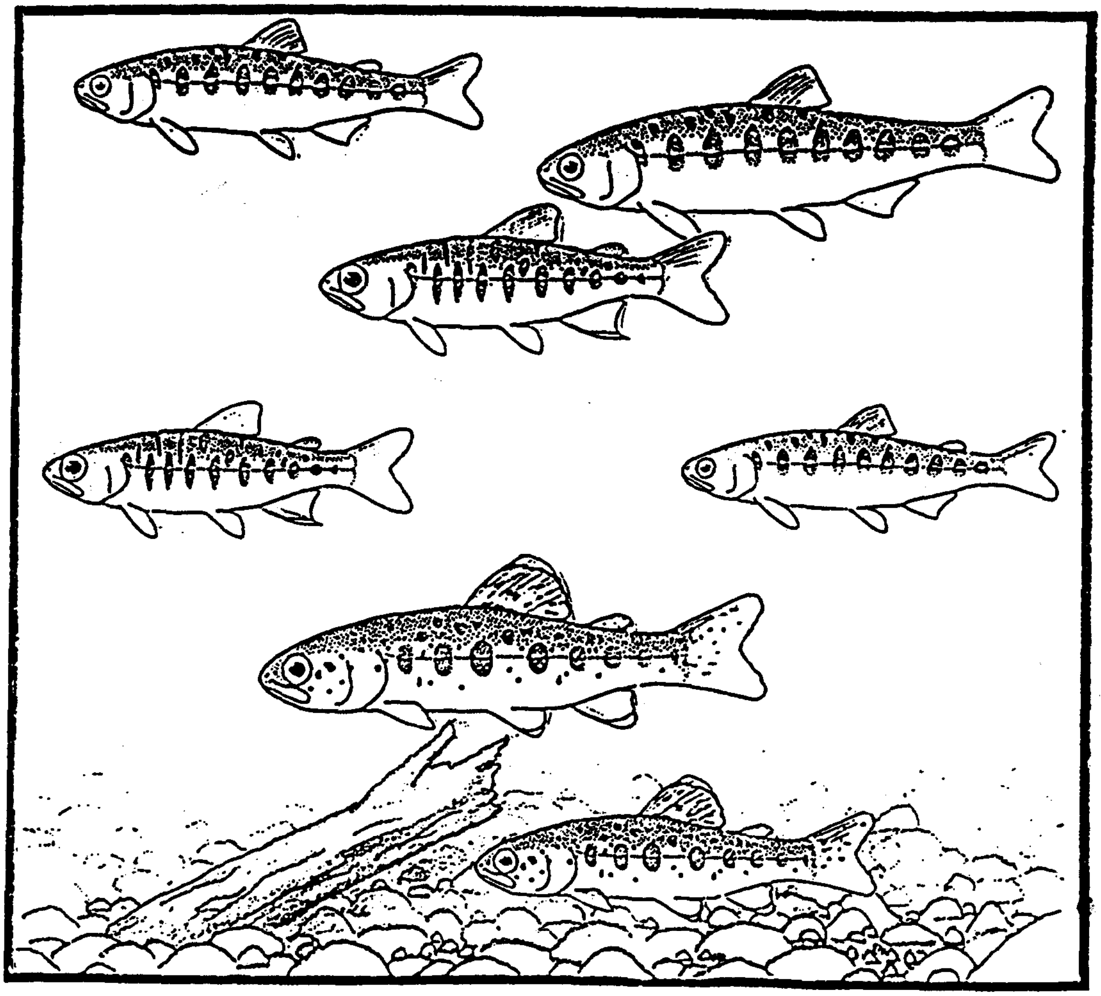
KLAMATH RIVER FISHERIES ASSESSMENT PROGRAM

KLAMATH RIVER BASIN
JUVENILE SALMONID FISHERIES INVESTIGATION

Coastal California Fishery Resource Office
Arcata, California
Region 1

Annual Report FY 1989
March 1991



ANNUAL REPORT

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KLAMATH RIVER BASIN JUVENILE SALMONID FISHERIES INVESTIGATION

1989

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ABSTRACT

This report details the second year of Klamath River basin juvenile salmonid fishery investigations and represents the first year of sampling with rotary screw traps. The rotary screw trap on the Klamath River at Big Bar (rkm 81) operated three to seven nights a week from April 12 to July 17, 1989, sampling a total of 76 nights. A total of 3,660 chinook salmon (Oncorhynchus tshawytscha), 153 steelhead (O. mykiss), and 69 coho salmon (O. kisutch) were captured. Peak weekly chinook catch, as an indicator of peak emigration, occurred the week of June 26 to July 2. A total of 53 (1.45%) AD-clip chinook were captured. A contribution of 1,757 (48%) hatchery chinook and 1,903 (52%) natural stock chinook was estimated for the total chinook captured. Mean migration rate for IGH chinook smolts was 10.7 (rkm/day) and 4.0 (rkm/day) for pre-smolts. The chinook abundance index calculated for the entire trapping period was 260,000. The Trinity River rotary trap at Willow Creek (rkm 38) operated three to seven nights a week from April 4 to August 4, 1989, sampling a total of 81 nights. A total of 37,377 chinook salmon, 1,788 steelhead, and 1,261 coho salmon were captured. Peak chinook emigration occurred the week of June 19 to June 25. A total of 1,663 (4.45%) AD-clip chinook were captured. A contribution of 19,877 (53%) hatchery chinook and 17,500 (47%) natural stock chinook was estimated for the total chinook captured. Mean migration rate for TRH spring chinook was 5.8 (rkm/day) and 14.0 (rkm/day) for TRH fall chinook. Based on trap efficiencies, we calculated that 1,482,000 chinook emigrated past the trap site during the study period. Chinook abundance index calculated for the same time period was 927,000. Klamath River mainstem seining was conducted from rkm 9.5 to 26.2, sampling 2 to 3 days a week from May 30 to July 13, 1989. During this period a total of 3,637 chinook salmon were captured in 121 seine hauls for a season mean C/E of 30.1 chinook per seine haul. Greatest weekly mean C/E values occurred the weeks of June 19 to June 25 (63.9 chinook per seine haul), and the week of June 26 to July 2 (59.2). A total of 151 (4.15%) AD-clip chinook were captured. A contribution of 1,540 (42%) hatchery chinook and 2,097 natural stock chinook was estimated for the total chinook captured. Migration rates of IGH and TRH chinook did not differ appreciably from rates calculated at upstream rotary traps. During the seining period, a total of 42 steelhead and 14 coho salmon were also captured. Klamath River estuary seining was conducted one day per week from July 19 to September 20, 1989. A total of 939 chinook salmon, 338 steelhead, and five cutthroat trout (O. clarki) were captured. Highest chinook C/E values (89.0) occurred on August 1. A total of 10 (1.06%) AD-clip chinook were captured during the sampling period. The observed AD-clip rate was lower than observed at the rotary screw traps and with mainstem seining. Mean length (mm) of all chinook captured in the estuary was significantly larger ($p<0.05$) than the mean length of all chinook captured at rotary screw traps and during mainstem seining.

INTRODUCTION

Within the Klamath River basin, federal, tribal and state programs have monitored the in-river harvest levels, spawning escapement and upstream migration of adult fall chinook salmon. These programs have provided information concerning returning adults which is utilized to manage the harvest and estimate the return of fall chinook salmon to the Klamath and Trinity Rivers. While this information is necessary to provide proper management of the resource, the ability to predict yearly variations in stock strength is diminished without knowledge of the factors affecting juvenile production.

Most information on chinook salmon juvenile life history within the Klamath River basin has come from limited natural stock assessment and production studies initiated by the California Department of Fish and Game (CDFG) in 1984 (Mills, T., personal communication). This work has been conducted within the tributaries of the upper Klamath River basin (Shasta, Scott, and Salmon rivers, and Bogus Creek), the Trinity River mainstem and tributaries (South Fork, North Fork, Canyon Creek), and in the Klamath River estuary. In addition to the natural production studies there is a need to evaluate migrational characteristics and survival of salmon and steelhead released from Iron Gate Hatchery (IGH) and Trinity River Hatchery (TRH), as well as from hatchery supplementation programs. The U.S. Fish and Wildlife Service (Service) initiated a juvenile salmonid monitoring program on the mainstem Klamath and Trinity Rivers during the spring of 1988 and continued monitoring during the spring of 1989. Additionally, an estuary sampling effort focusing on juvenile chinook salmon was continued in 1989 to complement the work by CDFG. The objective of these monitoring efforts was to gather additional information on out-migration timing, size and abundance, wild and hatchery components, residence time, timing of ocean entrance, and to develop a juvenile chinook population index.

Added importance has been placed on monitoring the Klamath River chinook production by the recent decision to allow 35% of a given brood years natural production to spawn, while 65% of the natural production may be harvested by the various ocean and in-river user groups (Pacific Fisheries Management Council 1989). It has been determined that this level of escapement is necessary to achieve maximum sustainable yield for the natural stocks of the Klamath River Basin.

Toward this end, the Service plans to continue monitoring juvenile production on an on-going basis to complement the restoration efforts of the Trinity River Basin Fish and Wildlife Management Program (P.L. 98-541) and the Klamath River Fish and Wildlife Restoration Act (P.L. 99-552).

METHODS

Klamath and Trinity River Trapping

Four locations were selected as suitable trapping sites (Figure 1). These sites afforded convenient access and the channel morphology was thought to be conductive towards efficient trapping throughout the anticipated range of river flows. Two of the 1989 sampling locations (Klamath River at river kilometer (rkm) 81, and Trinity River at rkm 38) were also used in juvenile salmonid investigations conducted in 1988 (USFWS 1989). Trapping in 1989 began at all sites in April. Trapping on the lower Klamath (rkm 13 and 14) was discontinued in May, 1989 due to equipment problems. Trapping at the upper Klamath site (rkm 81) was continued until July 17, 1989. The Trinity River trap (rkm 38) continued operation until August 4, 1989. Rotary screw traps (2.44m diameter) were used at all sites. The traps were fished to a depth of 1.22m sampling 2.34m^2 of river. The traps were positioned adjacent to, or in the thalweg. The traps were secured into position with 2.54 cm. polypropylene rope tied to available trees adjacent to the river or tied to a system of fence post anchored along the bank. Traps were re-positioned as necessary by adjusting rope length to accommodate varying river stages and to allow trapping at depths greater than 1m.

The traps were operated overnight and checked the following morning. Captured fish were identified to species, salmonids were anesthetized with Tricaine methane sulfonate (MS-222), measured to fork length (mm), and identified to developmental stage (0^+(fry), parr, smolt). Fork length measurements were taken on a maximum of 50 salmonids per species per day. Fish that were silver in color, lacked parr marks, and had loose scales were classified as smolts regardless of size. Delineating between parr and fry was subjective and largely based on size. Generally, fish 65mm and less were believed to be young-of-year fry and all larger fish parr. Captured chinook and coho were examined for presence of an adipose fin clip (AD-clip). Fish with AD-clips were sacrificed and retained for subsequent recovery of the coded-wire-tag (CWT). All rainbow trout were assumed to be the anadromous form (steelhead). Since hatchery (spring release) steelhead were unmarked in 1989 (Appendix A), they were identified to origin (wild or hatchery) based on the condition of the dorsal fin (Peven and Hays 1986). In this study, we define naturally-produced or wild fish as progeny of river or tributary spawning adults regardless of parent genetics (Bjornn 1977). To develop an index of condition, displacements were taken opportunistically on measured fish. Body volume, being proportional to weight, was used as a substitute measure (Anderson and Gutreuter 1983). The use of ordinary least-squares regression parameters was proposed by Cone (1989) as the appropriate method for evaluating the weight-length relationship and was used here.

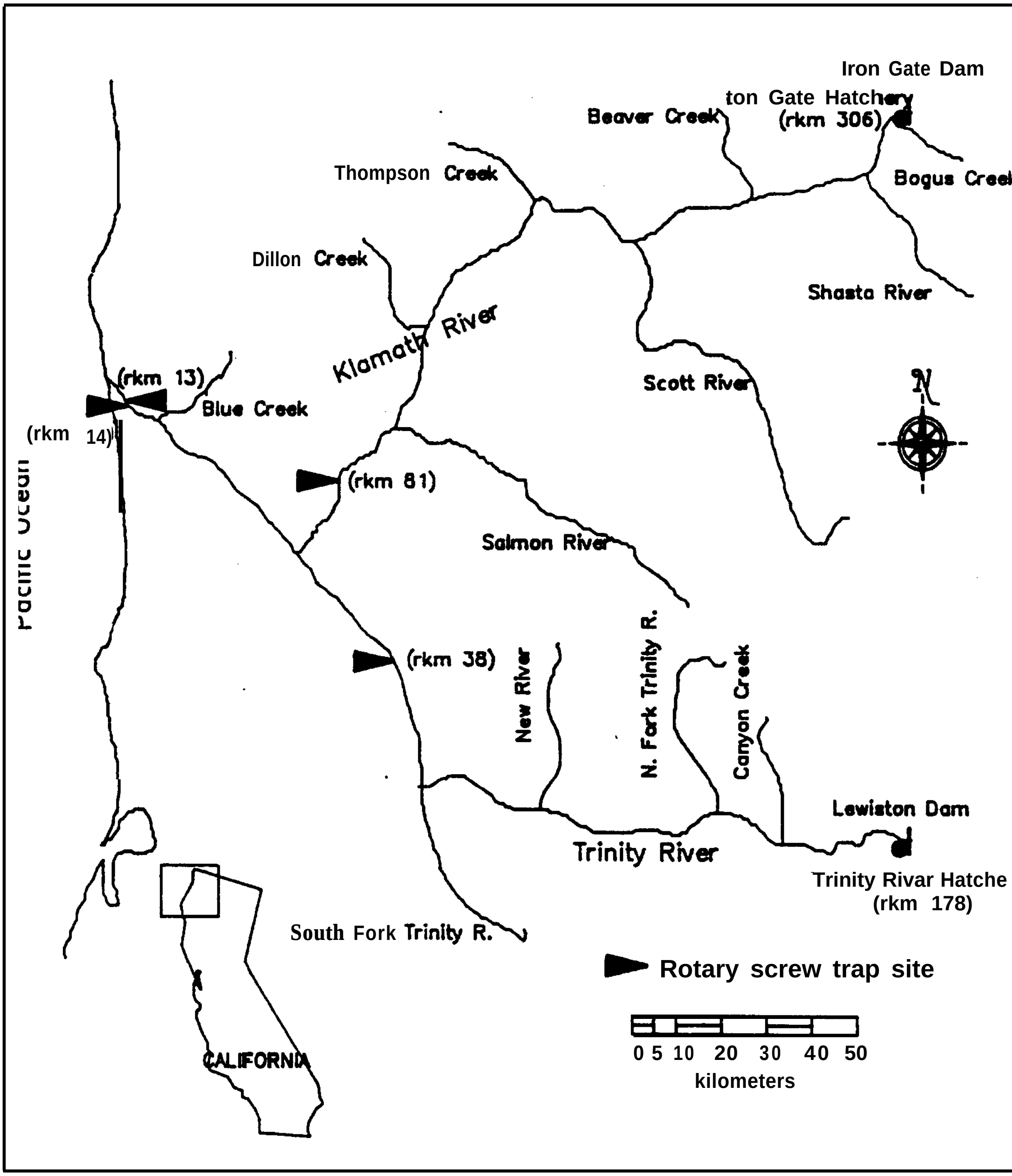

Figure 1. Rotary screw trap sites, Klamath and Trinity River, 1989.

Emigration Monitoring

Emigration trends were evaluated weekly based on catch effort (C/E) values calculated as total catch per species divided by the number of days sampled, expanded when necessary, for the entire seven-day week. A catch week began on Monday and ended Sunday, usually sampling at least four nights per week.

Hatchery and Natural Stock Estimate

The estimate of hatchery and natural stock chinook in catches was determined using tagging rates and CWT recoveries, specific to each CWT group, and is described by the equations:

$$H=(C/B)xE \text{ and } N=(T-H)$$

where H = estimated hatchery chinook in catch
B = number of hatchery chinook tagged (CWT) and released
C = total hatchery chinook released (tagged + untagged)
E = number CWTs recovered + (partitioned CWTs)
N = estimated natural stock chinook in catch
T = total chinook in catch

Partitioned CWTs were calculated as follows: lost tags, no tags (shed), and AD-clip chinook not returned to the lab for tag retrieval were assigned a tag code based on the daily CWT recovery rate for each tag group. In addition, a proportion of the chinook not sampled for marks (non-mark sampled), were assigned AD-clip designation based on the observed AD-clip rate with fish sampled that day. These non-sampled AD-clip chinook were then assigned a tag code based on the daily CWT recovery rate observed with each tag group.

The estimate assumes no differential mortality between tagged and non-tagged hatchery chinook and assumes equal vulnerability to capture between hatchery and natural stock fish. Where recoveries were sufficient, weekly contribution estimates were determined. It was assumed that all chinook captured in weeks preceding hatchery releases were of natural origin. The estimate does not account for AD-clips removed from the population at upstream sample locations by this office, and the Service office in Weaverville, since the number of AD-clip chinook removed is negligible compared to the number released.

Migration Rate and Duration

The initial migration rate was expressed as the number of days elapsed between release and initial capture divided by rkm traveled for specific CWT chinook release groups. Mean migration rate was calculated similarly using the median capture date (the date on which 50% of specific CWT chinook group had been captured).
The duration of migration was computed as the number of days between the 10% and 90% dates of capture (Fish Passage Center, 1985). The 10 and 90 percent capture dates are used to illustrate when the bulk of the specific CWT groups migrated.

Trap Efficiency

Initially, salmonids were captured with frame nets (1.52m x 3.05m x 8.5m) to provide fish for determining trap efficiency using mark-recapture methodologies. However, captures of salmonids were too low and infrequent and the use of frame traps was discontinued. The rotary screw traps generally provided a sufficient number of salmonids to determine trapping efficiencies.

Two methods of marking were used to determine efficiencies. Initial mark-recapture determination used fluorescent grit dye sprayed with a sandblast gun to mark fish (Phinney et.al. 1967). The gun was hooked to a compressed air tank regulated to 8.8 kg/cm^2 pressure. Approximately 50 dyed and 50 non-dyed fish were retained in live boxes to assess dye retention and delayed mortality. The remaining dyed fish were released in the late afternoon 500m upstream from the rotary screw trap. All salmonids subsequently caught in the rotary screw trap were individually passed through a viewing box illuminated with black lights. Examination of rotary screw trap captured salmonids for dye continued for approximately one week or until dyed control fish were not distinguishable. The second method used to mark salmonids was staining with Bismark Brown Y (Mundie and Traber 1983). Bismark Brown Y (48% concentration) powder was diluted to achieve an 1:102,000 solution by using 2 grams of the stain mixed with 94.6 liters of water. Fish were held in the aerated stain solution for 30 - 60 minutes. Fifty stained and 50 non-stained were retained in live boxes to assess stain retention and delayed mortality. All remaining stained fish were released in the late afternoon 500M upstream from the trapping site. Examination of trapped salmonids for stain continued for approximately one week or until stain was not evident in stained control fish.

Chinook Abundance Index

The chinook abundance index was based on the proportion of river volume sampled to total river volume multiplied by the number of chinook captured. The index was calculated for each day sampled. The weekly index estimate was simply an expansion of calculated daily index values by the proportion of days sampled for that week. The index is used to describe relative chinook abundance and is not intended as a population estimate. During the trapping season the rotary screw trap was occasionally repositioned to adjust for changing (normally decreasing) flow conditions. These position modifications were necessary to maintain what was considered to be the optimal "fishing" location at the trap site. Most position changes were on the order of a few meters away from the bank and closer to, or within, the thalweg. The index, assuming similar trapping methods, with particular regard to maintaining optimum "fishing" location at a site, will allow for comparisons of relative chinook abundance between years.

Flow and Water Temperature

Water velocity measurements were recorded within the rotary screw trap opening using a General Oceanics digital flowmeter (Model 2030). Flow velocities were taken daily using established instream flow criteria (.2 and .8 of water column depth) at center of trap mouth. River flow information was provided by the U.S. Geological Survey Water Resources Division from gauge stations at (rkm 94.7) for the Klamath River and at (rkm 19.8) for the Trinity River.

In addition to daily temperatures recorded with hand-held thermometers, Ryan Tempmentor thermographs were installed at both the upper Klamath River and Trinity River rotary screw trap sites. The thermographs were affixed to the rotary screw trap live box at both sites on June 2, 1989 and recorded ambient water temperatures every two hours until removed on October 17, 1989.

Mainstem Seining

A 30.5m x 3.5m x 7.9mm delta mesh (3.2mm bag mesh) beach seine was set by hand to capture salmonids. The net was pulled downriver along the shoreline for about 90 meters. At least one seine haul was conducted at each site. If a set was fouled by debris or encountered other problems a second set was made upstream from the initial set site and fish captured in the first (fouled) set were not used in analysis. Captured fish were identified to species, salmonids were anesthetized with MS-222, measured for fork length, identified to developmental stage, and examined for fin clips. Ad-clipped salmonids were sacrificed for later CWT recovery.

The lower Klamath River (rkm 9.5 through 26.2) was sampled 2 to 3 days per week, beginning May 30, 1989 and ending July 13, 1989. Initial seining efforts identified ten suitable sampling sites (Figure 2). Sites were chosen on the basis of water velocity, depth, and channel morphology which allowed for efficient seining. Due to time constraints, all sites could not usually be sampled in one day. Generally, seining began at the lowest sample site (rkm 9.5) and progressed upstream. Areas not sampled the first day were sampled the following day(s) until the upstream most site (rkm 26.2) was sampled.

Relative abundance of salmonids was described by catch and catch effort. Catch per unit effort must be used with caution as biases can influence data. Changes in physical characteristics and environmental conditions at seining locations can influence efficiency of sampling gear. All effort was made, however, to maintain consistency in sampling effort and minimize bias.

CWT chinook migration rates and duration, as well as contribution estimates of hatchery and natural chinook, were determined as before. However, to avoid generating rates for each sampling location, a mean location (rkm 17.8) was used. In addition, contribution estimates were generated for the sampling period in whole, and not on a weekly basis.

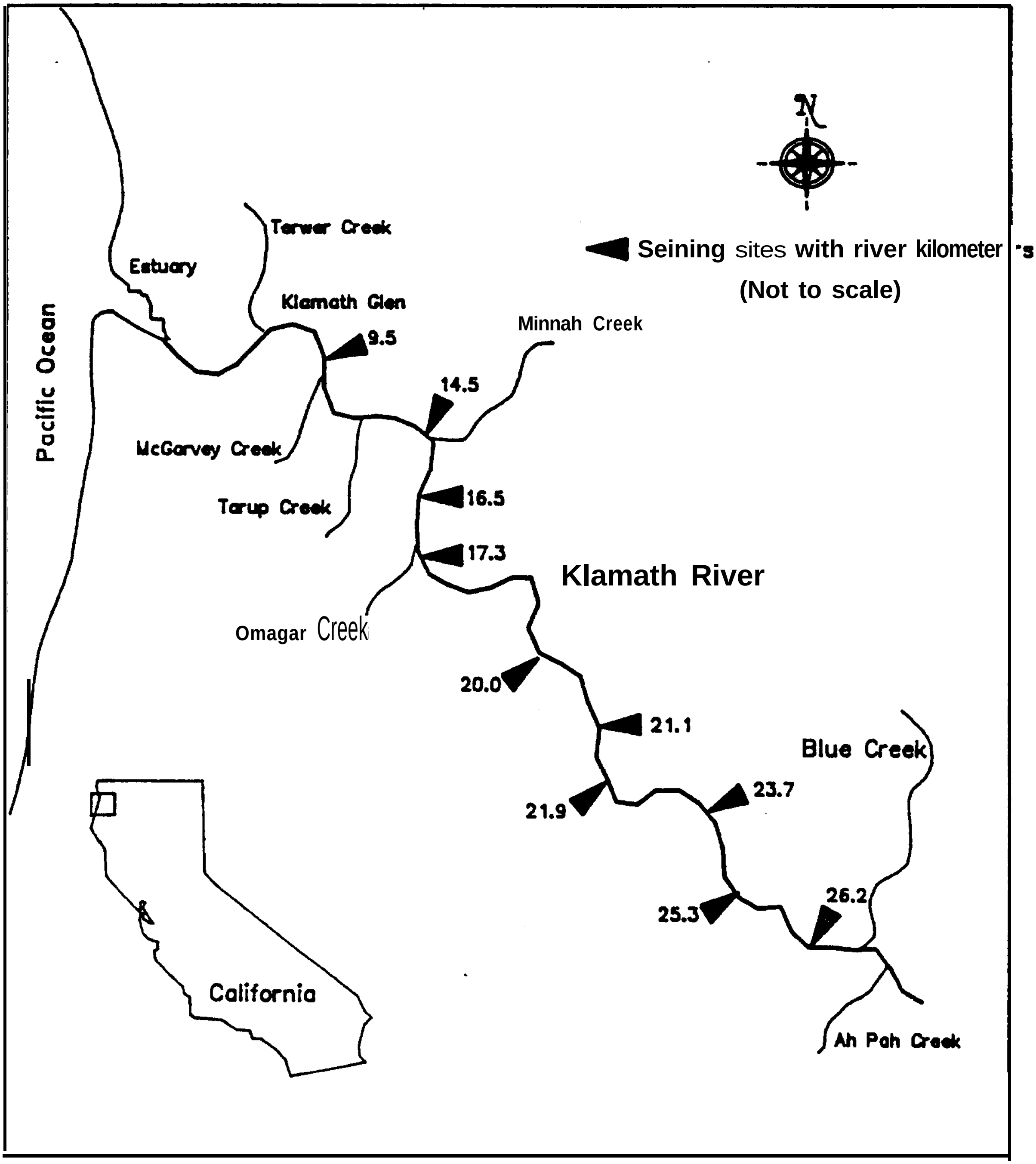

Figure 2. Lower Klamath River seining sites, 1989.

Estuary Seining

The Klamath River estuary (rkm 0) was sampled one day per week, beginning on July 19, 1989 and ending on September 20, 1989. Seining times ranged from 0630 hrs. to 1300 hrs. Up to eight seine hauls were made in shoreline areas devoid of large rocks, snags and other obstacles. Various sites were seined randomly in an effort to maximize capture of juvenile chinook. A 76.2m x 3.1m x 10mm delta mesh (2.5mm delta mesh bag) seine net was deployed with a Valco jet boat and manually pulled to shore. Captured fish were identified to species, enumerated, and released. Salmonids were anesthetized with MS-222, measured to fork length (mm) and examined for fin clips prior to release. Fork lengths were taken on a maximum of 50 chinook per haul. Salmonids with AD-clips were sacrificed for later removal of CWT. In addition, chinook salmon were placed in a graduated cylinder to determine their volumetric displacement, in order to obtain information on relative condition factors.

RESULTS AND DISCUSSION

KLAMATH RIVER TRAP(S)

The rotary screw trap at Big Bar (rkm 81) operated from April 12 to July 17 sampling a total of 76 nights. Chinook salmon were the most abundant salmonid captured (3,660) followed by 153 steelhead and 69 coho salmon. The two rotary screw traps located on the lower Klamath River (rkm 13 and 14) operated from April 17 and 19 to May 12 and 16, sampling a total of 15 and 16 nights, respectively. The limited sampling effort of these two traps was due to frequent clogging with large woody debris resulting in trap failures. Due to the curtailed sampling, the data collected is of limited use and will be used for comparative purposes only.

Chinook Salmon Emigration

Catches of juvenile chinook, relatively low in April and May, began a dramatic increase the week of June 5 - 11 (Figure 3). Catches, and weekly C/E values, continued to increase throughout June, with a peak weekly catch (1,477, mean daily C/E=211) occurring the week of June 26 - July 2. The greatest single-night catch (513) occurred June 26. Weekly catches declined rapidly after this time until mid-July when catches were similar to those before June. Trapping was discontinued on July 17 due to an increasing river load of filamentous algal mats which, in combination with increasing water temperature, contributed to a high rate of mortality on the few entrained salmonids.

The emigration of hatchery chinook contributed to the dramatic increase in catches the second week of June. However, based on AD-CWT recoveries and respective tagging rates, it is apparent that hatchery chinook alone did not account for all chinook captured during this emigration period (see Hatchery and Natural Stock Estimate). Hillman and Mullan (1989) found that releases of hatchery-reared chinook salmon "pulled" 38 to 78% of natural stock chinook downstream as the hatchery fish emigrated. In addition, they determined that the larger the release, the greater the percentage of natural stock chinook emigrating from the study stations.

Considering that over ten million chinook were released from IGH during this study period, it seems likely that hatchery releases could be influencing natural stock movement.

The influence of emigrating hatchery chinook may not be limited to natural stock chinook and may in fact partially explain emigration patterns among different hatchery release groups as well. While discussed later in this report (see Migration Rate and Duration), it is noteworthy to mention that the capture of AD-CWT pre-smolt chinook ("B-series") released from IGH April 24, coincided with the capture of AD-CWT smolt chinook ("6-series") which were released thirty-nine days later.

Although river flow, water temperature, and lunar phase undoubtedly effect emigrations to a degree, there was no apparent relationship between these factors and catches (Figure 3). Bjornn (1971) found no definitive relationship between onset of smolt emigration and temperature, food availability, flow, amount of cover, or fish densities and concluded that photoperiod and perhaps growth initiated physiological and behavioral changes associated with seaward migration. Given the substantial distances involved between IGH and the rotary trap, and the combinations of factors encountered by emigrating populations, it was not unexpected that no relationship was observed between any single factor and catches.

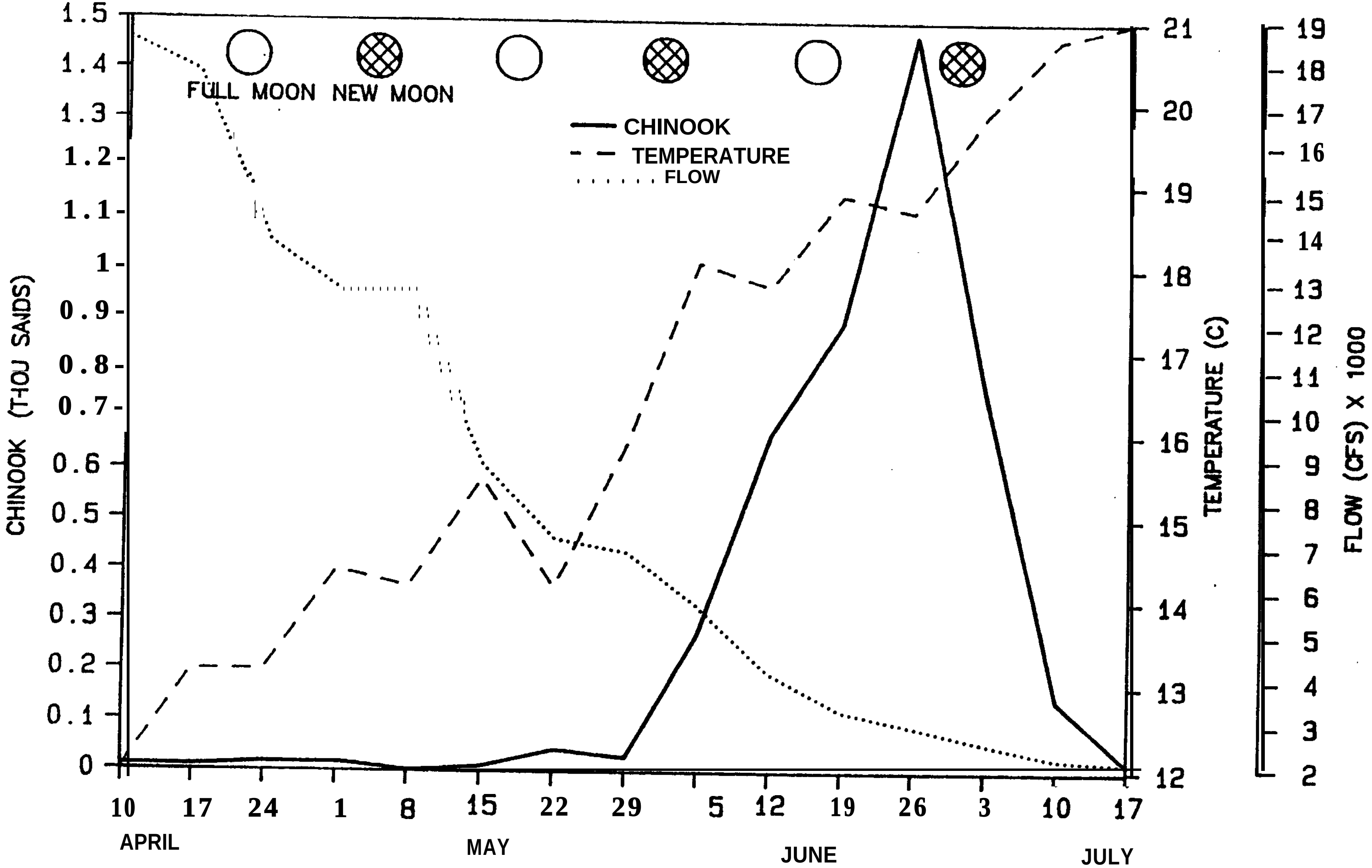

Figure 3. Chinook catch, flow, temperature, and lunar phase, Klamath River, 1989.
Catches represent seven day total based on weekly catch effort.

Chinook Size, Development, and Condition

During the trapping season, 1,015 chinook were measured. During April and May, fry-size chinook (range 25-60 mm) predominated in catches (Figure 4). It is believed that the capture of these fry does not constitute emigration but rather localized migrational behavior. Richards and Cernera (1989) reported that naturally spawned chinook did not disperse far from areas of emergence generally establishing residency in a relatively localized reach (1-2 rkm). Both Red Cap Creek and Boise Creek, located upstream within 8 rkm of the trap site, were identified as natural chinook spawning streams and in addition, Red Cap Creek has been used for artificial propagation (40,000 fall chinook capacity), and hatch box rearing (U.S. Dept. of Interior 1985). No attempt was made in this study to determine what component of the captured fry were the result of tributary spawning or mainstem spawning.

Mean weekly fork length increased significantly ($p<0.05$) the week of June 5 - 11 (Table 1). The increase in mean fork length reflects the onset of chinook smolt emigration and coincides with the first captures of AD-CWT chinook. Weekly mean fork length of AD-CWT ("B-series" and "6-series") did not significantly differ ($p<0.05$) from the weekly mean fork length of all other chinook in five of six weeks compared.

Though masked by the preponderance of larger chinook (smolts) in June and July, captures of fry-size chinook continued, although less frequent than observed in April and May. The occurrence of the fry indicates a degree of natural production locally and suggest a wide time range of spawning which may be related to variable life history strategies (ie: later spawning stocks).

Yearling-size chinook (fork length >120mm) were rarely captured which may indicate that emigration had already occurred. Hatchery yearling chinook are generally released in the fall and probably reach estuarine or ocean environments before the spring trapping season began. Avoidance is not believed to be a factor as yearling-size coho salmon and steelhead were captured regularly during their respective emigration periods.

Chinook generally fell into either of two developmental categories: young-of-year fry and smolts. Although IGH released pre-smolt chinook in April, at the time of capture in June, smoltification appeared to be complete.

As a measure of condition, displacements were taken on 168 of the chinook measured (Figure 5). Displacements were taken on chinook throughout the observed range of fork lengths and throughout the season and are believed to be representative. The calculated least-squares regression slope value (3.12) indicates a presumably better condition for Klamath River chinook than slope value indicated for Trinity River chinook (2.86) (Appendix B). However, this finding conflicts with general observations made by field crews who noted an overall poorer health quality with many of the Klamath River chinook. Many of the captured Klamath River chinook, randomly netted from the live box and sampled, exhibited a condition of swelling or edema. These fish were not selected out of the 50 fish daily sample. Although no definitive disease assessment was done, this condition was prevalent among many of the chinook captured and must be considered as having contributed to the greater slope value. The prevalence of this condition increased towards late June at which time nearly 25% of chinook examined had some type of swelling or edema. No attempt was made to differentiate between natural and non AD-clip hatchery chinook at the time of sampling and it is therefore unknown whether the condition is specific to, or widespread between natural and/or hatchery chinook.

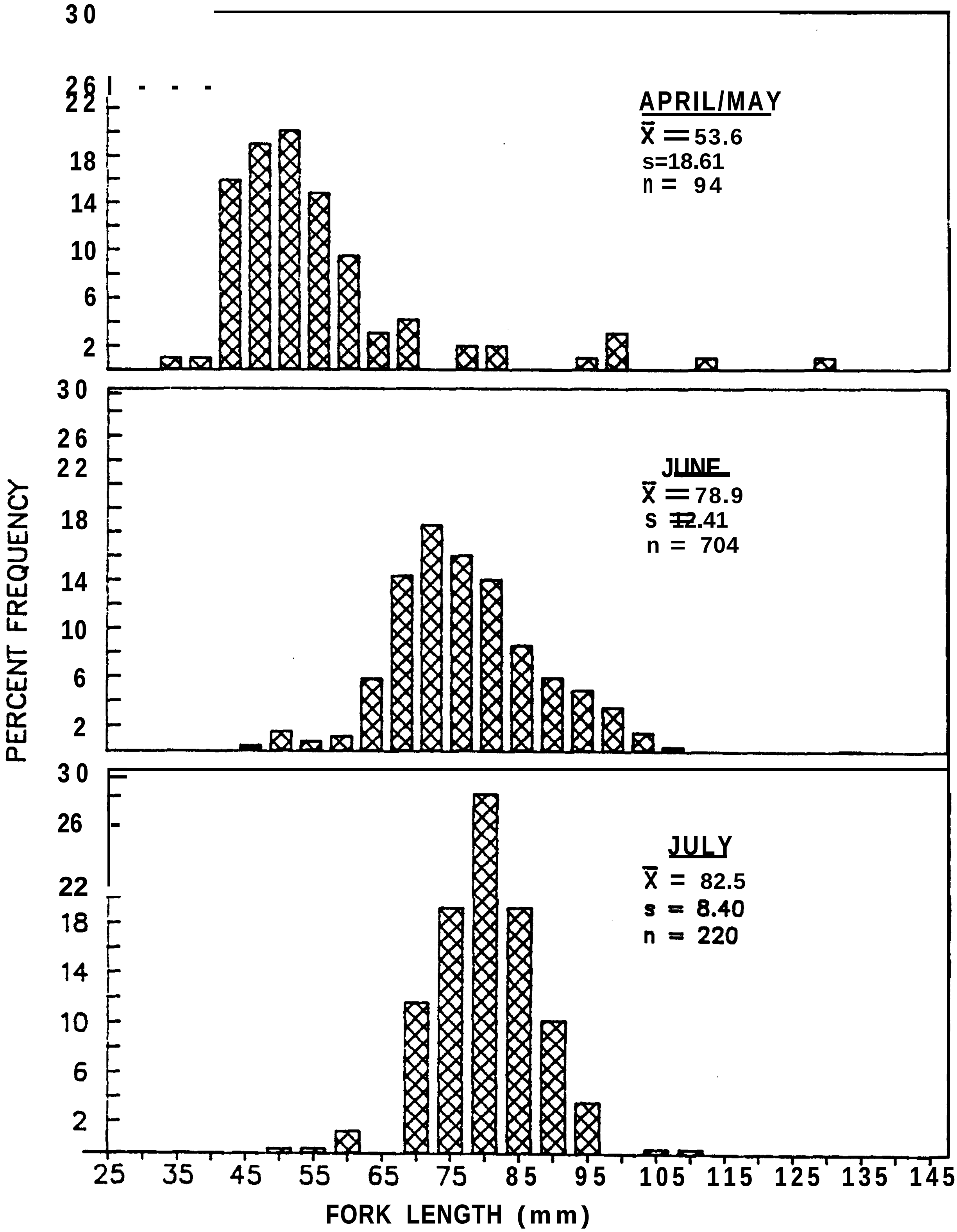

Figure 4. Chinook fork length percent frequency by month, Klamath River, 1989

Table 1. Weekly mean lengths of non AD-clip chinook and AD-clip chinookwithtest for significant difference (p=0.05), Klamath River, 1989.

All chinook captured				AD-CWT chinook captured							
				B-series tags			t-test sig dif	Six-series tags			t-test sig dif
Date	n	Mean fl.	s	n	Mean fl.	s	y/n	n	Mean fl.	s	y/n
4/12-4/16	5	47.8	2.17	0				0			
4/17-4/23	6	46.8	8.11	0				0			
4/24-4/30	15	52.1	25.04	0				0			
5/01-5/07	17	42.5	4.68	0				0			
5/08-5/14	1	117.0	0.00	0				0			
5/15-5/21	12	62.0	21.21	0				0			
5/22-5/28	31	58.3	17.27	0				0			
5/29-6/04	12	64.3	24.38	0				0			
6/05-6/11	153	85.9	17.81	0				1	81.0	0.00	
6/12-6/18	95	79.4	11.70	5	78.2	12.60	n	4	76.5	6.56	n
6/19-6/25	251	77.8	9.00	0				6	76.5	10.05	n
6/26-7/02	247	76.4	7.85	4	74.8	5.19	n	18	71.8	7.30	y
7/03-7/09	100	81.8	8.52	0				5	74.8	7.56	n
7/10-7/16	70	84.1	7.95	0				0			

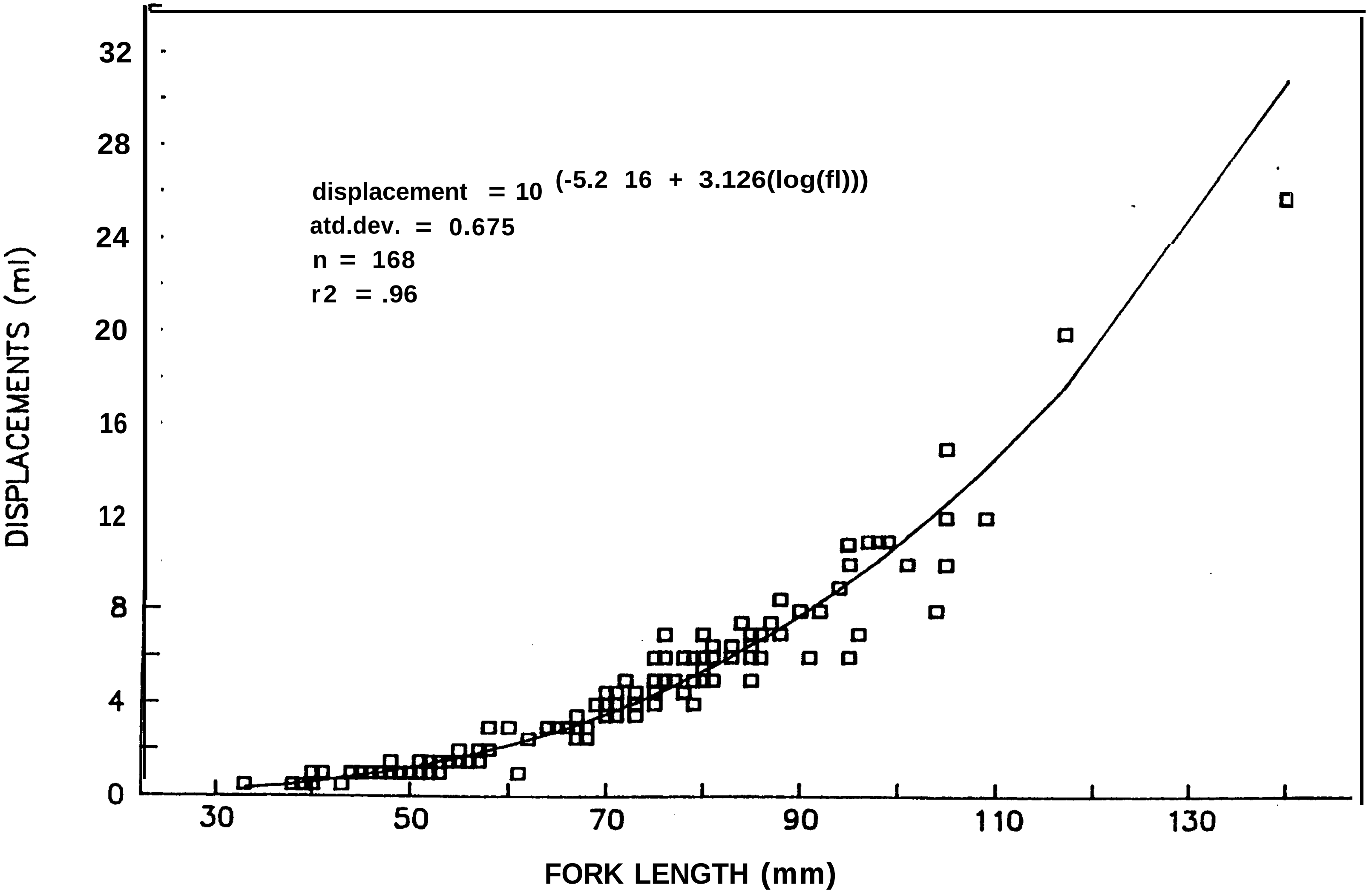

Figure 5. Chinook length-displacement relationship, Klamath River, 1989.

During the trapping season, 810 (22.1%) of the 3,660 chinook captured were moribund. It is presumed that mortality occurred during entrainment in the trap live box. Mortality, as a percent of total chinook captured, generally increased as the season progressed (Table 2). T-test comparison of fork lengths of all chinook and moribund chinook indicated significant differences ($p<0.05$) in half of the cases. In general, mean fork length of moribund chinook was less than the mean fork length of all live chinook measured. The smaller size of moribund chinook may indicate a poorer condition (ie: disease) of these chinook and/or may indicate some type of pecking order within the live box contributed to the mortality. Although AD-clip chinook sample size is small (53), AD-clip chinook had a greater mortality rate (32.1%) than non AD-clip chinook (22.0%).

Several other factors may have contributed to the high rate of mortality: increasing water temperatures and presumably lower dissolved oxygen (DO) levels, increasing algal loads within the live box, elevated stress levels associated with smoltification. While increasing water temperatures through the season are sure to exasperate the problem (DO levels were not evaluated), it is not believed to represent the whole answer. During the same time period, water temperatures on the Trinity River were consistently warmer, fish densities within the live box far greater, and mortality was very low (0.8%). Other than a differential disease problem between the two rivers, the only remaining inconsistency was the high algal load observed on the Klamath River and within the live box. It was routinely noted by field crews that many chinook, both entrained in the live box, and to a lesser degree, those observed in the river itself, trailed the filamentous algae which had become entangled around head, operculum, or fins. This problem was not evident in the Trinity River.

Table 2. T-test (p=0.05) comparison of weekly mean fork lengths of live chinook and moribund chinook, Klamath River, 1989.

Date	Total chinook captured	Live chinook measured	Mean fl.	s	Number moribund chinook	Percent of total catch(%)	Number measured	Mean fl.	s	t-test sigdif (y/n)	Mean Water Temp(c)
4/12-6/04	99	93	55.6	19.54	6	6.1	6	49.7	27.70	n	10.0-17.5
6/05-6/11	158	137	88.0	16.87	16	10.1	16	63.3	19.13	y	18.2
6/12-6/18	384	80	79.9	9.84	73	19.0	14	72.0	6.31	y	17.8
6/19-6/25	896	239	78.0	9.07	153	17.1	9	73.3	5.03	y	18.8
6/26-7/02	1477	247	76.4	7.85	377	25.5	0	-	-	-	18.7
7/03-7/09	537	95	82.1	8.56	137	25.5	5	77.4	6.73	n	19.9
7/10-7/16	102	55	84.4	7.96	41	40.2	15	82.9	8.06	n	20.8
7/17	7	0	-	-	7	100.0	0	-	-	-	21.0
Total	**3660**				**810**	**22.1**					

Hatchery and Natural Stock Estimate

Of the 3,660 chinook captured, 53 were ad-clipped. Forty-six of these marked chinook were retained for tag recovery. The majority (75.6%) of tags subsequently recovered were attributable to the June 2 release of smolts identified by the two "6-series" tag codes (Table 3). Tags attributable to the April 24 release of pre-smolts ("B-series") accounted for 20.0% of recoveries. Two tags recovered were identified to Elk Creek (offsite rearing facility). During CWT removal in lab, one tag was lost. While the relatively low number of tags recovered negates statistical analysis it is evident upon general comparison that "B-series" chinook experienced a level of survival less than that of the "6-series" chinook. Of the 290,329 CWT chinook released from IGH (does not include Elk Creek chinook), 31.8% were "B-series", 38.3% were "6-01" code, and 29.8% were "6-02" code. Of the 43 tags recovered (does not include partitioned tags) attributable to these three tag codes, 20.9% were "B-series", 48.8% were "6-01" code, and 30.2% were "6-02" code. Possible trap bias as related to size differences was considered but there was no significant difference ($p<0.05$) of mean length (mm) between the "6-series" chinook and "B-series" chinook at the time of capture. Higher mortality of the presmolt release is expected due to the lower survival rates of hatchery salmonids in natural rearing areas when compared to survival rates experienced under hatchery conditions.

Based on specific tagging rates and tag recoveries, a contribution of 1,757 (48%) hatchery chinook and 1,903 (52%) natural stock chinook was estimated for the 3,660 chinook captured. The estimate assumes no differential mortality of AD-CWT marked chinook. If however, differential mortality did occur, and AD-CWT chinook experienced a given percent of mortality beyond that experienced by non-clipped hatchery chinook, then the estimate would underestimate the contribution of hatchery chinook. The potential impacts of differential mortality with associated changes in contribution rates were calculated and are presented in Table 4. If mortality of all hatchery released chinook was equal then contribution rates would not change. Weekly contribution rates for hatchery and natural stocks were calculated based on weekly tag recoveries. During the period of greatest migration (June 4 to July 10), hatchery chinook dominated catches for two weeks (Figure 6).

Migration Rate and Duration

The rate and duration of migration for AD-CWT chinook released from IGH were determined by individual codes when possible, or by grouping similar release group codes (Table 5). "B-series" CWT chinook were released as presmolts (210 to 439/lb) using five tag codes (Appendix A). "6-series" CWT chinook were released as smolts (82 to 169/lb) using two tag codes. Due to the relatively low number of CWT recoveries all "B-series" tags were pooled. There were sufficient recoveries of "6-series" tags to allow for both individual and pooled comparison.

Table 3. Chinook captured, CWT recoveries and partitioned CWT by week and code, Klamath River, 1989.

Date	Chinook captured	Non sampled	AD-clips observed	AD-clips collected	6-1-2-1-1	6-1-2-1-2	B-series	6-28-10	Non CWT	Lost CWT	Partitioned CWT
6/05-6/11	158	0	1	1	1	0	0	0	0	0	0.00
6/12-6/18	384	2	9	9	4	0	5	0	0	0	0.05
6/19-6/25	896	11	12	8	5	1	0	2	0	0	4.15
6/26-7/02	1477	6	26	23	8	10	4	0	0	1	4.11
7/03-7/09	537	2	5	5	3	2	0	0	0	0	0.02
Total	3452	21	53	46	21	13	9	2	0	1	8.32
Total CWT(recovered+partitioned					25.1	15.4	9.8	3.0			

Table 4. Estimated hatchery and natural contribution to chinook catch given varying differential mortality rates of AD-CWT to non AD-CWT hatchery chinook, Klamath River, 1989.

Percent differential AD-CWT mortality	CWT groups*	Tagging rate with mortality	Expansion (1/tagging rate)	CWT recovered + partitioned	Estimated CWT group contribution	Chinook captured	Estimated combined hatchery contribution (% of total catch)	Estimated natural contribution (% of total catch)
0	"B" "Six"	.027615 .028937	36.212 34.558	9.77 40.51	[illegible] 1399.9	3660	1754 (47.9)	1906 (52.1)
10	"B" "Six"	[illegible]	[illegible]	[illegible]	[illegible]	3660	1943 (53.1)	1717 (46.9)
20	"B" "Six"	.022215 .023284	45.015 42.948	9.77 40.51	439.8 1739.8	3660	2180 (59.6)	1480 (40.4)
30	"B" "Six"	.019492 .020432	51.303 48.940	9.77 40.51	501.2 1982.6	3660	2484 (67.9)	1176 (32.1)
50	[illegible]	.014680	[illegible]	[illegible]	[illegible]	3660	3457 (94.4)	203 (5.5)

* "Six" series CWT groups do not include Elk Creek (6-28-10) chinook.

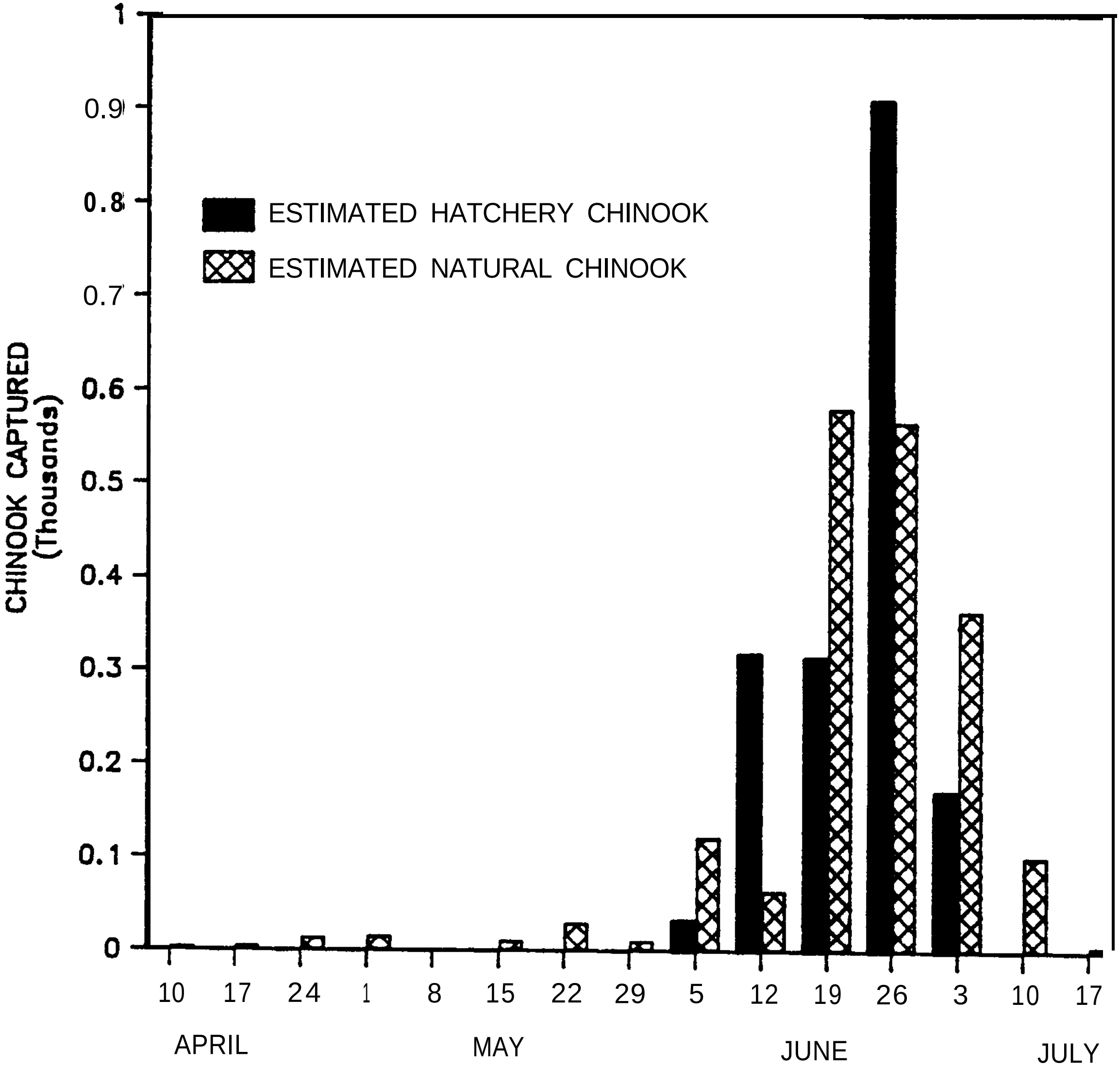

Figure 6. Estimated hatchery and noturol stock component of chinook catch by week, Klomoth River, 1989.

Table 5. Migration rates and duration of captured AD-CWT chinook, Klamath River, 1989.

CWT code.	n	Release date	Initial capture date	Initial capture rate (rkm/d)	Mean capture date	Mean capture rate (rkm/d)	10-90% duration (days)	10-90% duration (dates)
B-series	9	4/24	6/13	4.6	6/19	4.0	14	6/13-6/27
6-01	21	6/02	6/07	45.0	6/23	10.7	20	6/13-7/03
6-02	13	6/02	6/19	13.2	6/29	8.3	9	6/26-7/05
6-pooled	34	6/02	6/07	45.0	6/23	10.7	19	6/14-7/03

As might be anticipated, AD-CWT pre-smolt chinook migrated at a slower rate than the AD-CWT smolt chinook (4.0 rkm per day (rkm/d) to 10.7 rkm/d, respectively). Mean capture date of the pre-smolts (June 19) preceded that of the smolts (June 23) by only four days though pre-smolts were released 39 days before the smolts. This disparity would seem to indicate that either: 1) the pre-smolts migrated at the slower rate or 2) the pre-smolts resided upriver until physiological conditioning (smolting), environmental factors, and/or the influence of 6.8 million hatchery migrating smolts caused their migration. Richards et al. (1989) and Symons (1969) reported highest densities of released non-smolt salmonids to be near the release site for several months. This would seem to favor option 2 as the most likely scenario.

The duration of migration for the AD-CWT pre-smolts was 14 days while the AD-CWT smolt chinook duration was 20 days. The difference in duration period between the two release groups is possibly explained by the greater number of smolts released (6.8 million) than pre-smolts (3.3 million).

Comparisons between the two "6-series" smolt groups reveals some curious differences regarding migration rates and duration. While smolts of tag code 6-1-2-1-1 migrated at a mean rate of 10.7 rkm/d, duration 20 days, smolts of tag code 6-1-2-1-2 migrated at a mean rate of 8.3 rkm/d with a relatively narrow duration period of 9 days. Although the low number of tags recovered makes comparisons tenuous, the data does seem to indicate some disparity between chinook of the two tag codes beyond which might be explained by just the relative number released. There was no significant difference ($p<0.05$) of mean length between the two "6-series" tag code groups at the time of capture.

Population Estimates and Indices

Trap efficiency

Trap efficiency estimates were attempted on several occasions and in each case initial mortality of marked chinook was unacceptable to allow the process to continue. Reasons for the high mortality are believed two fold. The primary factor was believed to be the poor health quality of the chinook. The second contributing factor which compounded the problem was that due to the low number of chinook captured in the trap, it became necessary to retain daily catches in holding pens for several days until sufficient quantities existed for marking. It was evident that the retention only compounded the health problems to the point that these fish could not be assumed representative of the population as a whole and therefore the efficiency tests were discontinued. Alternative methods of capture were attempted using fyke nets and seines but catches were low and the stress associated with these techniques was unacceptable.

Chinook Abundance Index

Chinook abundance index values were greatest (84,728) the week of June 26 - July 2 (Figure 7). Sample index values, used as catch expansion factors, are essentially the inverse of the proportion of river flow sampled. A low volume sampled value at a particular flow would therefore generate a greater expansion factor (with associated greater error) than would a higher volume sampled at the same flow. During the two weeks of greatest catches (June 19-July 02), sample index values, or expansion values, were the lowest values calculated for the season (Appendix C). This indicates that although flows generally declined through the season, the trap sampled a greater volume of flow during the apparent peak of migration, and therefore the chinook abundance index values are believed to be representative.

For nights sampled during the trapping season, the abundance index estimate was 221,000 chinook. For the trapping season, which includes nights sampled as well as nights not sampled, the abundance index estimate was 260,000 chinook. It is important to remember that the abundance index is not a population estimate but rather a method of describing the relative abundance comparable between years, given changing flow conditions and different trapping locations.

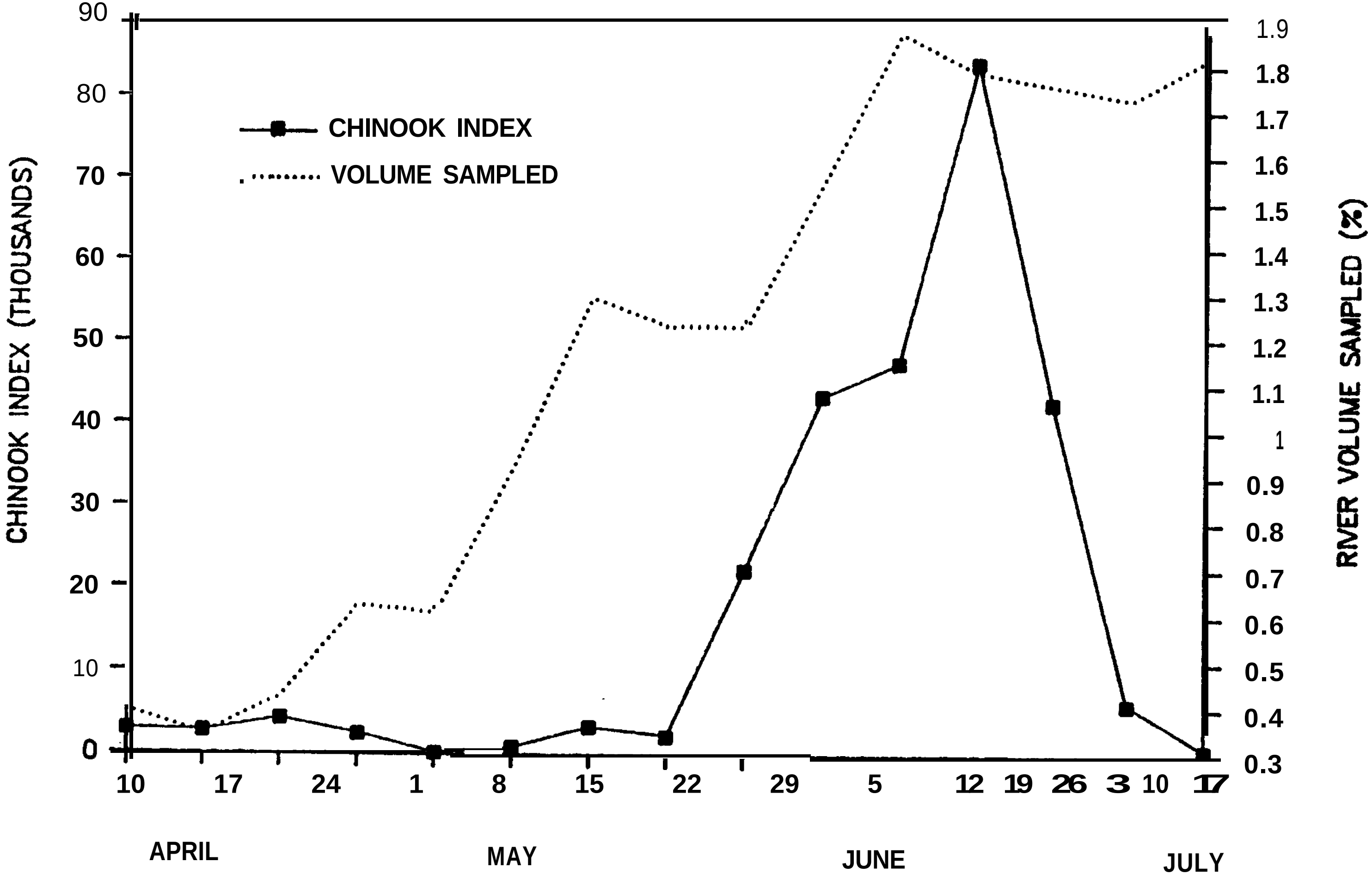

Figure 7. Chinook abundance index and percent river volume sampled by the rotary screw trap by week, Klamath River, 1989.

Steelhead

A total of 153 steelhead were captured during the sampling period. Catches of steelhead were greatest in April and May, with a peak weekly catch (37) occurring the first week of May (Figure 8). Peak steelhead catches were also reported during May, 1988, using fyke nets at the same approximate location (USFWS 1989). In 1989, catches declined to only 7 fish the following week, then increased to 20 the week after. This up and down catch trend continued, though catches generally declined, until mid-June when low catches predominated. Steelhead were the most abundant salmonid captured in April.

Since hatchery steelhead are released as yearling plus it was assumed all fry were natural stock. Of eight steelhead classified as parr, seven were believed natural stock based on the condition of the dorsal fin. Of eight steelhead classified as smolt, five were believed to be hatchery stock. Extrapolating these data in combination with steelhead development data indicates that approximately 21% of all steelhead captured were hatchery stock and 79% of captured steelhead were natural stock.

During the trapping period, 144 steelhead were measured to fork length (Figure 9). A bimodal length frequency grouping representing parr and smolt-size steelhead was observed. Classification of development stage was conducted on 130 of the 144 steelhead measured (Table 6). Over 85% of steelhead were classed as parr or smolt (51.5% and 33.8%, respectively). Many of the larger steelhead classified as parr were in a pre-smolt condition and like smolts, were believed to be actively emigrating. It is believed that the capture of smaller parr and fry does not necessarily represent active emigration of these fish but rather local migrational behavior perhaps in response to the abundance of larger emigrating steelhead in the area. The capture of the fry does indicate that emergence occurred in the general vicinity of the trap site. What component of these fry were the result of spawning in the mainstem or in nearby tributaries is unknown.

Table 6. Steelhead development and associated length (mn) data.

Development Class	Sample Size	Mean Length	Range Min	Range Max	Standard Deviation
Fry	19	56.6	37	78	14.42
Parr	67	103.4	67	160	25.84
Smolt	44	168.1	103	200	18.88

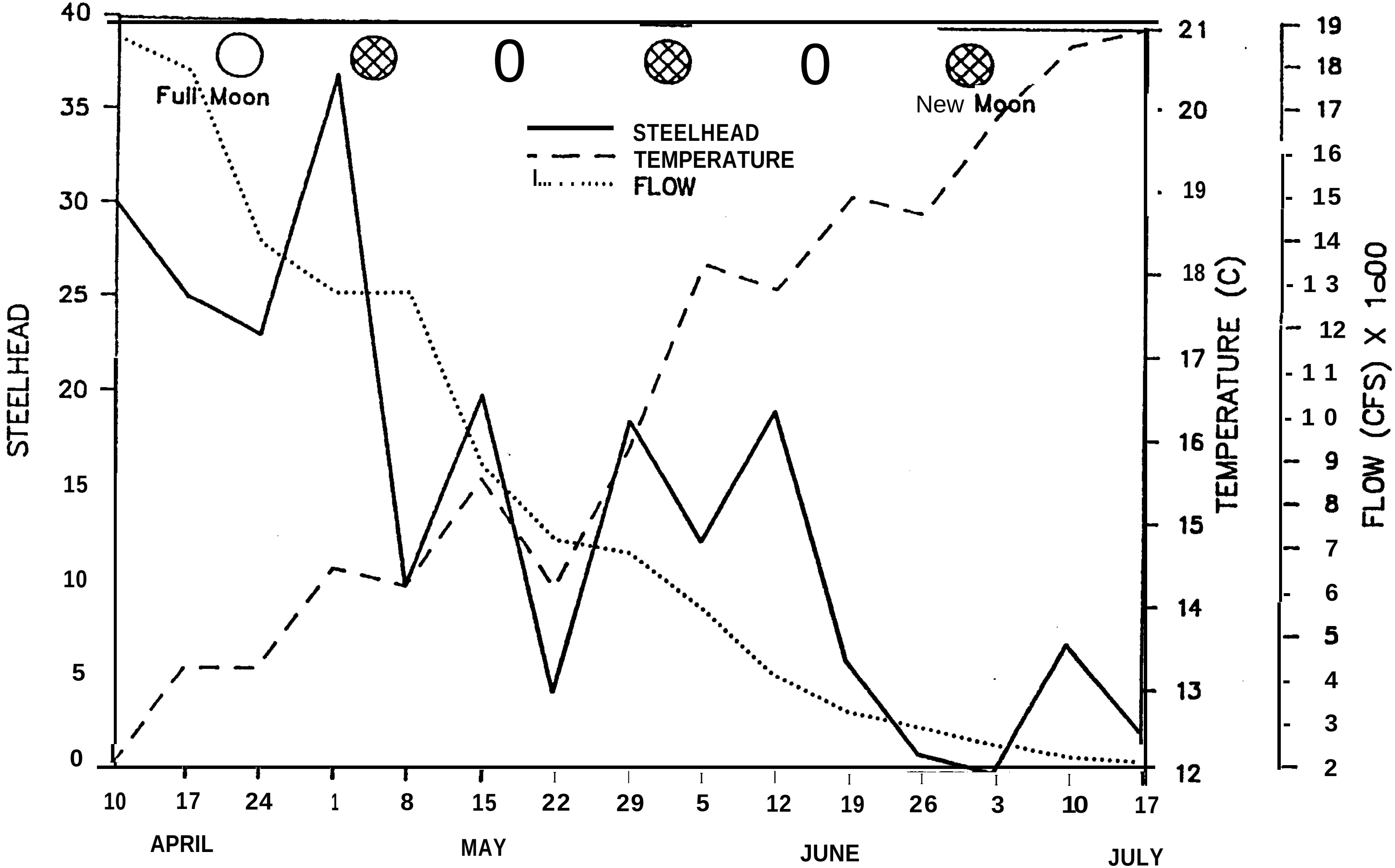

Figure 8. Steelhead catch, flow, temperature, and lunar phase, Klamath River, 1989. Catch represents seven day total based on weekly catch effort.

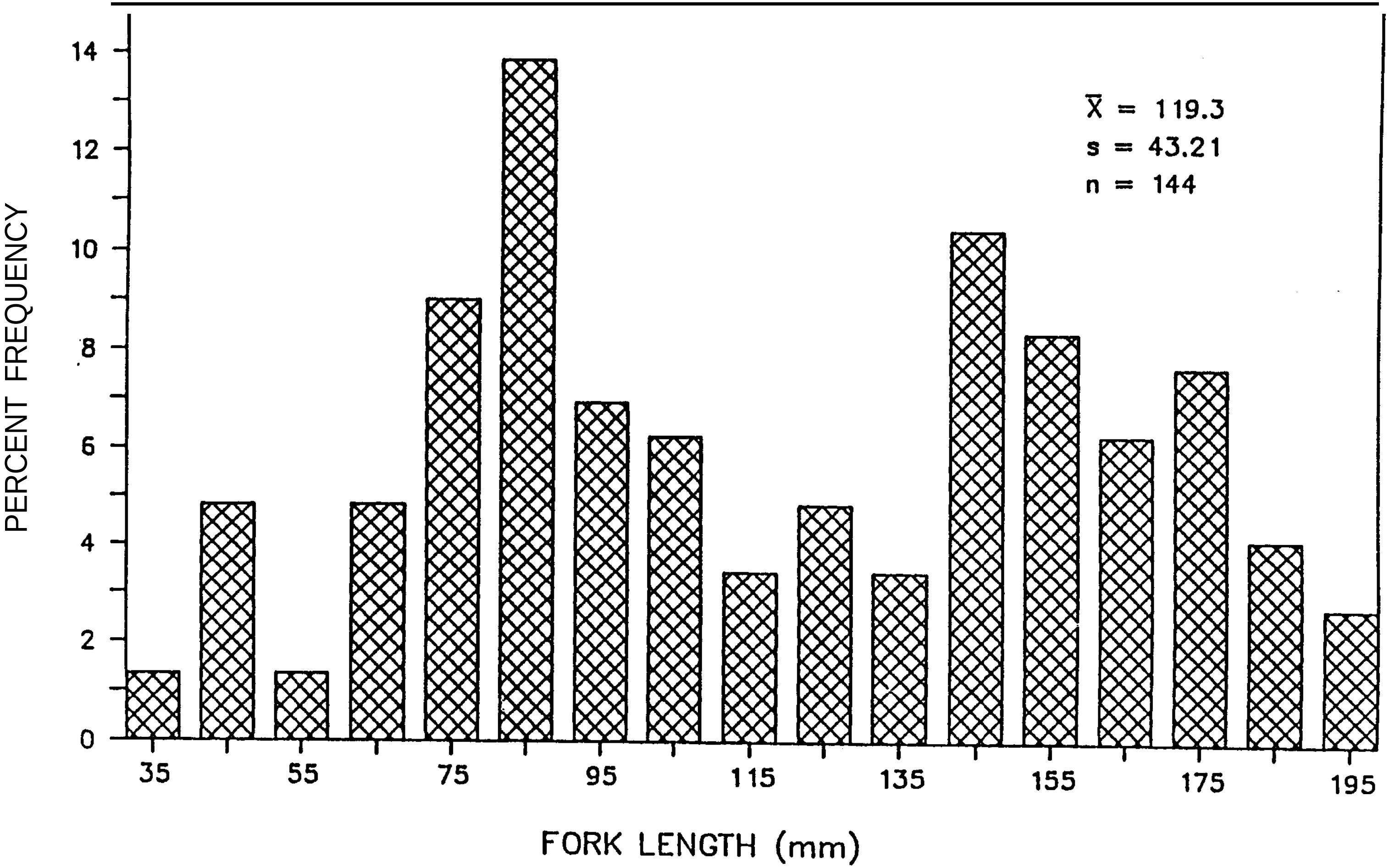

Figure 9. Length frequency of steelhead during 1989 trapping season, Klamath River.

As a measure of condition, displacements were taken on 81 of the steelhead measured to fork length. Condition of Klamath River steelhead, as indicated by slope value (2.95), was less than calculated for Trinity River steelhead 3.07(natural), 3.29(hatchery) (Appendix B). Regression values and slope will be compared in subsequent years for Klamath River steelhead, and when sample size allows, comparisons between hatchery and natural stocks will also be evaluated.

Coho Salmon

A total of 69 coho were captured during the sampling season. Catches were greatest the first three weeks of May, with a peak weekly catch (20) occurring the week of May 15-21 (Figure 10). The timing of peak weekly catch was nearly identical to that in 1988 (USFWS 1989). Catches declined steadily through the remainder of May and June. No coho were captured in July. The relatively low number of coho captured may indicate that the trapping period did not fully encompass the coho emigrational period. On March 15, IGH released on site 76,000 coho yearlings of which 42,000 were AD-CWT. It is likely that most, if not all of these fish, had emigrated past the trap site before sampling initiated (April 12). This is supported by the fact that no AD-clip coho were captured during trapping. In addition, another 67,000 non-marked coho yearlings were released at various off-site locations from April 27 to May 18 (Appendix A). Since trapping was in operation during this period, it is probable that some of these fish contributed to the relatively higher catches observed the first three weeks of May.

During the season, 67 coho were measured to fork length (Figure 11). A trimodal length frequency grouping was observed. Each grouping was representative of a particular life history stage (fry, parr, smolt) and the relative length, or range of lengths, that occur at that respective stage.

Sixty-four of the 67 coho measured were classified to development stage (Table 7). Coho smolts and fry were the most common development type. As with steelhead, the occurrence of fry in catches is believed to represent more localized migrational behavior and not that of active emigration. Displacements were taken on 36 cohos of the 67 measured and included coho of all three development stages. Regression slope value of 3.08 was calculated and will be compared to values calculated in subsequent sample years to measure relative condition between years.

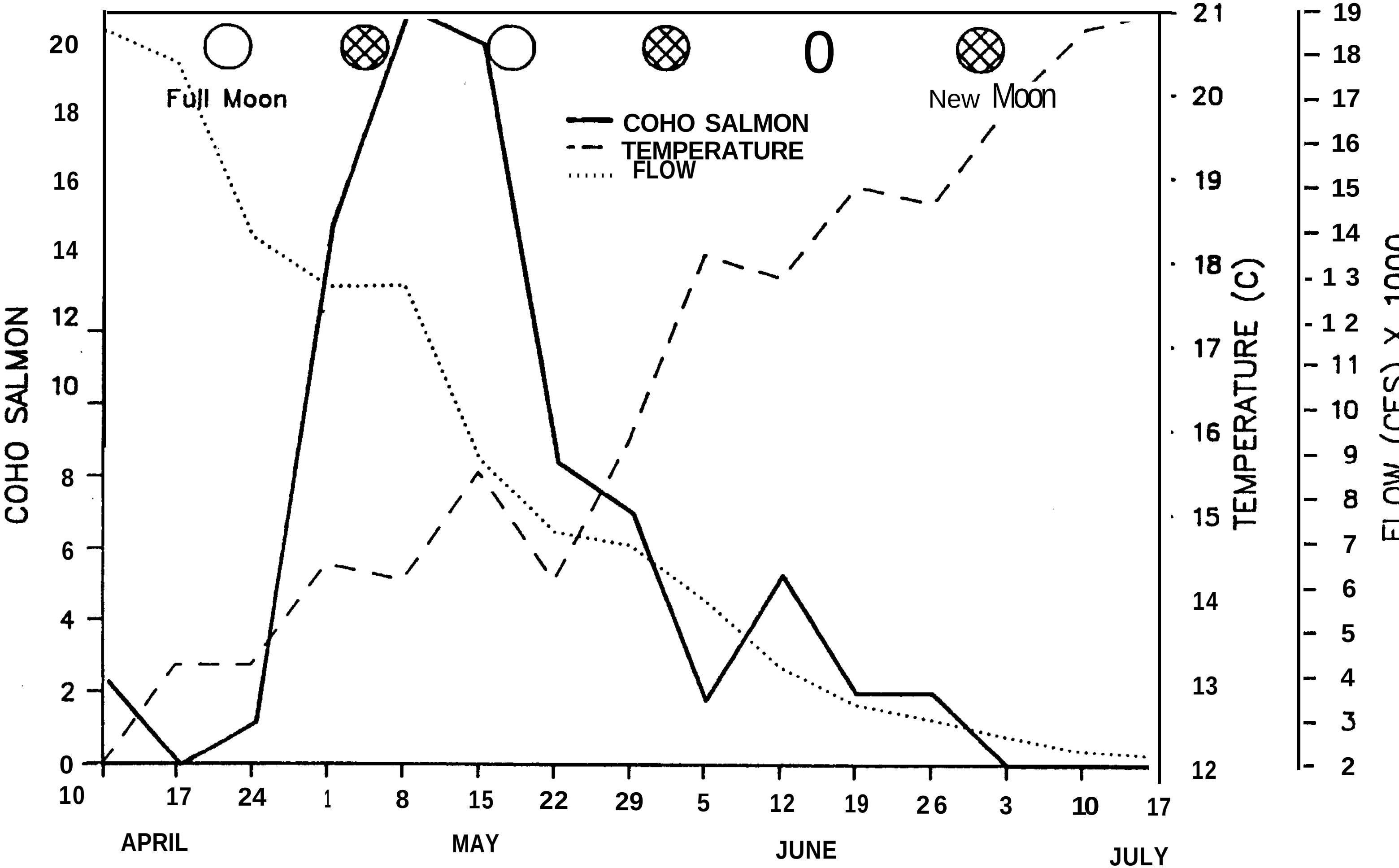

Figure 10. Coho catch, flow, temperature, lunar phase, Klamath River, 1989. Catch represents seven day total based on weekly catch effort.

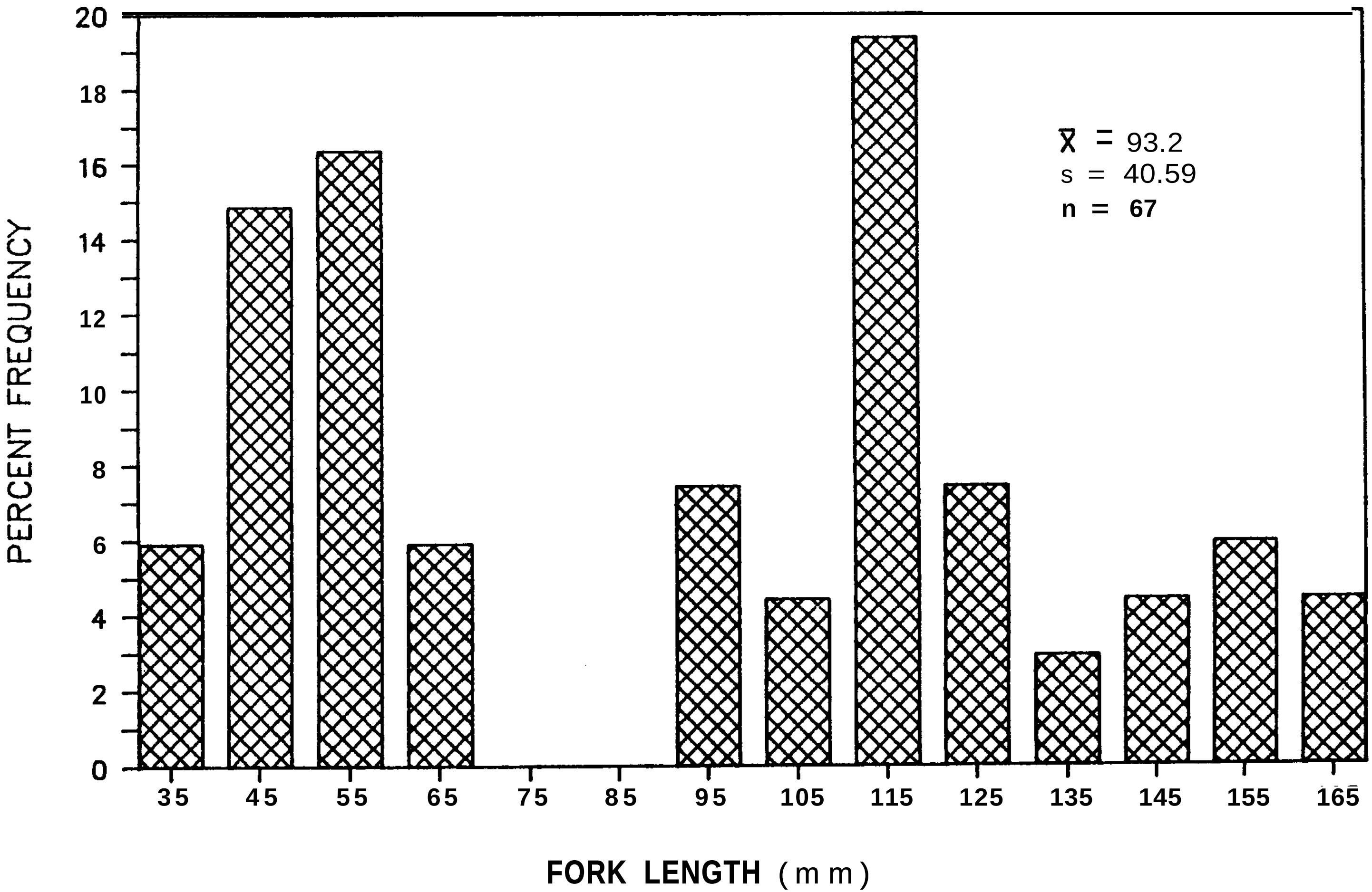

Figure 11. Length frequency of coho salmon during the 1989 trapping season, Klamath River.

Table 7. Coho salmon development and associated length (mm) data.

Development Class	Sample Size	Mean Length	Range Min	Range Max	Standard Deviation
Fry	27	49.9	38	63	7.51
Parr	7	99.7	66	118	22.19
Smolt	30	126.6	95	170	20.61

Other Species

During the sampling period a wide variety of non-salmonid species were trapped. Listed in order of frequency: Klamath smallscale sucker (Catastomus rimiculus), Pacific lamprey (juvenile and adult) (Lampetra tridentata), speckled dace (Rhinichthys osculus), sculpin (Cottus sp.), threespine stickleback (Gasterosteus aculeatus), catfish (Ictalurus sp.), golden shiner (Notemigonus chrysoleucas), yellow perch (Perca flavescens), green sunfish (Lepomis cyanellus), American shad (Alosa sepidissima). Captures of juvenile (includes ammocete) and adult pacific lamprey were greatest in May. Fourteen adult American shad (moribund) were captured in July. Seven of the shad were internally examined: four were female, three were male, all were unspawned.

TRINITY RIVER TRAP

The Trinity River trap at Willow Creek (rkm 38) was operated from April 4 to August 4 sampling a total of 81 nights. Chinook salmon were the most abundant salmonid (37,377), followed by steelhead (1,788), and coho salmon (1,261).

Chinook Salmon Emigration

Catches of juvenile chinook at the Trinity River trap indicated a bimodal emigrational period occurred in June (Figure 12). Captures of chinook, relatively low in April and May, began to substantially increase the week of May 29 to June 4. An initial peak daily catch (1,923) occurred June 6. Subsequent daily catches declined steadily until June 14 (158). A second catch increase began June 15 and continued into the week of June 19-23. The peak daily catch (2,622) for the season occurred on June 23. Catches declined steadily after this time but remained greater throughout July than was observed before June. Trapping was discontinued on August 4 due to funding constraints. While emigration, as indicated by catches, was still substantial at this period of time, the general trend was towards declining catches and the seasons trapping results are believed to accurately reflect the period of greatest emigration. The timing of peak migration on the Trinity River was similar to that observed on the Klamath River.

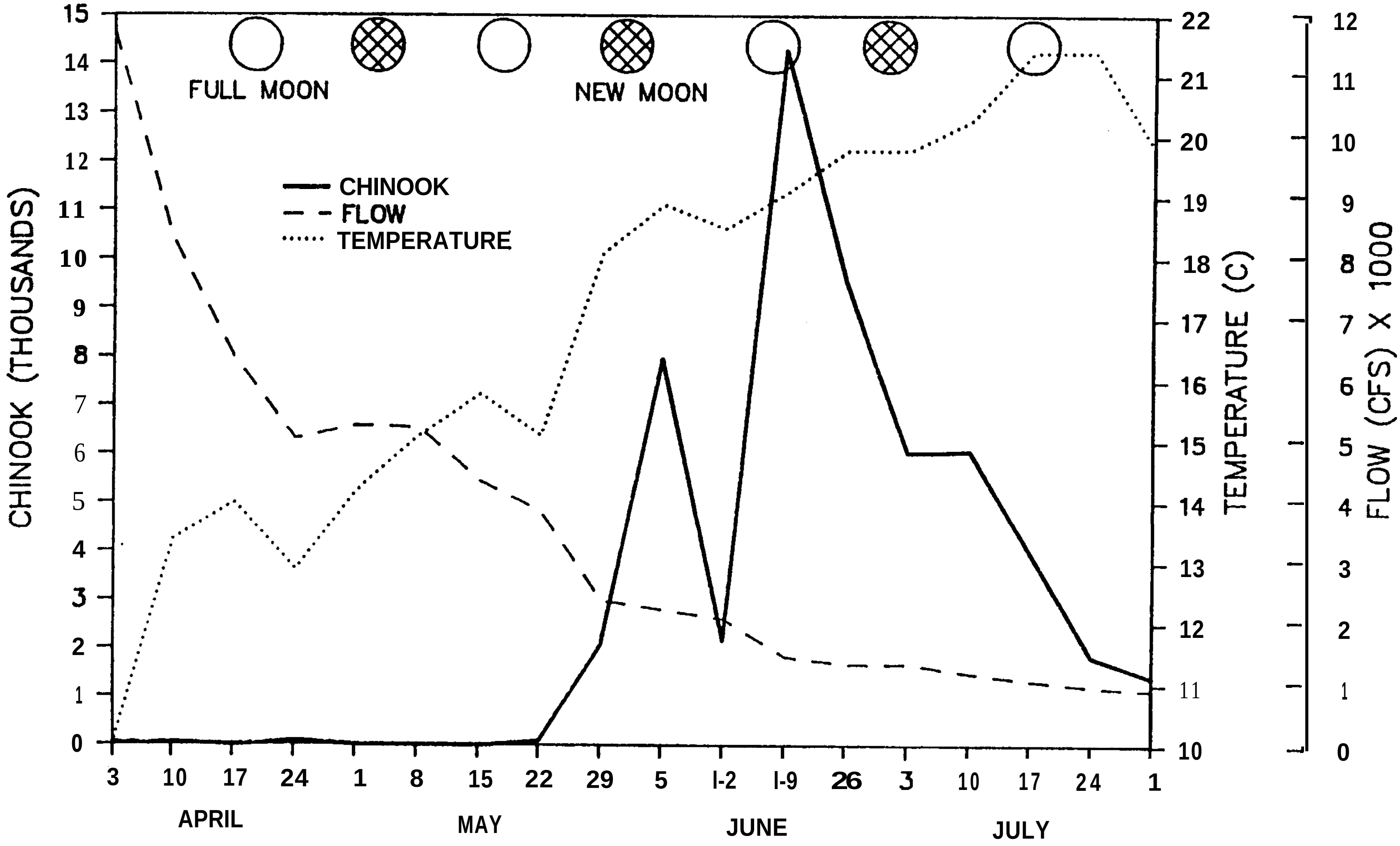

Figure 12. Chinook catch, flow, temperature, and lunar phase, Trinity River, 1989. Catch represents seven day total based on weekly catch effort.

The increase in catches observed during both migrational peaks represents two distinct periods of hatchery influenced emigrations. CWT recoveries indicate that the initial peak was nearly exclusively spring run hatchery chinook released from TRH on May 26 (Appendix A). After a week of declining catches the second, and much greater emigration occurred. This migrational period consisted of spring run CWT chinook, natural stock CWT chinook, and to a greater extent, fall run CWT chinook (Figure 13). The occurrence of significant numbers of spring run chinook among the predominantly fall run emigration indicates that migrational patterns of individual hatchery stocks, as well as natural stocks, may be influenced by large hatchery releases. Assessing the migrational response of natural origin chinook to hatchery releases was facilitated by the presence of Ad-CWT natural stock chinook. Chinook were captured on the upper mainstem Trinity River (rkm 170) in the early spring preceding hatchery releases. Chinook were AD-clipped and coded-wire-tagged (Appendix A). No attempt was made to differentiate between spring and fall run chinook (Zuspan, M., personal communication, CDFG). Although the tagging and release of natural stock chinook was conducted from March to mid-May, not a single AD-CWT chinook from this group was recovered until the onset of the TRH spring run emigration. Recoveries of CWT natural stock coincided with recoveries of CWT hatchery chinook throughout the emigration period and remained relatively stable even as hatchery CWT recoveries declined (Figure 13). This may indicate that while natural stock chinook did migrate concurrent with the TRH chinook, a large component of natural stock chinook tended to follow, or shadow, the larger hatchery emigration. A more graphic representation of this migrational pattern was generated based on weekly CWT recoveries and TRH tagging rates (Figure 14).

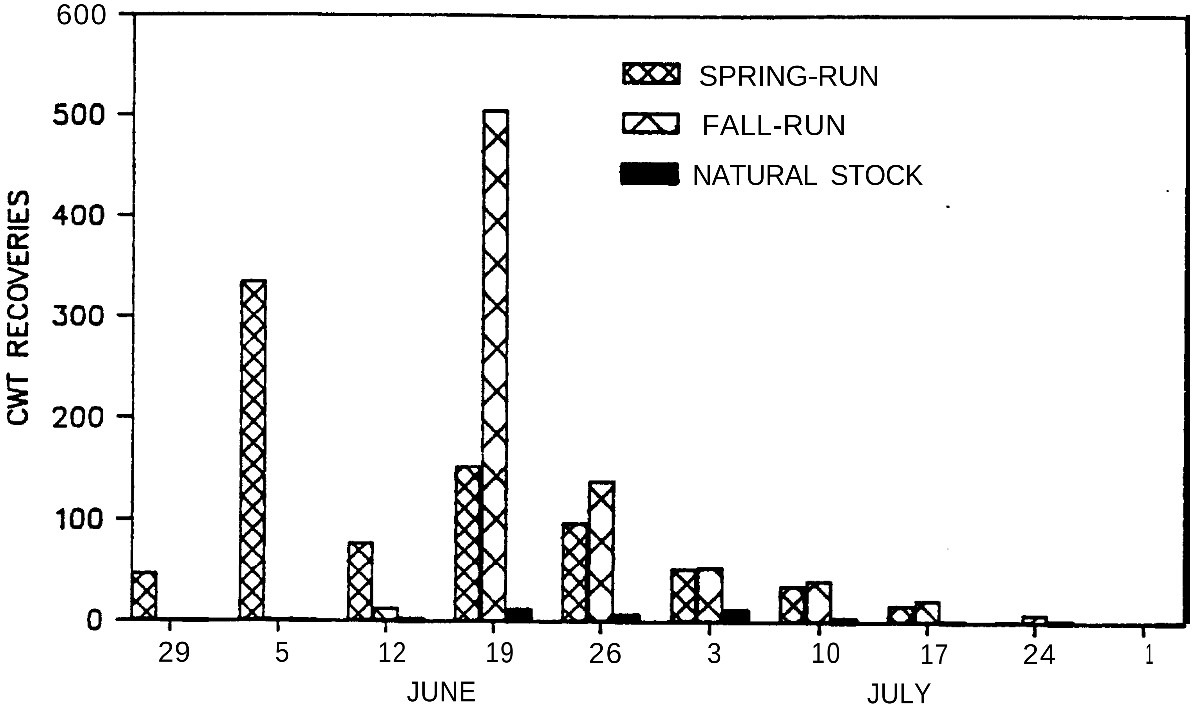

Figure 13. CWT recoveries by week, Trinity River, 1989.

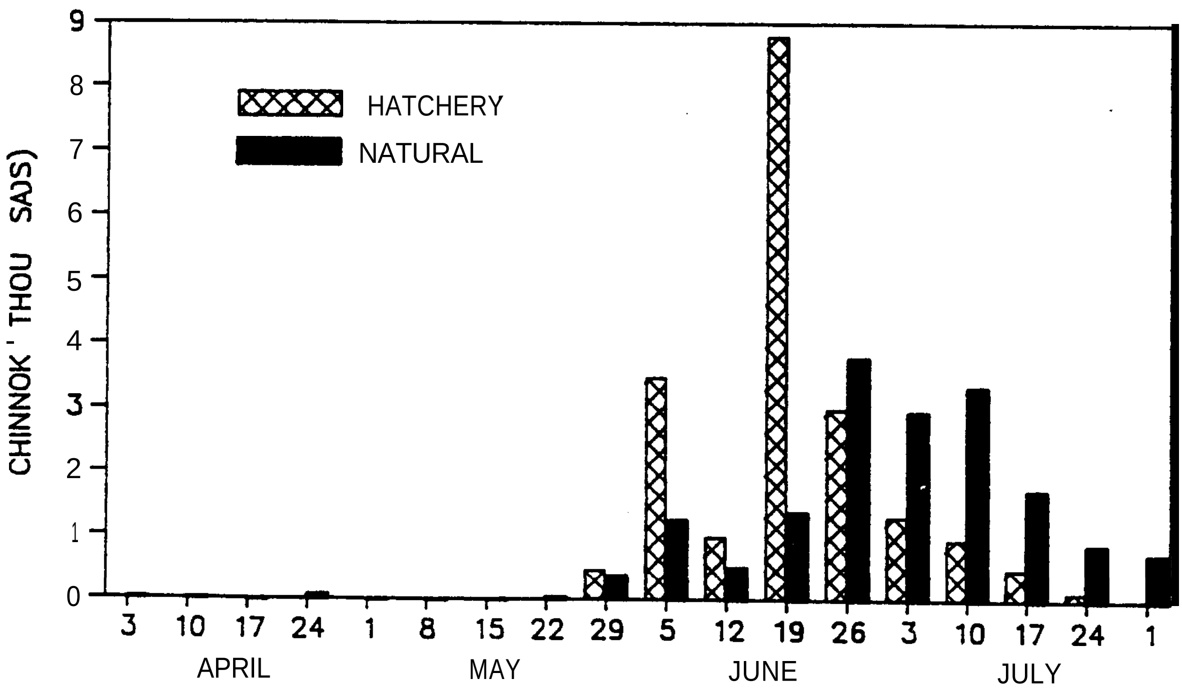

Figure 14. Estimated hatchery and natural stock component of chinook catch by week, Trinity River, 1989

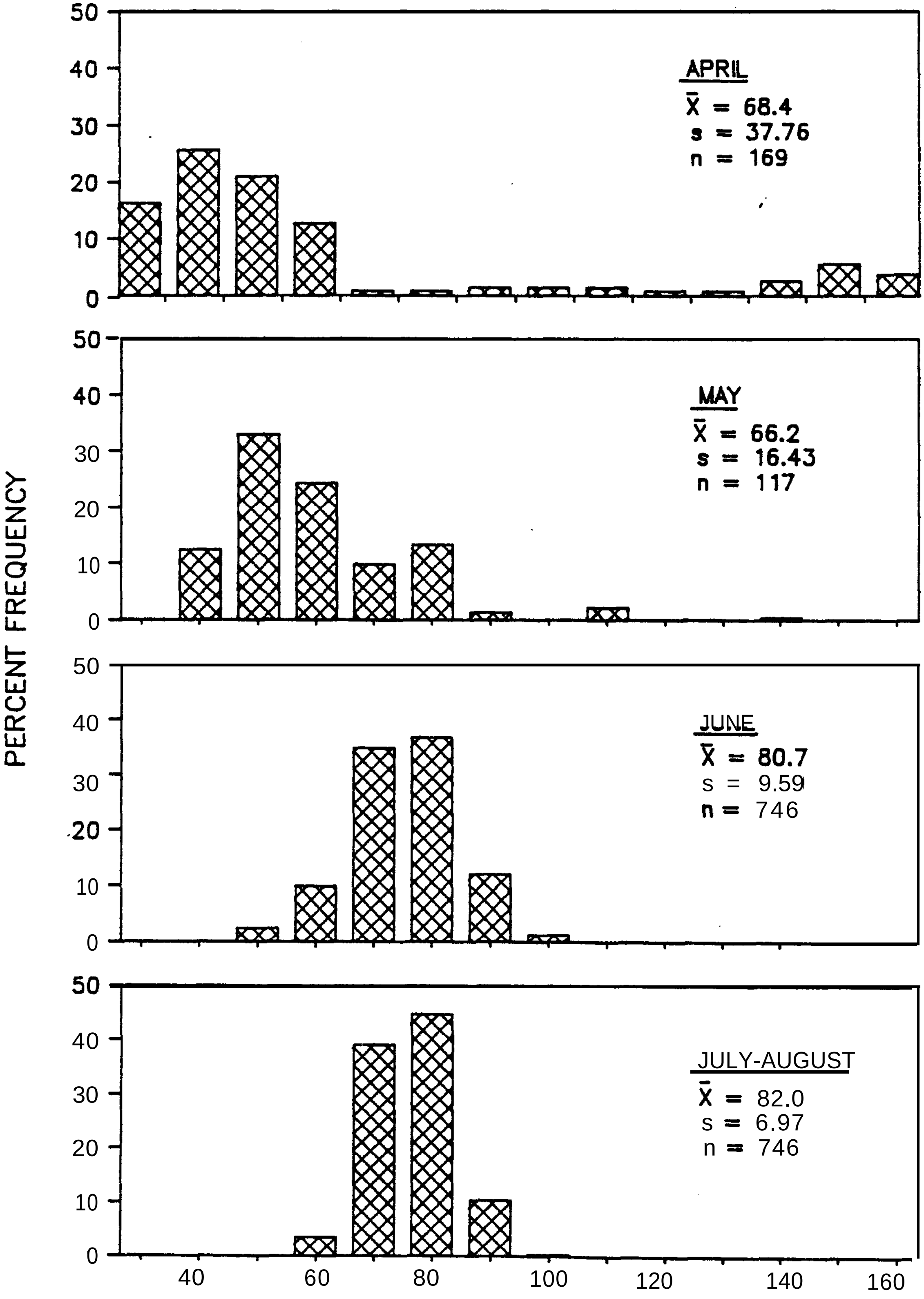

Figure 15. Chinook fork length percent frequency by month, Trinity River, 1989.

There was no apparent relationship between chinook catches and river flow, water temperature, or lunar phase. In fact, contrary to what might be assumed, the hatchery spring run chinook, released at flows of 1000 cfs, actually migrated at a slower rate to the trap site than the fall chinook released in 800 cfs. Chinook and other salmonids, migrating over significant distances, encounter a wide range of factors which may or may not effect the migration to some degree. Any correlation between catches at a given point in time with conditions present at that time is, as discussed with Klamath River chinook emigrations, at best a coincidence.

Chinook Size, Development, and Condition

A bimodal length frequency grouping was observed for chinook in April (Figure 15). Young-of-year chinook fry dominated catches in April and May with relatively few yearling size (>130mm) chinook captured. Hatchery yearling chinook are generally released in the fall and probably reach estuarine or ocean environments before the spring trapping began.

As observed on the Klamath River, a significant ($p<0.05$) increase in weekly mean fork length occurred the week of 5/29 to 6/4 (Table 8). The timing of increase in mean fork length coincides with the timing of the first captures of AD-CWT chinook. In general, weekly mean fork lengths of AD-CWT chinook were similar to the fork length means of non AD-CWT chinook captured concurrently. Fork length means of AD-CWT natural stock chinook were generally smaller, although not usually significantly different ($p>0.05$), than the mean fork lengths of all non AD-CWT chinook captured (Table 8).

During June and July, captures of chinook fry (35-65mm) continued, suggesting a wide time range of spawning. It is believed their occurrence in catches does not reflect active emigration but rather localized migrational behavior, perhaps a result of, or in response to, the abundance of larger chinook (smolts) emigrating through the area.

As a measure of condition, displacements were taken on 224 of the 1,778 chinook measured (Figure 16). As previously mentioned, although displacements were taken opportunistically, they encompassed the range of fork lengths in approximate proportions and are believed to be representative. The calculated slope value, as the indicator of condition, was greater for the Klamath River chinook (3.12) than for the Trinity River chinook (2.86)(Appendix B). While the observed slope values reflect a better condition for Klamath River chinook, general observation indicated otherwise. Condition values for Trinity River chinook will be compared in subsequent years and may help to identify factors affecting the condition of chinook on a yearly basis.

Table 8. Weekly mean length of non AD-clip and AD-clip chinook with test for significant difference (p=0.05), Trinity River, 1989.

	Non Ad-Clip Chinook			Ad-CWT Chinook											
				(6-61-49)			t-test	(6-56-35)			t-test	(86-13-06)			t-test
Date	n	x̄	s	n			Y/N	n		s	Y/N	n			Y/N
4/03-4/09	38	74.3	45.55	0				0				D			
4/10-4/16	36	53.3	28.94	0				0				0			
4/17-4/23	7	65.6	29.65	D				0				0			
4/24-4/30	96	71.0	35.99	0				0				0			
5/01-5/07	11	55.5	9.04	0				0				0			
5/08-5/14	5	114.4	23.36	0				0				0			
5/15-5/21	8	58.6	6.50	0				0				0			
5/22-5/28	65	62.5	11.81	0				0				0			
5/29-6/04	121	82.0	11.11	38	79.8	14.13	N	0				1	87.0		
6/05-6/11	186	82.6	8.73	44	82.0	5.84	N	3	78.3	4.73	N	1	74.0		
6/12-6/18	92	78.4	9.24	20	80.9	6.98	N	2	72.0	19.80	N	0			
6/19-6/25	138	81.3	7.46	54	80.1	5.81	N	134	81.6	9.51	N	2	68.5	0.71	Y
6/26-7/02	192	76.7	8.62	72	82.3	7.88	Y	89	80.4	7.36	Y	5	74.6	7.54	N
7/03-7/09	97	78.2	6.72	32	82.2	8.60	Y	27	81.6	7.28	Y	6	71.7	4.55	Y
7/10-7/16	170	79.8	7.49	31	84.6	6.72	Y	37	81.1	5.70	N	4	76.8	8.50	N
7/17-7/23	196	80.6	5.59	17	86.5	8.06	Y	21	81.4	4.60	N	2	75.5	2.12	N
7/24-7/30	169	83.8	5.26	2	81.5	0.71	Y	8	86.4	10.68	N	2	84.0	5.66	N
8/01-8/04	100	89.1	5.42	1	76.0			2	88.5	4.95	N	2	92.5	3.54	N

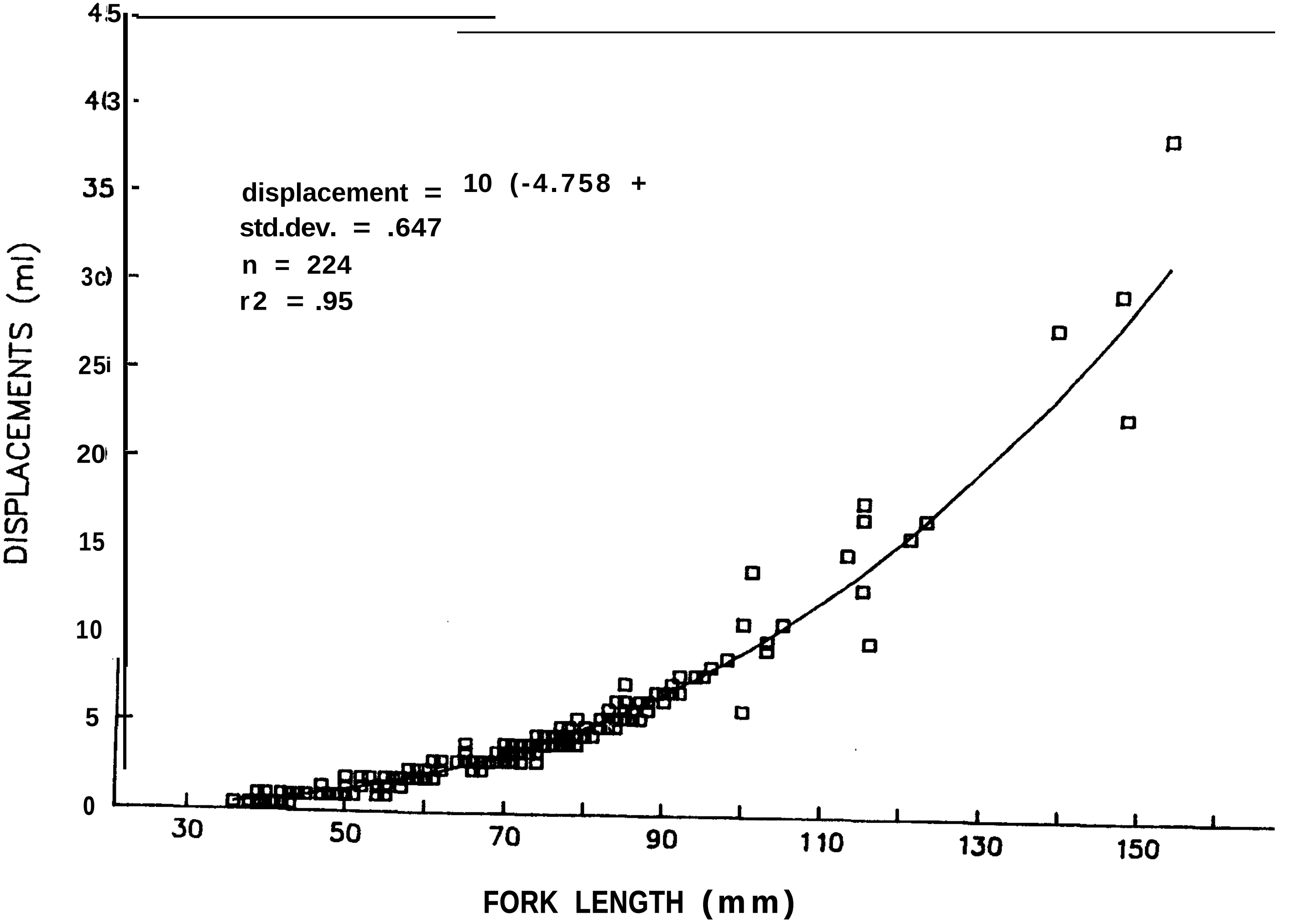

Figure 16. Chinook length-displacement relationship, Trinity River, 1989.

During the trapping season, 302 (0.8%) of the 37,377 chinook captured were moribund (Table 9). As with the Klamath River trap, mortality was presumed to have occurred within the trap live box. Unlike the Klamath River, where the rate of mortality generally increased as the season progressed, mortality on the Trinity River seemed independent of time, water temperature, or density dependant factors. Field crews routinely noted a wide disparity in overall condition of fish between the Klamath River trap catch (poor) and the Trinity River trap catch (good) based on general appearance and activity of the entrained chinook.

Date	# Chinook Captured	# Chinook Mortalities	Percent of Total Catch	Mean Water Temperature (C)
4/03-4/09	40	0	0.0	10.0
4/10-4/16	36	0	0.0	13.3
4/17-4/23	7	0	0.0	13.9
4/24-4/30	96	2	2.1	12.8
5/01-5/07	12	2	16.7	14.1
5/08-5/14	6	0	0.0	15.0
5/15-5/21	8	0	0.0	15.7
5/22-5/28	65	1	1.5	15.0
5/29-6/04	903	1	0.1	18.0
6/05-6/11	4802	25	0.5	18.8
6/12-6/18	1555	10	0.6	18.4
6/19-6/25	10219	95	0.9	19.0
6/26-7/02	6840	79	1.2	19.7
7/03-7/09	4308	32	0.7	19.7
7/10-7/16	4353	34	0.8	20.2
7/17-7/23	2268	16	0.7	21.3
7/24-7/30	1053	3	0.3	21.3
8/01-8/04	807	2	0.2	19.7
	Total	37377	302	0.8

TABLE 9. Chinook mortality, Trinity River, 1989.

Hatchery and Natural Stock Estimate

Of the 37,377 chinook captured, 1,663 were Ad-clipped and of these 1,616 were retained for CWT recovery (Table 10). A total of 1,443 tags were recovered of which 1,397 were attributed to TRH and 46 to the CDFG natural stock tagging program. In 1989, TRH tagged and released 385,856 chinook smolts of which 48.7% were spring run and 51.3% were fall run. Of the 1,397 tags recovered and attributable to TRH, 685 (49.0%) were spring run and 712 (51.0%) were fall run chinook. Tag recoveries were nearly in exact proportion to tag releases and lends to the assumption that sampling accurately represented migrational characteristics of hatchery chinook. In 1989, the CDFG released 15,703 AD-CWT natural stock chinook or approximately 3.9% of all AD-CWT released into the Trinity River system. Of the 1,443 tags recovered, 46, or 3.2% were from this natural stock program. While the proportion of natural stock AD-CWTs recovered is slightly less than expected, it does reflect fairly accurate representation.

Based on specific tagging rates and tag recoveries (including partitioned tags), a contribution of 19,877 (53.2%) hatchery chinook and 17,500 (46.8%) natural stock chinook was estimated for the 37,377 chinook captured. Of the estimated hatchery chinook, 8,550 (43.0%) were believed to be spring run chinook and 11,327 (57.0%) to be fall run chinook. No attempt was made to differentiate between spring and fall run natural stocks. The estimate does not account for approximately 1,500 Ad-CWT chinook captured upstream (rkm 131) and removed from the population by Service personnel in Weaverville (Krakker, J., personal communication). Assuming tag groups were recovered in the same proportion as recovered at our trap, the removal of these tags would serve to change our estimate of hatchery chinook upward by 0.3% to approximately 19,937 hatchery chinook.

Estimates of hatchery and natural stocks are generated for use as indices for comparisons between years and may be useful to evaluate: hatchery rearing and release strategies, impacts on natural stocks from habitat improvements or degradations, and differential harvest impacts between natural and hatchery stocks.

Migration Rate and Duration

On May 26, TRH released spring run chinook smolts (tag code 6-61-49) on site (rkm 178)(Appendix B). Thirty-eight AD-CWT chinook from this release were captured June 4 for an initial migration rate of 15.6 (rkm/day) (Table 11). The initial rate may have actually been faster as trapping was not conducted June 2 or 3. Mean capture date of the marked spring chinook was June 19, for a mean rate of 5.8 (rkm/day). The duration of migration for spring chinook was a rather prolonged, thirty days.

Table 10. **Chinook captured, CWT recoveries and partitioned CWT by week and code, Trinity River, 1989.**

Dates	Chinook Captured	Non Mark Sampled	AD-CWT Observd.	6-61-49	6-56-35	B6-13-06	No Tag	Lost Tag	Partitioned CWT
5/29-6/04	832	3	49	38	0	1	9	1	10.17
6/05-6/11	4802	3	342	266	3	2	31	20	71.21
6/12-6/18	1555	173	89	53	12	3	7	1	28.71
6/19-6/25	10219	31	671	138	452	11	29	36	72.12
6/26-7/02	6840	10	247	89	126	7	14	4	25.39
7/03-7/09	4308	30	120	50	51	12	6	0	7.91
7/10-7/16	**4353**	**27**	**83**	**31**	**36**	**4**	**7**	**4**	**12.57**
7/17-7/23	**2268**	**13**	**43**	**17**	**21**	**2**	**3**	**0**	**3.27**
7/24-7/30	1053	7	14	2	9	2	1	0	1.10
8/01-8/04	807	3	5	1	2	2	0	0	0.02
Total	37,037	300	1663	685	712	46	107	66	225.48
Total CWT (recovered + partitioned)				829.17	794.13	52.19			

Table 11. Migration rates and duration for CWT chinook, Trinity River, 1989.

AD-CWT Code	# Recvrd	Rel. Date	Initial Capture Date	Initial Capture Rate (rk/d)	Mean Capture Date	Mean Capture Rate (rk/d)	10-90% Duration (days)	Duration Dates
6-61-49 (Spring)	685	5/26	6/04	15.6	6/19	5.8	30	6/5-7/5
6-56-35 (Fall)	712	6/12	6/16 (6/08)	35.0	6/22	14.0	18	6/19-7/7

Three chinook, AD-CWT code (6-56-35), captured 6/08, were not included in calculations, since capture date preceeded release date.

On June 12, TRH released fall run chinook smolts (tag code 6-56-35), also on site. Initial captures of AD-CWT chinook from this release group were on June 8, suggesting an escapement of tagged chinook from TRH or a lab error on our part. Since no further AD-CWT chinook from this group were recovered in following days these initial recoveries were not included in calculations regarding migration rates and durations. The next recovery of the fall AD-CWT chinook was on June 16 for an initial migrational rate of 35.0 (rkm/day). Mean capture date was June 22 yielding a mean rate of 14.0 (rkm/day). The duration of migration was 18 days.

The faster rate and shorter duration of fall AD-CWT chinook, when compared to the slower rate and longer duration of the spring AD-CWT chinook, is curious considering that the spring chinook were released at flows of 1000 cfs compared to flows of 800 cfs at the time of the fall release.

Population Estimates and Indices

Trap Efficiency

Trap efficiency tests were conducted weekly, from June 19 to July 25 encompassing the period of greatest emigration. Nearly all marked chinook were recovered the day following the day of release. Those few marked chinook captured in subsequent days were not included in trap efficiency calculations. During the tests, control group mortality rate was higher in four of six cases than the corresponding experimental group mortality rate. It is believed that the conditions in which the control and experimental chinook were held (ie: relatively small holding box, unshaded, and low velocity flow) had more to due with the observed mortality rate than the marking procedure. Therefore, it is believed that the observed mortality rates are not representative, and differential mortality of released chinooks was assumed to be zero.

Efficiency values ranged from 2.39% to 5.06% and were independent of river flow or volume sampled (Table 12). Since only six efficiency tests were conducted during 17 weeks of sampling, all efficiency values were pooled and a subsequent mean efficiency value (3.80%) was used to estimate the number of chinook migrating past the trapping location for a seven-day week, for all 17 weeks. The estimated population of chinook emigrating between April 4 and August 4 was 1,482,000 (Appendix D). Due to the use of a mean efficiency value, no attempt was made to derive confidence intervals for the population estimate. Expanding the calculated hatchery and natural stock component for the estimated chinook population results in an estimate of 788,000 hatchery chinook (339,000 spring run, 449,000 fall run), and 694,000 natural stock chinook.

Since over 4.7 million chinook were released from TRH alone, it appears our trap efficiency-based estimates were probably low, and/or there was high mortality of TRH chinook between release and trapping locations. Since the proportion of Ad-CWTs (between tag groups) released and recovered was approximately the same, substantial differential mortality of AD-CWT hatchery chinook is unlikely although substantial mortality may have occurred equally between tagged and non-tagged hatchery chinook. In addition, it is possible that our trap efficiencies were biased towards higher efficiency results than what were actually occurring. Although great effort was extended to mark and release fish in good condition, we had to assume that marked fish used for efficiency testing were able to avoid the trap as well as non-marked fish.

Aside from our marking and release methods, and the possibility of substantial post release mortality of hatchery chinook, it is possible that the sampling period did not fully encompass the entire emigration of chinook. At the time sampling was concluded (week of August 1 -7), catches were still relatively substantial (9.9% of peak week catch), indicating that the chinook emigration was still in progress. This would in part address some of the observed discrepancy between our population estimate and that expected considering the number of chinook released from TRH.

Table 12. Trap efficiencies, June 19 to July 26, Trinity River, 1989.

Test a/ Dates Day-1 Day-2	**Marked** Released Day 1	**Marked** Captured Day 2	Trapping Efficiency	**River Flow** Day-l Day-2 (cfs)	**Volume Sampled** Day-l Day-2 (cfs)
June 19 - 20	754	18	.0239	1520 1490	91.9 - 89.3
June 26 - 27	899	40	.0445	1330 1300	86.4 - 88.2
July 05 - 06	743	21	.0283	1340 1300	88.4 - 87.3
July 10 - 11	534	27	.0506	1220 1190	83.7 - 85.3
July 18 - 19	567	20	.0353	1080 1070	80.5 - 80.0
July 25 - 26	263	12	.0456	967 950	68.3 - 74.5
		Mean trap efficiency	**.0380**		

a/ **Day 1 = Day of release**
Day 2 = Day of capture

Chinook Abundance Index

Chinook abundance index values, based on catches and proportion of river discharge sampled, estimated 643,000 chinook to have migrated during the trapping season (April 4-August 4) for nights fished, and a total of 927,000 chinook to have emigrated during the same period for all nights (Appendix E). The highest weekly abundance index value (234,000) was calculated for the week of June 19-25 (Figure 17). The abundance index value for that week coincides with, and is partly as a result of, the season-high weekly catch total.

Sampling index values are a measure of trap sampling efficiency used to expand catch totals based on volume sampled and river discharge. The lower the sampling index value the greater the proportion of river volume sampled and the lower the catch expansion factor. Following a relatively significant change in trapping location on April 21, there was a significant drop in sampling index values reflecting a greater efficiency with respect to proportion of river flow sampled. Throughout the remainder of the trapping season, minor adjustments were made in trap positioning resulting in a high proportion of stream discharge being sampled, despite steadily decreasing flows. This increased efficiency was reflected in steadily decreasing sampling index values.

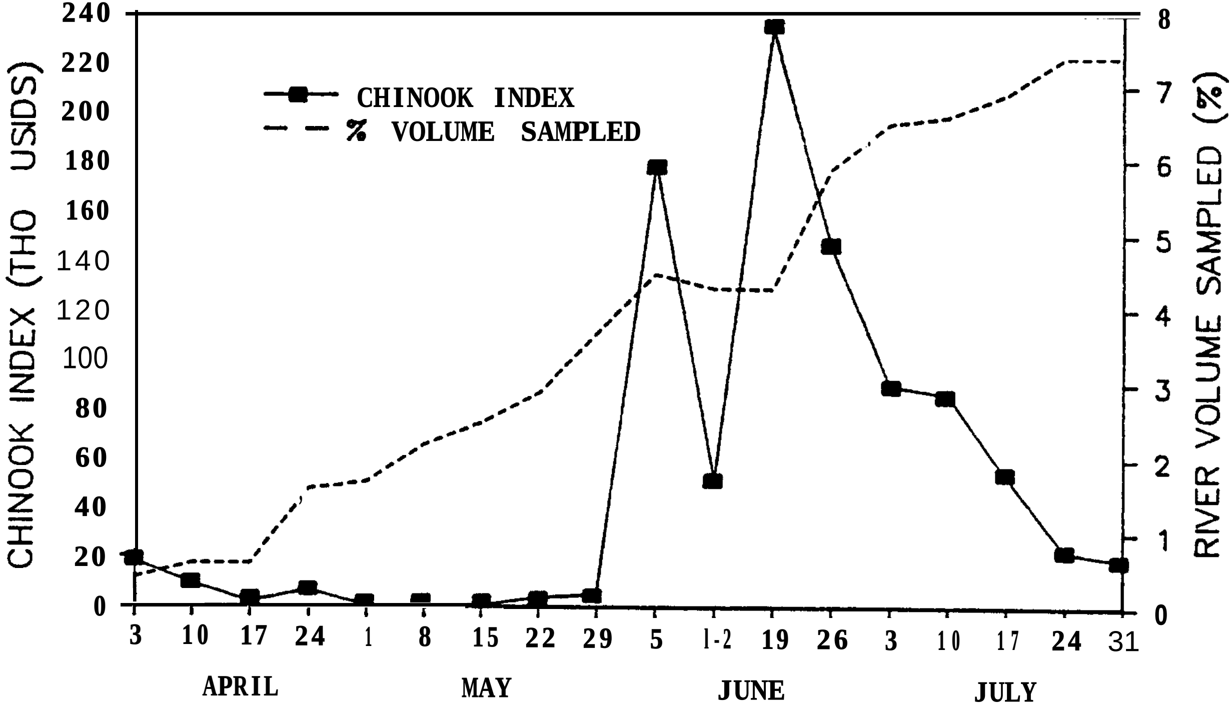

Figure 17. Chinook abundance index and percent river volume sampled rotary screw trap, Trinity **River, 1989.**

Steelhead

A total of 1,795 steelhead were captured during the sampling period. Catches of steelhead, relatively low in April, began to significantly increase by the end of the month (Figure 18). An initial emigration peak occurred the week of May 15-21 coinciding with the season-high week catch of coho salmon. Catches of steelhead and coho dropped sharply the following week (May 22-28). While catches of coho continued to decline in subsequent weeks, catches of steelhead increased dramatically. Season high weekly catches (463) and C/E values (154.3) occurred the week of May 29-June 4 (Table 13). The largest single day catch of the season (270) occurred June 4. Catches decreased substantially by the week of June 12-18 signaling the end of the major emigration period. Throughout the remainder of the sampling season, weekly catches varied little and were generally low. The bimodal emigration trend was also evident in 1988 (USFWS 1989).

The season high weekly catch (May 29-June 4) occurred during a period of decreasing flows, substantially increased water temperatures, and new moon (Figure 18). However, considering the distance involved between release and trap locations, the apparent relationship may be largely one of coincidence.

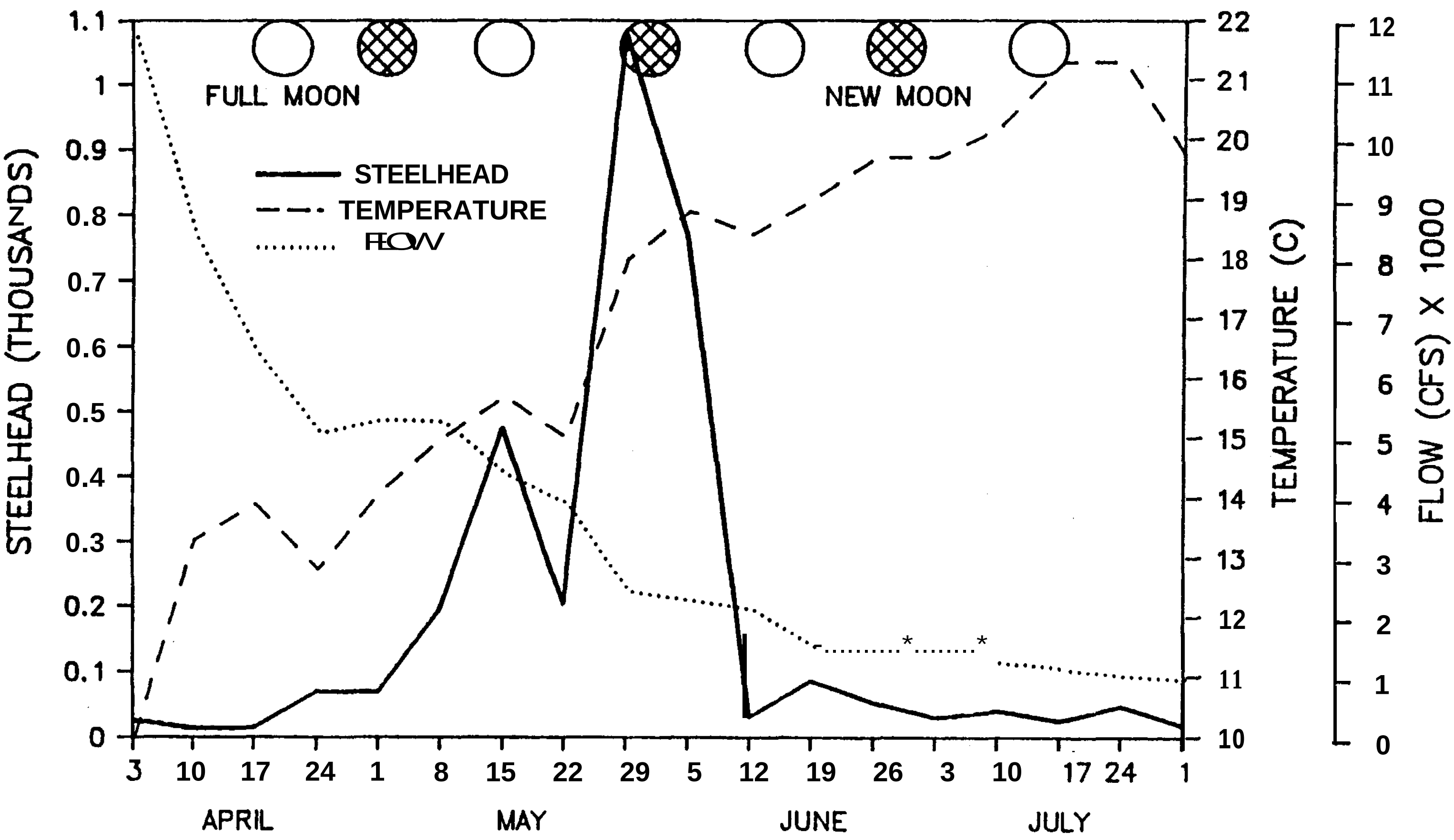

Figure 18. Steelhead catch with flow, temperature, and lunar phase, Trinity River, 1989. Catch represents seven day total based on weekly catch effort.

During the trapping season 1,017 steelhead were measured and all but five of these were classified to development stage. There was a bimodal length frequency grouping in April, indicating the presence of multiple age classes (Figure 19). The majority of steelhead in April were believed sub-yearling parr, although age analysis was not conducted. During May and early June, when emigration was greatest, the vast majority of steelhead measured were believed to be yearling and yearling-plus. Of the 753 steelhead measured and classified to development stage during this period (May 1-June 11), 698 (92.7%) were identified as smolts. Based on the condition of the fin margins (with particular emphasis on the dorsal), we estimated that 53% of the smolts evaluated were of hatchery origin during this period and were more abundant than steelhead of natural origin in four of the six weeks (Table 13). It was estimated that TRH produced up to 61% of the successful spring Trinity River smolt emigration during the years 1974, 1975, and 1976 (CDFG 1977). Hatchery smolts were significantly larger ($p<0.05$) than natural smolts although size was not used to discriminate between the two (Table 14). For the entire period of trapping, smolts accounted for 76.8% of all steelhead classified to development stage and an estimated 54% of these were of hatchery origin. Assuming that emigrating populations of steelhead are predominantly made up of fish undergoing or having completed the process of smoltification, then the observed majority of steelhead smolts in catches would indicate representative sampling of the emigrating population.

Table 13 . Steelhead catch, catch effort, and development stage by week, Trinity River, 1989.

Date	Days trapped	Total catch	C/E (sh/day)	Natural-stock fry	Natural-stock parr	Natural-stock smolt	Hatchery smolt	Not classified
4/03-4/09	4	16	4.0	1	8	4	3	0
4/10-4/16	4	8	2.0	0	6	1	1	0
4/17-4/23	4	9	2.3	0	8	0	1	0
4/24-4/30	6	61	10.2	5	24	13	16	3
5/01-5/07	7	69	9.9	0	19	22	28	0
5/08-5/14	4	113	28.3	0	5	35	69	4
5/15-5/21	4	272	68.0	0	1	98	86	87
5/22-5/28	4	116	29.0	1	9	41	61	3
5/29-6/04	3	463	154.3	1	8	59	71	324
6/05-6/11	4	439	109.8	2	9	73	55	300
6/12-6/18	5	23	4.6	1	1	4	3	14
6/19-6/25	5	62	12.4	5	1	3	13	40
6/26-7/02	5	38	7.6	22	2	4	10	0
7/03-7/09	5	22	4.4	13	1	0	4	4
7/10-7/16	5	30	6.0	29	1	0	0	0
7/17-7/23	4	15	3.8	13	2	0	0	0
7/24-7/30	4	28	7.0	21	5	0	0	2
7/31-8/06	4	11	2.8	6	4	0	0	1
Totals	81	1795		120	114	357	421	782

Table 14 . Steelhead development and associated length (mm) data, Trinity River, 1989.

Development Class	Sample Size	Mean Length	Range Min	Range Max	Standard Deviation
Fry	120	57.1	39	76	9.17
Parr	114	110.6	75	168	22.43
Smolt (Hatchery)	421	196.3	107	257	22.04
Smolt (Natural)	357	171.2	100	271	24.15

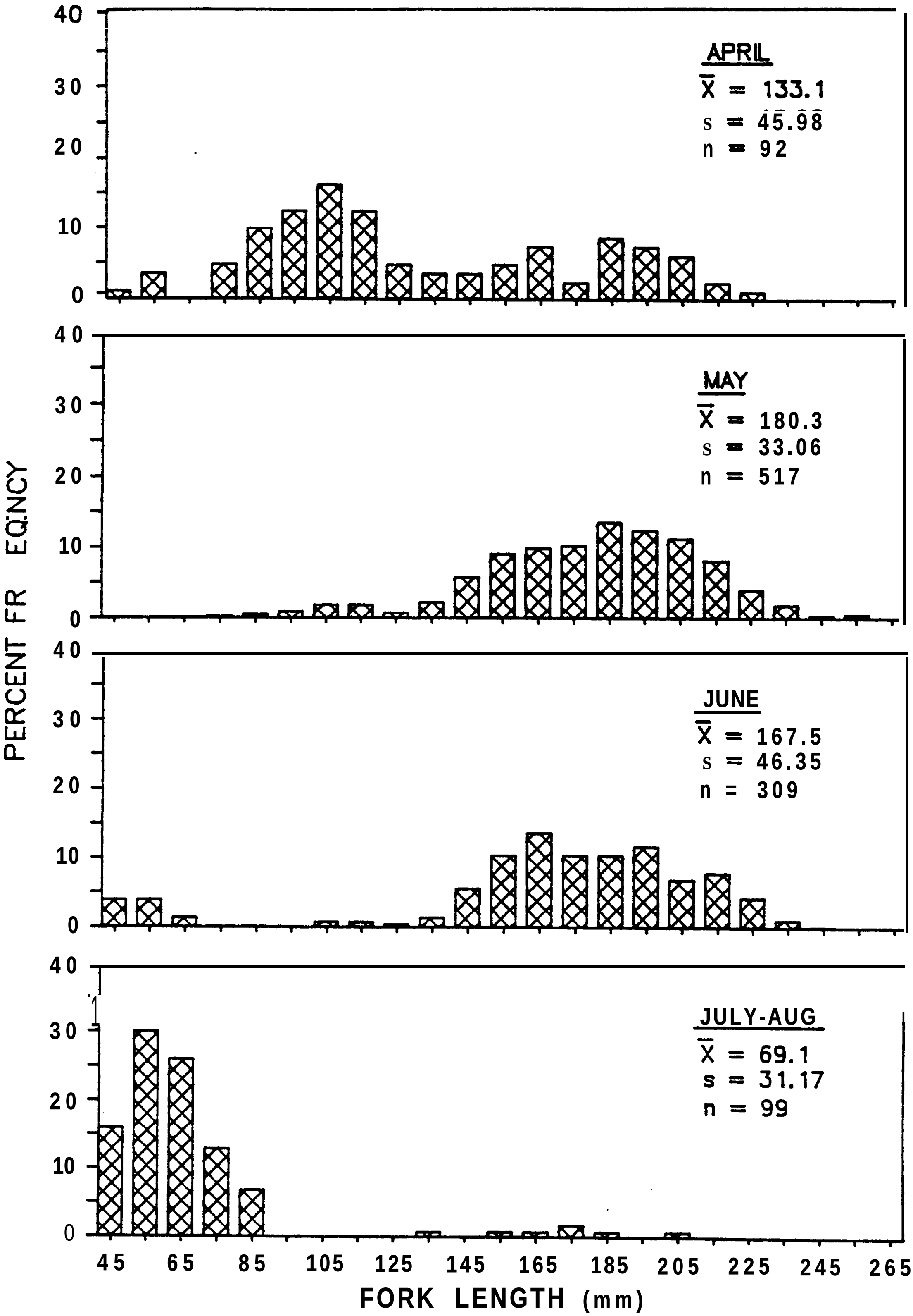

Figure 19. Steelhead fork length percent frequency by month, Trinity River, 1989.

As trapping progressed throughout June and July, the proportion of steelhead fry in catches substantially increased while the number of smolts substantially decreased. The capture of steelhead fry, as noted with chinook fry, indicates fairly significant and proximate emergence of natural stocks in the mainstem and/or emigration from the tributaries in the vicinity of the trapping site.

As a measure of condition or fit, displacements were taken from parr and both hatchery and natural smolt steelhead. During the sampling period, hatchery smolts had a greater condition factor (slope value 3.29) than natural smolts (3.07) (Appendix B). Steelhead parr had a condition factor value of 2.71.

Coho Salmon

A total of 1,260 coho were captured during the sampling period. Catches of coho, relatively low in April, increased dramatically in May (Figure 20). Coho emigration, as indicated by catches, was greatest the week of May 15-21 (374, C/E=93.5). The timing and duration of emigration was nearly identical to that observed with coho salmon at the Klamath River trap. Only two coho were captured from July to the end of the trap season (August 4).

For the season, 818 coho were measured to fork length (Figure 21). The majority of coho ranged in length from 115-165mm with a season mean of 140.1mm. A minor length grouping of fry size coho was observed in April and May. The occurrence of the fry suggest that emergence occurred in the relative vicinity either in the mainstem or in the local tributaries.

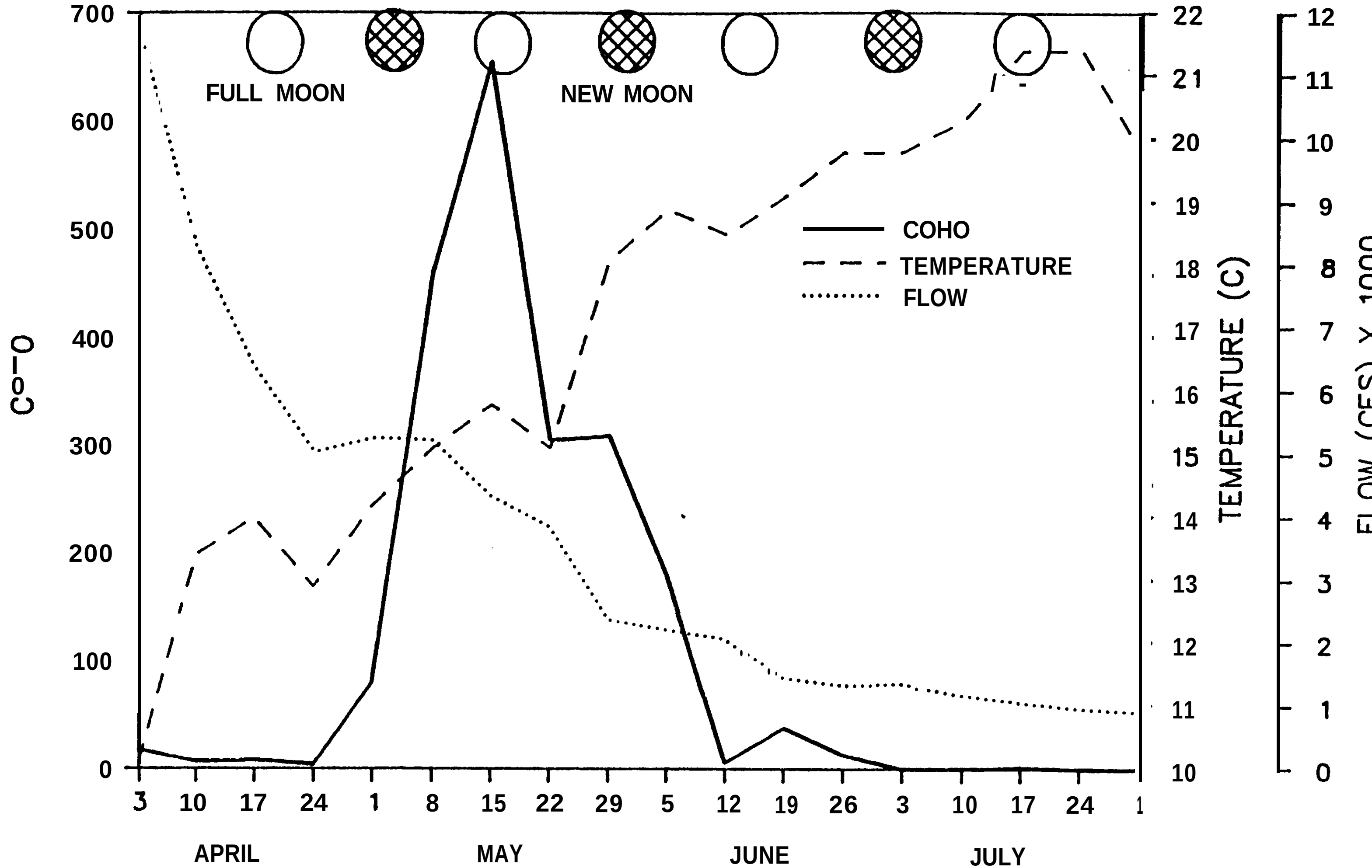

Figure 20. Coho catch, river flow and temperature, and lunar phase by week, Trinity River, 1989. Catch represents seven day total based on weekly catch effort.

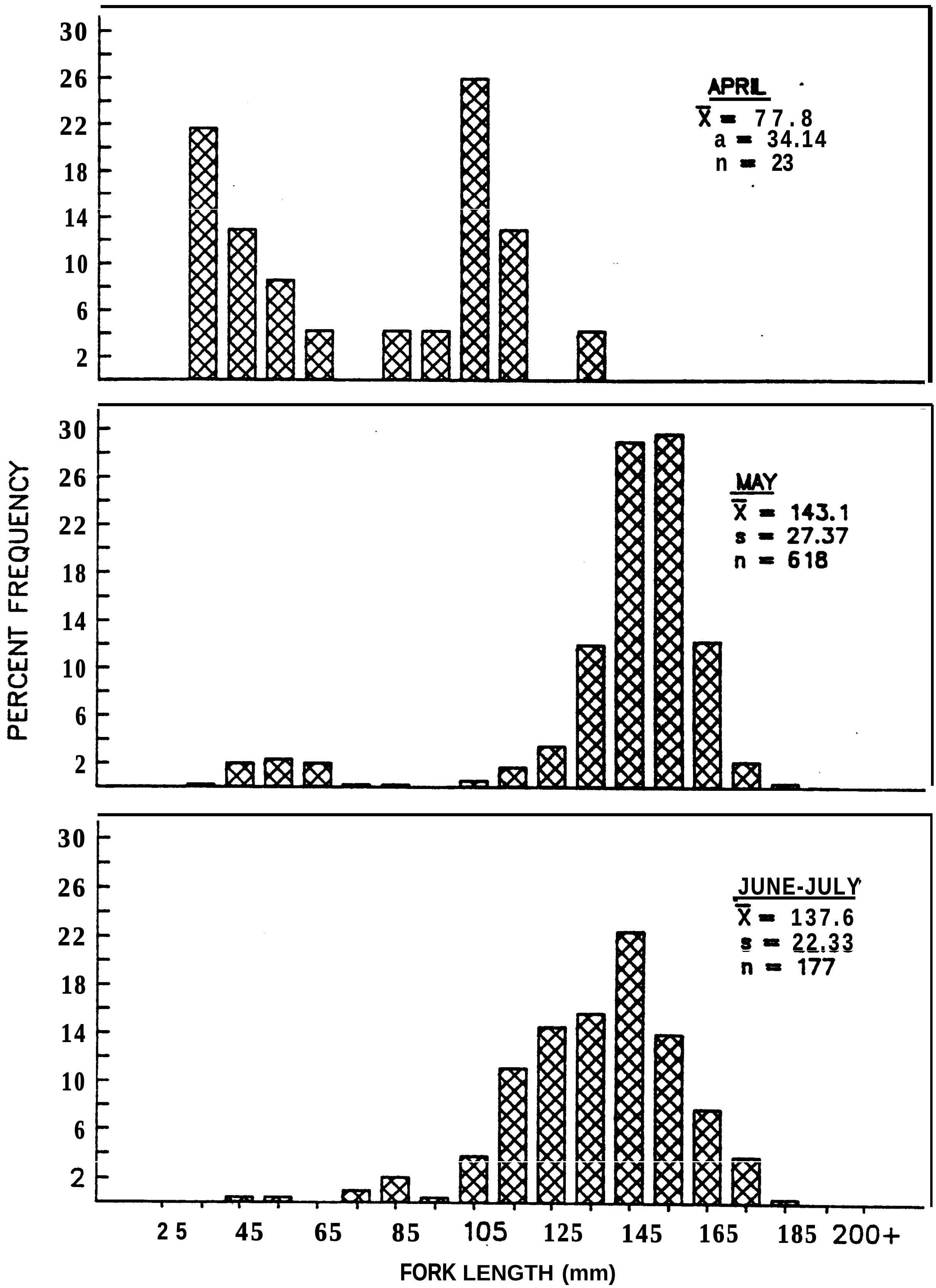

Figure 2 1. Coho salmon fork length percent frequency by month, Trinity River, 1989.

Of the 818 coho measured, 801 were identified to development stage (Table 15). Length frequency data indicated coho smolts accounted for the majority (86.3%) of coho identified to development stage. Coho parr exhibited a relatively wide length range and the highest standard deviation of any development stage which may indicate the presence of sub-yearling and yearling fish.

Displacements were measured on 417 coho in approximate proportion to the number of coho in each development stage (Appendix B). Coho parr had a greater condition factor value than smolts (3.14 to 2.72) which may reflect poorer condition of coho that had recently undergone, or were undergoing smoltification. Field crews noted that many of the coho smolts seemed quite thin although not obviously diseased. It was believed that most of these coho were of hatchery origin based on dorsal fin quality. However, the difference in fin quality between hatchery and natural was slight and therefore no quantitative assessment was conducted.

Table 15. Coho salmon development and associated length (mm) data, Trinity River, 1989.

Development Class	Sample Size	Mean Length	Range Min	Range Max	Standard Deviation
Fry	49	51.8	34	77	9.16
Parr	61	103.2	65	134	20.51
smolt	691	149.5	101	194	12.90

Other Species

During the sampling period a variety of salmonid and non-salmonid species were trapped. As was observed on the Klamath River, the Klamath smallscale sucker and Pacific lamprey (adult and juvenile) were the most commonly encountered non-salmonid species. The remaining non-salmonid species are listed in order of frequency: speckled dace, sculpin, threespine stickleback, catfish, golden shiner, and green sunfish. In addition, seven adult American shad were captured in July. All of the shad were found moribund and unspawned (four female, three male). Two juvenile green sturgeon (Acipenser medirostris) (total length 92 and 102 mm) were also captured in July. Other salmonids included a 48 cm brown trout (Salmo trutta) captured May 25. The brown trout was believed to be a sea run based on the silver pigmentation. Unfortunately a scale sample, which may have confirmed this belief, was lost. A single juvenile (65 mm) chum salmon (O. keta) was captured on July 27. Chum salmon typically emigrate as fry soon after they emerge from the gravel or, at most, after a brief period of stream rearing (Bell 1986). In addition, an adult chinook salmon (81cm)(male) was found moribund in the trap on July 25. The chinook, presumably spring-run, was found in relatively good condition, bright (silver), and with underdeveloped gonads.

MAINSTEM SEINING

Chinook Abundance

During the sampling period a total of 3,637 chinook were captured in 121 seine hauls for a season mean C/E of 30.1 chinook per seine. The greatest single day catch (851) occurred on June 26. Relative abundance as described by catch effort varied throughout the sampling season with the majority of chinook and highest C/E values occurring between June 12 and July 5. The greatest daily C/E value (90.8 chinook per haul) occurred on June 20 (Table 16). The highest weekly mean C/E value (63.9) occurred the week of June 19-25 (Figure 22). During the following week, the daily mean number of chinook captured (557) was the highest for the season and a weekly mean C/E of 59.2 was observed. The timing of greatest chinook abundance, as indicated by seine catches, was similar to that observed at the upstream rotary screw traps.

Table 16. Seining catch and catch effort by sample day, Klamath River, 1989.

Date	Sets	# Chinook(Ad-CWT)		C/E	Steel head	Coho
05/31	14	108	(0)	7.7	2	0
06/01	8	122	(0)	15.3	1	0
06/06	5	83	(0)	16.6	6	0
06/07	4	41	(0)	10.3	7	7
06/12	6	150	(5)	25.0	1	2
06/14	6	178	(16)	29.7	2	1
06/15	4	100	(2)	25.0	4	3
06/20	4	363	(21)	90.8	1	0
06/21	4	148	(7)	37.0	0	0
06/26	12	903	(52)	75.3	4	0
06/28	8	421	(12)	52.6	2	0
06/29	7	348	(14)	49.7	10	0
07/05	9	204	(8)	22.7	0	0
07/06	7	138	(6)	19.7	1	0
07/10	8	125	(4)	15.6	0	0
07/12	7	99	(3)	14.1	1	1
07/13	8	106	(1)	13.3	0	0
Totals	121	3637	(151)	30.1	42	14

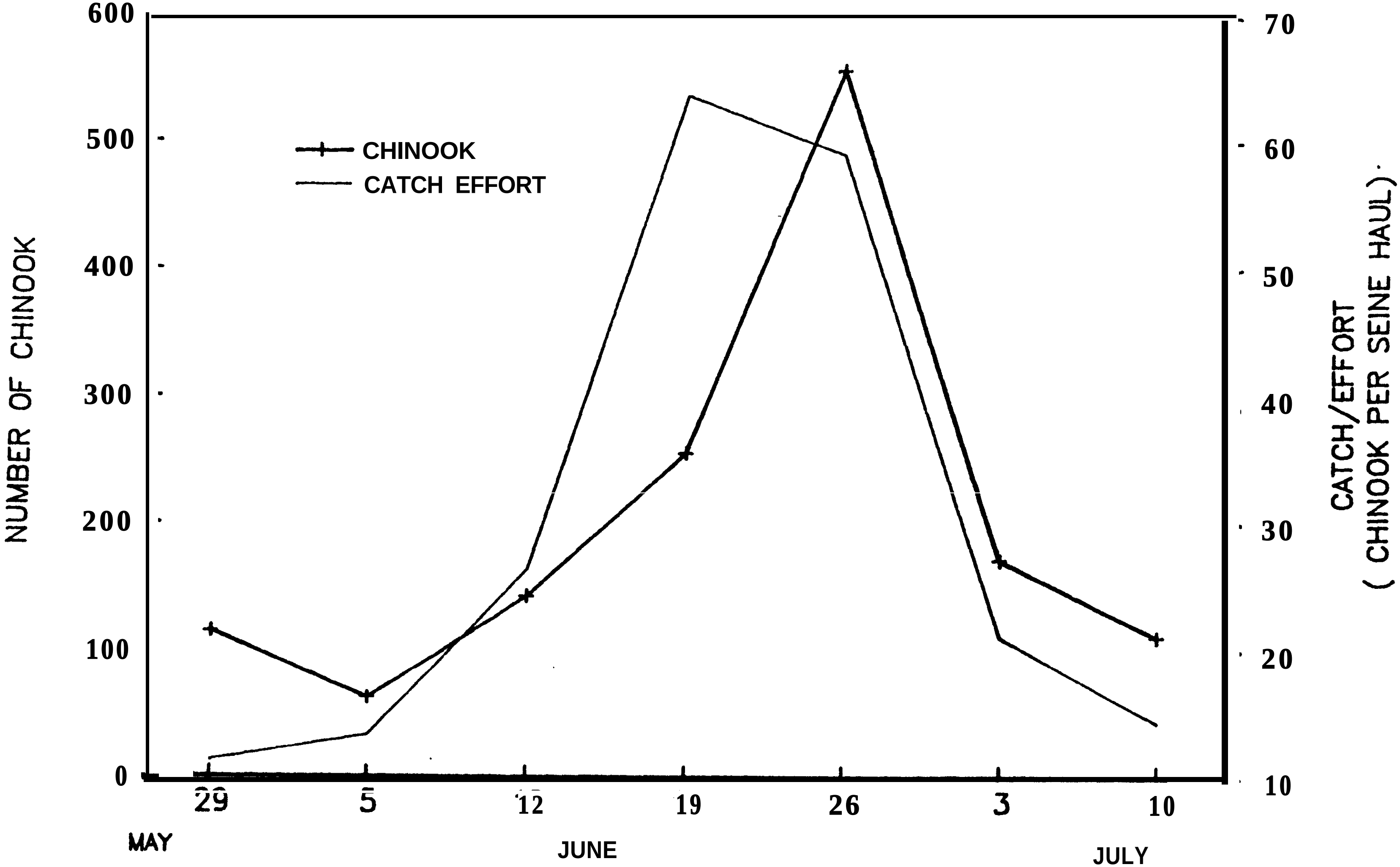

Figure 22. Doily average chinook catch and catch effort for days seined, by week, Klamath River, 1989.

Chinook Size and Development

Mean fork length of chinook captured May 31 to June 7 were indicative of presumably natural stocks based on the relatively small mean length and absence of hatchery CWT chinook. A significant ($p<0.05$) increase in mean length was observed with chinook captured June 12 (Table 17). The date of increase in chinook mean length coincides with the first captures of TRH CWT chinook. Mean length was over 10 mm greater than that of the previous sample date and indicates the influence of the larger hatchery chinook in catches. Interestingly, mean length of chinook captured the following sample date (June 14), decreased significantly ($p<0.05$). The decrease in mean length may be attributed to a high incidence of natural stock chinook from Blue Creek (rkm 26.4). This is supported by several factors: seine sites on June 14 were from river kilometer 20 to 26.2, and of sixteen AD-clip chinook recovered this date, nine were tagged on Blue Creek (USFWS 1990) (Appendix A). The seven remaining AD-clipped chinook had no tag but their respective lengths were similar to the lengths of the Blue Creek AD-CWT chinook recovered.

Mean fork lengths increased significantly ($p<0.05$) June 15 when seining was conducted on the lower 8 kilometers of the sampling area. The only AD-clip chinook captured was of TRH origin. The absence of Blue Creek CWT chinook may indicate rearing behavior near the confluence of Blue Creek and the Klamath River and/or a slow migration rate. Mean length decreased significantly ($p<0.05$) the following sample date (June 20) when sampling was again conducted from river kilometer 20 to 26.2. Of the twenty tags recovered this date ten were from Blue Creek. Mean lengths varied little throughout the remainder of the sampling season, increasing to 89mm by the last sampling date (July 13).

Table 17. **Number and length (mm) data for non-CWT and CWT chinook captured seining, Klamath River, 1989.**

Sample Date	# Non-CWT Chinook Measured	X	s	TRH 6-61-49 #	X	s	TRH 6-56-35 #	X	s	IGH 6-1-2-1-1 #	X	s	IGH 6-1-2-1-2 #	X	s	Blue Creek 5-1-1-1-6 #	X	s
5/31	105	69.4	13.07	0			0			0			0			0		
6/01	120	68.9	11.03	0			0			0			0			0		
6/06	70	71.1	10.32	0			0			0			0			0		
6/07	40	71.1	10.58	0			0			0			0			0		
6/12	131	81.3	9.04	5	82.6	3.36	0			0			0			0		
6/14	130	74.1	10.39	0			0			0			0			9	61.3	4.83
6/15	86	84.8	6.71	1	95.0	n/a	0			0			0			0		
6/20	186	79.8	8.04	5	83.4	4.39	5	85.0	2.00	0			0			10	63.6	6.00
6/21	48	82.0	4.78	3	79.7	0.58	2	83.5	2.12	1	76.0	n/a	0			0		
6/26	214	82.0	5.59	9	83.4	4.36	10	81.8	5.67	2	78.0	4.14	5	75.4	6.80	17	74.3	7.33
06/28	122	82.0	6.48	1	85.0	n/a	3	82.3	4.04	3	75.3	5.51	0			1	67.0	n/a
6/29	95	83.1	6.35	1	87.0	n/a	6	80.5	6.60	0			0			4	74.5	1.73
7/05	109	84.3	10.84	0			2	90.0	0.00	2	86.0	1.41	1	97.0	n/a	1	59.0	n/a
7/06	78	85.9	5.16	0			2	95.5	0.71	0			1	83.0	n/a	1	77.0	n/a
7/10	101	86.3	5.67	0			1	95.0	n/a	0			0			3	73.3	2.52
7/12	59	86.3	6.66	0			0			0			0			2	69.5	0.71
7/13	63	88.9	6.51	0			0			0			0			1	77.0	n/a
Total	**1757**			**25**	**83.5**	**4.43**	**31**	**84.1**	**6.20**	**8**	**78.8**	**7.67**	**7**	**79.6**	**9.90**	**49**	**70.0**	**8.04**

Hatchery and Natural Stock Estimate

Of the 3,637 total chinook captured, 151 were AD-clipped (Table 18). Of the 127 CWTs recovered, 44.1 % were of TRH origin followed by chinook tagged on Blue Creek and IGH (38.6 and 14.2% respectively). Eighteen chinook (11.9%) had shed their tag and six (4%) were lost during tag removal procedures.

Of concern is the low percentage of IGH CWT chinook recovered. Combining the number of CWT chinook released from IGH and TRH for all tag groups generates a total of 676,185 CWT chinook available. Of this total, 385,856 (57.1%) were from TRH and 290,329 (42.9%) were from IGH. CWT chinook should have been sampled in approximately these proportions assuming non-differential mortality and equal susceptibility to sampling gear. Although sampling did not occur daily, CWT recoveries for all tag groups did occur approximately mid-sampling season and may be assumed to be a reasonable representation of the CWT chinook migrations. Of the 74 tags recovered attributable to either hatchery, 56 (75.7%) were from TRH and only 18 (24.3%) were from IGH. The disparity between the proportion of IGH CWT released and actual recoveries suggest the possibility of greater mortality with the IGH CWT chinook than those of TRH.

Based on CWT recoveries and partitioned CWT recoveries, a contribution of 1,540 (42.3%) hatchery chinook, and 2,097 (57.7%) natural stock chinook, was estimated from total chinook seined. It can be anticipated that as one samples the chinook population progressively lower in the river system, the percentage of natural stock chinook should increase due to greater influence of chinook from tributaries and possible mainstem spawning and due to possible additional post release mortality of hatchery chinook. This increase in the proportion of natural stock chinook is supported by estimates of natural stock chinook captured at the Klamath and Trinity River rotary traps located upstream (52 and 47% respectively). It is unlikely however, that production from both tributaries and mainstem spawners located between the rotary screw traps and seine locations, was sufficient to account for the observed increase in the proportion of natural stocks calculated with seine catches. Much of the calculated increase in natural stocks could be explained by even limited levels of differential mortality of AD-CWT chinook greater than that of non-AD-CWT hatchery chinook and/or substantial mortality of all hatchery stocks.

Migration Rate and Duration

The duration and rate of migration for CWT chinook released from IGH and TRH were determined based on a median location (rkm 17.8) (Table 19). Several tagging programs (Trinity and Blue Creek natural stocks) have a broad release time making specific duration and migration rates difficult. Duration of migration for both TRH spring and fall chinook was similar (14 and 15 days respectively). Based on mean recapture date the TRH fall chinook migrated at a faster mean rate than the spring chinook (13.6 to 7.9 rkm/day respectively). By comparison, IGH fall chinook had a shorter migration duration (10-14 days) and, despite flows that were nearly three times greater than Trinity River flows, had a slower mean migration rate (11.1-11.4 rkm/day) than TRH fall chinook. Information on IGH pre-smolt chinook is given but due to the low number of CWT recoveries must be viewed with caution.

Table 18. Chinook CWT recoveries, lost tags, no tags, and (recovered plus partitioned CWT's) by sample date, Klamath River seining, 1989.

Sample Date	TRH 6-61-49	TRH 6-56-35	TR-Wild B6-13-06	Horse Linto 6-29-23	IGH Six-01	IGH Six-02	IGH B-series	Blue CK 5-1-1-1-6	Lost CWT	No CWT
06/12	5	0	0	0	0	0	0	0	0	0
06/14	0	0	0	0	0	0	0	9(16)	0	7
06/15	1(2)	0	0	0	0	0	0	0	1	0
06/20	5(5.25)	5(5.25)	0	0	0	0	0	10(10.5)	0	1
06/21	3(3.5)	2(2.33)	0	0	1(1.16)	0	0	0	1	0
06/26	9(10.4)	10(11.56)	1(1.16)	1(1.16)	2(2.31)	5(5.78)	0	17(19.64)	2	5
06/28	1(1.09)	3(3.27)	0	1(1.09)	3(3.27)	0	2(2.18)	1(1.09)	0	1
06/29	1(1.16)	6(7.0)	0	0	0	0	1(1.16)	4(4.67)	2	0
7/05	0	2(2.29)	0	1(1.14)	2(2.29)	1(1.14)	0	1(1.14)	0	1
7/06	0	2(3.0)	0	0	0	1(1.50)	0	1(1.50)	0	2
7/10	0	1	0	0	0	0	0	3	0	0
7/12	0	0	0	0	0	0	0	2(3.0)	0	1
7/13	0	0	0	0	0	0	0	1	0	0
Total	25(29.21)	31(35.70)	1(1.16)	3(3.39)	8(9.03)	7(8.42)	3(3.34)	49(61.54)	6	18

Table 19. Migration rate and duration of CUT chinook captured seining (rkm 17.8), Klamath River, 1989.

CUT Code	Hatchery	Release Date	Initial Caoture Date	Initial Caoture Rate (rkm/day)	Mean Caoture Date	Mean Caoture Rate (rkm/day)	10-90% Ouration (days)
B-series	IGH	4/24	6/28	3.5	6/28	3.5	n/a
6-1-2-1-l	IGH	6/02	6/21	15.2	6/28	11.1	14
6-l-2-1-2	IGH	6/02	6/26	12.0	6/29	11.4	10
6-61-49	TRH	5/26	6/12	13.5	6/21	7.9	14
6-56-35	TRH	6/12	6/20	25.5	6/27	13.6	15

Comparing migration data calculated at both the rotary screw traps and with seining indicate relatively little change in the migration rates between the respective hatcheries and the median seine location. Chinook pre-smolts released from IGH (April 24) migrated to the rotary screw trap (rkm 81) at a mean rate of 4.0 rkm/day and to the median seine location at a mean rate of 3.5 rkm/day. IGH smolt chinook which migrated to the rotary screw trap at a mean rate of 10.7 rkm/day continued the additional 64 rkm to the median seine location at approximately the same rate (11.1 to 11.4 rkm/day). TRH spring chinook had a slightly faster mean migration rate to the median seine location (7.9 rkm/day) than was calculated at the rotary screw trap (5.8 rkm/day) while the fall chinook had a slightly slower mean rate to the seine location (13.6 rkm/day) than was calculated 64 rkm upstream at the rotary screw trap (14.0 rkm/day).

Development of yearly indexes regarding migration duration and rates will allow comparisons between years and may be related to flows and or other environmental conditions. This information may be of value to hatchery release programs to help facilitate optimum migration and survival of hatchery releases.

Other Species

A total of 42 steelhead and 14 coho salmon were captured. Mean fork length of steelhead was 132mm and coho was 77mm. The relatively low number of steelhead captured may be due to their ability to avoid the seine and preference for higher velocity flows in areas unavailable to a hand set seine. The low number of coho captured may be attributable to the fact that coho migration had already peaked before the onset of seining. Rotary screw traps on the upper Klamath and Trinity River registered a peak coho migration by the middle of May. The discontinued mainstem Klamath River rotary screw traps both registered increasing numbers of coho right up until trap failures in mid May.

Other species captured by the lower mainstem rotary screw traps and subsequent seining included brown trout, juvenile lamprey, three-spine stickleback, speckled dace, prickly sculpin (Cottus asper), staghorn sculpin (Leptocottus armatus), Klamath smallscale sucker, and golden shiner.

ESTUARY SEINING

Chinook Abundance

The highest catch/per seine effort (C/E) occurred during the high slack stage (322), and early afternoon (89.3). However, these results may not be representative; the high slack C/E was based on one seine haul, and only six hauls were made after 1200 hours, all on the same day (August 1, 1989). This day was the largest chinook catch (534) date, representing 56.9% of the season total (939). For all other sampling dates, the catches were very small, regardless of time or tidal stage.

The weekly and overall season catches were substantially less than the 1988 juvenile seining season. This may be explained by a decrease in abundance of juvenile chinook within the lower estuary, or the distribution of chinook has shifted from in-shore to off-shore areas that are inaccessible to the seine. The decrease in abundance may stem from either a reduction in the number of juveniles reaching the estuary or from diminished residence time within the estuary. However, the apparent disparity in catches between years may be primarily a function of sampling efficiency. Seining in 1988 was conducted entirely in the early morning hours (low light conditions) and within a channel which surrounded an island from which seining efforts concentrated. Seining in 1989 was conducted over a greater period of the day (greater light intensity) and, although sampling again focused on the channel surrounding the island, the depth of the channel had decreased. Therefore, comparisons of catch and catch effort between these two years are tenuous.

During the time period of the 1989 juvenile sampling, considerable juvenile chinook were captured (crowded to the shore) in the adult beach seine net (150m length x 6m depth x 3.2cm bar mesh); however these chinook escaped through the net mesh. Based on this observation, it appears that juvenile chinook were in at least fair abundance throughout the season, however they were frequenting deeper areas of the estuary that were inaccessible to the juvenile seine. This is supported by data collected by the CDFG. The CDFG has conducted juvenile salmonid sampling in the estuary since 1985 (Zuspan M., personal communication,). Daytime seining and mid-channel trawling, and nighttime electroshocking have been conducted concurrently. Results indicate that mid-channel trawling has captured larger chinook than seining. However, catches have been relatively low with either method. Electroshocking has been the most successful capture method with regard to catch effort, and has resulted in chinook catches of the greatest size range. In addition, it has been determined that larger chinook were utilizing shallower areas of the estuary at night. In an effort to increase our sample size and quality of catch, it is proposed that seining by this office, in following years, be conducted entirely at night.

Chinook Size, Development, and Condition

The mean length of sampled chinook increased over the ten weeks of sampling, from 94.6mm to 112.9mm (Table 20). The mean of all chinook measured was 100.2mm, and was significantly larger ($p<0.05$) than the mean length of all chinook captured at rotary screw traps and during mainstem seining. All chinook captured were classified as smolts.

Table 20. Weekly catch of chinook salmon, catch per effort (C/E), mean length (mm) and standard deviation (sd), Klamath River estuary, 1989.

Sample Date	Seine Hauls	Chinook Catch	(C/E)	Length Data n	$\bar{X}$	sd
07/19	7	12	1.7	12	94.6	9.92
07/26	8	6	0.8	6	91.3	5.24
08/01	6	534	89.0	103	94.6	7.31
08/09	8	51	6.4	51	99.3	7.91
08/16	8	53	6.6	53	94.3	5.35
08/23	9	95	10.6	64	100.5	6.03
08/30	9	96	10.7	81	105.4	8.24
09/06	9	34	3.8	34	103.4	8.42
09/13	6	48	8.0	48	108.7	8.45
09/20	8	10	0.8	10	112.9	7.98
Totals	78	939	12.0	462	100.2	9.12

Volumetric displacements were recorded from 378 chinook (Figure 23). The mean length of these chinook was 101mm, and did not differ ($p<0.05$) in size from all chinook measured. The mean displacement was 11.5ml. The regression slope value of 2.91 was greater than the slope value calculated for chinook captured at the Trinity River rotary trap (2.86) and less than calculated for chinook captured at the Klamath River Rotary trap (3.12) (Appendix B). The slope value, as a measure of condition, was identical to that calculated with chinook captured during estuary seining in 1988.

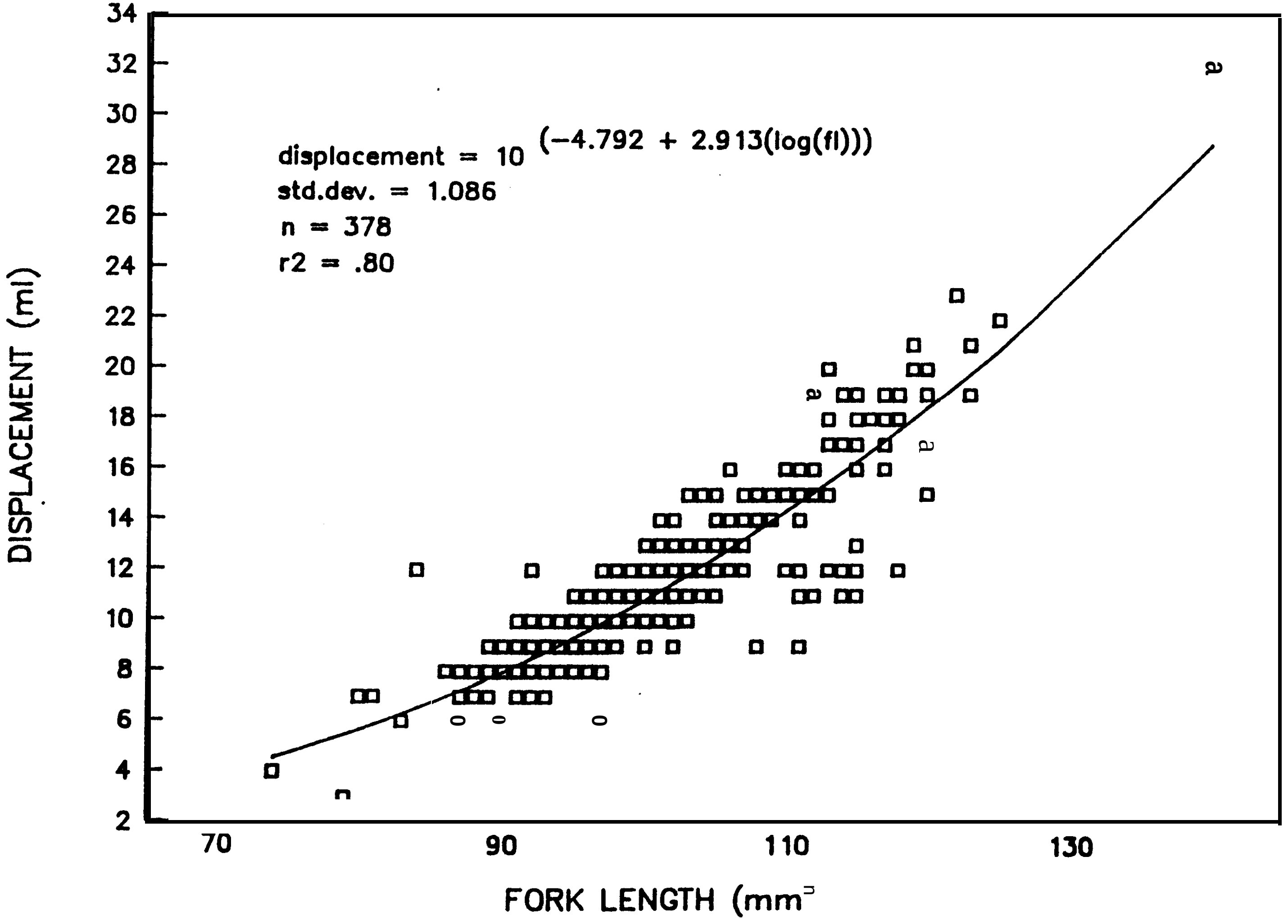

Figure 23 Chinook length–displacement relationship, Klamath River Estuary, 1989.

Chinook AD-CWT Recoveries

Of the 939 chinook sampled, ten were AD-clipped and eight CWT's were recovered (Table 21). The observed AD-clip rate (1.06%) was lower than
observed at the rotary screw traps (1.45% Klamath River, 4.45% Trinity River), and with Klamath River mainstem seining (4.15%). Due to the limited AD-CWT recoveries, no attempt was made to calculate a hatchery and natural stock estimate or a migration rate for AD-CWT chinook. Despite the low number of AD-CWT's recovered, nearly every IGH and TRH tag group was represented.

Table 21. CWT recoveries from chinook captured by seine in the Klamath River estuary, 1989.

Sample date	CWT code'	Number recovered	Lost or/ no tags	Release date	Number released	Release site
8/01	6-1-2-1-1	2	2	6/02/89	111,299	IGH
	6-61-49	2	0	5/26/89	188,036	TRH
8/09	6-56-35	1	0	6/12/89	197,820	TRH
8/23	6-1-2-1-2	1	0	6/02/89	86,629	IGH
	B6-13-06	1	0	3/29-5/12	15,703	TRW
9/16	B6-14-13	1	0	4/24/89	38,222	IGH

TRW = Trinity River natural tagging program (CDFG)

Other Species

During estuary seining, 338 steelhead and five cutthroat trout (O. clarki) were captured. Catches of steelhead were highly variable through the season, dependant more on sample location than tidal stage or time. Mean length (mm) of steelhead varied weekly (Table 22). Although steelhead were not classified to development, there was a wide length range observed indicative of multiple age classes. The season mean length of all steelhead measured (215mm) was greater than observed with steelhead smolts at upstream sample locations. The difference in size is more pronounced considering that steelhead fry and parr (based on length data) were included in season mean length calculations of estuary captured steelhead. The five cutthroat trout were all measured to length (X = 280mm, sd = 38.9).

Table 22. Weekly catch of steelhead, catch per effort (C/E), mean length (mm) and standard deviation (sd), Klamath River estuary, 1989.

Sample Date	Seine Hauls	Steelhead Catch	(C/E)	Length Data n	X	sd
07/19	7	19	2.7	19	226.3	37.12
07/26	8	2	0.3	2	251.0	16.97
08/01	6	114	19.0	53	193.9	26.77
08/09	8	3	0.4	3	172.0	28.62
08/16	8	16	2.0	16	172.0	24.63
08/23	9	4	0.4	4	273.3	52.03
08/30	9	8	0.9	8	237.3	39.81
09/06	9	167	18.6	47	219.7	34.40
09/13	6	0	0.0	0	-	-
09/20	8	5	0.6	5	82.4	75.60
Totals	78	338	4.3	157	215.1	57.54

A wide variety of non-salmonid fish were also captured during estuary seining and are listed in order of occurrence: smelt (family Osmeridae), sculpin, threespine stickleback, shiner surfperch (Cymatogaster aggregata), starry flounder (Platichthys stellatus) and Klamath smallscale sucker. In addition, a single pipefish (family Syngnathidae), and a saddleback gunnel (Pholis ornata) were also captured. The marine species were captured predominantly on incoming and high tides.

RECOMMENDATIONS

This season marks the second year of juvenile salmonid investigations in the Klamath River basin and represents the first year of sampling with the rotary screw trap. Comparisons between the 1988 trapping results (utilized fyke nets at the same sample locations) and the 1989 trapping results indicate a disparity of both numbers and age class of fish captured. It is apparent that the rotary screw traps captured a greater number and greater size range of fish, and their use is therefore considered to be a successful change in trapping method. However, catch comparisons between the Klamath River and Trinity River rotary screw traps indicate that there are still some problems to address concerning the Klamath River trap. It appears that the Klamath River trap never attained an optimal "fishing" position within the river as we believe the Trinity River trap did. The primary reason for this shortcoming was that due to concern for trap equipment and personnel safety, we were hesitant to fish the trap in the main thalweg of the Klamath River where river flows were generally three times that of the Trinity River. Improved anchoring gear, strengthened rotary cone components, and the addition of safety railings may help to alleviate these problems. In addition, there is a need to develop supplemental trapping methods to secure sufficient numbers of fish to allow for additional rotary trap efficiency tests.

Recommendations for mainstem seining include: 1) seining be conducted over a greater length of river at more established intervals and sites; 2) seine net size (length and depth) be increased and set by boat; 3) that the length of the seine haul be increased to effectively sample a greater area; and 4) measure the area seined on a per haul basis to develop a relative abundance index, thereby supplementing the simple catch per effort method used this year. The use of a boat to deploy the seine net would allow for sampling of a greater portion of the thalweg previously inaccessible to a hand set seine. As previously mentioned, it is recommended that estuary seining be conducted at night. This method change alone may increase the sample size sufficiently enough to allow for the desired analysis on estuary residence time, migration rates, hatchery and natural stock component, as well as describe the period of ocean entrance.

Recommendations inclusive to all sampling methods and areas include: 1) initiate sampling earlier in the year (February-April) to facilitate data collection on coho and steelhead emigrations; 2) continue sampling into the fall to assess yearling chinook, coho, and steelhead emigration; and 3) begin collection of scale samples for age analysis. Having completed the second season of juvenile salmonid investigations, it is apparent that sampling design modifications will continue to be a necessary function of this program. As investigations continue however, it is probable that such changes will become less frequent and the most efficient sampling methods will be established.

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PERSONAL COMMUNICATION

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APPENDICES

Appendix A: CWT and non-mark salmonid release information, Klamath and Trinity Rivers, 1989.

Appendix B. Length-volume regression analysis.

Appendix C: Chinook abundance index, Klamath River, 1989.

Appendix D: Chinook population estimate by week using mean trapping efficiency value (.0380), Trinity River, 1989

Appendix E: Chinook abundance index, Trinity River, 1989.

Appendix A: CWT and non-mark Salmonid release information, Klamath and Trinity Rivers, 1989.

Iron Gate Hatchery

Species	Size	CWT-code	#Released	Non-CWT Released	Total Released	Release Information
Chinook (presmolts)	210-439/lb	B6-14-13	38,222	3,253,599	3,346,000	Released 4/24, 1989, on site (rkm 305.8), Klamath River.
	210-439/lb	B6-15-03	13,111			
	210-439/lb	B6-15-04	14,552			
	210-439/lb	B6-15-07	15,654			
	210-439/lb	B6-15-10	10,862			
Chinook (smolts)	82-169/lb	6-1-2-1-1	111,299	6,642,072	6,840,000	Released 6/02, 1989, on site.
	82-169/lb	6-1-2-1-2	86,629			
Chinook	n/a	6-28-10	n/a	n/a	n/a	Elk Creek, scheduled for release 10/89. Pond failure; escapement/survival unknown (pers. comm. Chesney, B.,CDFG)
Coho (yearl ing)	13/lb	6-59-38	42,096	34,104	76,200	Released 3/15,1989, on site.
	13/lb	no CWT	n/a	n/a	16,800	Beaver Creek, 4/26& 5/17,198

Appendix A: CWT and non-mark salmonid release information, Klamath and Trinity Rivers, 1989 (continued).

Species	Size	CWT-code	#Released	Non-CWT Released	Total Released	Release Information
			IGH (continued)			
Coho (yearling)	13/lb	no CWT		n/a	25,200	Elk Creek, Released 4/27,5/1,5/3, 1989.
		no CWT		n/a	25,200	Indian Creek, Rel. 5/8,5/10,5/18,1989.
Steelhead	n/a	no mark		n/a	219,000	Released at IGH, 5/16,1989.
			Trinity River Hatchery			
Spring Chinook	73/lb	no CWT		899,944		Released 5/26/89, on site (rkm 178), in 1,000 cfs.
Spring Chinook	83/lb	6-61-49	188,036	275,934	1,938,914	
Spring Chinook	100/lb	no CWT		575,000		
Fall Chinook	73/lb	6-56-35	197,820	1,189,180		Released 6/12/89, on site, in 800 cfs.
Fall Chinook	91/lb	no CWT		986,986	2,822,022	
Fall Chinook	101/lb	no CWT		448,036		
Steelhead	8.5/lb	no mark			5,100	Released at Sawmill site, 3/1/89.

Appendix A: CWT and non-mark Salmonid release information, Klamath and Trinity Rivers, 1989 (continued).

Species	Size	CWT-code	#Released	Non-CWT Released	Total Released	Release Information
			TRH (continued)			
Steelhead	8.5/lb	no mark	n/a	n/a	525,100	Released at TRH on site, 4/3/89. Dorsal fin erosion noted on both release groups.
Coho (yearling)	13.0/lb	no mark	n/a	n/a	421,100	Released 3/20/89, on site, in 150 cfs.
			Trinity River Natural Chinook			
Natural Chinook	n/a	B6-13-06	15,703		15,703	Released 3/29 to 5/12, 1989, at rkm 145. (personal communication Mark Zuspan, CDFG)
			Blue Creek Natural Stock			
Chinook	38-76mm	5-1-1-1-6	10,071	n/a	n/a	Tagged and released 4/29 to 7/21, 1989, on Blue Creek. (USFWS 1990)
			Horse Linto			
Chinook	n/a	6-29-23	25,584	6,544	32,128	6-29-23 released at Horse Linto Creek on 5/26/89. (personal communication, Mary K. Buck, United States Forest Service)
Chinook	n/a	6-29-24	25,803	n/a	n/a	

Appendix B. Length-volume regression analysis.

Klamath River chinook at Big Bar (rotary screw trap).

Regression Output	
Constant	-5.21556
Std. Error of Y Estimate	0.081842
R Squared	0.955941
# of Observations	168
Degrees of Freedom	166
X Coef(s) .(Slope)	3.125572
Std. Error of Coef.	0.052080

Klamath River steelhead at Big Bar.

Regression Output	
Constant	-4.88162
Std. Error of Y Estimate	0.098103
R Squared	0.959096
# of Observations	81
Degrees of Freedom	79
X Coef(s).(Slope)	2.948378
Std. Error of Coef.	0.068504

Klamath River coho at Big Bar.

Regression Output	
Constant	-5.16965
Std. Error of Y Estimate	0.095972
R Squared	0.977317
# of Observations	36
Degrees of Freedom	34
X Coef(s).(Slope)	3.084763
Std. Error of Coef.	0.080595

Trinity River chinook at Willow Creek (rotary screw trap).

Regression Output	
Constant	-4.75817
Std. Error of Y Estimate	0.079992
R Squared	0.951839
# of Observations	224
Degrees of Freedom	222
X Coef(s).(Slope)	2.864380
Std. Error of Coef.	0.043243

Appendix B. Length-volume regression analysis (continued).

Trinity River steelhead parr at Willow Creek.

Regression Output	
Constant	-4.41840
Std. Error of Y Estimate	0.075674
R Squared	0.819323
# of Observations	64
Degrees of Freedom	62
X Coef(s).(Slope)	2.712630
Std. Error of Coef.	0.161777

Trinity River steelhead smolt (natural).

Regression Output	
Constant	-5.21368
Std. Error of Y Estimate	0.058354
R Squared	0.933832
# of Observations	116
Degrees of Freedom	114
X Coef(s).(Slope)	3.068622
Std. Error of Coef.	0.076503

Trinity River steelhead smolt (hatchery).

Regression Output	
Constant	-5.72958
Std. Error of Y Estimate	0.059250
R Squared	0.888845
# of Observations	139
Degrees of Freedom	137
X Coef(s).(Slope)	3.288406
Std. Error of Coef.	0.099351

Trinity River coho parr.

Regression Output	
Constant	-5.27902
Std. Error of Y Estimate	0.074566
R Squared	0.945465
# of Observations	24
Degrees of Freedom	22
X Coef(s).(Slope)	3.143027
Std. Error of Coef.	0.160935

Appendix B. Length-volume regression analysis (continued).

Trinity River coho smolts.

Regression Output	
Constant	-4.44461
Std. Error of Y Estimate	0.055797
R Squared	0.735471
# of Observations	356
Degrees of Freedom	354
X Coef(s).(Slope)	2.717864
Std. Error of Coef.	0.086632

Klamath River Estuary chinook.

Regression Output	
Constant	-4.79201
Std. Error of Y Estimate	0.055864
R Squared	0.804240
# of Observations	378
Degrees of Freedom	376
X Coef(s).(Slope)	2.913475
Std. Error of Coef.	0.074128

Appendix C: Chinook abundance index, Klamath River, 1989.

DATE		VOLUME SAMPLED (CFS)	RIVER FLOW (CFS)	SAMPLE INOEX	NUMBER CHINOOK	CHINOOK INDEX	WEEKLY INDEX ESTIMATE
April	12	71.0	18400	259.2	3	777	
	13	71.0	17900	252.1	2	504	
	14	73.7	18400	249.7	0	0	2991
	15		18900				
	16		18300				
	17		17900				
	18	67.8	18000	265.5	4	1062	
	19	56.1	18200	324.4	0	0	
	20	56.1	17900	319.1	0	0	
	21	64.3	16900	262.8	2	526	2778
	22		15500				
	23		14300				
	24		13600				
	25	53.5	13600	254.2	5	1271	
	26	56.3	13800	245.1	3	735	
	27	58.1	14100	242.7	1	243	
	28	60.5	14400	238.0	6	1428	
	29	67.0	14100	210.4	0	0	
	30	57.9	13500	233.2	0	0	4290
MAY	1	51.5	13800	268.0	0	0	
	2	50.8	13200	259.8	0	0	
	3	50.8	11600	228.3	0	0	
	4	77.6	11600	149.5	9	1345	
	5	91.1	12600	138.3	6	830	
	6	91.0	13300	146.2	2	292	
	7	86.3	13200	153.0	0	0	2468
	8	90.9	13200	145.2	0	0	
	9	95.5	14300	149.7	1	150	
	10		14800				
	11		13000				
	12	67.1	12000	178.8	0	0	
	13	62.2	11600	186.5	0	0	
	14	57.2	10700	187.1	0	0	210
	15	62.8	10300	164.0	0	0	
	16	76.7'	10100	131.7	0	0	
	17	131.8	9650	73.2	0	0	
	18	111.0	9140	82.3	4	329	
	19	103.0	8050	78.2	2	156	
	20	94.9	7570	79.8	0	0	
	21	93.6	7410	79.2	6	475	961
	22	90.8	7300	80.4	6	482	
	23	92.8	7690	82.9	6	497	
	24	91.8	7220	78.6	7	551	

Appendix C: Chinook abundance index, Klamath River, 1989 (continued).

DATE		VOLUME SAMPLED (CFS)	RIVER FLOW (CFS)	SAMPLE INDEX	NUMBER CHINOOK	CHINOOK INDEX	WEEKLY INDEX ESTIMATE
	25	93.1	7130	76.6	10	766	
	26	100.5	7010	69.8	2	140	
	27		7120				
	28		7170				3410
	29		6930				
	30		6480				
	31	74.3	6270	84.4	4	338	
JUNE	1	86.7	6870	79.2	2	158	
	2	90.3	7320	81.1	6	486	
	3		7400				
	4		7300				2292
	5		7130				
	6	83.1	6510	78.3	47	3682	
	7	78.3	6060	77.4	54	4179	
	8	61.7	5470	88.7	44	3901	
	9	61.7	5190	84.1	13	1094	
	10		4890				
	11		4680				22497
	12		4560				
	13	62.9	4400	70.0	62	4337	
	14	63.4	4230	66.7	170	11342	
	15	68.1	4200	61.7	44	2714	
	16	69.2	4210	60.8	108	6571	
	17		3960				
	18		3790				43686
	19	68.4	3650	53.4	137	7311	
	20	62.9	3540	56.3	172	9680	
	21	66.5	3440	51.7	110	5690	
	22	61.8	3310	53.6	51	2732	
	23	58.6	3240	55.3	94	5197	
	24	60.1	3190	53.1	166	8811	
	25	61.5	3100	50.4	166	8367	47788
	26	51.3	3040	59.3	513	30400	
	27	51.2	2980	58.2	403	23456	
	28	51.0	2940	57.6	183	10549	
	29	55.8	2980	53.4	120	6409	
	30	58.0	3180	54.8	84	4606	
July	1	55.8	3040	54.5	85	4631	
	2	53.5	2910	54.4	86	4678	84728
	3	52.6	2810	53.4	108	5770	
	4	50.1	2760	55.1	106	5840	

DATE	VOLUME SAMPLED (CFS)	RIVER FLOW (CFS)	SAMPLE INDEX	NUMBER CHINOOK	CHINOOK INDEX	WEEKLY INDEX ESTIMATE
5	47.6	2700	56.7	106	6013	
6	46.3	2630	56.8	119	6760	
7	40.1	2560	63.8	98	6256	
8		2500				
9		2460				42893
10	39.8	2400	60.3	33	1990	
11	42.8	2350	54.9	16	879	
12	39.4	2320	58.9	20	1178	
13	38.3	2200	57.4	24	1379	
14	37.3	2230	59.8	9	538	
15	38.1	2200	57.7	3	173	
16	38.9	2180	56.0	2	112	
17	39.7	2180	54.9	2	110	7017
SEASON TOTALS				3657	220873	268008

Appendix D: Chinook population estimate by week using mean trapping efficiency value (.0380), Trinity River, 1989.

Date	Days Fished	Chinook Captured	Expanded Week Estimate	Weekly Population Estimate
4/03-4/09	4	40	70	1842
4/10-4/16	4	36	63	1658
4/17-4/23	4	7	12	316
4/24-4/30	6	96	112	2947
5/01-5/07	7	12	12	316
5/08-5/14	4	6	11	289
5/15-5/21	4	8	14	368
5/22-5/28	4	65	114	3000
5/29-6/04	3	903	2107	55447
6/05-6/11	4	4802	8404	221158
6/12-6/18	5	1555	2177	57289
6/19-6/25	5	10219	14307	376500
6/26-7/02	5	6840	9576	252000
7/03-7/09	5	4308	6031	158711
7/10-7/16	5	4353	6094	160368
7/17-7/23	4	2268	3969	104447
7/24-7/30	4	1053	1843	48500
8/01-8/07	4	807	1412	37158
Total	**81**	**37,377**	**56,327**	**1,482,314**

Appendix E: Chinook abundance index, Trinity **River, 1989.**

DATE		VOLUME SAMPLED (CFS)	RIVER FLOW (CFS)	SAMPLE INDEX	CHINOOK CAPTURED	CHINOOK INDEX	WEEKLY INDEX ESTIMATE
April	4	43.0	12200	283.7	11	3121	
	5	43.0	11300	262.8	9	2365	
	6	43.0	10900	253.5	10	2535	
	7	43.0	10700	248.8	10	2488	18391
	8		10400				
	9		9890				
	10		9390				
	11	54.4	8670	159.4	15	2391	
	12	54.4	8120	149.3	5	746	
	13	54.4	7730	142.1	13	1847	
	14	51.5	7540	146.4	3	439	9491
	15		7450				
	16		7030				
	17		6720				
	18	46.2	6590	142.6	3	428	
	19	44.8	6450	144.0	1	144	
	20	39.9	6250	156.6	0	0	
	21	30.8	5910	191.9	3	576	2008
	22		6060				
	23		5770				
	24		5540				
	25	107.8	5180	48.1	21	1009	
	26	88.9	4960	55.8	42	2343	
	27	91.4	4750	52.0	18	935	
	28	90.2	4580	50.8	15	762	
	29	85.2	5060	59.4	0	0	
	30	91.9	5220	56.8	0	0	7069
May	1	83.6	5460	65.3	5	327	
	2	91.6	5170	56.4	0	0	
	3	84.3	5040	59.8	6	359	
	4	85.0	5070	59.6	1	60	
	5	87.7	5200	59.3	0	0	
	6	90.8	5350	58.9	0	0	
	7	90.3	5570	61.7	0	0	745
	8		5510				
	9	120.4	5580	46.3	3	139	
	10		6040				
	11		5270				
	12	125.8	4890	38.9	0	0	
	13	103.6	4700	45.4	3	136	
	14	116.3	4600	39.6	0	0	481
	15	114.1	4520	39.6	0	0	

Appendix E: Chinook abundance index, Trinity River, 1989 (continued).

DATE	VOLUME SAMPLED (CFS)	RIVER FLOW (CFS)	SAMPLE INDEX	CHINOOK-CAPTURED	CHINOOK INDEX.	WEEKLY INDEX ESTIMATE
16	109.7	4450	40.6	0	0	
17	109.6	4450	40.6	0	0	
18		4440				
19		4260				
20	112.3	4140	36.9	8	295	
21	103.0	4110	39.9	8	319	413
22		4110				
23		4340				
24	107.7	4300	39.9	20	799	
25	114.1	3390	29.7	14	416	
26	108.5	3130	28.8	23	664	3845
27		3040				
28		2990				
29		3010				
30		2840				
31	105.4	2320	22.0	27	594	
June 1	105.4	2170	20.6	44	906	
2		2210				
3		2320				
4	98.1	2340	23.9	832	19846	5251
5	98.2	2320	23.6	962	22727	
6	95.6	2290	24.0	1923	46063	
7		2220				
8	92.7	2150	23.2	936	21709	
9	93.1	2100	22.6	750	16917	178168
10		1990				
11		1920				
12	80.9	1910	23.6	216	5100	
13	96.0	2170	22.6	209	4724	
14	90.9	2150	23.7	158	3737	
15	87.9	2150	24.5	422	10322	
16	91.2	2130	23.4	550	12845	51420
17		1720				
18		1560				
19	91.9	1520	16.5	2002	33113	
20	89.3	1490	16.7	1549	25846	
21	88.7	1420	16.0	1867	29889	
22	81.4	1370	16.8	2179	36674	
23	87.4	1380	15.8	2622	41400	233689
24		1390				
25		1360				
26	86.4	1330	15.4	1790	27554	
27	88.2	1300	14.7	1932	28476	

Appendix **E:** Chinook abundance index, Trinity **River, 1989** (continued).

DATE		VOLUME SAMPLED (CFS)	RIVER FLOW (CFS)	SAMPLE INDEX	CHINOOK CAPTURED	CHINOOK INDEX	WEEKLY INDEX ESTIMATE
	28	85.8	1270	14.8	1352	**20012**	
	29	88.2	1340	15.2	634	**9632**	
	30	87.7	1410	16.1	1132	**18200**	145425
July	1		1450				
	2		1400				
	3	95.5	1380	14.5	1204	**17398**	
	4	88.4	1340	15.2	735	**11141**	
	5	88.4	1340	15.2	735	**11141**	
	6	87.3	1300	14.9	704	**10483**	
	7	86.3	1280	14.8	930	**13794**	89541
	8		1250				
	9		1240				
	10	83.7	1220	14.6	676	**9853**	
	11	85.3	1190	14.0	809	**11286**	
	12	82.8	1170	14.1	862	**12180**	
	13	80.5	1130	14.0	970	**13616**	
	14	80.5	1130	14.0	1036	**14543**	86070
	15		1120				
	16		1110				
	17		1090				
	18	80.5	1080	13.4	700	**9391**	
	19	80.0	1070	13.4	674	**9015**	
	20	78.6	1050	13.4	588	**7855**	
	21	79.6	1030	12.9	306	**3960**	52886
	22		1010				
	23		1000				
	24		985				
	25	68.3	967	14.2	324	**4587**	
	26	74.5	950	12.8	280	**3570**	
	27	73.1	940	12.9	253	**3253**	
	28	69.3	927	13.4	195	**2608**	22717
	29		913				
	30		907				
	31		907				
Aug	1	69.6	915	13.1	162	**2130**	
	2	72.9	915	12.6	162	**2033**	
	3	66.9	904	13.5	242	**3270**	
	4	60.9	891	14.6	241	**3526**	19178
SEASON TOTALS					**37146**	**642564**	**926788**