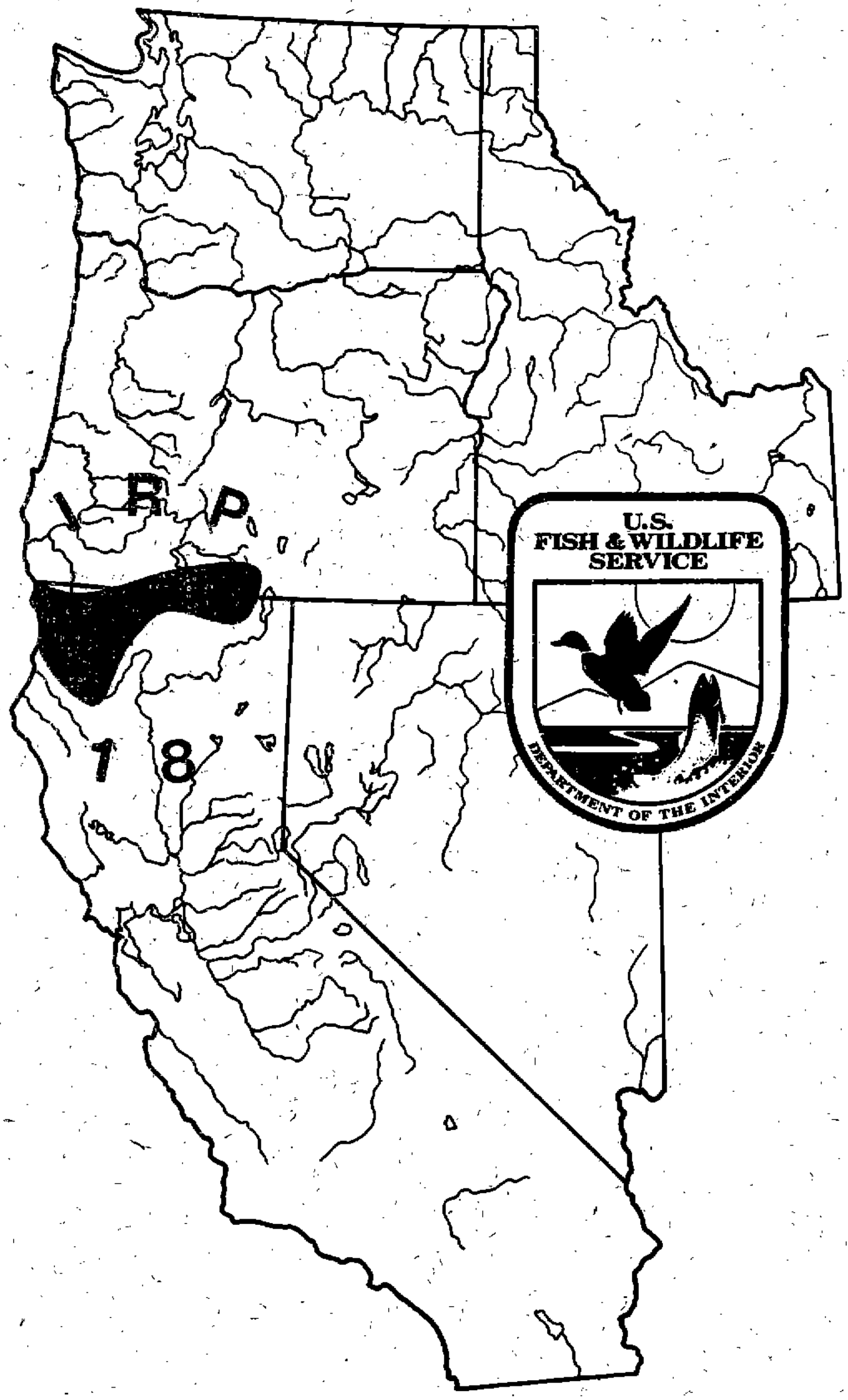
KLAMATH RIVER FISHERIES INVESTIGATION PROGRAM



ANNUAL REPORT - 1982

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KLAMATH RIVER FISHERIES INVESTIGATION PROGRAM

1982

U.S. Fish and Wildlife Service
Fisheries Assistance Office
Arcata, California

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TABLE OF CONTENTS

LIST OF FIGURES

Figure | Page

LIST OF TABLES

LIST OF PLATES

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FORWARD

The Klamath River watershed drains approximately 40,400 sq km in Oregon and California, including about 26,000 sq km in California, most included within the boundaries of the Six Rivers, Klamath, Shasta, and Trinity National Forests (Figure 1). The Hoopa Valley Indian Reservation, comprising approximately 583 sq km in Humboldt and Del Norte counties, borders the lower 68 km of the Klamath River and lower 26 km of the Trinity River, the largest tributary in the drainage. The most important anadromous salmonid spawning tributary streams in the basin include the Trinity River, draining approximately 7,690 sq km, and the Shasta, Scott, and Salmon rivers, each draining approximately 2,070 sq km. Iron Gate Dam on the Klamath River and Lewiston Dam on the Trinity River represent the upper limits of anadromous salmonid migration in the basin, and hatcheries located near the base of each dam (Iron Gate and Trinity River hatcheries) were constructed in mitigation for natural fish production losses resulting from each project.

The Klamath River basin has historically supported large runs of chinook salmon *(Oncorhynchus tshawytscha)* and steelhead trout *(Salmo gairdneri)*, which have contributed considerably to subsistence, sport, and commercial fisheries in California. Generations of Indians have utilized fishing grounds in the drainage, and their fisheries for salmon, steelhead, and sturgeon have historically provided the mainstay of Indian economy in the area. Sport fishing for salmon and steelhead in the drainage may exceed 200,000 angler days annually, and Klamath River stocks may account for 30 percent of commercial chinook salmon landings in northern California and southern Oregon, landings which have averaged approximately 400,000 per year over the last decade. The U.S. Forest Service (USFS) estimated an annual net economic value of salmon and steelhead fisheries attributable to the Klamath River basin of $25 million, and mean annual net economic values per kilometer of chinook salmon, coho salmon *(Oncorhynchus kisutch)*, and steelhead trout habitat in the basin of $15,500, $1,400, and $2,800, respectively. In 1980, the Department of the Interior included the Klamath and Trinity rivers in the National Wild and Scenic Rivers System. However, recent federal court rulings have questioned the status of the rivers under the federal Wild and Scenic Rivers program. Portions of the Klamath and Trinity Rivers are also under California state classification as Wild and Scenic Rivers.

Concern about the depletion of anadromous salmonid resources and associated habitat in the basin emerged around the turn of the century, and has accelerated in recent decades coincident with expanded logging and fishing operations, dam building activity, road construction, and other development. As in other river systems of the Pacific Northwest, chinook salmon of the Klamath River basin have experienced the continued effects of habitat degradation and over-exploitation, as reflected by declining runs in recent decades. Since passage of the Fishery Conservation and Management Act of 1976 and the

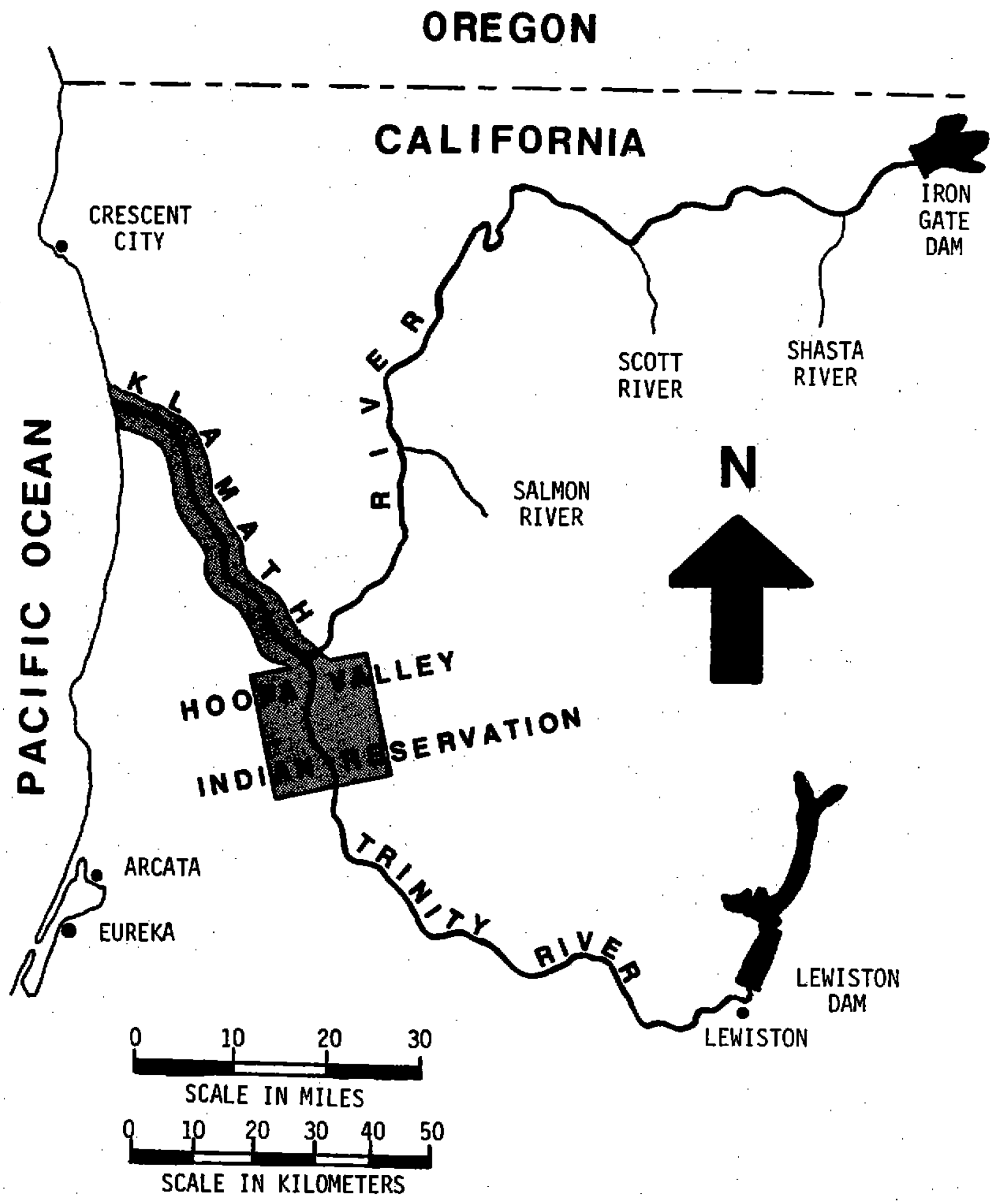


FIGURE 1. The Klamath River basin and Hoopa Valley Indian Reservation.

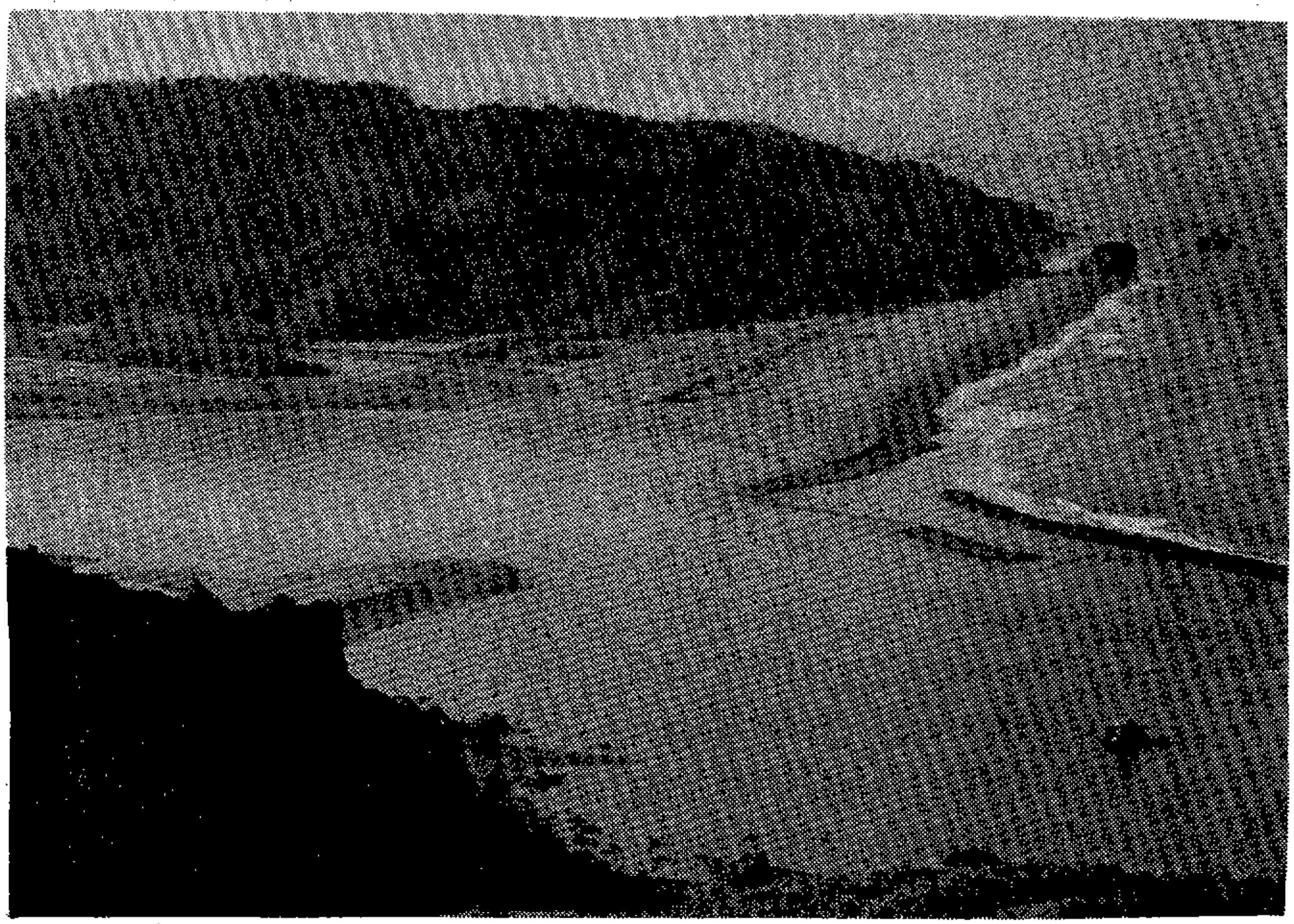


PLATE 1. The mouth of the Klamath River during spring of 1982.

promulgation of the first set of federal fishing regulations governing Indian fishing on the Hoopa Valley Reservation in 1977, considerable attention has focused on the depressed chinook salmon runs and associated fisheries, notably the ocean troll fisheries and the Indian gill net fishery on the Klamath and Trinity rivers.

The U.S. Fish and Wildlife Service (USFWS) ranked anadromous salmonid problems of the Klamath River basin Number 18 of 78 "Important Resource Problems" (IRP's) in the United States (USFWS 1980a). The Assistant Secretaries of Indian Affairs and Fish, Wildlife, and Parks, in addressing Departmental resource and Indian Trust responsibilities concerning the Klamath River basin and Hoopa Valley Reservation, have entered into annual fiscal memoranda of understanding (MOU) providing for fisheries investigation programs focusing on the monitoring and evaluation of chinook salmon runs in the Klamath River, and the monitoring of Indian net harvest levels on the Hoopa Valley Reservation. This is the fourth in a series of annual reports covering the Klamath River Fisheries Investigation Program, conducted through the Fisheries Assistance Office, Arcata, California (FAO-Arcata) under the recent MOU.

The program consists of 6 major groupings of related activities:

(1) Beach Seining Operations focus on (a) development of a model for annual estimation of fall chinook run size on an in-season basis, and (b) the annual monitoring of fall chinook runs to evaluate natural/hatchery composition, to assess hook scarring and gill net marking incidences, to collect age-growth, length-frequency, and length-weight data, and to provide data on run timing and migration patterns by external tag application.

(2) Harvest Monitoring and Evaluation Efforts focus on (a) the annual estimation of Indian net harvest levels on the Hoopa Valley Reservation involving chinook salmon (spring and fall runs), steelhead trout (fall and winter runs), coho salmon, green sturgeon *(Acipenser medirostris)*, and white sturgeon *(Acipenser transmontanus)*; (b) development of a model for annual estimation of fall chinook run size on an in-season basis in conjunction with data collected through the beach seining operations; and (c) the annual monitoring of chinook and coho salmon, steelhead trout, and green sturgeon runs to evaluate natural/hatchery composition, to assess length-frequency, age-growth, and length-weight relationships within the harvest and to collect run-timing and migration pattern data by recovery of tags placed during beach seining operations.

(3) Coded-Wire Tag Analyses involve the collection and reading of coded-wire tags recovered from the net fishery during harvest monitoring activities and use of this data in statistical evaluation of the various tagged release groups through their occurrence in the ocean and in-river net fisheries.

(4) Scale Analyses involve the mounting and interpretation of chinook salmon scales obtained through the beach seining and net harvest monitoring programs to assess age, growth and racial compositions of the runs.

(5) Sturgeon Investigations, in conjunction with the net harvest monitoring and beach seining programs, focus on the collection of a variety of baseline data concerning the life history, abundance, and harvest of Klamath River green and white sturgeon populations.

(6) Program Planning, Direction, and Coordination involves keeping abreast of program planning and direction in conjunction with guidance received from the USFWS and Interior Department, annual budgeting and other administrative functions, coordinating the program with and disseminating data to a variety of concerned agencies, interest groups, and the general public.

Methods utilized and results obtained during 1982 through these program activities are detailed in sections summarizing data collected on chinook salmon, coho salmon, steelhead trout, and sturgeon, respectively. Abstracts covering the primary points preceed each of the major sections of this report. While previous annual reports have included sections detailing information on juvenile salmonid investigations within the basin, no such data is available for 1982 since budget constraints precluded field activities involving juvenile salmon and steelhead.

CHINOOK SALMON INVESTIGATIONS

ABSTRACT

A total of 2,901 chinook salmon, including 782 grilse, were captured during 1982 seining operations in the Klamath River estuary. Adipose fin-clipped chinook comprised 8.1% of the sample, and a respective 0.3 and 57.7% of the chinook exhibited gill net markings and hook scars. Scales were collected from 1,107 chinook for age analysis.

Gill net harvest on the Hoopa Valley Reservation during 1982 is estimated at 16,281 fall and 3,200 spring chinook. The 1982 harvest represents a 54% reduction in the fall chinook fishery and a 12% increase in the spring chinook fishery over respective 1981 levels. Most noticeable is an 80% drop in fall chinook harvest in the Estuary Area from 1981. Catch per net-night indices in 1982 for the Estuary and Resighinni area fisheries are the lowest among recent years.

Age analysis from scale samples and coded-wire tag recoveries indicates the dominance of 4-year-olds in the 1982 returns of fall and spring chinook. Age composition data are detailed for fall and spring chinook, and estimated brood year contributions to fall chinook runs and spring chinook net harvests are given.

Catch-effort data collected through beach seine and harvest monitoring operations during 1980-1982 are analyzed regarding the possibility of predicting run size on an in-season basis. Correlations between indices developed and counts of fall chinook at weirs in the basin appear strong, and some suggestions concerning the potential utility of such information are offered.

A total of 4,397 spaghetti and jaw tags were placed on fall chinook salmon during beach seining operations in 1979, 1980 and 1982. A total of 669 of these were recovered within the basin for an overall recovery rate of 0.152. Information on migration patterns of fall chinook within the basin is discussed.

A total of 576 coded-wire tags (CWT), representing 17 fall and 12 spring chinook release groups, were recovered in the 1982 net fisheries on the Hoopa Valley Reservation. These recoveries expand to a total estimated harvest of 1,466 CWT fall and 1,641 CWT spring chinook in the 1982 fisheries. Contribution rates to the net fisheries and other pertinent information concerning these groups are discussed. In-river net and preliminary ocean CWT return data suggest an overall ratio of ocean to in-river net landings of CWT Klamath River fall chinook of approximately 6.8:1 in 1982.

Utilizing available harvest data, and applying various assumptions concerning contribution of Klamath River chinook to the ocean fisheries and associated noncatch mortality, an estimated 5.1 Klamath River chinook were lost through ocean and river fisheries for each one spawning in the basin since 1979. The ratio between ocean fishing losses and river returns during the 1979-1982 period is estimated at 2.7:1.

BEACH SEINING PROGRAM

INTRODUCTION

A beach seining program was initiated by FAO-Arcata biologists in 1979 with the intent of evaluating potential for development of in-season and post-season run size estimates utilizing catch/effort and mark-recapture techniques and collecting biological data on fall chinook salmon. Problems encountered during the 1980 season in satisfying the requirements and conditions of mark-recapture methodology resulted in a decision to discontinue the mark-recapture post-season population estimation program and focus efforts on developing the catch/effort in-season and biological data portions of the program.

METHODS

Between July 19 and September 22, 1982, beach seining operations were conducted on the south spit of the Klamath River estuary (Figure 2). An estuarine site was again chosen in attempt to sample the fall chinook run prior to impacts of the various size-selective in-river fisheries and to provide data comparability with the 1979-1981 seasons. Site selection within the estuary was based on previous experience indicating that fall chinook tend to migrate through the deep channel of cool, highly saline water adjacent to the south spit and on depth and temperature profile data collected in order to locate this channel during the 1982 season. Hydro-acoustic surveys conducted in July and September of 1982 indicated that the channel configuration within the estuary changed little during this period.

Methods utilized in 1982 were similar to those of previous years. Seining was conducted 5 days per week during daylight hours by a 6 to 8 man crew of biologists and technicians. A 150 m long by 6 m deep seine of 8.9 cm stretched mesh was set from a Valco river boat and retrieved utilizing gas powered winches.

Once crowded, fish were transferred into holding cages then individually examined in a padded cradle for tags, fin-clips, hook scars, gill net marks and other distinguishing characteristics. All salmonids were measured to the nearest centimeter fork length and each chinook salmon received a 9.5 mm (3/8 inch) or 6.4 mm (1.4 inch) hole punched through the upper caudal lobe for recapture identification. In addition, a numbered aluminum or monel-metal band was applied to the right mandible of every other chinook sampled over 48 cm for the purpose of evaluating migration patterns. Fish under 48 cm were not tagged due to the incompatibility of the band sizes available to the small jaw sizes. Scale samples were taken as in previous years for age analysis (see age composition section).

Large numbers of fish in some sets (>50) necessitated subsampling to minimize handling time and stress to fish sampled. Fish not examined were identified as to species and size class (i.e., grilse, adult) prior to release,

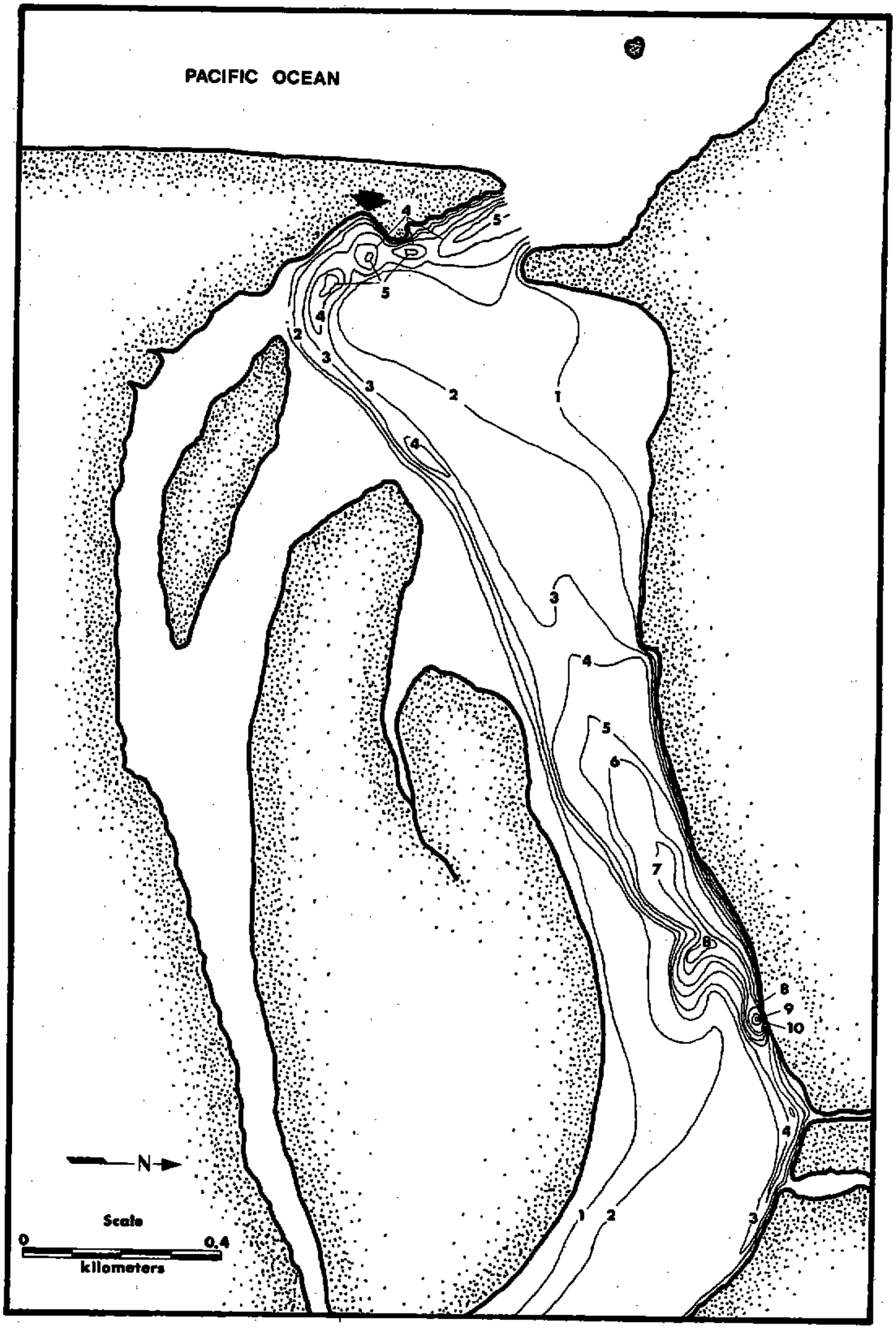
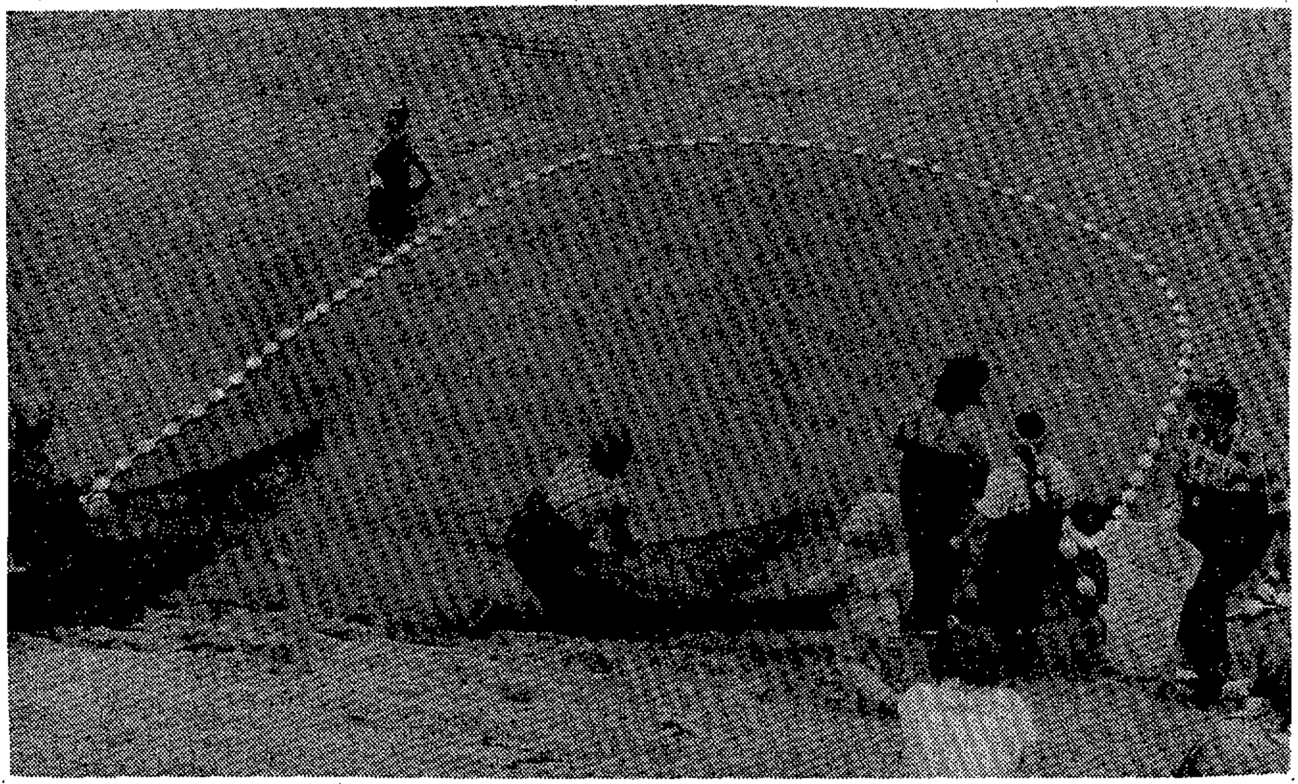


FIGURE 2. Depth contours (expressed in meters below mean high tide) of the Klamath River estuary during July, 1982. Arrow depicts beach seining site.



PLATES 2 & 3. The crowding (above) and examination (below) of fish captured through 1982 beach seining operations in the Klamath River estuary.

for inclusion in catch/effort data. Tests were conducted on data from partially sampled sets to insure that their inclusion would not bias data presented herein.

RESULTS AND DISCUSSION

A total of 2,901 chinook salmon were captured in 257 seine hauls during 1982 operations, of which 2,246 (77.4%) were examined. Grilse (<58 cm) accounted for 27% of all chinook captured. One subsampled set (28 of 85 chinook) was discarded from length frequency analysis due to significantly disproportionate grilse-adult ratio of chinook sampled versus chinook captured (chi-square analysis, $p < 0.05$). Data from 14 additional subsampled sets were included as no bias was apparent. All fish from the remaining 242 sets were examined. A shift in the length-frequency distribution of adults from 1981 to 1982 appears to indicate an increase in the proportion of 4-year-olds in the run (Figure 3). Comparatively, 3 and 2-year-olds dominated the 1981 and 1980 runs, respectively. The shift in proportion of age classes is also reflected in a significant increase in mean length of adults from 71.8 cm in 1981 to 77.3 cm in 1982 (t-test; $p < 0.05$).

Adipose fin-clips representing various hatchery coded-wire tag (CWT) release groups occurred on 29 of 650 grilse (4.4%) and 152 of 1,596 adults (9.5%) examined. Mean length of adipose fin-clipped adults, 75.8 cm, differed significantly from non-adipose clipped adults, 77.5 cm (t-test; $p < 0.10$). Mean lengths of adipose clipped grilse did not differ significantly from non-adipose clipped grilse ($p > 0.05$; Figure 4). Of other fin-clips observed, 30 (4.6%) grilse and 13 (0.8%) adults exhibited right ventral (RV) clips while 6 (0.9%) grilse and 11 (0.7%) adults exhibited left ventral (LV) clips.

RV and LV fin-clipped chinook represent a constant fractional marking program which was initiated in 1979 to assist in estimation of the proportional contribution of hatchery fish to production within the basin, and ultimately to assist in escapement estimation. Since complete marking of 1979 brood release groups was not accomplished, only chinook marked during 1980 brood and subsequent releases represent data groups fully utilizable for intended purposes of the program. As a result, 2 but not 3 or 4-year-old chinook returns during the 1982 spawning run provide useful data. Fully comparable data on 2, 3 and 4-year-old age components will not be available until the 1984 spawning run regarding the fractional marking program. For this reason, only data from 2-year-old ventral clipped chinook in 1982 will be discussed. Mean length of ventral clipped, 47.8 cm, and non-clipped, 48.5 cm, grilse returns in 1982 showed no significant difference ($p > 0.05$). Attempts were made at estimating proportional contribution of hatchery fish to the 1982 grilse run component, however, sample size was insufficient to lend significant results according to Hankin (1982). Potential bias due to incomplete marking in 1979 and size overlap between 2 and 3-year-old chinook would also render such an estimate of questionable validity.

The constant fractional marking program also allows differentiation of fish by hatchery origin, LV representing Iron Gate Hatchery and RV representing Trinity River Hatchery. In 1982, behavior differences were noted between RV and LV fish with respect to timing of river entry. A significantly greater

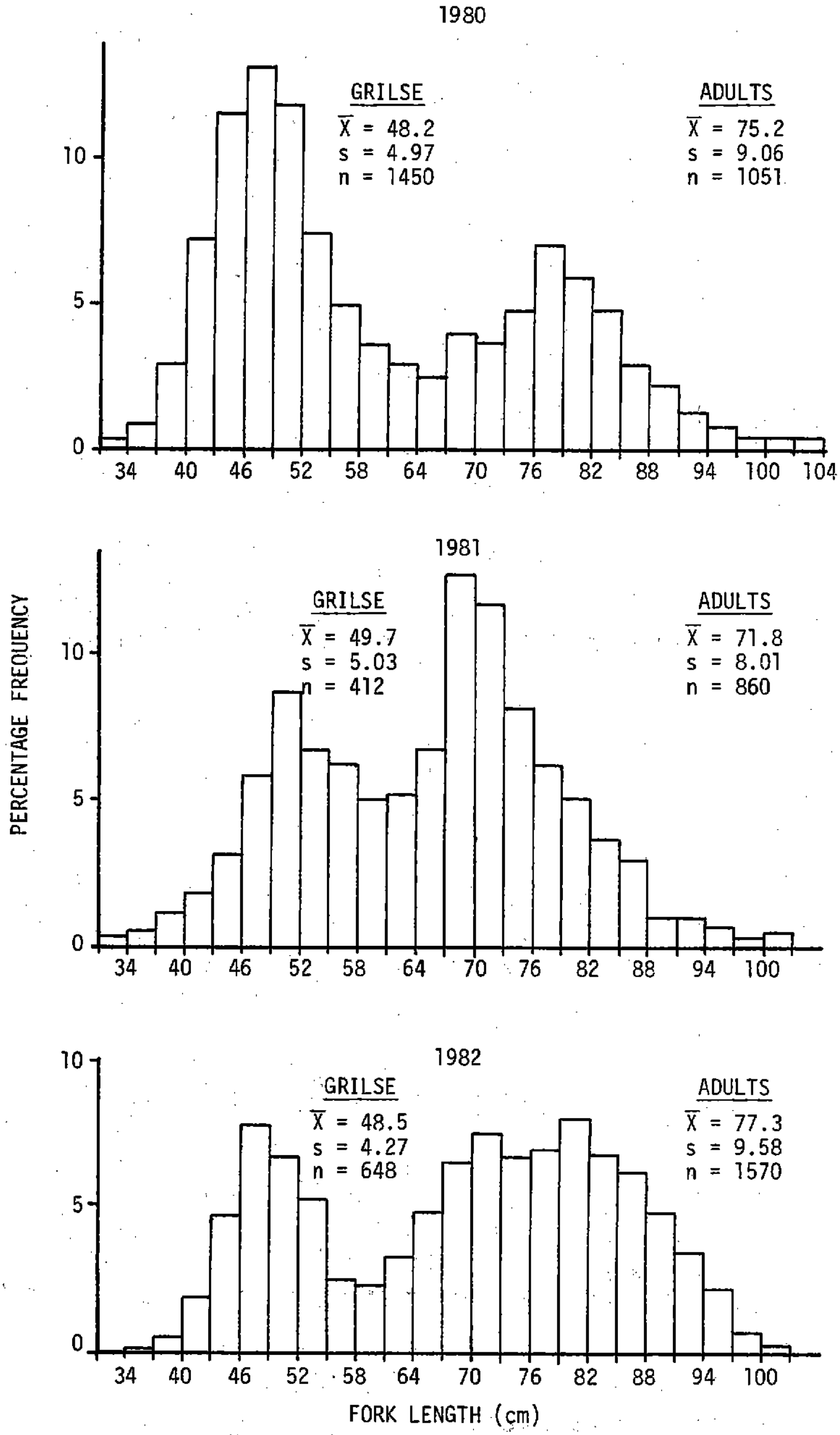


FIGURE 3. Length frequency distributions of chinook salmon captured during beach seining operations in the Klamath River estuary in 1980, 1981 and 1982.

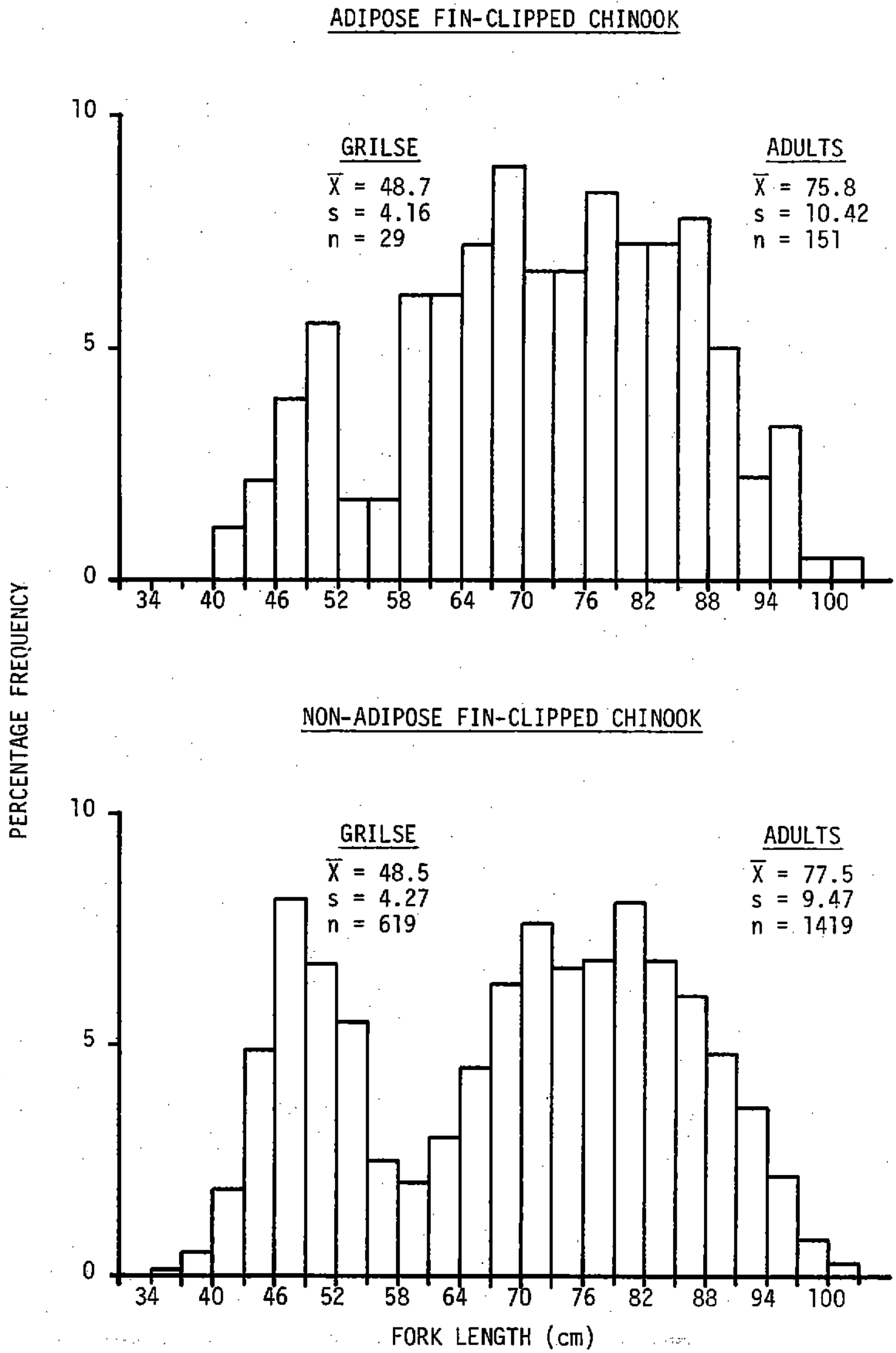


FIGURE 4. Length frequency distributions of adipose fin-clipped and non-adipose fin-clipped chinook salmon captured in 1982 beach seining operations.

percentage of sampled LV fish (76%) entered before September 5 while the majority of sampled RV fish (67%) entered after this date (chi-square, $p < 0.05$, Figure 5). This trend correlates strongly with run timing differences with respect to maturity schedules (to be discussed shortly) as grilse accounted for 65.5% of 1982 fall chinook returns to TRH yet only 18% of those to IGH. Such discernible differences may prove useful in future management of in-river fisheries if indeed a long term trend is indicated.

A significant run timing difference between grilse and adults was evident in 1982 with 64% of the adult sample component of the run entering before August 27 while only 35% of the grilse sample component had entered the river by this date (chi-square, $p < 0.05$). An apparent difference in timing between 3 and 4-year-old adult run sample components also occurred. Prior to August 20, 769 adults were measured resulting in a mean length of 81.0 cm while after August 20, 827 adults were measured with a mean length of 73.8 cm (significant, t-test, $p < 0.05$). These tests may indicate a dominance of 4-year-olds earlier and 2 and 3-year-olds later in the run.

A total of 10 chinook salmon bearing spaghetti tags applied by CDFG biologists at the Waukell Creek seining site (river kilometer 5.2) were captured during 1982 seining operations. Periods between tagging and recovery ranged from 1 to 15 days and averaged 7.4 days.

Gill net marks were observed on 7 of 2,246 (0.3%) chinook examined. Hook scarring incidence was 57.7% for the season. Gill net marking and hook scarring data for 1982 are discussed in detail in a subsequent section of this report.

Metal band tags were applied to the right mandibles of 1,018 chinook prior to release. Information from 1982 recoveries of 179 tags within the basin is discussed in a subsequent section.

Run Timing and Catch/Effort Analysis

Numbers of fall chinook captured per seine haul in 1982 were 3.04 for grilse and 8.24 for adults. Comparative grilse and adult catch/effort values were 1.90 and 3.92 in 1981 and 2.40 and 1.65 in 1980 respectively. For reasons discussed herein, direct comparison of these figures would not be valid in addressing differences in magnitude between 1980, 1981 and 1982 runs.

When comparing catch/effort values between seasons, it is necessary to take into account any bias that may influence the data. Changes in physical and environmental conditions in the estuary, differences in run timing between age classes, gear selectivity, migration patterns of fish through the estuary, holding of fish in the estuary and inconsistent sampling effort all provide potential sources of bias. These problems were discussed in the 1981 Annual Report (USFWS, 1982) and will be reiterated only briefly in order to qualify any data manipulations aimed at reducing bias in reporting and comparing seasonal catch/effort information.

Variations in physical environmental conditions in the estuary are uncontrollable yet appear to have exerted minimal influence on catch/effort values, considering the seining site location in relationship to the river mouth and to the main channel within the estuary has remained relatively uniform

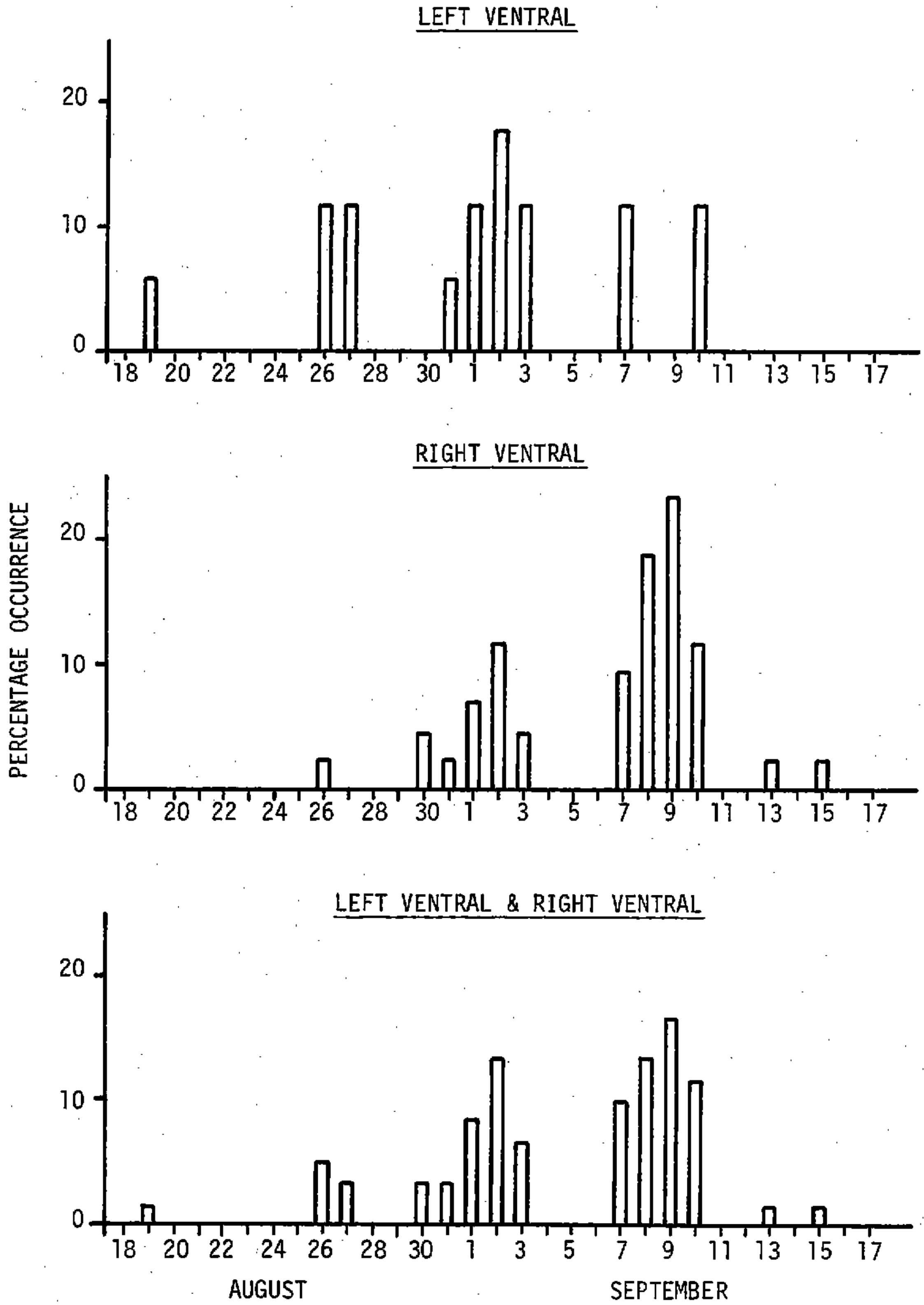
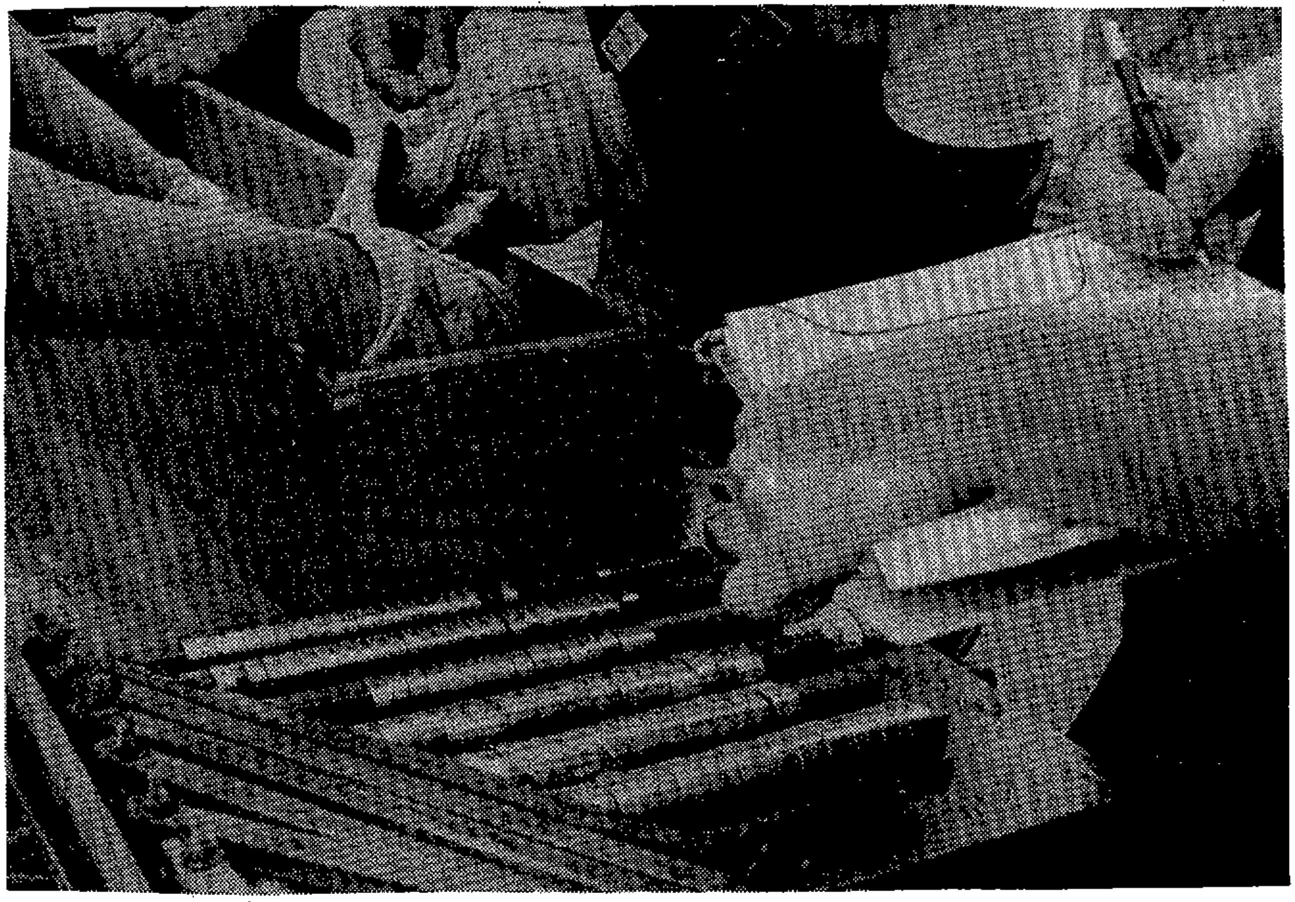
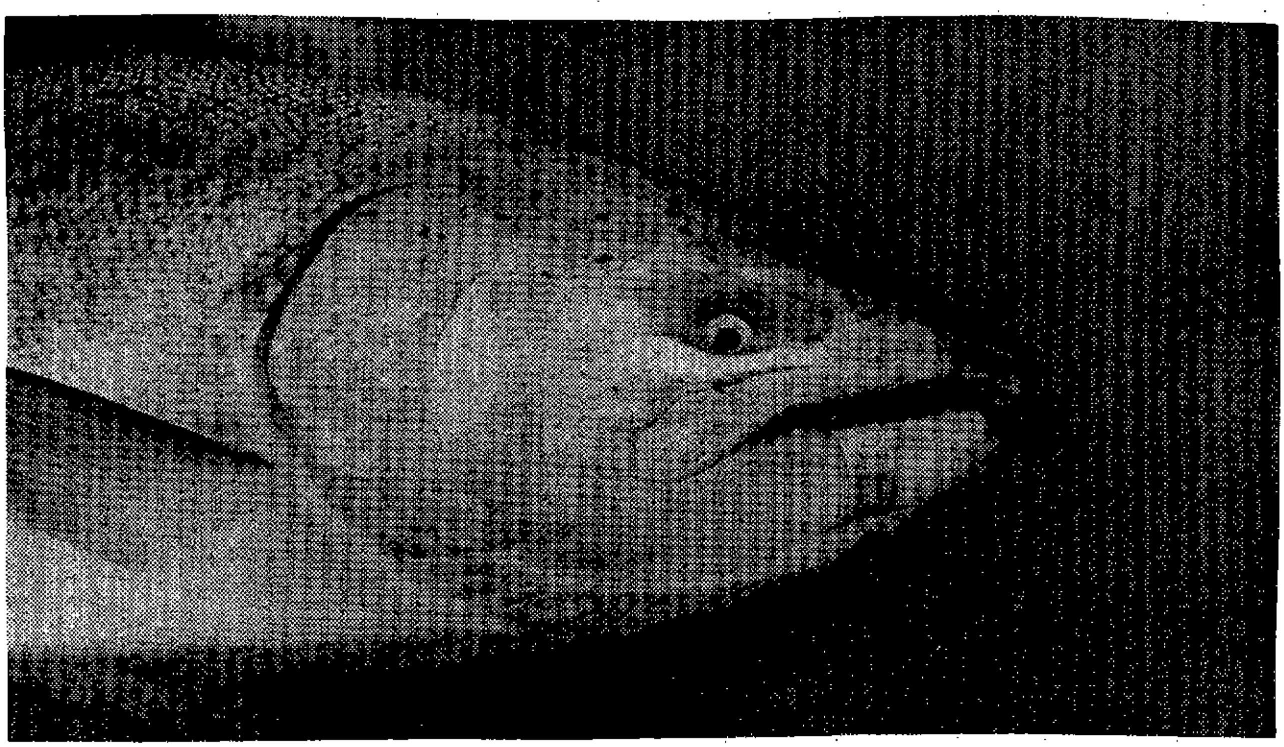


FIGURE 5. Percentage occurrence of left ventral and right ventral clipped chinook by day during 1982 beach seining operations.





PLATES 4 & 5. A total of 1,018 chinook salmon were jaw tagged during 1982 beach seining operations.

from year to year. Differences in run timing between age classes are treated by separating adult from grilse data, adult data being more heavily weighed in escapement figures. Gear selectivity, whether affected by site location or by directly introducing size selection into the data, has not been apparent. Any tendency of chinook to linger in the lower estuary is treated by eliminating recaptures from the data. Recapture rates, 1.1% in 1982 and averaging 2.0% from 1979 to 1982, indicate this to be a minor problem.

Catch/effort statistics indicate most movement of chinook into the estuary occurs between the latter stages of outgoing and the beginning of incoming tide (Table 1). It has also been noted that these movement pulses peak on a daily basis over a short time interval, usually 1 to 2 hours in duration. Considering that 1980, 1981 and 1982 beach seining efforts have successfully focused on these anticipated movement pulses and that seasonal effort has therefor remained somewhat proportional, particularly with regard to tide (Table 2), no special bias-related treatment appears necessary here.

As these movement patterns have become apparent, effort has been applied in a more consistent and efficient manner aimed at the daily major movement periods. Consequently, total effort has dropped sharply from 1980 to 1982 (Table 3), as has daily effort (8.2, 6.1 and 5.6 sets per day for 1980, 1981 and 1982 respectively), while catch has remained high. As a result, comparisons of total season catch/effort between a high effort year (1980) and a low effort year (1982) would exaggerate the relative strength of the low effort year (i.e. 1982). To compensate for this bias, seasonal catch/effort data were compared from the 3 highest consecutive daily seine hauls (peak 3 sets) only. This treatment appears effective considering that 73, 80 and 80% of the total chinook catches during 1980, 1981 and 1982 respectively were captured in the peak 3 daily sets.

Further bias in seasonal comparisons of catch/effort data on run strength can be caused by variation in the proportion of total effort taking place outside of a seasonal run peak, which would change from year to year depending on the duration of the run and duration of the sampling period. For example, 68% of 1980 and 62% of 1981 effort (number of sets) took place outside the defined run peak period, compared with only 50% in 1982. This bias can be treated by comparing only catch/effort data collected during the peak of each annual run. Seasonal differences in duration of run peak periods may then be considered by comparing the number of days each peak lasted.

To assist in identifying run peaks, daily and daily cumulative adult chinook catch/effort values were plotted for all sets (Figures 6 and 7 respectively) and daily peak 3 sets (Figures 8 and 9 respectively). Run peaks in 1980 and 1981 were defined as those periods during which adult catch/effort values in the peak 3 sets consistently exceeded 4.0. The justification for choosing this value was that it eliminated as many points as possible that the peak run period and outlying periods had in common. For example, in 1981 only 2 of the outlying daily peak 3 set catch/effort values were above 4.0 while 4 of the values in the estimated run peak period were below 4.0. Applying this criterion in 1982, a peak 3 set value of 10.0 was used. In this case, 2 of the outlying values were above 10.0 and 2 of the peak period values were below 10.0. A summary of estimated run peak periods and associated catch/effort values resulting from various data treatments is included in Table 4. Use of beach seine catch and effort data in addressing fall chinook run size within the basin is explored in a subsequent section.

TABLE 1. Adult chinook salmon catch per seine haul by time of day and tidal stage during 1980, 1981 and 1982 beach seining operations in the Klamath River estuary (all sets included).

YEAR	TIDAL STAGE	HOURS OF DAY 0800-1100	1100-1400	1400-1700	ALL HOURS
	Outgoing	24.87	6.27	14.46	11.70
	Low Slack	11.66	10.88	17.50	12.00
1982	Incoming	5.08	6.54	4.60	5.86
	High Slack	0.00	1.10	0.00	0.93
	ALL TIDES	12.29	6.24	10.44	8.24
	Outgoing	1.00	4.54	5.38	4.29
	Low Slack	0.50	1.90	11.00	3.91
1981	Incoming	0.55	5.26	3.41	3.85
	High Slack	0.00	2.94	7.40	3.35
	ALL TIDES	0.58	4.25	5.29	3.92
	Outgoing	0.67	0.75	1.27	0.90
	Low Slack	0.22	1.24	2.79	1.15
1980	Incoming	1.19	1.42	4.32	2.27
	High Slack	0.00	1.09	1.00	0.92
	ALL TIDES	0.81	1.21	3.01	1.65

TABLE 2. Percent effort (from number of sets) by time of day and tidal stage during 1980, 1981 and 1982 beach seining operations in the Klamath River estuary

YEAR	TIDAL STAGE	HOURS OF DAY 0800-1100	1100-1400	1400-1700	ALL HOURS
	Outgoing	3.1	17.1	19.5	39.7
	Low Slack	1.2	3.5	0.8	5.5
1982	Incoming	4.7	30.7	13.6	49.0
	High Slack	0.4	5.0	0.4	5.8
	ALL TIDES	9.4	56.4	34.2	100.0
	Outgoing	3.3	12.8	6.9	23.0
	Low Slack	3.9	9.5	4.6	18.0
1981	Incoming	8.8	25.6	16.0	50.5
	High Slack	1.3	5.6	1.6	8.5
	ALL TIDES	17.4	53.4	29.2	100.0
	Outgoing	8.5	9.2	9.4	27.1
	Low Slack	5.6	3.3	3.0	12.0
1980	Incoming	13.9	21.9	16.5	52.4
	High Slack	1.1	5.0	2.3	8.5
	ALL TIDES	29.2	39.6	31.2	100.0

TABLE 3. Effort (number of sets) by time of day and tidal stage during 1980, 1981 and 1982 beach seining operations in the Klamath River estuary.

YEAR	TIDAL STAGE	HOURS OF DAY 0800-1100	1100-1400	1400-1700	ALL HOURS
1982	Outgoing	8	44	50	102
	Low Slack	3	9	2	14
	Incoming	12	79	35	126
	High Slack	1	13	1	15
	ALL TIDES	24	145	88	257
1981	Outgoing	10	39	21	70
	Low Slack	12	29	14	55
	Incoming	27	78	49	154
	High Slack	4	17	5	26
	ALL TIDES	53	163	89	305
1980	Outgoing	54	59	60	173
	Low Slack	36	21	19	76
	Incoming	89	140	105	334
	High Slack	7	32	15	54
	ALL TIDES	186	252	199	637

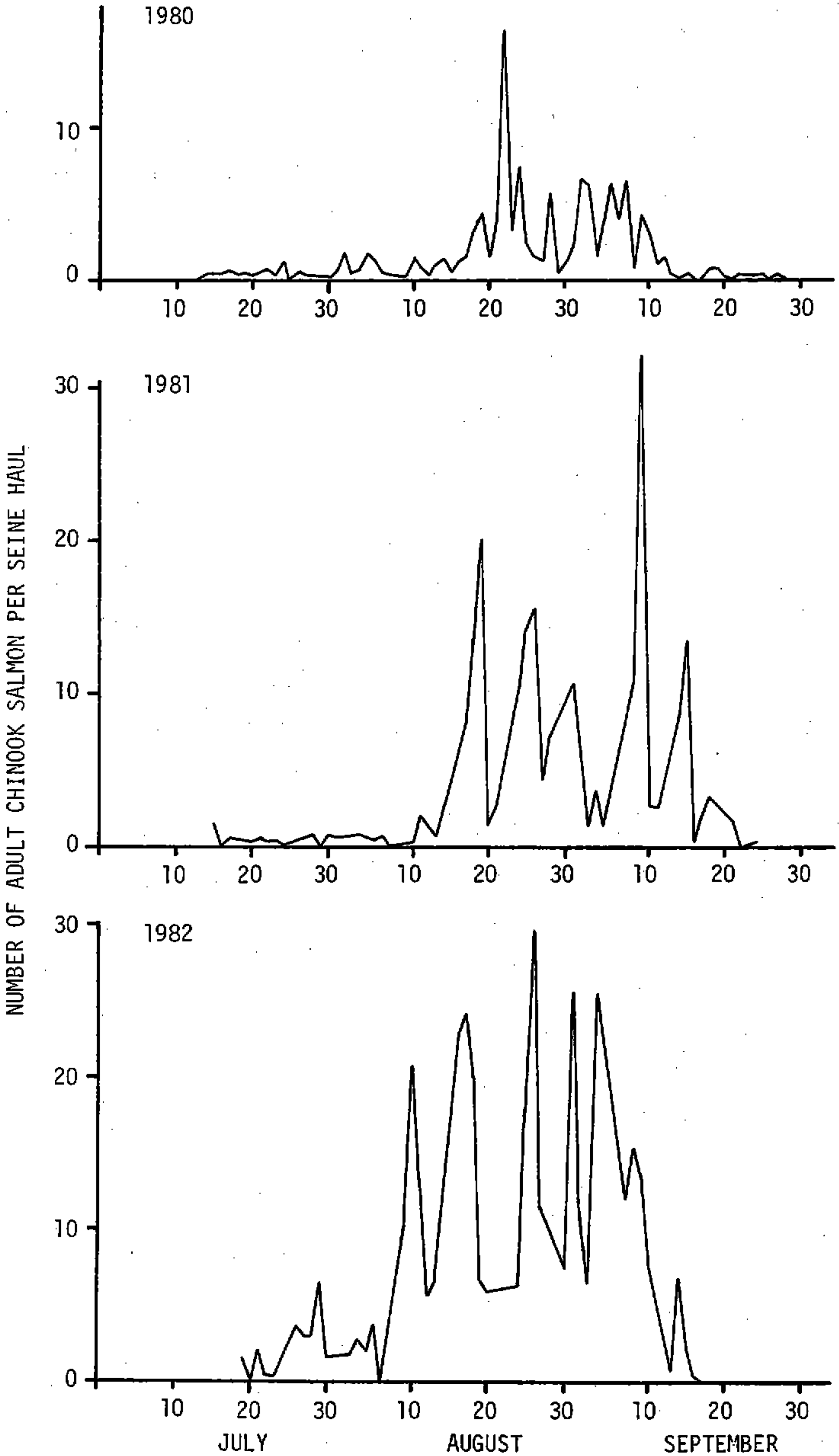


FIGURE 6. Daily numbers of adult chinook salmon captured per beach seine haul in the Klamath River estuary in 1980, 1981 and 1982 (all sets included).

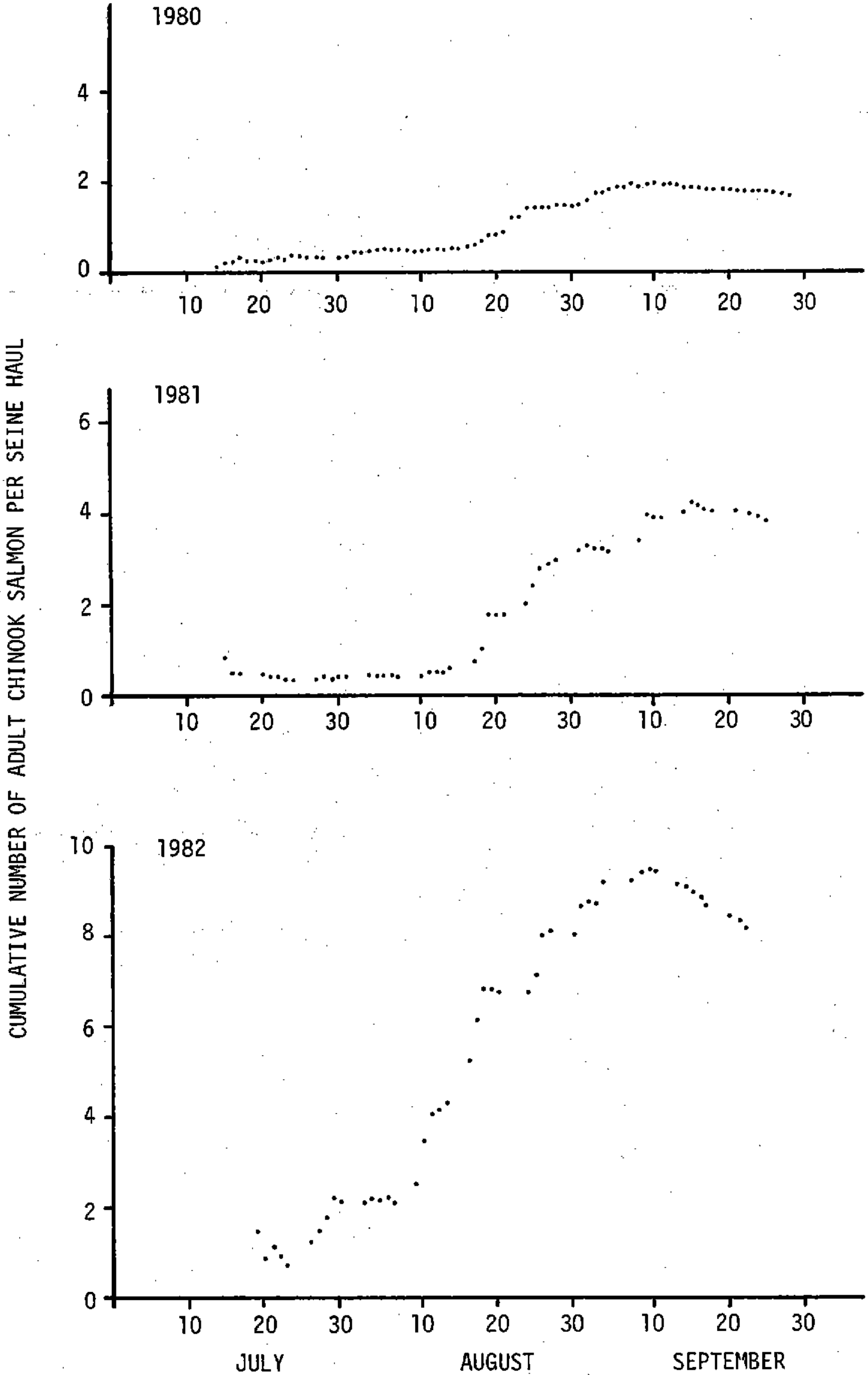


FIGURE 7. Cumulative daily adult chinook salmon catch/effort values in 1980, 1981 and 1982 beach seining operations in the Klamath River estuary (all sets included).

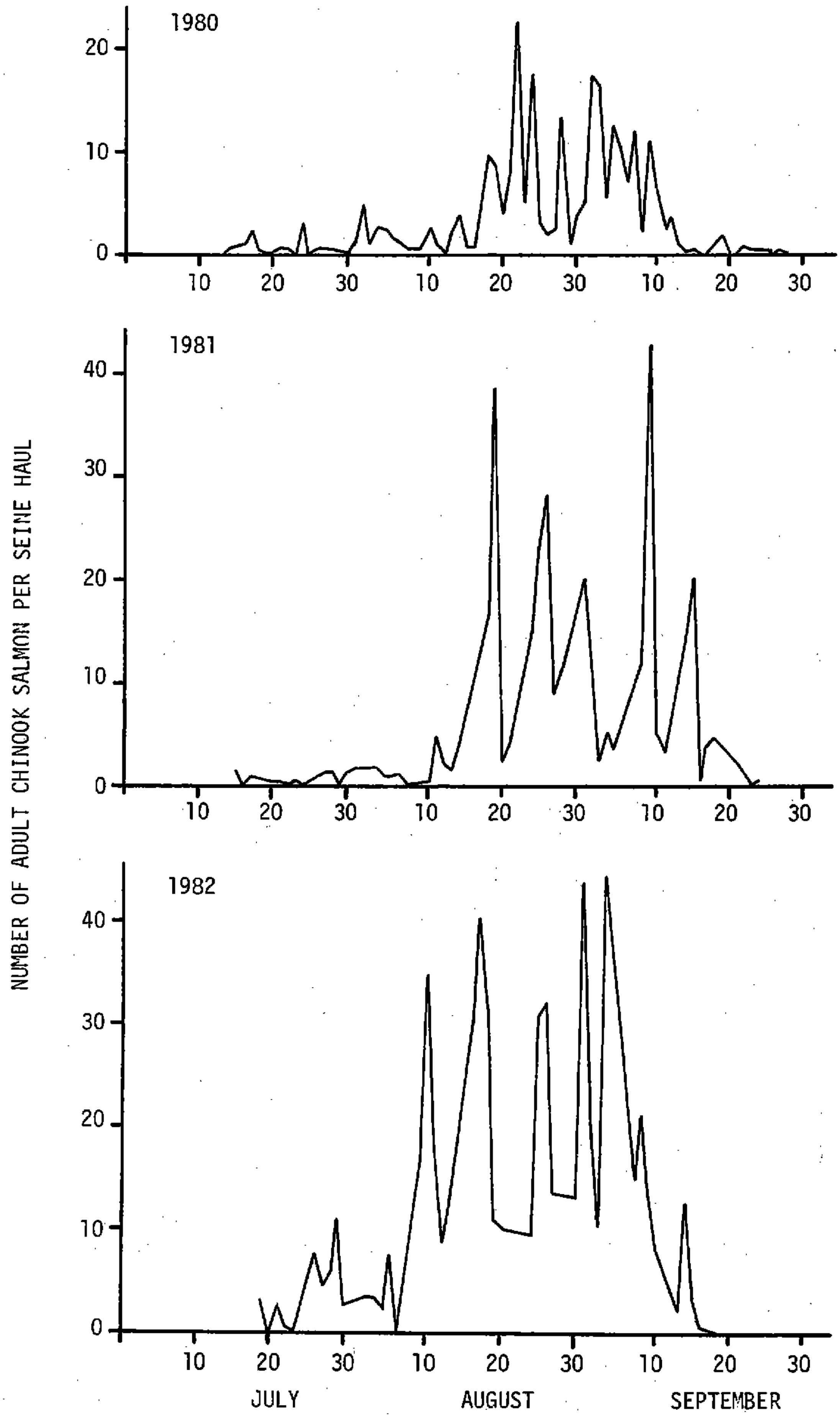


FIGURE 8. Daily numbers of adult chinook salmon captured per beach seine haul (peak 3 sets only) in the Klamath River estuary in 1980, 1981 and 1982.

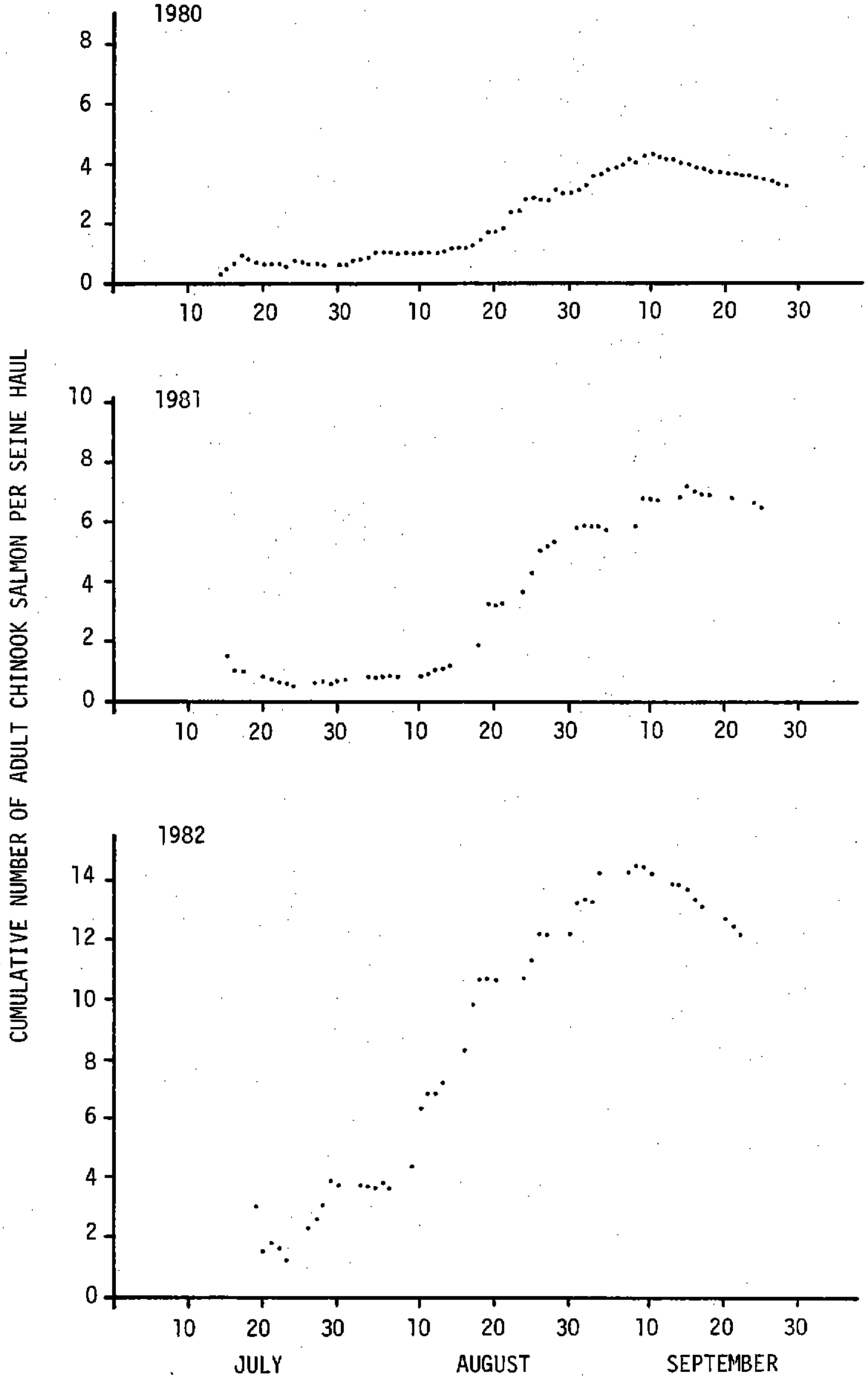


FIGURE 9. Cumulative daily chinook salmon catch/effort values (peak 3 sets only) in 1980, 1981 and 1982 beach seining operations in the Klamath River estuary.

TABLE 4. Summary of catch/effort data for chinook salmon captured in 1980, 1981 and 1982 beach seining operations in the Klamath River estuary.

TIMING	CHINOOK RUN COMPONENT	YEAR 1980	YEAR 1981	YEAR 1982
Total Season		7/13-9/28	7/13-9/25	7/19-9/22
All Sets	Grilse	2.40	1.90	3.04
	Adults	1.65	3.92	8.24
	All Chinook	4.06	5.82	11.28
Peak 3 Sets	Grilse	4.73	2.97	4.49
	Adults	3.41	6.55	12.19
	All Chinook	8.14	9.51	16.68
Run Peak Period		8/18-9/10	8/18-9/15	8/9-9/9
All Sets	Grilse	5.13	4.21	5.41
	Adults	4.11	9.18	14.42
	All Chinook	9.24	13.39	19.83
Peak 3 Sets	Grilse	9.90	6.28	8.14
	Adults	8.57	14.38	21.80
	All Chinook	18.47	20.67	29.94

NET HARVEST MONITORING PROGRAM

INTRODUCTION

Hoopa, Yurok, and Karok Indians living along the Klamath and Trinity rivers have traditionally fished for salmon, steelhead, sturgeon, and other species utilizing a variety of techniques including spears, dip nets, weirs, and most recently gill nets. Historically, salmon consumption by these people exceeded 907,000 kg (2 million pounds) annually (Hoptowit 1980). Historical accounts of the Indian fisheries are included in Hoptowit (1980), Bearss (1981), and USFWS (1981a).

Regulations governing Indian fishing on the Hoopa Valley Reservation were first promulgated by the Department of the Interior in 1977, and FAO-Arcata biologists began monitoring gill net harvest levels on the reservation in 1978 (USFWS 1981a), focusing efforts on fall chinook salmon. Considerable progress was made in ascertaining net harvest levels with the establishment in 1978 of a net harvest monitoring station in the lower Klamath River. In 1981, net harvest monitoring operations were expanded to the upper Klamath and Trinity river portions of the reservation with the opening of an upriver station near Pecwan. In a cooperative effort with the Hoopa Valley Tribe, further expansion of the net harvest program continued in 1982 with the establishment of a third monitoring station in Hoopa.

Substantial time closures were imposed on the net fishery which resulted in a 40% reduction of fishing time in 1982 during the fall chinook run. Gill net fishing was closed from 9 a.m. Monday to 5 p.m. Wednesday and from 9 a.m. to 5 p.m. on Thursday and Friday for each week from August 1 to September 30. With this reduction in fishing time and the additional station in Hoopa, FAO-Arcata biologists were able in 1982, for the first time, to expand to full-time daily monitoring of each of the 4 areas of the Hoopa Valley Reservation.

METHODS

Net harvest monitoring data were collected and compiled from 4 contiguous areas (Estuary, Resighinni, Upper Klamath, and Trinity) of the Hoopa Valley Reservation in 1982 (Figure 10). The tidewater (tidal-influenced) portion of the lower Klamath River was divided into 2 census areas: the Estuary Area, representing the lower 6 km of the river from the mouth to the Highway 101 Bridge, and the Resighinni Area, encompassing the uppermost portion of tidewater from the Highway 101 Bridge to the mouth of Terwer Creek, 8.5 km above the river mouth. The Upper Klamath Area includes the 61 km stretch of the Klamath River between Terwer Creek and Weitchpec, a relatively remote and inaccessible portion of the reservation. The Trinity Area represents the lower 26 km of the Trinity River contained within the Hoopa Square portion of the reservation. Following is a description of monitoring procedures employed for each area.

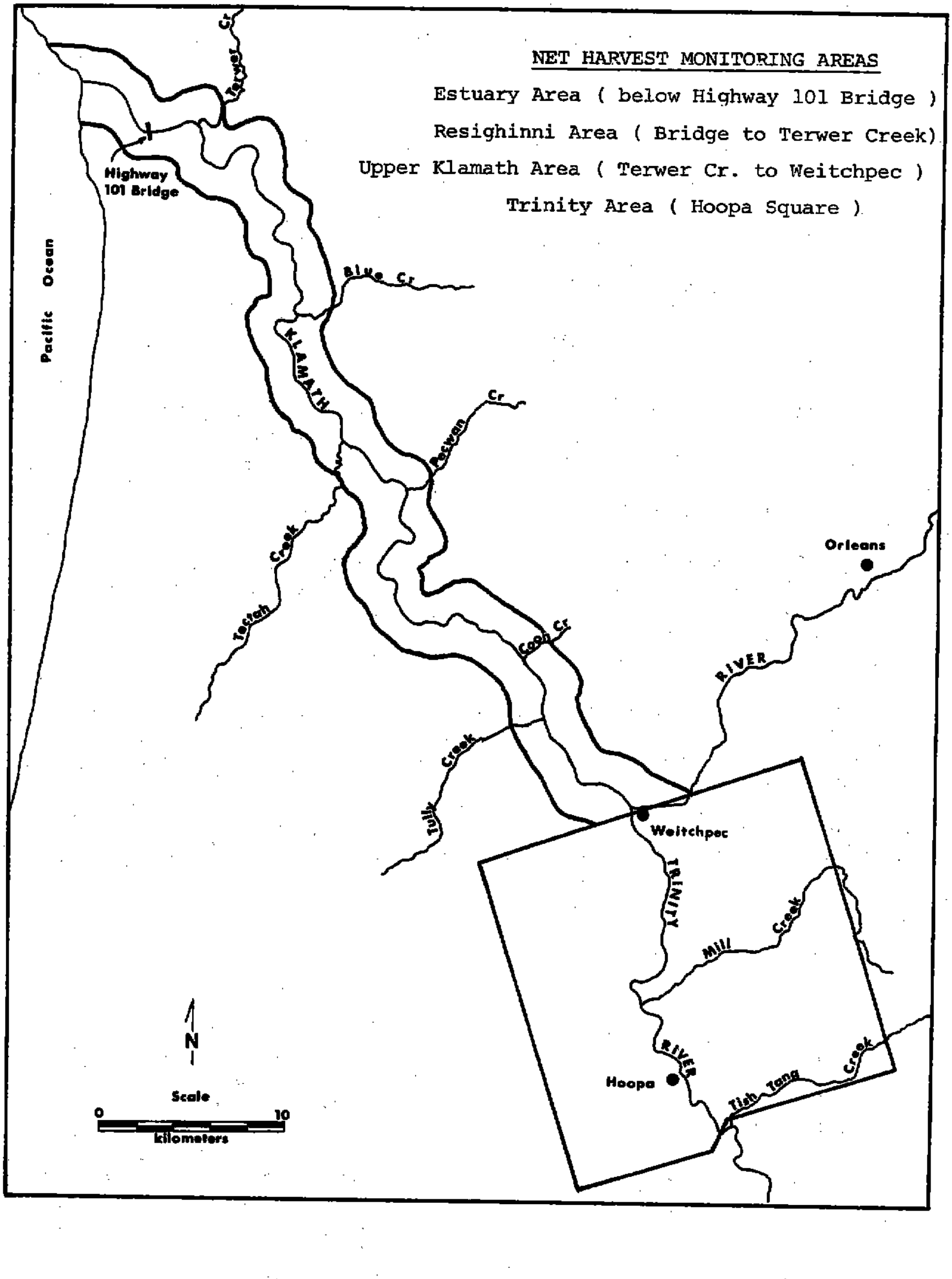
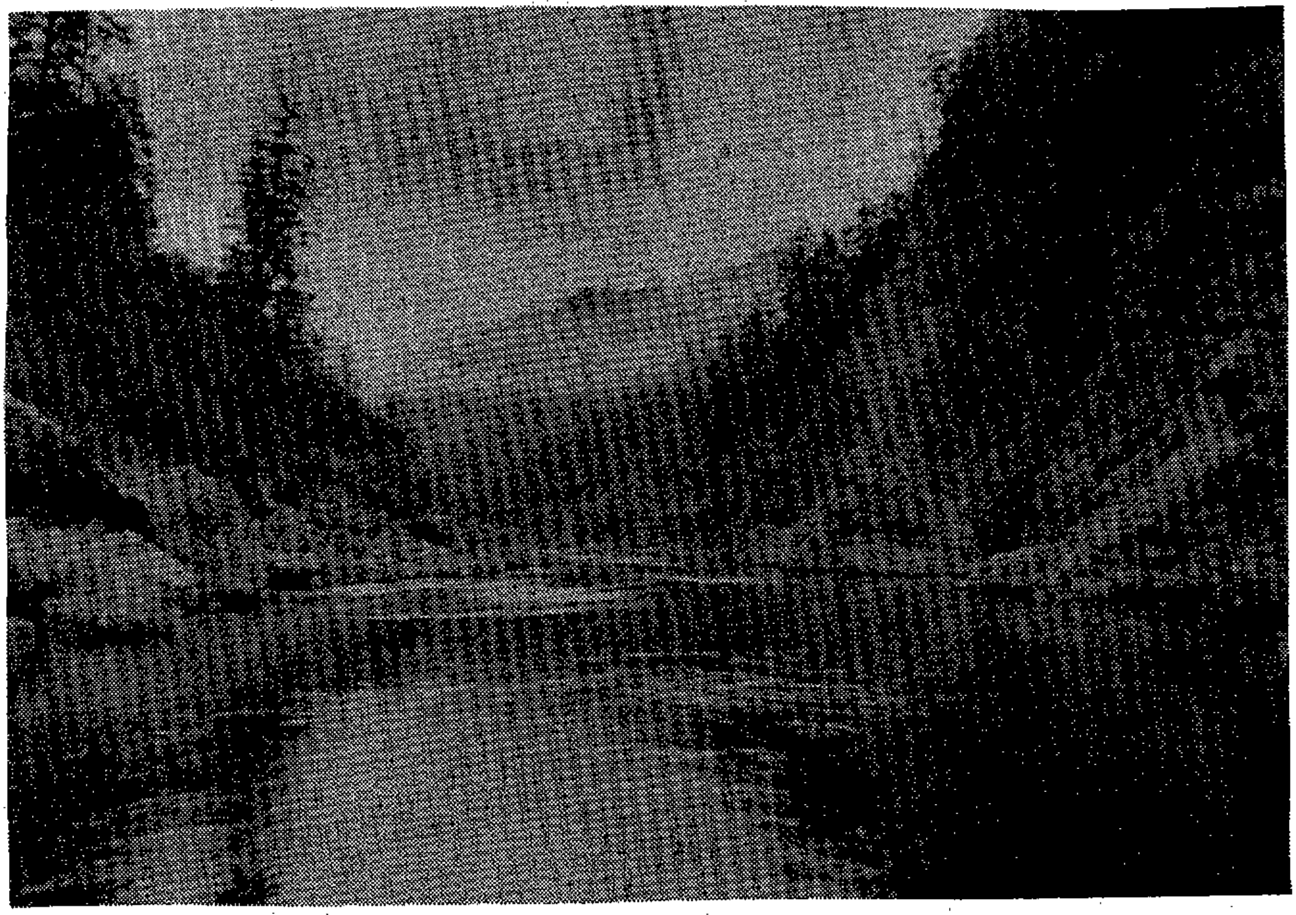
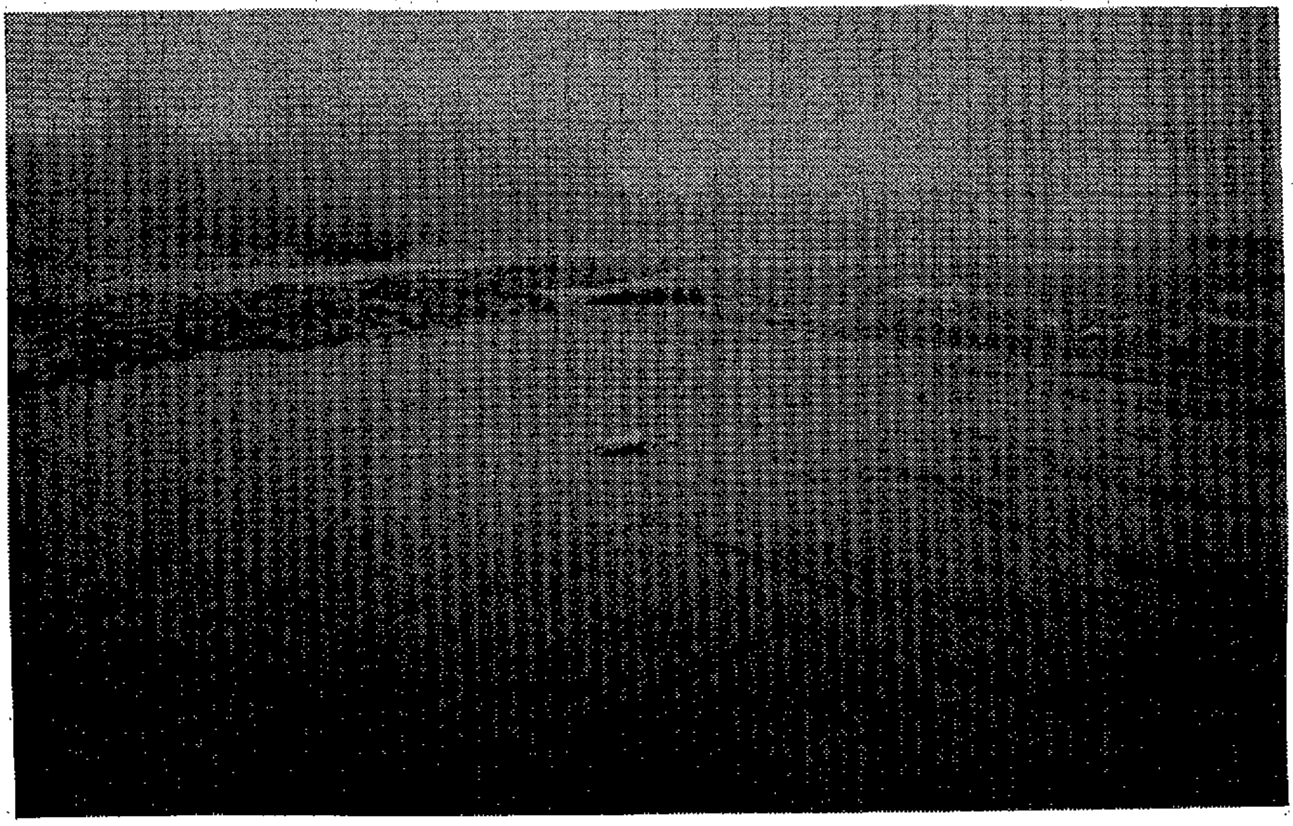


FIGURE 10. Net harvest monitoring areas - Hoopa Valley Indian Reservation.





PLATES 6 & 7. The Trinity River gorge (above) and an eddy net fishing in an upper river area (below) during 1982.

Estuary Area

FAO-Arcata personnel, operating from a base camp at Welk-Wau Village located near the river mouth at the southern edge of the estuary, monitored the Estuary Area on a periodic basis during the spring chinook run and daily from July 16 to September 26 to assess fall chinook harvest levels. Indian fishers were contacted while in their boats, at their riverside camps, or at several boat landings in the area. Monitoring activities were generally concentrated in the lower 2 km of the estuary, as Indian fishers typically set their nets in the deep channel off the south spit or just off the north bank of the river below Requa (Figure 11). Daily surveys, scheduled to coincide with the hours the fishery was open, typically occurred during the hours of 5 p.m. to 2 a.m. and 7 a.m. to 9 a.m., with additional hours of 9 a.m. to 5 p.m. during the 24-hour weekend fishery. Daily net counts made just prior to dark were adjusted to include additional nets that subsequently entered the fishery.

Resighinni Area

The Resighinni Area was monitored periodically during the spring chinook run and on a daily basis from August 1 to October 5 during the fall run. Surveys, conducted by FAO-Arcata personnel stationed at Welk-Wau Village, were made during the morning hours when fishers typically checked their nets and cleaned their fish. Occasional surveys were also made in the evening. Net counts were made daily during the morning survey.

Upper Klamath River Area

Net harvest monitoring in the Upper Klamath Area was conducted from a base camp located at Johnson, 39 km upstream from the river mouth. Indian fishers operating from Klamath Glen to Coon Creek were contacted at their netting sites or at their residences. Operation of the upriver station occurred periodically during the spring fishery and daily during the 5-day-a-week fall fishery. Surveys were conducted at fishing sites during the early morning hours when Indian fishers normally checked and removed their nets. Later in the day, Indian fishers not contacted earlier were interviewed at their residences.

Trinity Area

Personnel from the Fisheries Department of the Hoopa Valley Tribe and from FAO-Arcata cooperatively monitored the Trinity Area fishery on a daily basis during the spring and fall chinook runs (April 28 to October 29). Surveys were conducted with Indian fishers on the river during the early morning hours or later in the day at their residences.

Methods utilized in estimating net harvest levels for all 4 monitoring areas in 1982 were similar to those of previous years. Estimated daily and monthly net harvest levels were derived by (1) summing numbers of chinook measured, seen but not measured, and reported caught by reliable sources, and

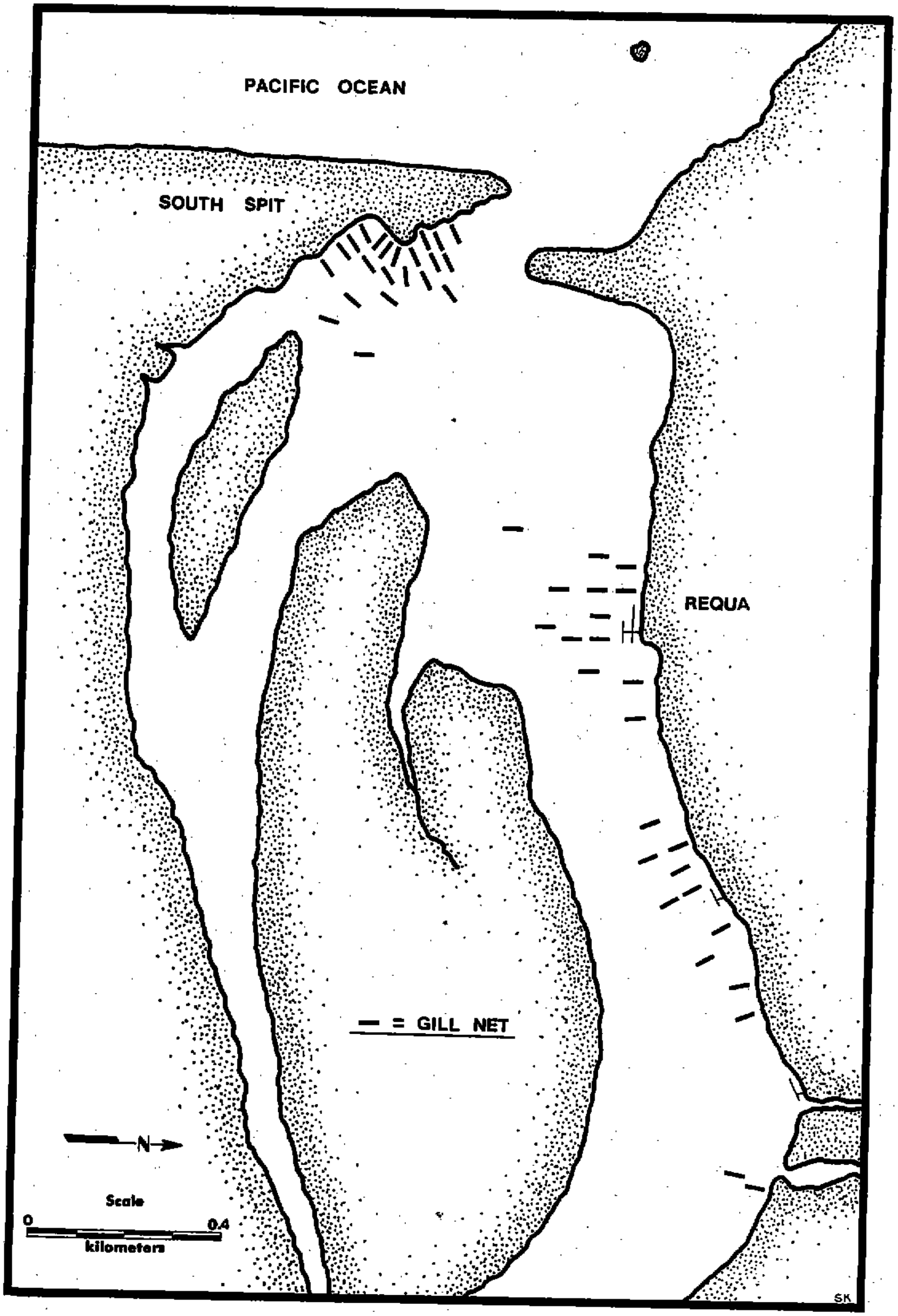


FIGURE 11. Typical net placement pattern in the Klamath River estuary on a high effort night during the peak of the 1982 fall chinook salmon run.

(2) dividing these respective sums by estimated percentages of net harvest these sums were judged to represent, based on net count information, our intimate knowledge of the net fisheries and our network of contacts on the reservation. Fall chinook harvest estimates were derived daily and spring chinook harvest estimates were determined monthly for each of the 4 areas. The close association between FAO-Arcata biologists and the Indian fishing communities afforded opportunities to formulate reasonably dependable, albeit subjective, judgements regarding the reliability of unseen harvest data supplied. Questionable harvest data obtained was routinely evaluated by field biologists and subjected to possible adjustment taking into account a variety of factors including (1) fishing location, (2) average catch/effort values of nets in close proximity to the fishing location, (3) netting proficiency of individual fishers as gleaned over a period of time, and (4) the reliability of past reporting by individual fishers.

A contact is defined as an interview with an Indian fisher sometime during or after the time the fisher had set a net in the river. Indian fishers using 2 nets were counted as 2 contacts per interview. In the Resighinni, Upper Klamath, and Trinity areas, interviews with Indian fishers occurred once a day, each interview being recorded as one contact per net fished. In the Estuary Area, where large numbers of salmon were often caught over a relatively short time period, Indian fishers were commonly interviewed 2 or 3 times daily, counting each interview as a separate contact. For example, an Indian fisher who used 2 nets and was interviewed twice in one evening was regarded as 4 contacts.

Estimates of seasonal effort for fall chinook in the Estuary and Resighinni areas were made by summing daily net counts. In the Upper Klamath and Trinity areas, where no daily net counts were made, seasonal effort estimates were derived by dividing the number of contacts in each area for the season by the estimated percentage of net effort these contacts or net-nights were judged to represent.

Catch per net-night values for the Estuary and Resighinni areas were derived from estimated daily net harvests divided by daily net counts. In the Upper Klamath and Trinity areas, catch per net-night values were derived by dividing weekly summaries of the combined harvest catagories (measured, seen but not measured, and reliable unseen) by the weekly tabulations of contacts. In these areas, contacts were considered interchangeable with net-nights, because only one interview per Indian fisher was made daily, and the number of nets used was reflected in the number of contacts made.

Catch per net-night indices for fall chinook salmon were developed to compare yearly variations in catch/effort data within an area fishery over a fixed time period during which most of the catch had occurred. The period from August 10 to September 15 was used for the Estuary Area index. In the last 3 years, at least 82% of the yearly harvest of fall chinook was taken during this time. The Resighinni Area index period selected was August 20 to September 25, when in the last 2 years, at least 86% of the yearly fall chinook catch had occurred.

Chinook sampled in the net fishery were measured to the nearest centimeter fork length and examined for fin-clips. A subsample of chinook in the lower

Klamath were weighed to the nearest pound and these weights were then converted to kilograms. Snouts were removed from adipose fin-clipped fish for subsequent coded-wire tag identification. Additional snouts were obtained through voluntary returns by Indian fishers. Scales were taken from spring chinook for age analysis.

Based on CWT recoveries in the net fishery, it became apparent that a substantial mixed-race fishery occurred in the Trinity Area between July 1 and August 15, 1982. Contributions of spring and fall chinook to the Trinity fishery during this time period were estimated by comparing observed percentages of adipose fin-clipped chinook caught in the mixed-race fishery with observed percentages of clipped chinook recovered before and after this period, when harvest was considered to consist of only one race. Coded-wire tag recoveries in the Estuary, Resighinni, and Upper Klamath areas revealed relatively distinct timing of entry patterns of the 2 races into these fisheries; consequently, cutoff dates of July 10 for the Estuary Area, and July 31 for the Resighinni and Upper Klamath areas were established to separate the harvest of spring from fall chinook.

RESULTS AND DISCUSSION

Fall Chinook Salmon

FAO-Arcata biologists observed over 8,000 fall chinook salmon harvested by Indian fishers on the Hoopa Valley Indian Reservation in 1982. Of these, 5,993 were mark-sampled for tags and fin-clips and 5,174 were measured to fork length. Based on over 4,100 contacts with Indian fishers during the fall season, reservation-wide net harvest was estimated at 16,281 fall chinook salmon, including 14,482 adults (89%) and 1,799 grilse (58 cm).

Over half of the 1982 net harvest occurred in the lower 8.5 km of the Klamath River, with the fisheries in the Estuary and Resighinni areas accounting for 4,837 (29.7%) and 3,919 (24.1%) salmon, respectively (Table 5). Grilse comprised 6.0% of the Estuary and 9.4% of the Resighinni area catches, representing approximately 658 salmon.

The remaining 46.2% of the 1982 harvest was spread throughout the 87 km of river included in the Upper Klamath and Trinity areas. The Upper Klamath Area fishery accounted for 35% (5,700) while the Trinity Area fishery accounted for 11.2% (1,825) of the total 1982 fall chinook net harvest. Grilse comprised 14.5 and 17.2% of the Upper Klamath and Trinity area catches, respectively, representing a total of 1,141 chinook.

Most of the salmon harvested in the Estuary Area were taken during a 7-week period from August 5 to September 22, with peak harvesting occurring during the week ending September 8 (Figure 12). During this period, weekly harvest levels ranged from 139 to 1,448, with an average catch of 658 chinook. Daily catch estimates ranged from 4 to 693, and averaged 131 chinook. The daily number of nets fished in the Estuary Area during this time period ranged from 13 to 85, averaging 40 nets per night for the 5-day-a-week fishery. Weekly mean catch per net-night values ranged from 1.4 to 5.0 chinook, and averaged 3.1.

TABLE 5. Semi-monthly net harvest estimates of fall chinook salmon captured in the 4 monitoring areas of the Hoopa Valley Reservation in 1982.

TIME PERIOD		NET HARVEST MONITORING AREA				SEMI-MONTHLY TOTAL (ALL AREAS)	CUMULATIVE SEASONAL TOTAL
		ESTUARY	RESIGHINNI	UPPER KLAMATH	TRINITY		
Jul	1-15	0	0	0	24	24	24
	16-31	90	0	0	56	146	170
Aug	1-15	753	45	75	78	951	1,121
	16-31	1,868	1,161	1,402	322	4,753	5,874
Sep	1-15	1,901	1,538	2,495	515	6,449	12,323
	16-30	225	1,039	1,358	634	3,256	15,579
Oct	1-15	0	136	350	159	645	16,224
	16-31	0	0	20	37	57	16,281
TOTAL		4,837	3,919	5,700	1,825		16,281
PERCENTAGE		29.7	24.1	35.0	11.2		

The Estuary Area fishery exhibited an 80% decrease in harvest of fall chinook in 1982 (4,837) from 1981 (24,009). Harvest timing patterns in the Estuary Area fishery, however, were similar in both years with peak catch per net-night values occurring during the weeks ending August 25 and September 8. Catch per net-night indices showed the Estuary Area harvest rate for 1982 as the lowest among the 3 year data base, representing a value only half of the 1980 index and one quarter of the 1981 index (Table 6).

TABLE 6. Catch per net-night indices of fall chinook salmon harvested in the Estuary (1980-1982) and Resighinni (1981-1982) areas of the Klamath River.

AREA (Time Period)	YEAR	CATCH/NET-NIGHT INDEX	PERCENT OF HARVEST
Estuary Aug. 10 - Sept. 15)	1980	7.47	90
	1981	15.49	82
	1982	3.74	83
Resighinni (Aug. 20 - Sept. 25)	1981	13.47	86
	1982	12.03	89

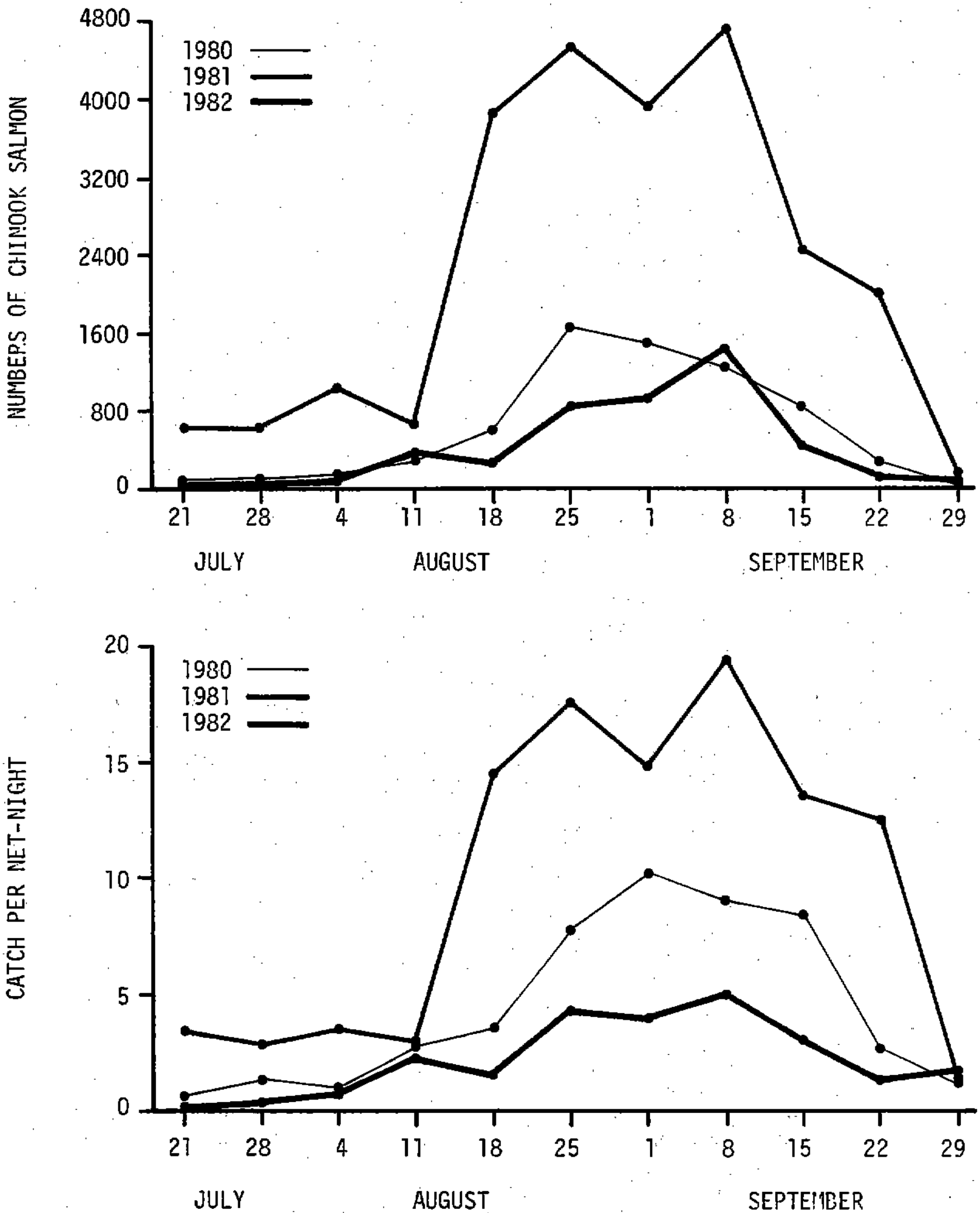


FIGURE 12. Estimated weekly Indian gill net harvests (above) and catches per net-night of effort (below) of chinook salmon in the Estuary Area of the Hoopa Valley Reservation in 1980, 1981, and 1982.

Over 90% of the 1982 fall chinook harvest in the Resighinni Area occurred during a 6-week period from August 19 to September 29, with the highest weekly catch occurring during the week ending September 8 (Figure 13). Weekly harvest ranged from 441 to 909 chinook and averaged 615, resulting in weekly mean catch per net-night values ranging from 7.2 to 16.5 and averaging 11.7. Daily catch estimates ranged from 27 to 364 chinook and averaged 11.5. Effort was generally consistent, averaging 11 nets per day.

The harvest estimate for the Resighinni Area in 1982 was 19% greater than the 1980 harvest estimate but 15% lower than that of 1981. Effort in the Resighinni Area was slightly down from 1981, with 5% fewer nets in 1982. Weekly catch estimates and catch per effort values indicate similar run timing patterns for the 3 years, especially between 1981 and 1982 (Figure 13). The Resighinni catch per net-night index for 1982 was 11% below the 1981 index, indicating a slight reduction in harvest rate (Table 6).

The majority of fall chinook harvest in the Upper Klamath Area took place during a 7-week period from August 19 to October 6, with peak harvest occurring during the week ending September 8 (Figure 14). During this period, the weekly catch ranged from 440 to 1,571 chinook and averaged 864. Daily catch ranged from 23 to 606 chinook and averaged 173 for the 5-day-a-week fishery.

The 1982 Upper Klamath chinook net harvest was up 17% from 1981. Although harvest patterns were similar, with peak catch in both years occurring during the week ending September 8, a greater harvest took place in 1982 during the peak week (Figure 14). Total effort for the fall season in the Upper Klamath Area was estimated at 1,372 net-nights, up 31% from the estimated 1,049 net-nights in 1981. Weekly mean catch per net-night values for the same time period were generally lower in 1982, especially after the peak week of harvest had occurred. Based on estimates of harvest and effort, the mean seasonal catch per net-night in 1982 was 4.15, down 11% from the 1981 value of 4.65.

Seventy-five percent of 1982 chinook harvest from the Trinity Area was taken during a 6-week period from August 19 to September 27, with the highest weekly catch occurring during the week ending September 22 (Figure 15). Weekly harvest ranged from 67 to 382 chinook, averaging 238. Daily harvest ranged from 4 to 113 chinook, averaging 48 during the 6-week period. Weekly mean catch per net-night during the 6 weeks ranged from 0.5 to 2.5, and averaged 1.8 chinook.

Fall chinook net harvest in the Trinity Area in 1982 was down 8% from 1981. Effort in 1982 totaled an estimated 1,181 net-nights with a mean seasonal catch per net-night value of 1.55 chinook. Harvest patterns observed in the 1982 Trinity Area fishery differed from those observed in 1981. In the Trinity Area, fall chinook were harvested over a more protracted time period in 1982 than in 1981, with lower catches occurring during the peak harvest weeks. During 1982, considerable numbers of fall chinook were harvested in the Trinity Area in August whereas in 1981 there had been no harvest of fall chinook in August.

The length-weight relationship $\text{Log } W = \bar{4}.906 + 3.043 (\text{Log } L)$ was determined for chinook salmon captured in the lower Klamath River, based on a sample of 69 fish ranging in fork length from 69 to 108 cm and in weight from 5.0 to 19.1 kg

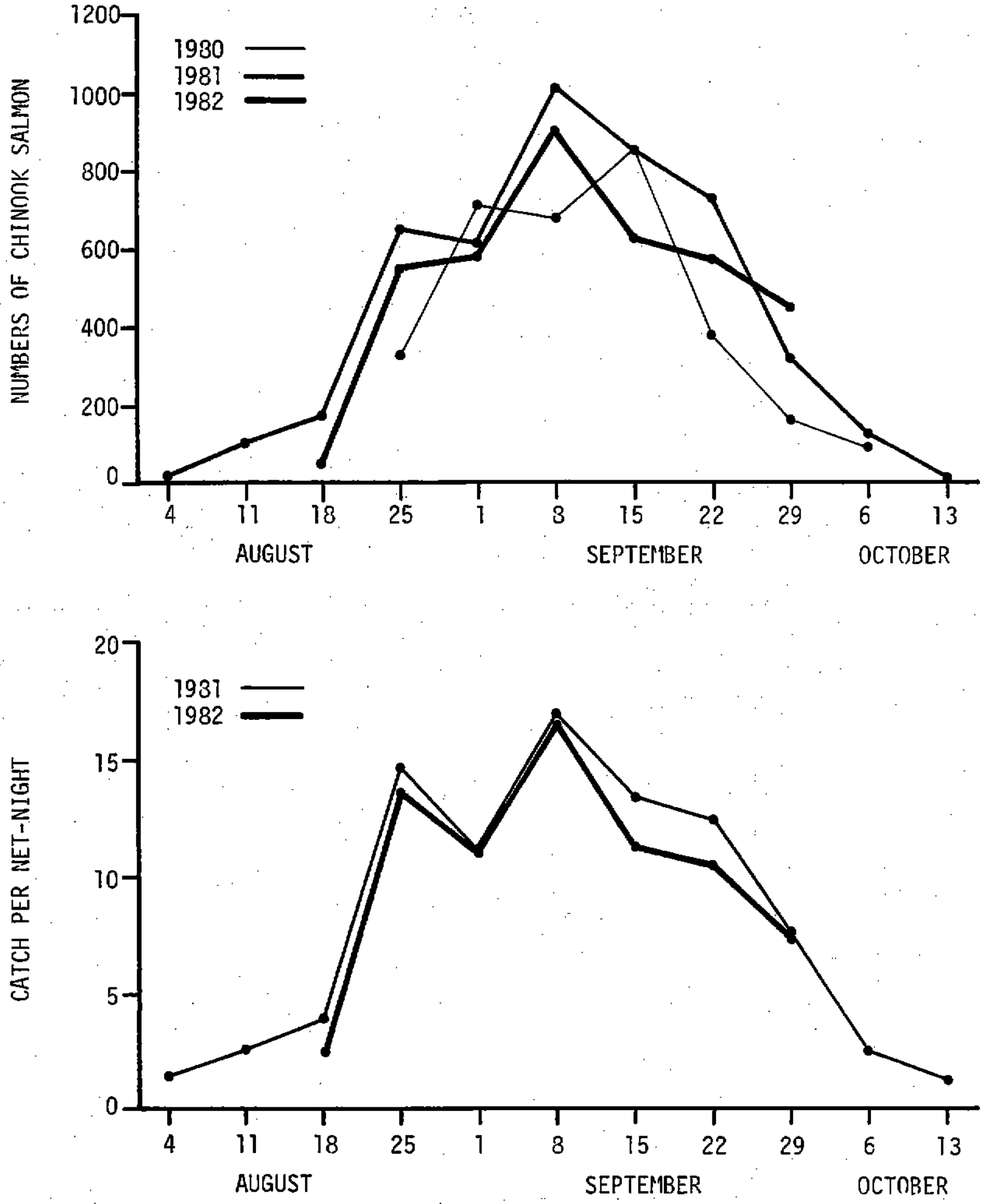


FIGURE 13. Estimated weekly Indian gill net harvests (above) and catches per net-night of effort (below) of chinook salmon in the Resighinni Area of the Hoopa Valley Reservation in 1980, 1981, and 1982.

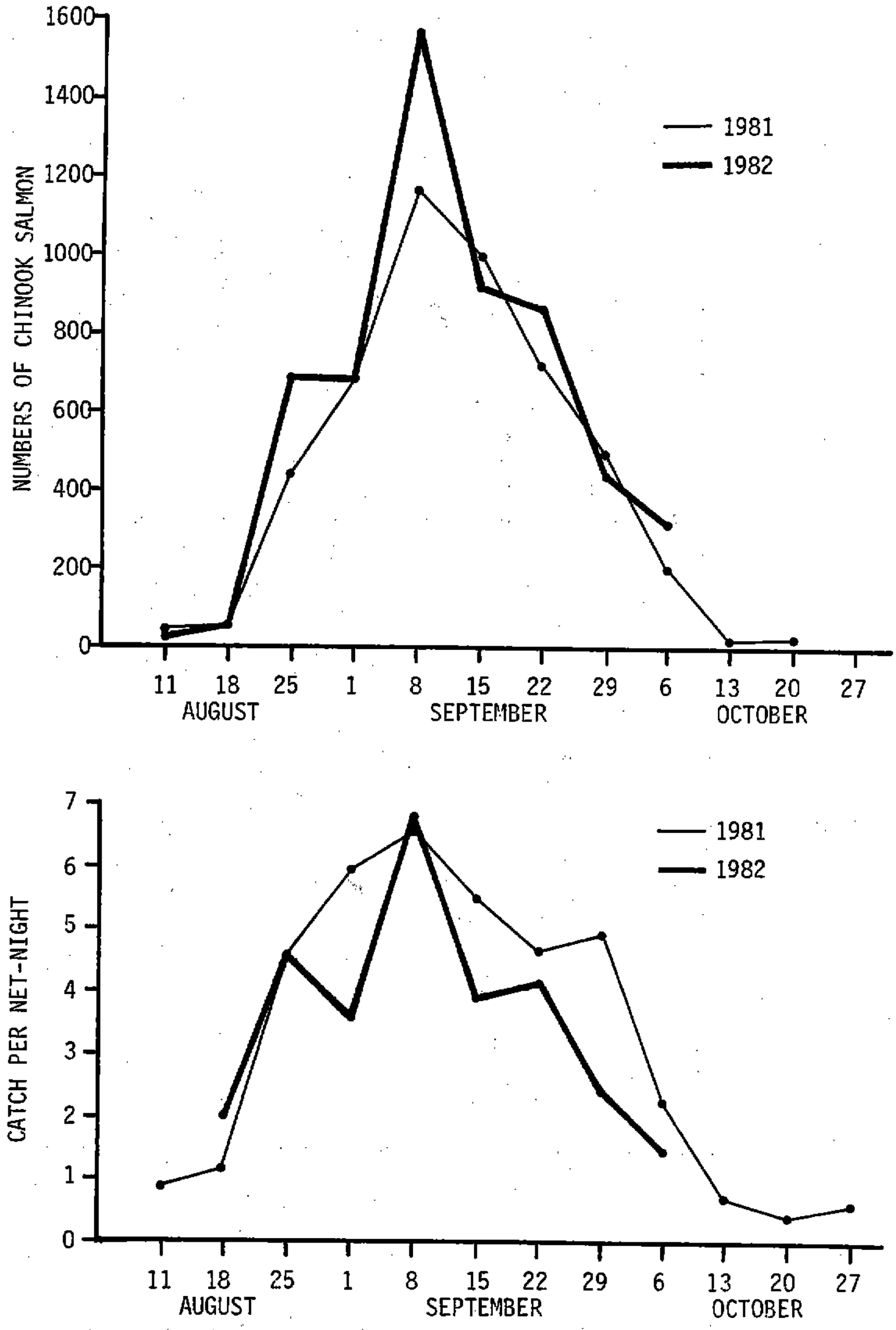


FIGURE 14. Estimated weekly Indian gill net harvests (above) and catches per net-night of effort (below) of chinook salmon in the Upper Klamath Area of the Hoopa Valley Reservation in 1981 and 1982.

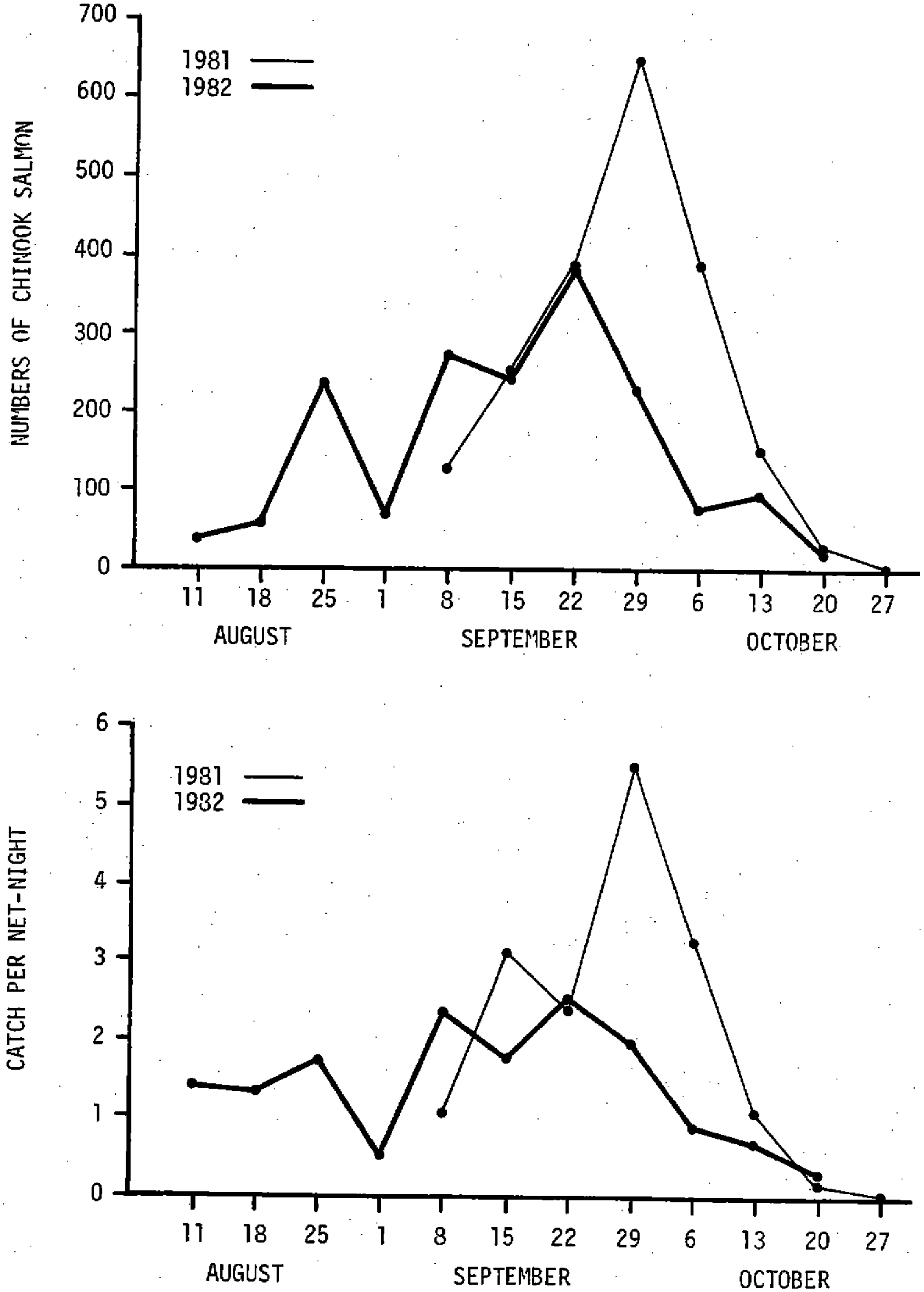


FIGURE 15. Estimated weekly Indian gill net harvests (above) and catches per net-night of effort (below) of chinook salmon in the Trinity Area of the Hoopa Valley Reservation in 1981 and 1982.

(Figure 16). Chinook grilse captured in the net fishery averaged 49.5 cm fork length and 1.8 kg round weight, and adults averaged 78.5 cm and 7.3 kg. Combining grilse and adult samples, the average fall chinook salmon taken in the fishery measured 75.3 cm and weighed 6.4 kg.

Chinook exhibiting adipose fin-clips, representing various hatchery CWT release groups, comprised 8.9% of the total 1982 fall chinook net harvest, and 8.7, 6.5, 9.4 and 15.4% of the harvest in the Estuary, Resighinni, Upper Klamath, and Trinity areas, respectively (Table 7). Adipose-clipped adult chinook averaged 77.2 cm in length and were significantly smaller (t-test; $p < 0.05$) than non-clipped adults, 78.5 cm (Figure 17). Adipose-clipped grilse averaged 50.4 cm in length and did not differ significantly ($p > 0.05$) from non-clipped grilse (49.5 cm).

TABLE 7. Numbers of fin-clipped fall chinook salmon observed in the 1982 Indian gill net fishery on the Hoopa Valley Reservation.

AREA	MARK SAMPLE	FIN-CLIPS AD n	AD %	LV n	LV %	RV n	RV %
Estuary	1,778	154	8.7%	2	0.1%	6	0.3%
Resighinni	1,913	124	6.5%	2	0.1%	15	0.8%
Upper Klamath	1,546	146	9.4%	6	0.4%	12	0.8%
Trinity	644	102	15.4%	0	0.0%	24	3.6%
TOTAL	5,901	526	8.9%	10	0.2%	57	1.0%

Ventral fin-clipped fall chinook representing a constant fractional marking program entered the net fishery as 2 and 3-year-olds in 1982. Chinook released from Iron Gate Hatchery displayed a left ventral clip (LV) while a right ventral clip (RV) identified fish released from the Trinity River Hatchery. A total of 10 LV and 57 RV clipped chinook were observed in the 1982 sample harvest (Table 7). LV clipped chinook were observed in each of the 3 Klamath areas with 60% of the recoveries occurring in the Upper Klamath Area fishery. No LV clipped chinook were observed in the Trinity Area net fishery. Of the RV clipped chinook, 42% were observed in the Trinity Area fishery, with 21 of 24 (88%) being taken during a 2-week period from September 10 to September 24. Of 6 RV clipped chinook observed in the Estuary Area, 5 (83%) were harvested during a one week period from September 5 to September 11. Because of insufficient sample size, no attempt was made to estimate proportional contribution of hatchery fish to the grilse component of the 1982 Hoopa Valley Reservation harvest (Hankin 1982).

Length-frequency comparisons of fall chinook harvested in the 4 areas are presented in Figures 18 and 19. As in 1981, the mean length of adult chinook captured in the Estuary Area was significantly greater (t-test; $p < 0.05$) than those of the upriver areas while the Trinity Area adults were significantly smaller ($p < 0.05$) than salmon harvested in the 3 Klamath areas. Mean lengths

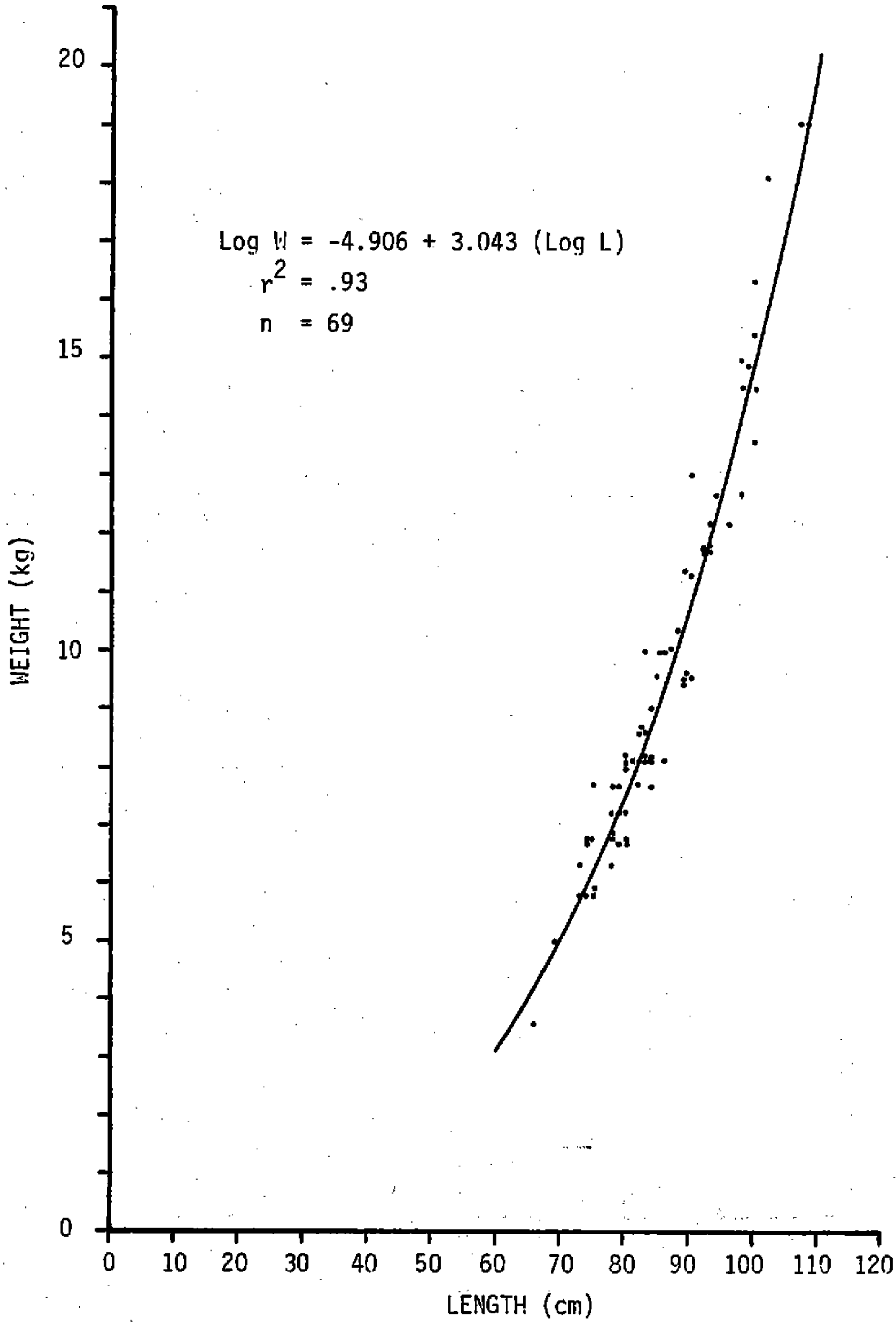


FIGURE 16. Length-weight relationship of chinook salmon caught by Indian gill netters on the lower Klamath River in 1982.

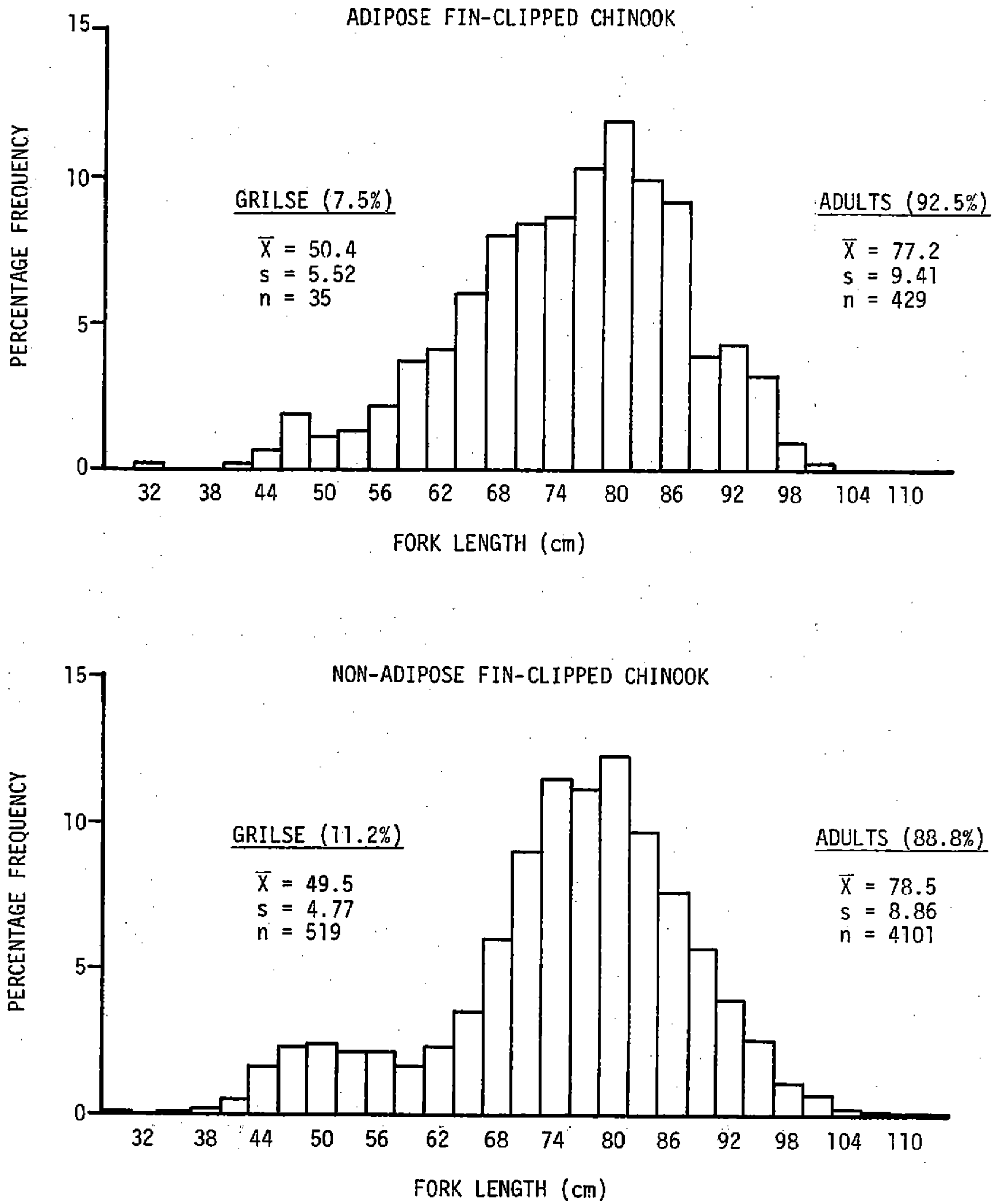


FIGURE 17. Length-frequency distributions of adipose fin-clipped and non-adipose fin-clipped fall chinook salmon harvested by Indian gill netters on the Hoopa Valley Reservation in 1982.

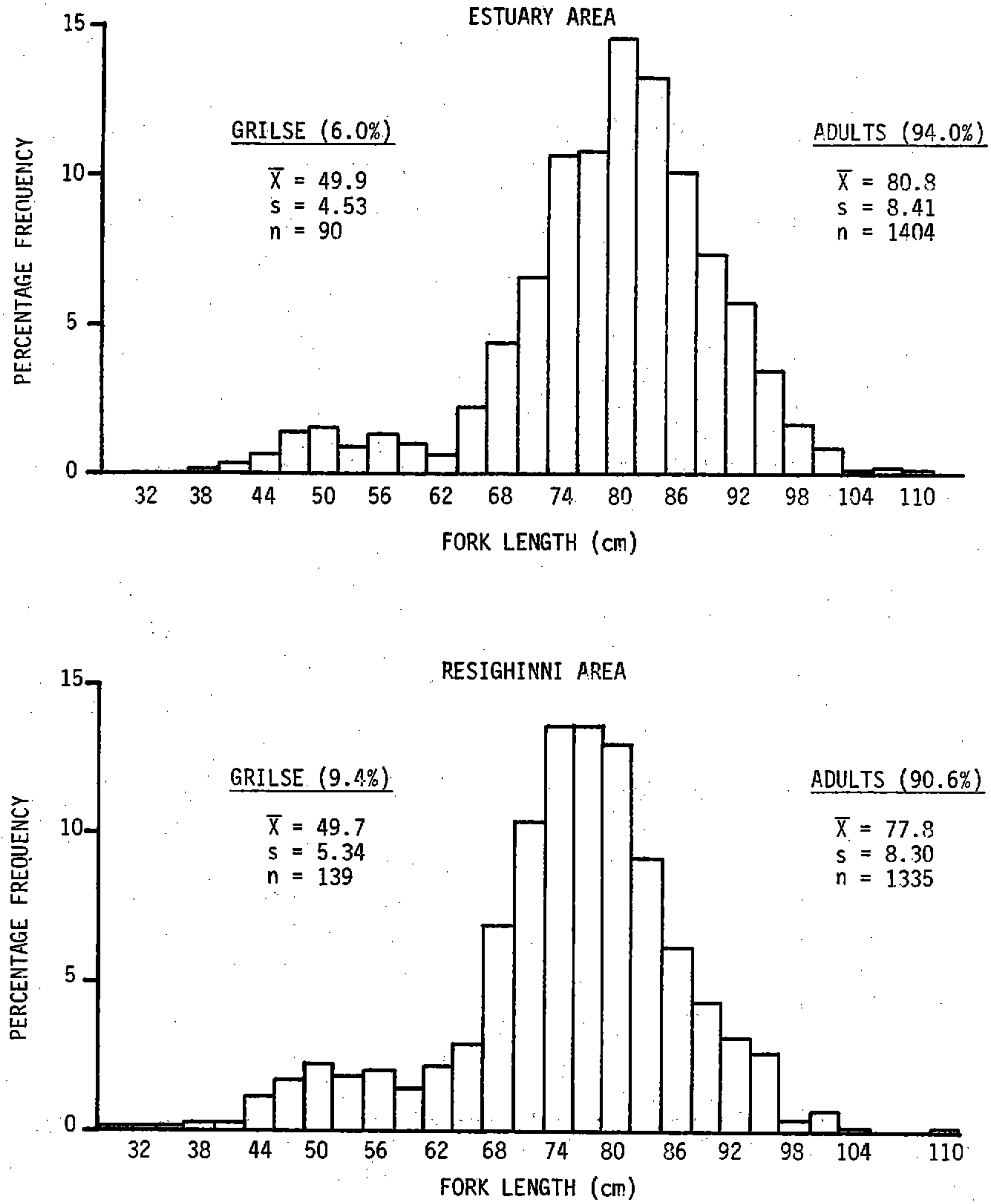
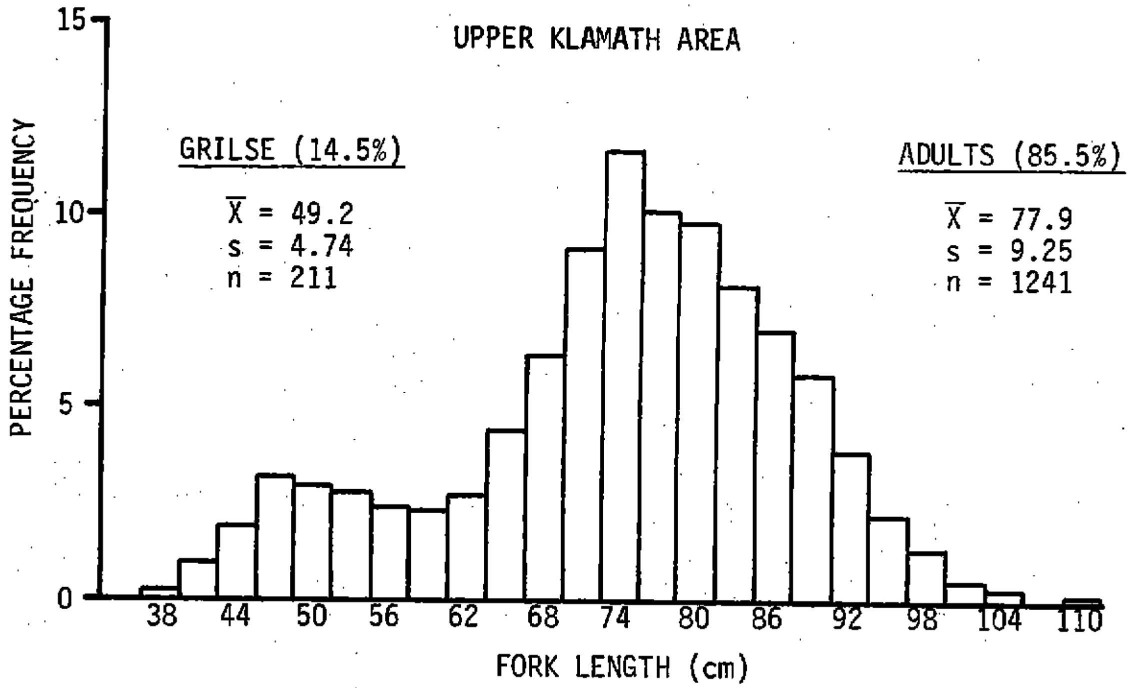


FIGURE 18. Length-frequency distributions of fall chinook salmon caught by Indian gill netters in the Estuary and Resighinni areas of the Hoopa Valley Reservation in 1982.



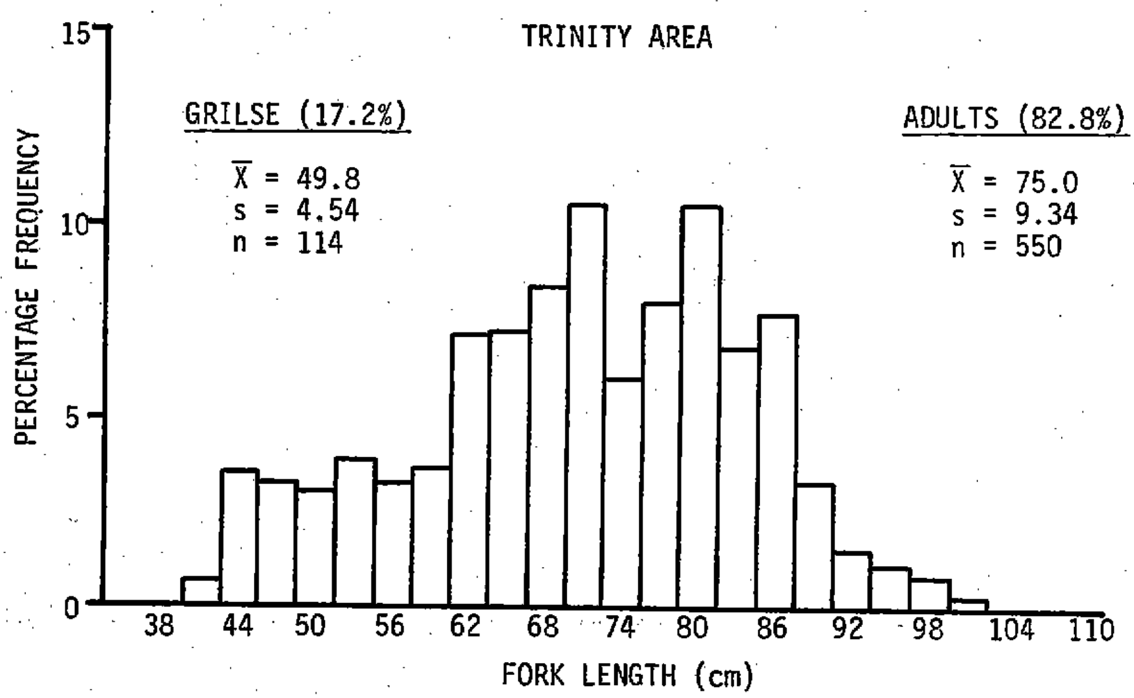


FIGURE 19. Length-frequency distributions of fall chinook salmon caught by Indian gill netters in the Upper Klamath and Trinity areas of the Hoopa Valley Reservation in 1982.

of adult chinook taken in the Resighinni and Upper Klamath areas, 77.8 and 77.9 cm respectively, did not differ significantly ($p > 0.05$). Grilse displayed no significant differences ($p > 0.05$) in mean length between the 4 areas.

Length-frequency distributions of fall chinook taken in the 1980, 1981 and 1982 net fisheries of the lower Klamath River (Estuary and Resighinni Areas) are presented in Figure 20. Grilse captured in the 1982 net fishery showed no significant mean length differences ($p > 0.05$) from grilse harvested in either 1980 or 1981. Mean length of adult chinook captured in 1982 were significantly greater ($p < 0.05$) than in either 1980 or 1981, suggesting a higher contribution of 4-year-olds than 3-year-olds to the 1982 fishery.

Table 8 summarizes harvest estimates of fall chinook salmon in the Hoopa Valley Reservation Indian gill net fishery during the period from 1977 through 1982. As discussed in USFWS (1981), preliminary harvest estimates made in 1977, 1978 and 1979 were subsequently revised based on additional information which became available during more intensive monitoring efforts in 1980. Harvest estimates made for the Indian net fishery prior to 1980 should be considered more speculative in nature compared with those of 1980, 1981 and 1982, since efforts to census the fisheries have increased markedly as has the coöperation of the fishermen involved. The average estimated harvest of fall chinook for the 6-year period from 1977-1982 is 21,630, which compares closely to the 1980-1982 3-year average of 21,593.

Spring Chinook Salmon

FAO-Arcata biologists examined 576 spring chinook salmon on the Hoopa Valley Reservation in 1982. Based on over 1,500 contacts with Indian fishers, reservation-wide net harvest was estimated at 3,200 spring chinook salmon, including 3,155 adults (98.6%) and 45 grilse (<52 cm).

Net harvest of spring chinook began in April and continued through August, with 80% of the reservation-wide total occurring during May and June (Table 9). The peak harvest month for the 3 Klamath areas (Estuary, Resighinni, and Upper Klamath) was May, while the peak month for the Trinity Area was July (Figure 21). The Upper Klamath fishery accounted for 46.9% of the total harvest, with fisheries in the Estuary, Resighinni, and Trinity areas comprising an additional 5.5, 25.0, and 22.6%, respectively.

Adult spring chinook harvested in the net fishery in 1982 were significantly larger ($p < 0.05$) than in 1981 but significantly smaller ($p < 0.05$) than in 1980 (Figure 22). Age analysis of the sampled harvest (see Age Composition section) indicates that 1980 and 1982 harvests of spring chinook were largely composed of 4-year-old salmon, (83% and 62%, respectively), whereas 3-year-olds dominated in 1981, representing 73% of the catch.

Length-frequency distributions of spring chinook harvested in the Estuary-Resighinni, Upper Klamath, and Trinity areas are presented in Figure 23. Length-frequency distributions of the Estuary and Resighinni areas were combined due to the low sample size in the Estuary Area. As in 1981, mean length of adult chinook captured in the Trinity fishery was significantly smaller ($p < 0.05$) than

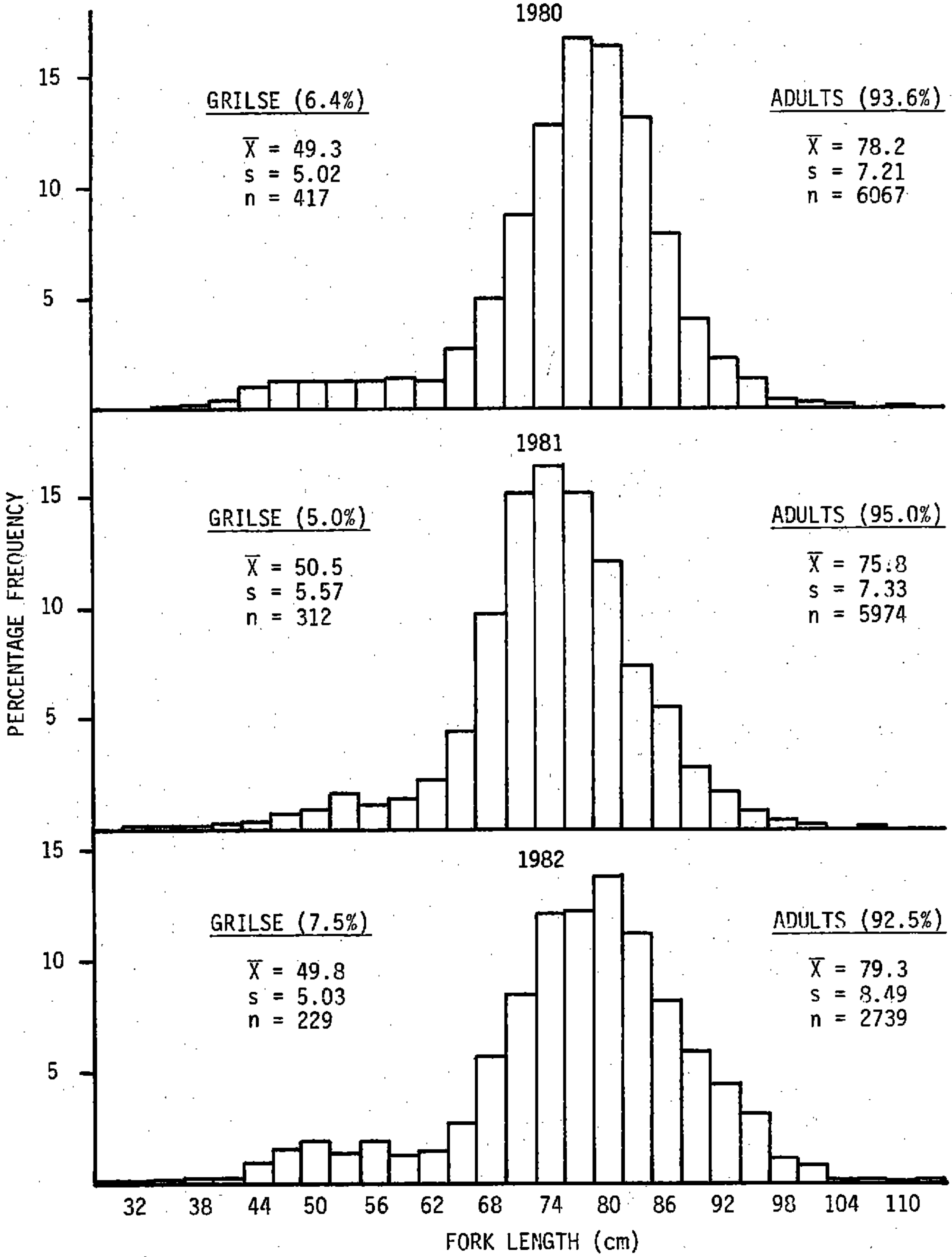


FIGURE 20. Length-frequency distributions of fall chinook salmon caught by Indian gill netters in the lower Klamath River in 1980, 1981, and 1982.

TABLE 8. Final harvest estimates of fall chinook salmon captured in the Indian net fishery of the Hoopa Valley Reservation from the years 1977 through 1982.

YEAR	ADULTS	GRILSE	TOTAL
1977	27,300	2,700	30,000 1/
1978	18,200	1,800	20,000 2/
1979	13,650	1,350	15,000 3/
1980	12,013	987	13,000 4/
1981	33,033	2,456	35,498 5/
1982	14,482	1,799	16,281 6/

1/ From the 1980 Annual Report. No direct monitoring of the catch. Based upon commercial sales receipts and assuming additional subsistence harvest. Grilse contribution was derived from a weighted average of the percentage of grilse contribution in 1980 and 1981 to the total harvest by monitoring area.

2/ From the 1980 Annual Report. Revised downward from 25,000 previously estimated. Based upon harvest monitoring activities through August 28, 1978, and on speculative information throughout remainder of season. Grilse contribution was derived from a weighted average of the percentage of grilse contribution in 1980 and 1981 to the total harvest by monitoring area.

3/ From the 1980 Annual Report. Revised downward from 20,000 previously estimated. Based on aerial net counts and catch per net night values derived through contacts with a number of Indian fishers. Grilse contribution was derived from a weighted average of the percentage of grilse contribution in 1980 and 1981 to the total harvest by monitoring area.

4/ Estimation methods described in 1980 Annual Report.

5/ Estimation methods described in 1981 Annual Report.

6/ Estimation methods described in 1982 Annual Report.

in either the Estuary-Resighinni or Upper Klamath fisheries. No significant difference ($p > 0.05$) was found between mean lengths of spring chinook in the Estuary-Resighinni and Upper Klamath fisheries. Although differences in mesh sizes of nets used in the 4 area fisheries may influence mean length of the harvest in each area, no such differences were apparent in 1982.

TABLE 9. Monthly net harvest estimates of spring chinook salmon captured in the 4 monitoring areas of the Hoopa Valley Reservation in 1982.

Month	NET HARVEST MONITORING AREA				Monthly Total (All Areas)	Cumulative Seasonal Total
	Estuary	Resighinni	Upper Klamath	Trinity		
April	25	25	50	0	100	100
May	100	625	800	25	1,550	1,650
June	50	125	600	225	1,000	2,650
July	0	25	50	300	375	3,025
August	0	0	0	175	175	3,200
TOTAL	175	800	1,500	725	3,200	
PERCENTAGE	5.5	25.0	46.9	22.6	100.0	

Adipose fin-clipped salmon comprised 51.8% of the total 1982 spring chinook sample and 54.8, 48.1 and 55.3% of the Estuary-Resighinni, Upper Klamath and Trinity area samples, respectively. Adipose-clipped adult spring chinook averaged 71.8 cm in length and, as in 1981, were significantly smaller ($p < 0.05$) than non-clipped adults, 73.4 cm (Figure 24).

Table 10 summarizes harvest estimates of spring chinook salmon captured in the Hoopa Valley Reservation Indian gill net fishery during the 1980-1982 period. It should be noted that spring chinook harvest estimates are based upon periodic sampling of the catch and therefore more speculative in nature than fall chinook harvest estimates.

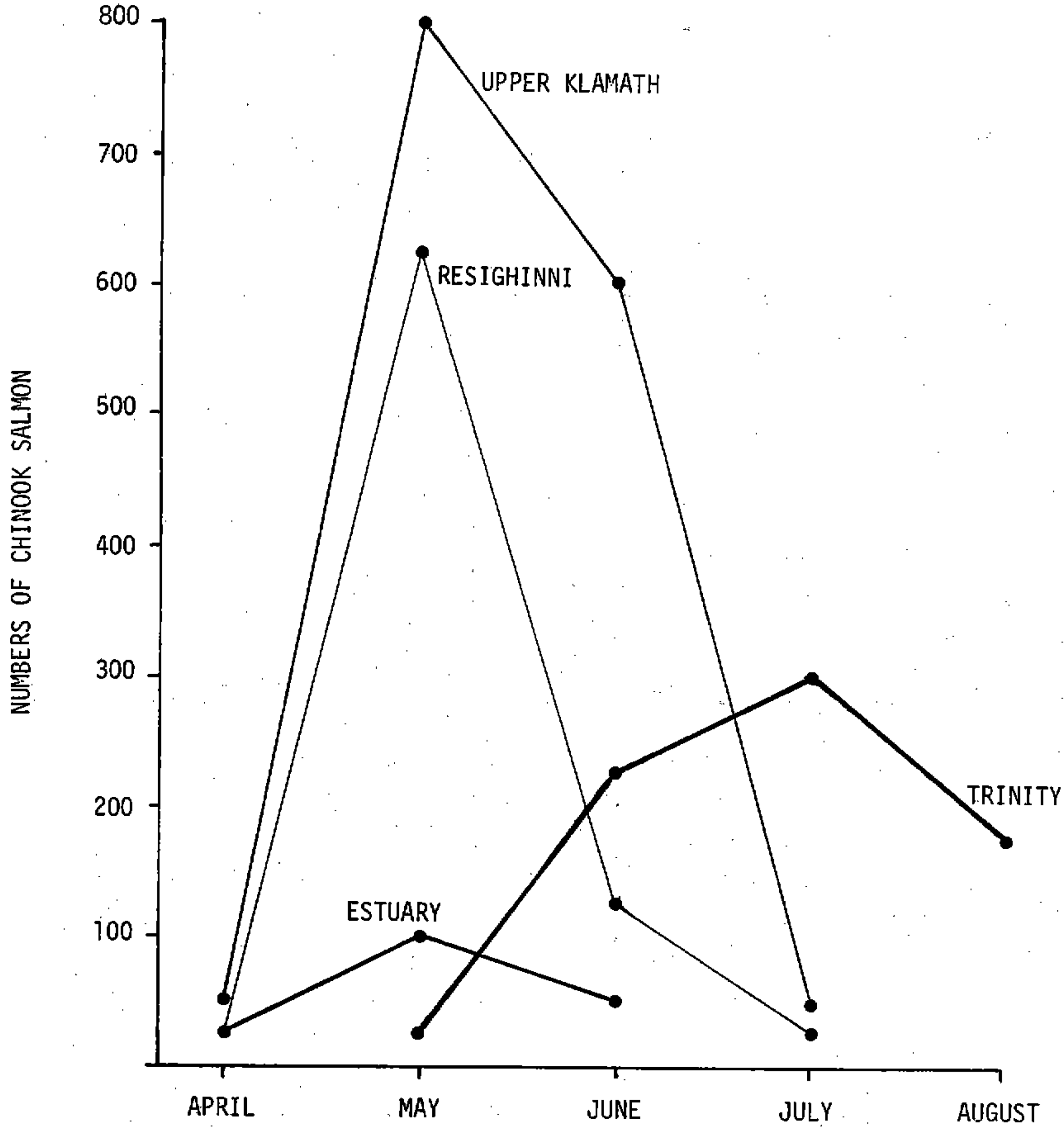


FIGURE 21. Estimated monthly Indian gill net harvests of spring chinook salmon in the four monitoring areas of the Hoopa Valley Reservation in 1982.

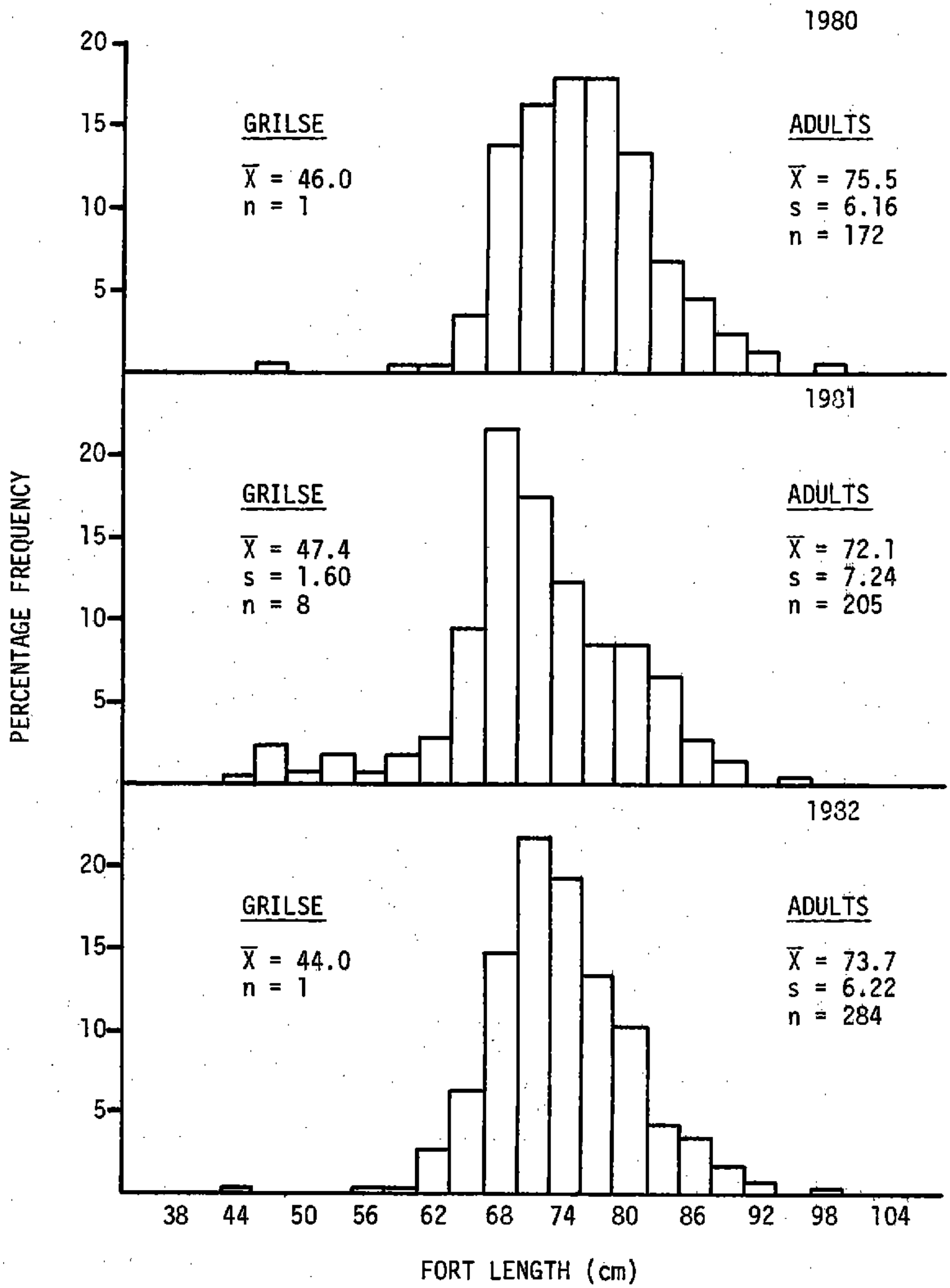


FIGURE 22. Length-frequency distributions of spring chinook salmon caught by Indian gill netters in the Estuary, Resighinni, and Upper Klamath areas of the Hoopa Valley Reservation in 1980, 1981, and 1982.

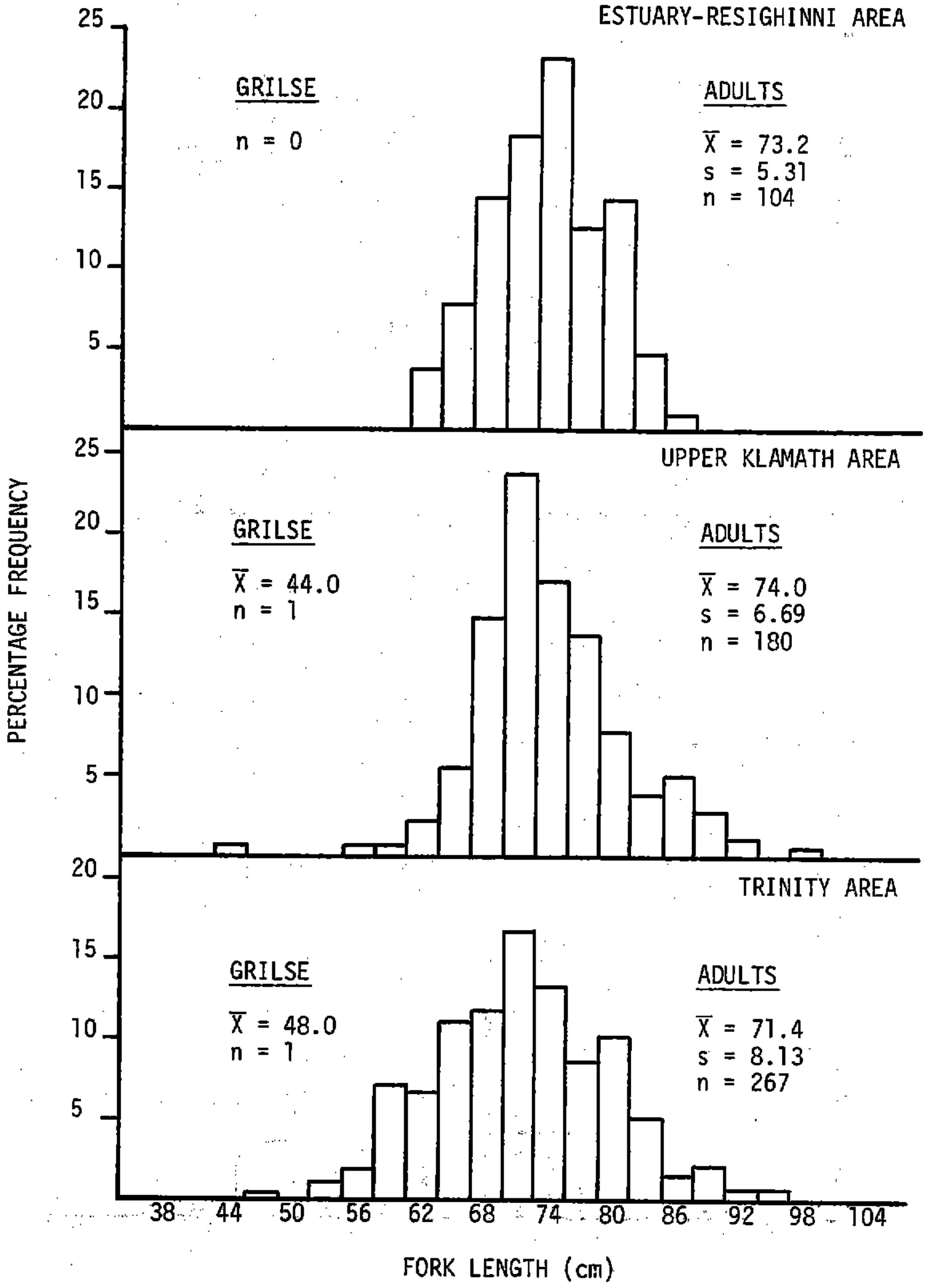


FIGURE 23. Length-frequency distributions of spring chinook salmon caught by Indian gill netters in the Estuary-Resighinni, Upper Klamath, and Trinity areas of the Hoopa Valley Reservation in 1982.

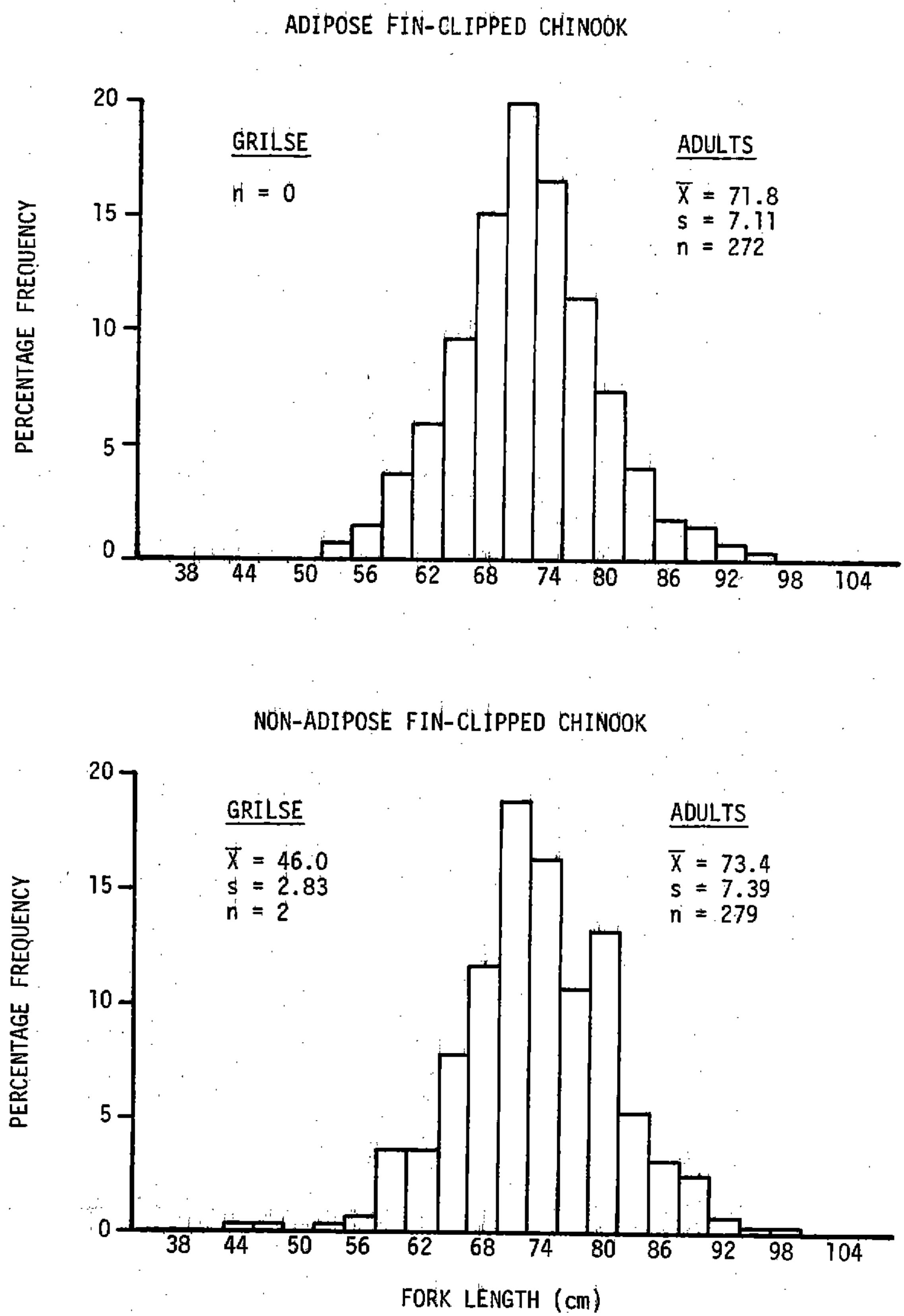


FIGURE 24. Length-frequency distributions of adipose fin-clipped and non-adipose fin-clipped spring chinook salmon harvested by Indian gill netters on the Hoopa Valley Reservation in 1982.

TABLE 10. Final harvest estimates of spring chinook salmon captured in the Indian net fishery of the Hoopa Valley Reservation from the years 1980 through 1982.

YEAR	ADULTS	GRILSE	TOTAL
1980	980	20	1,000 1/
1981	2,807	57	2,864 2/
1982	3,155	45	3,200 3/

1/ From the 1980 Annual Report. Grilse contribution was derived from a weighted average of the percentage of grilse contribution in 1981 and 1982 to the total harvest by monitoring area.

2/ Estimation methods described in 1981 Annual Report.

3/ Estimation methods described in 1982 Annual Report.

AGE COMPOSITION

INTRODUCTION

Continuous monitoring of the age composition of a fishery impacted population is essential to sound resource management. Age data, in conjunction with length and weight measurements, can give information on stock composition, age at maturity, mortality, growth and production. As part of a continuing effort to evaluate age composition of chinook salmon runs in the Klamath basin, scale samples and coded-wire tags (CWT) were collected from spring and fall races through 1982 net harvest monitoring and beach seining programs. A summary of age information collected on chinook salmon runs entering the Klamath since 1979 is presented herein.

METHODS

Percentage age composition of the fall chinook run was determined through data collected in beach seining operations conducted near the mouth of the Klamath during the 1979-1982 return years. Age composition was assessed through scale analysis in 1979, 1981 and 1982 and through length frequency distribution in 1980, when no scales were collected. Assignment of age group contribution to in-river runs by brood and return years was determined using information from 2 sources. The in-river run estimates were separated into grilse (age 2) and adult components as reported by the Pacific Fishery Management Council (PFMC, 1983). Grilse estimates were utilized without alteration. The adult component of the run estimates was then broken down into age group contributions using the percentage age composition of adult fall chinook captured in beach seining operations as indicated by scale analysis and length frequency distribution.

Adult structure of the fall chinook run in 1982 was assessed through analysis of 551 scale samples from chinook salmon captured in beach seining operations (Plate 8). The age composition of fall salmon seined from July 19 to September 21 is assumed to represent the entire fall chinook run entering the Klamath River.

Percentage age composition of the spring chinook net harvest was assessed through scale analysis and CWT recoveries from 1980, 1981 and 1982. Scale samples (589) and CWT (371) were collected from the gill net fishery from April to early July in the Klamath River and from May to early August in the Trinity River. Because of the limited sample size on the spring fishery, scales and CWT's collected from all available catch samples were utilized in the age composition assessment without corrections for potential sampling bias. Assignment of age group contribution to net harvest estimates by brood and return years was determined each season by applying the percentage age composition to the total estimated spring chinook net harvest.

Cellulose acetate impressions of spring and fall chinook scales were made utilizing a Carver Model C laboratory press, and viewed on a Bell and Howell

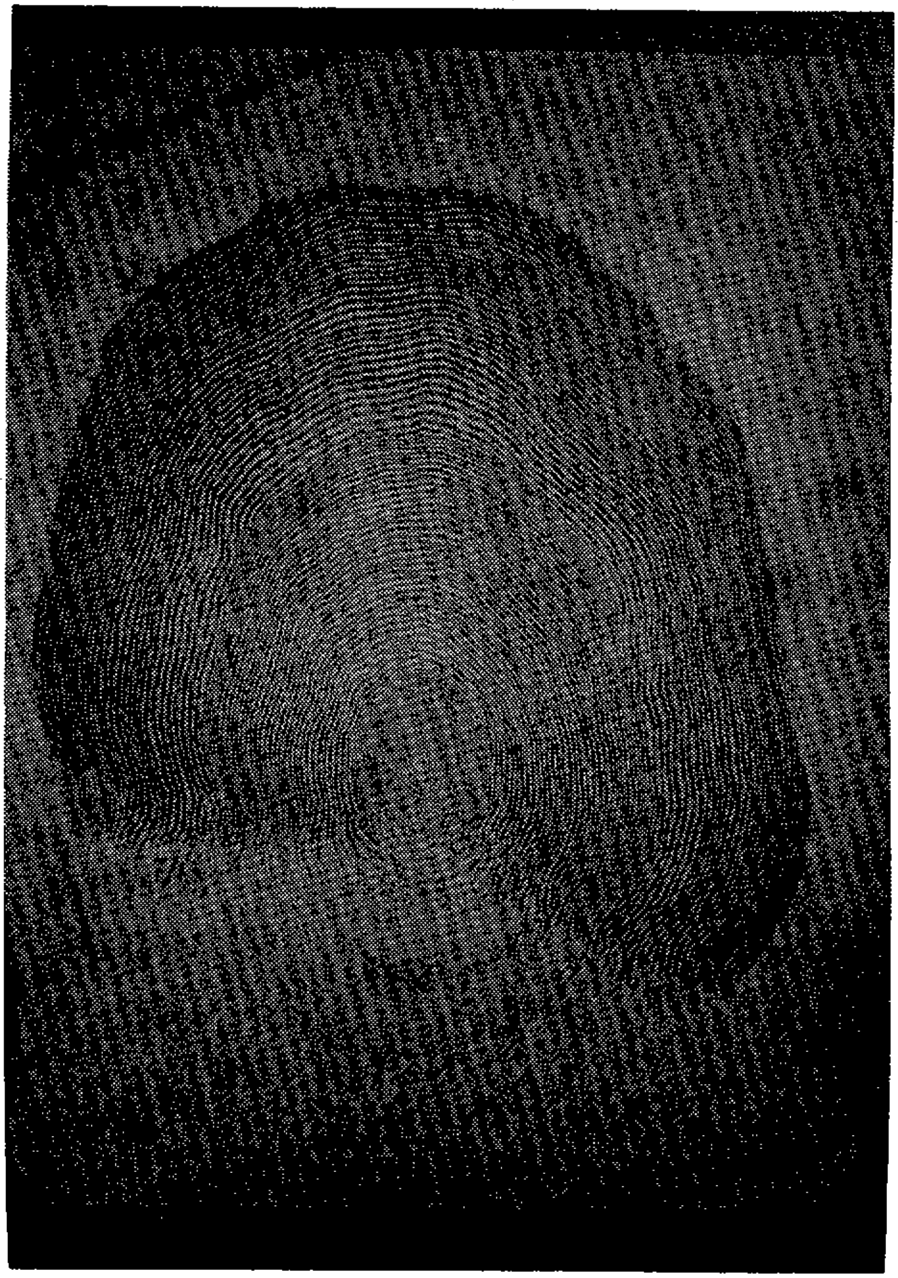


PLATE 8. Scale impression from a Klamath River chinook salmon sampled during 1982.

ABR-1020 dual lens projector. Scale impressions were analyzed independently by 2 interpreters, with a third reading by both when the initial 2 interpretations differed. Scales not aged with confidence after the third reading were excluded from the age analysis. Scales from known age fish (CWT recoveries) were used to assist in age evaluation.

RESULTS AND DISCUSSION

Fall Chinook Salmon

The age composition of fall chinook returning in 1982 showed a preponderance of 4-year-old (36.1%), followed by 3-(32.0%), 2-(29.1%), and 5-year-old (2.8%) salmon (Table 11). The percentage of grilse in the 1982 run was slightly below the 1981 return (32.9%) and the 1979-1982 4-year average of 33.6%. Mose evident in the 1982 run in respect to the 1981 return was the increasing proportion of age 4 fish (36.1% to 12.0%, respectively) and the coinciding decrease of age 3 (32.0% to 53.6%, respectively) chinook. The percentage of age 5 salmon increased slightly from 1.5% to 2.8%, but still fell below the 4-year average of 3.9%.

TABLE 11. Percentage age composition of Klamath River fall chinook as derived from scale analysis and length-frequency information during the 1979-1982 return years.

RETURN YEAR	AGE 2	AGE 3	AGE 4	AGE 5 1/
1979	14.4	32.8	46.6	6.2
1980 2/	58.0	17.8	19.1	5.1
1981	32.9	53.6	12.0	1.5
1982	29.1	32.0	36.1	2.8
1979-1982 Average	33.6	34.1	28.5	3.9

1/ Includes some 6-year-old fish.

2/ Based on length frequency data only. No scales collected in the 1980 season.

The high percentage of age 4 chinook in 1982, along with the high percentage of age 3 fish in 1981, and age 2 (58.0%) salmon in 1980, demonstrate the dominance of the 1978 brood in recent return years. Conversely, the percentage contribution for age 2 (14.4%) fish in 1979, age 3 (17.8%) fish in 1980, and age 4 (12.0%) salmon in 1981, were the lowest for their respective ages reflecting the severely depressed returns of the previous brood year (1977).

Estimates of age group contribution of fall chinook in-river runs during the 1979-1982 return years are given in Table 12. It should be noted here that

California Department of Fish and Game (CDFG) estimates of grilse and adult run sizes in the basin, from which these were derived, are not always in relative agreement with age contribution data from scale analysis described herein (Table 11). A decision was made to use CDFG run size estimates (as described in PFMC 1983) in derivation of age group contribution estimates even though these may not be in agreement with age data described here, in attempt to remain consistent with the run-size data base.

TABLE 12. Estimated number of fall chinook by age entering the Klamath River during the 1979-1982 return years.

RETURN YEAR	2[1/]	3	4	5	Adults	Total
1979	11,423	18,866	26,803	3,565	49,234	60,657
1980	35,780	17,839	19,144	5,110	42,093	77,873
1981	26,763	60,343	13,507	1,692	75,542	102,305
1982	36,098	28,295	31,925	2,476	62,696	98,794
1979-1982 Average	27,516	29,430	24,598	3,363	57,391	84,907

1/ Using CDFG grilse estimates.

For 1982, the returns of age 2 and age 4 chinook were the highest for their respective ages among the 4 return years. The 4-year-old chinook contribution for 1982 was 30% higher than the 1979-1982 average demonstrating the strength of the 1978 brood relative to other brood years since 1975. The estimated number (28,295) of age 3 chinook returning in 1982 represented only 47% of the 1981 contribution of 60,343, but was larger than the depressed returns of 1979 (18,866) and 1980 (17,839). The 1982 return of age 3 chinook was 4% below the 1979-1982 average of 29,430. Age 5 chinook contribution in 1982 increased 46% over the poor 1981 return but was 26% below the 4-year average.

As depicted in Figure 25, the 1978 brood clearly dominated in-river returns among brood years between 1975 and 1979. The 1978 brood, with an estimated age 2 return of 35,780 grilse in 1980, age 3 return of 60,343 in 1981, and age 4 return of 31,925 in 1982, has a 3-year estimated in-river contribution of 128,048 chinook. With a 5-year-old component still to return, the 1978 brood has an in-river return over twice and nearly 3 times greater than the completed 4-year returns of the severely depressed 1976 and 1977 brood years, respectively.

The dominance of the 1978 brood may be primarily attributed to the larger escapement of 71,451 adult fall chinook in 1978, compared to 40,528 or fewer in any subsequent year. Although basin-wide escapement estimates are not available prior to 1978, counts of adult chinook at Iron Gate and Trinity River hatcheries and the Shasta River racks indicate that escapements at those facilities during 1976 and 1977 were of a lesser magnitude than during 1978. Hence, fall chinook escapements to the Klamath basin during 1978 appear to have exceeded

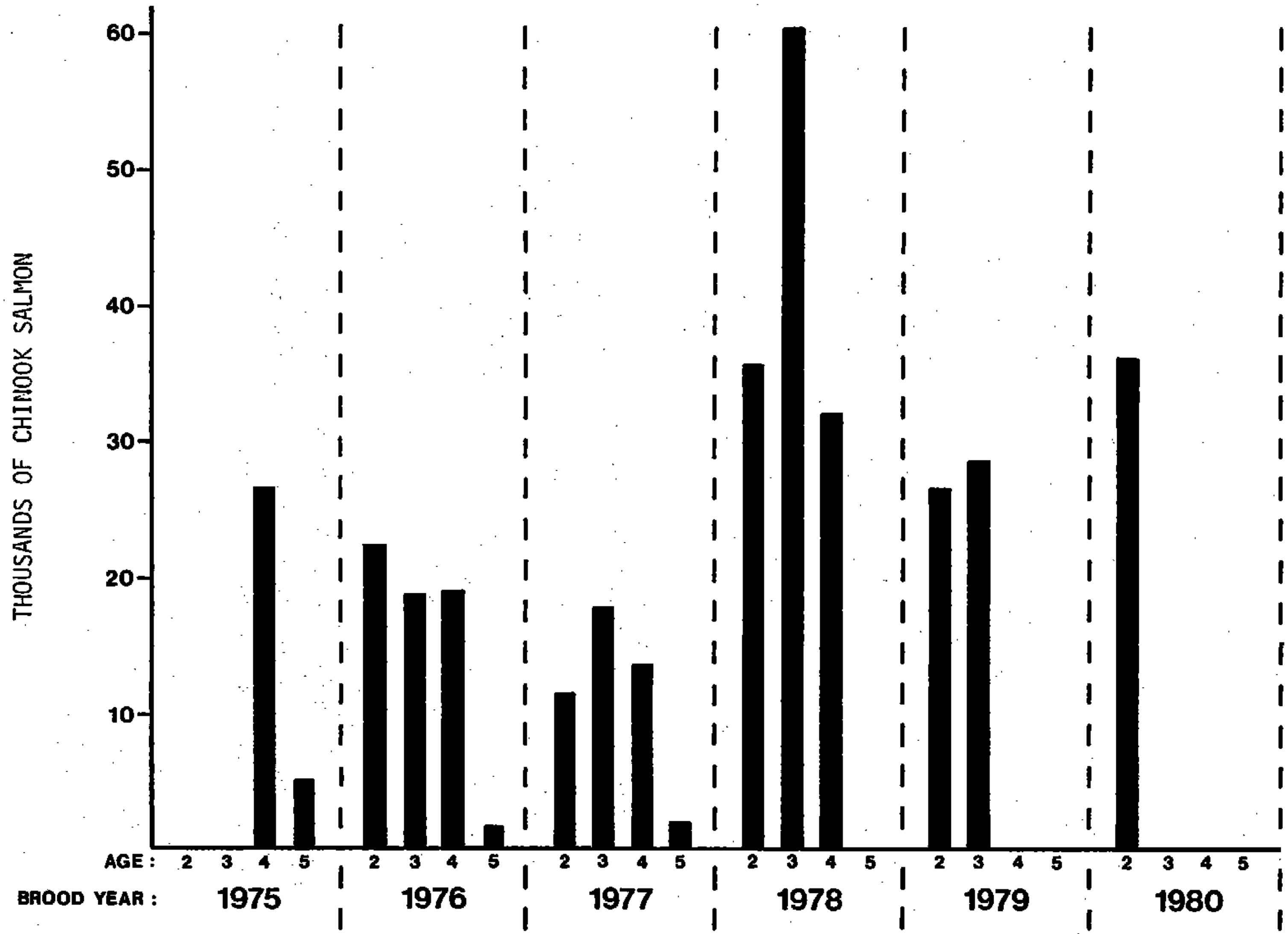


FIGURE 25. Brood year contribution by age of fall chinook to the 1979-1982 Klamath River returns (Includes grilse contribution to the 1978 return year).

all other return years between 1976 and 1981 (Adair 1982).

Based on in-river returns of age 4 chinook in 1979 (26,803) and age 5 chinook in 1980 (5,110), the next-to-highest and highest returns for their respective age (Table 12), the 1975 brood appears to be the next most dominant brood year. The relative strength of the 1975 brood, as seen through the returns of age 4 and age 5 fish, may be masked by the unusually high interception rate of the northern California ocean troll fishery in 1979. The troll fishery, with a 1979 3-port harvest 47% above its 1971-1975 average, would presumably have a higher than normal impact on the 4 and 5-year-old returns of the 1975 brood.

With an estimated in-river return of 36,098 grilse to the Klamath in 1982, the 1980 brood, despite an estimated spawning escapement of only 27,994 adult chinook in 1980, had the highest estimated in-river contribution of age 2 grilse among the presented brood years. If not an inflated estimate, the high contribution of grilse may, in part, be attributable to increasing releases of hatchery yearlings which tend to return at younger ages at proportionally higher percentages than wild fish or hatchery fingerlings. Yearling production of fall chinook in 1981, returning as grilse in 1982, totalled 2.1 million compared to 1.8 million or fewer in any previous year.

The 1979 brood year, with an estimated grilse return of 26,763 and a 3-year-old contribution of 28,295, appears to be intermediate in strength to the dominating 1978 brood and the depressed broods of 1976 and 1977. Age 3 chinook returns from the 1979 brood year were 53% below that of the age 3 chinook of the 1978 brood and 50% and 59% above the age 3 returns of the respective 1976 and 1977 brood years.

The 1976 and 1977 brood years appeared severely depressed with completed 4-year returns of 62,238 and 45,245 fish, respectively. For the respective brood years, adult contribution consisted of only 39,702 and 33,822 fish. The depressed nature of the 1976 and 1977 brood years can be seen in the return of 3 and 4-year-old adults, where the combined 1976 and 1977 brood contributions totalled only 75% of the 1978 brood alone (69,356 to 92,268).

Based upon Shasta River weir counts, the natural spawning component in the Klamath basin may have had a poor return in 1976 and 1977. The potentially poor spawner escapement could be attributed to high harvest rates in the fisheries or severe environmental conditions. The high rate of the ocean troll harvest in 1979 would appear to have impacted both the 1976 and 1977 broods. The 1977 brood would have been impacted further by the high Indian net harvest in 1977 estimated at 27,300 adult fall chinook compared to the 1978-1982 6-year average of 19,800 adult fish. Finally, the severe drought of 1976-1977 potentially could have had the most severe impact upon the natural spawning component of the 1976 brood year.

The average age composition of fall chinook based upon the completed returns of the 1976 and 1977 brood years was 31.6% age 2, 34.1% age 3, 30.4% age 4, and 3.9% age 5. The mean age at return of fall chinook from the 1976 brood was 3.00 and from the 1977 brood was 3.16, averaging 3.07 for the 2 brood years.

Mean length of fall chinook (aged by scale analysis) returning at each age to the Klamath River in 1979, 1981 and 1982 is given in Table 13. Age 2 grilse in 1982 were significantly smaller ($p < 0.05$) than grilse taken in 1981, but showed no significant size difference ($p > 0.05$) with age 2 fish captured in 1979. No significant difference ($p > 0.05$) in mean length of age 3 chinook returning in 1982 with either 1981 or 1979 age 3 fish was apparent. Age 3 chinook in 1981, however, were significantly smaller ($p < 0.05$) than those taken in 1979. Comparison of mean lengths of age 4 chinook captured in the 3 return years indicate that in 1982 the age 4 chinook were significantly larger ($p < 0.05$) than in either 1981 or 1979. No significant size difference ($p > 0.05$) in mean lengths of age 5 fish could be detected between return years.

TABLE 13. Mean length of fall chinook returning at each age in 1979, 1981 and 1982 return years.

AGE AT RETURN	Mean Length At Return in 1979		Mean Length At Return in 1981		Mean Length At Return in 1982	
	n	$\bar{X} \pm$ 95% CI	n	$\bar{X} \pm$ 95% CI	n	$\bar{X} \pm$ 95% CI
2	97	48.8 ± 1.3	176	50.2 ± 0.7	161	48.3 ± 0.7
3	221	70.1 ± 0.8	287	68.1 ± 0.8	177	69.3 ± 1.0
4	314	80.3 ± 0.6	64	80.5 ± 1.5	200	83.2 ± 1.0
5	42	88.7 ± 2.0	8	89.0 ± 5.0	13	87.2 ± 4.5
6					3	94.3 ± 3.8

Spring Chinook Salmon

A total of 588 spring chinook were aged from scales and CWT's taken during the 1982 net harvest monitoring program. The age composition of spring chinook in the 1982 Indian net fishery showed a high percentage (62.1) of age 4 chinook, similar to 1980, when age 4 fish represented 82.5% of the sampled harvest (Figure 26). The high 1982 catch of age 4 chinook followed the high catch of age 3 fish (73.2%) in 1981 indicating the relative strength of the 1978 spring brood to the net harvest compared to the 1977 and 1979 broods. Age 3 chinook comprised 36.3% of the 1982 sampled harvest, intermediate to the age 3 harvest in 1981 and 1980. Contrary to the harvest of 5-year-old chinook in 1980 (11.2%) and 1981 (7.4%), age 5 chinook were nearly absent (0.4%) from the sampled catch in 1982. As in previous years, age 2 grilse were of minimal importance to the spring fishery comprising only 1.2% of the total harvest.

Estimates of age group contribution of spring chinook to the Indian net harvest for the 1980-1982 return years are given in Table 14. Despite large fluxuations in the percentage contribution of age 3 and 4 salmon to the net fishery between return years, equal numbers of 3 and 4-year-old chinook have on the average been harvested over the 3-year period. Age 5 chinook have comprised 5% and age 2 grilse only 1% of the overall 3-year catch.

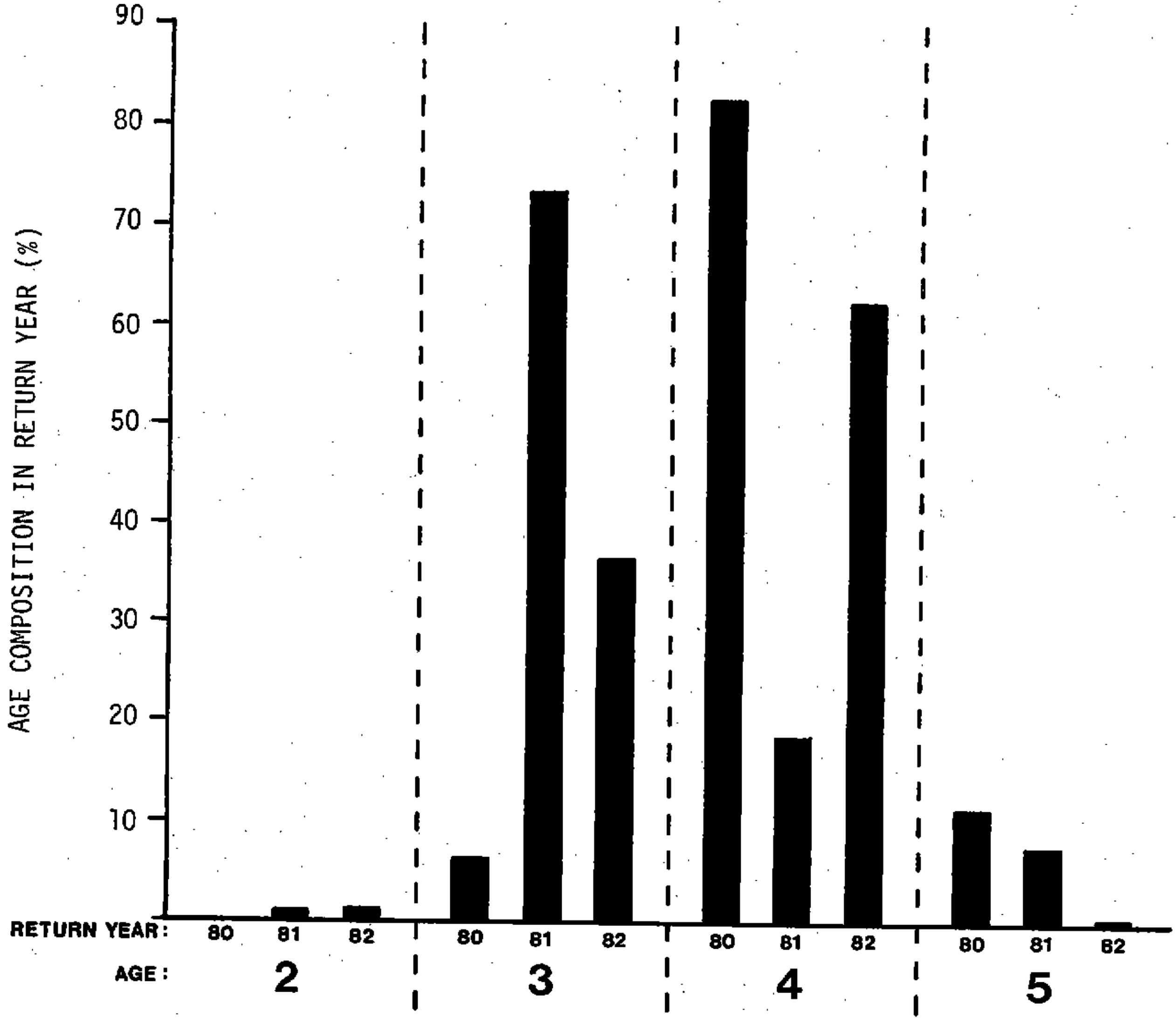


FIGURE 26. Age composition of spring chinook salmon harvested in Indian net fishery during the 1980-1982 return years.

TABLE 14. Estimated number of spring chinook by age captured in the Indian net fishery of the Hoopa Valley Reservation during the 1980-1982 return years.

RETURN YEAR	AGE 2	3	4	5	Total
1980	0	63	825	112	1,000
1981	32	2,123	531	214	2,900
1982	38	1,162	1,987	13	3,200
$\overline{1980-1982}$	35	1,116	1,114	113	2,367

Contribution by brood year reveals the 1978 brood, with an estimated 3 and 4-year-old harvest return of 4,110 salmon, had a harvest contribution nearly 7 times greater than the 3 and 4-year-old return of the completed 1977 brood (Table 15). Based on the harvest contribution of age 4 chinook, the contribution of the 1978 brood appears to have been well over twice that of the 1976 brood. The 1978 brood year had a harvest contribution of age 3 salmon nearly twice that of the 1979 brood year.

TABLE 15. Brood year contribution of spring chinook by age to the Indian net fishery of the Hoopa Valley Reservation during the 1980-1982 return years.

BROOD YEAR	AGE 2	3	4	5
1976	---	---	825	214
1977	---	63	531	13
1978	0	2,123	1,987	STR[1/]
1979	32	1,162	STR	STR

1/ Still to return.

Mean length of spring chinook by age taken in the Indian net fishery during the 1980-1982 return years is given in Table 16. Age 4 chinook taken in the fishery in 1982 were significantly larger ($p < 0.05$) than age 4 fish harvested in either 1980 or 1981. Age 3 chinook captured in 1982, however, were significantly smaller ($p < 0.05$) than 3-year-olds taken in 1981, but showed no significant difference ($p > 0.05$) in mean length with age 3 fish harvested in 1980. No significant size difference ($p > 0.05$) in mean lengths of age 2 grilse in 1981 and 1982 nor between age 5 chinook in 1980 and 1981 could be detected.

TABLE 16. Mean length of spring chinook by age captured in the Indian net fishery during the 1980, 1981 and 1982 return years.

AGE AT RETURN	Mean Length At Capture In 1980		Mean Length At Capture In 1981		Mean Length At Capture In 1982	
	n	$\overline{X} \pm$ 95% CI	n	$\overline{X} \pm$ 95% CI	n	$\overline{X} \pm$ 95% CI
2	---	-----------	3	46.0 ± 6.6	7	51.7 ± 5.4
3	10	68.8 ± 7.2	208	69.3 ± 0.7	214	67.9 ± 0.7
4	132	74.4 ± 0.9	52	73.7 ± 1.3	366	75.6 ± 0.6
5	17	84.1 ± 3.3	21	80.8 ± 2.8	1	75.0 ± ---
6	1	86.0 ± ---	---	----------	1	88.0 ± ---

RUN SIZE ESTIMATION PROGRAM

INTRODUCTION

While the California Department of Fish and Game (CDFG) has prepared annual estimates of fall chinook salmon run sizes within the Klamath-Trinity basin on a post-season basis since 1978, no in-season indices have been developed for use in management of the in-river fisheries. The potential utility of such indices in making in-season management adjustments to fishing regulations is apparent. Because of this, FAO-Arcata biologists began exploring the possibility of using catch/effort data from beach seine and harvest monitoring programs in developing in-season Klamath River fall chinook salmon run size indices. This section summarizes information available from the initial 3 sampling seasons.

METHODS

Specific methodologies involved in derivation of catch/effort data from beach seine and harvest monitoring programs were discussed in preceding sections of this report. In each program, data were collected with the expressed intent of use in derivation of in-season abundance indices.

RESULTS AND DISCUSSION

The validity of using catch/effort data derived through FAO-Arcata field programs in estimating in-season abundance relies on 4 basic assumptions:

1) chinook salmon caught by beach seine and gill net in the Klamath River estuary are of Klamath River origin and of that year's spawning run in the basin;

2) catch per seine haul values in beach seining operations and catch per net-night values in the net fishery are able to be quantified and are comparable between years;

3) there is a discernible relationship between number of fish in the run and numbers of fish captured per unit of effort in beach seine sampling and gill net harvest; and

4) post-season run size estimates utilized in defining relationships between run size and catch/effort statistics are accurate in representing true run size.

A brief discussion of the potential validity of these underlying assumptions therefore appears necessary.

Assumption #1 appears to pose no problem in this instance. Of 201 and 93 coded-wire tags (CWT) recovered from fall chinook captured in the estuarine gill net fisheries during 1981 and 1982 net harvest monitoring programs, 99.5 and 98.9% respectively were of Klamath River origin. It does not appear that chinook from other rivers of origin frequent the Klamath River during the fall run period. Similarly, jaw tag recovery and length frequency information does not seem to imply that large numbers of non-spawning Klamath River chinook frequent the river during this period.

Assumption #2 is more difficult to satisfy. Both catch and effort associated with the net fishery may vary widely within a season and between seasons. Direct quantification is not possible for either and accurate estimation is difficult. Further, harvest rate information as gleaned from comparisons between estimated net harvest and post-season run size estimates shows fluctuations between seasons, especially for the estuarine net fishery. For these reasons, catch/effort data from the net fishery may be of questionable use in deriving abundance indices. Catch/effort data from the beach seine are, on the other hand, directly quantified and effort can be controlled in order to provide some assurance of consistency within a season and comparability between seasons. However, as discussed in the beach seine section of this report, physical and environmental changes in the estuary and alterations in fish behavior patterns remain uncontrollable and unpredictable in effect. With these reservations, beach seine data may warrent further consideration.

Assumption #3 and #4 may be difficult to satisfy; however, direct discussion of the data available would appear the best means of validation.

Information on adult fall chinook run size in the Klamath-Trinity basin has been available through the CDFG since 1978. Portions of the information are based on weir counts, other portions on mark and recapture or spawning ground survey data. Since counts at weirs may be more likely to satisfy the fourth assumption here, a logical approach would seem to segregate counts from estimates in the run size information and explore 2 separate relationships between these and beach seine catch/effort data (Table 17).

For a discussion of the methods utilized in indexing beach seine catch/effort data for use in in-season abundance estimates, see USFWS (1982a). Basically, the following seasonal run strength indices were developed by multiplying catch/effort in the peak 3 sets during run peak periods by the seasonal duration of these periods (number of consecutive days) as follows:

Grilse (<58cm)	1980	Run Strength Index = 9.90 x 24 = 237.60
	1981	" " " = 6.28 x 29 = 182.12
	1982	" " " = 8.14 x 32 = 260.48
Adults (≥58cm)	1980	" " " = 8.57 x 24 = 205.68
	1981	" " " =14.38 x 29 = 417.02
	1982	" " " =21.80 x 32 = 697.60

The relationships between these indices and post-season run size information from CDFG may be defined by fitting least squares linear regressions through the corresponding data sets. The 4 relationships depicted in Figures 27 and 28 were chosen as representative. While 3 of the regressions were highly correlated, a fourth showed little correlation (r^2 = .30) between adult catch/effort indices and adult run size estimates during 1980-1982. Three possible explanations for this low correlation coefficient might be:

1) there is a difference in in-river harvest rate between adult chinook returning to Iron Gate Hatchery (IGH), Trinity River Hatchery (TRH), and the Shasta and those returning to other areas in the basin;

2) there is a lack of correlation between catch/effort indices and run sizes in the basin (assumption #3 is violated); and

3) there is a lack of correlation between post-season run size estimates and run size in the basin (assumption #4 is violated).

TABLE 17. Post-season run size estimates for Klamath River fall chinook during 1980-1982.1/

	1980 2/		1981 2/		1982 3/	
	Grilse	Adult	Grilse	Adult	Grilse	Adult
WEIR COUNTS						
IGH	451	2,412	540	2,055	1,833	8,353
TRH	2,256	4,099	1,004	2,370	3,916	2,063
SHASTA	4,334	3,762	4,330	7,890	1,912	6,531
Subtotal	7,041	10,273	5,874	12,315	7,661	16,947
ESTIMATED BALANCE 4/ BASIN	28,739	31,820	20,889	63,227	28,437	45,749
TOTAL RUN SIZE BASIN	35,780	42,093	26,763	75,542	36,098	62,696

1/ All estimates from the CDFG except that portion of total run size derived from net harvest data collected by FAO-Arcata, USFWS.

2/ FINAL ESTIMATES for these years.

3/ 1982 ESTIMATES PRELIMINARY.

4/ Estimates for Trinity River, Bogus Creek and Scott River partially from weir counts but included in this column since substantial data portions were estimated during 1980-1982 period.

While each of these may have exerted an influence, careful review of the data presented would appear to disproportionately incriminate #3. This would

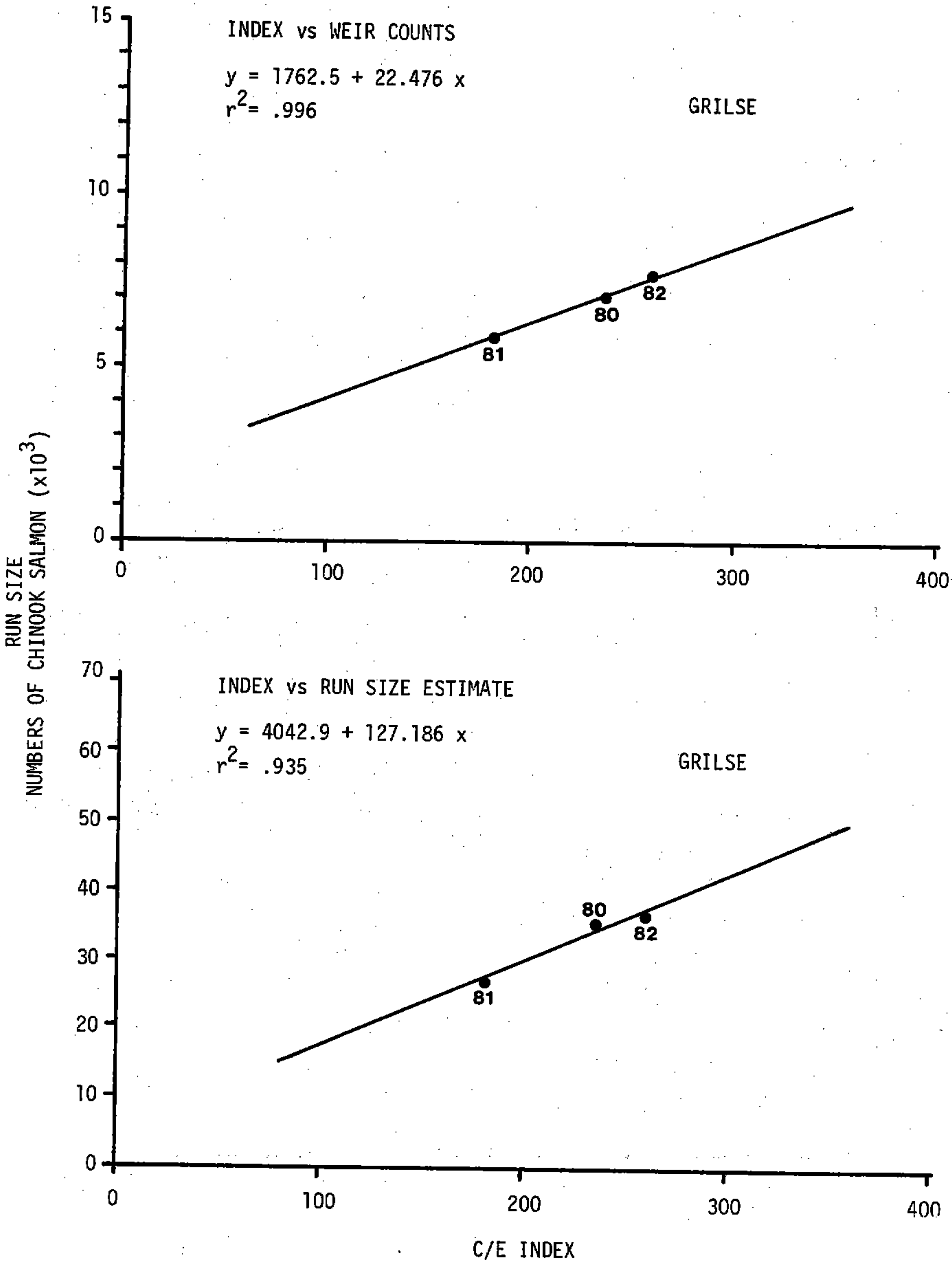


FIGURE 27. Linear relationships between beach seine C/E indices and run size estimates of chinook returning as grilse in 1980-1982.

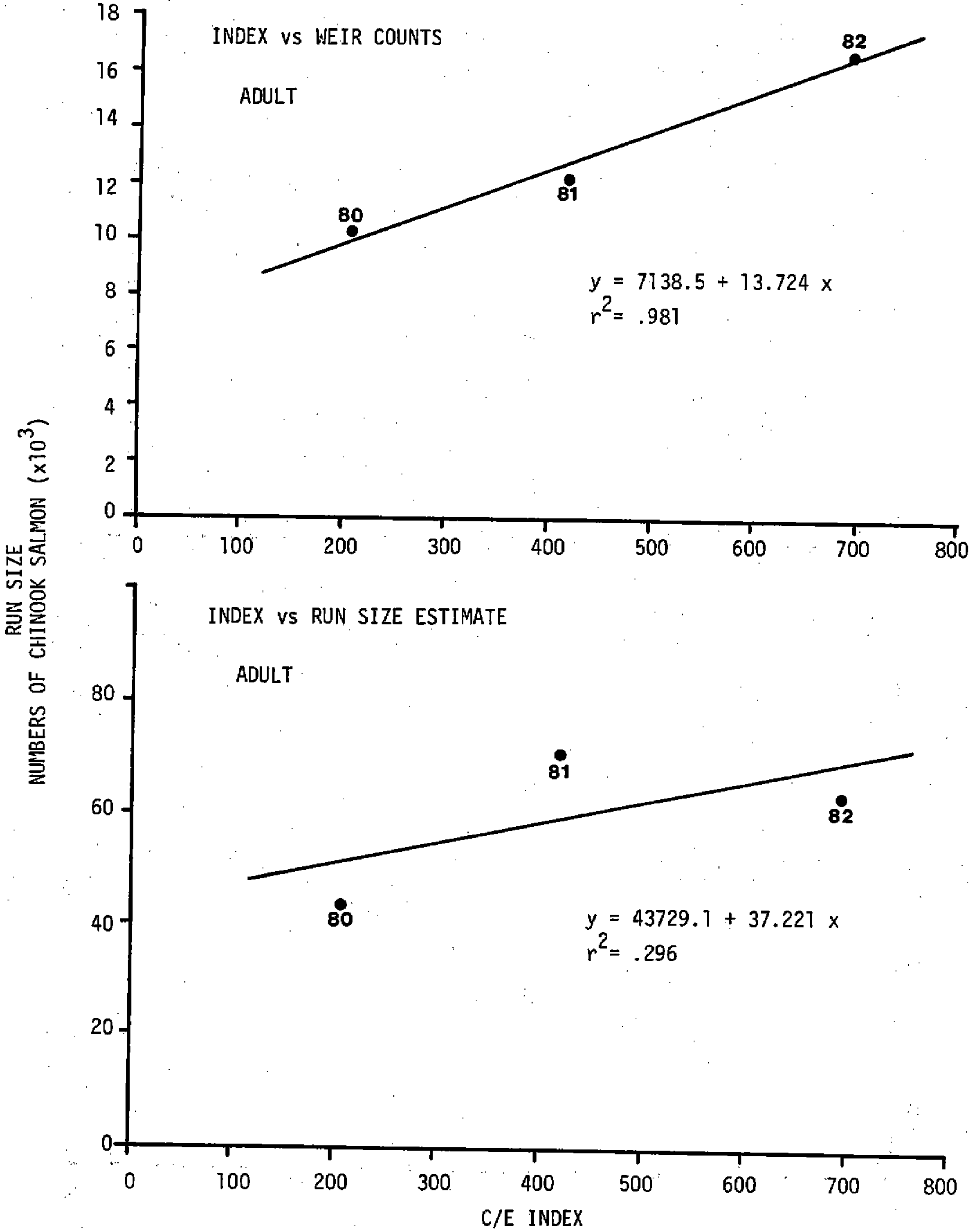


FIGURE 28. Linear relationships between beach seine C/E indices and run size estimates of chinook returning as adults in 1980-1982.

not appear unlikely as total adult fall chinook run size is an extremely critical and difficult to estimate factor in management, and there is an admitted need to be conservative in this data. Still, the high degree of correlation between weir counts and adult and grilse catch/effort indices in the basin seems to point to the potential utility of these relationships in future management. These impressions would also appear to point to the adviseability of placing additional counting weirs in the basin with an eye toward increasing accuracy and comparability of data. It is further apparent from the slopes of all 4 equations that rate of increase in capture in the beach seine occurs at greater than a direct 1:1 proportion to the increase in run size. Therefore, to construe a seasonal doubling in catch/effort index as representing a doubling in run size within the basin would appear to result in an overestimate of abundance. Each additional season of data will assist in defining the true relationship more accurately.

Of course the catch/effort indices on which the defined relationships are based are also not available in-season. A method must be derived through which a critical in-season date can be chosen by which an estimate of the final season catch/effort index can be made with confidence. For this, cumulative daily adult chinook catch/effort in the daily peak 3 sets were plotted through each of the 1980, 1981 and 1982 run peak periods (Figure 29). It can be seen from this that seasonal cumulative catch/effort values during the run peaks varied less than 5% from respective final season indices as of 9-1-80, 9-2-81 and 8-25-82. These dates fall 14, 15 and 17 days into or 58.3, 51.7 and 53.2% of the way through 1980, 1981 and 1982 run peak periods respectively. Critical dates for 10% error level occur considerably earlier. Since major portions of the in-river harvest occur further upriver in areas where even smaller percentages of the annual run would have passed by these dates, the timeliness for use in in-season adjustment is apparent. For example, 45.7, 54.6 and 22.1% of the total in-river fall chinook net harvest occurred by the 1980, 1981 and 1982 critical dates respectively (5% error). In other words, the potential appears to exist of estimating the final season index to run strength within 5% error well before the bulk of that years run has entered the river. The final step would be to apply a figure for average run duration, 28.33 days for 1980-1982, to the predicted catch/effort value. With this index value, an estimate of post-season run size within a defined confidence interval can be calculated from the appropriate linear regression equation.

Even though such a model for predicting run size on an in-season basis appears to have potential, some reservations should be registered. If a point in the future is reached where in-season management of in-river fisheries becomes finite and such data are actually utilized, dependence on such data could in itself cause problems. Availability of such indices could, during a given season, be removed by various circumstances such as lack of funding to field the data collection program or extreme physical-environmental changes in the estuary resulting in inability to conduct effective beach seine operations or in short-term aberrant behavior of the fish. For this reason, alternative means of promulgating in-season management adjustments must always be considered. Exploration into the potential of developing alternate models for use of data from the in-river net fishery may therefore be appropriate.

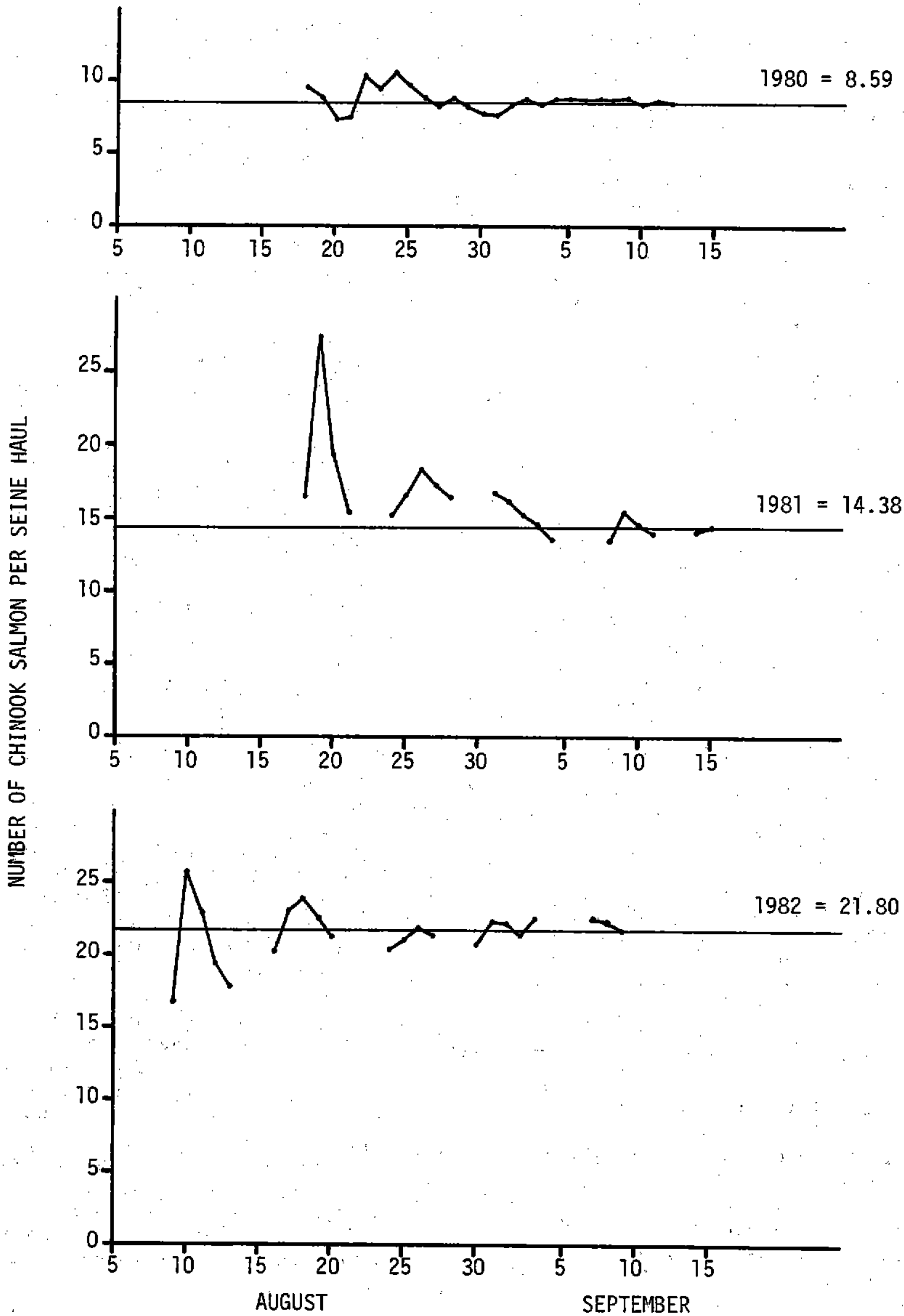


FIGURE 29. Cumulative daily adult chinook salmon catch-effort values (during peak 3 sets of run peak periods) in 1980, 1981 and 1982 beach seining operations, relative to final season statistics.

MARK-RECAPTURE ANALYSIS

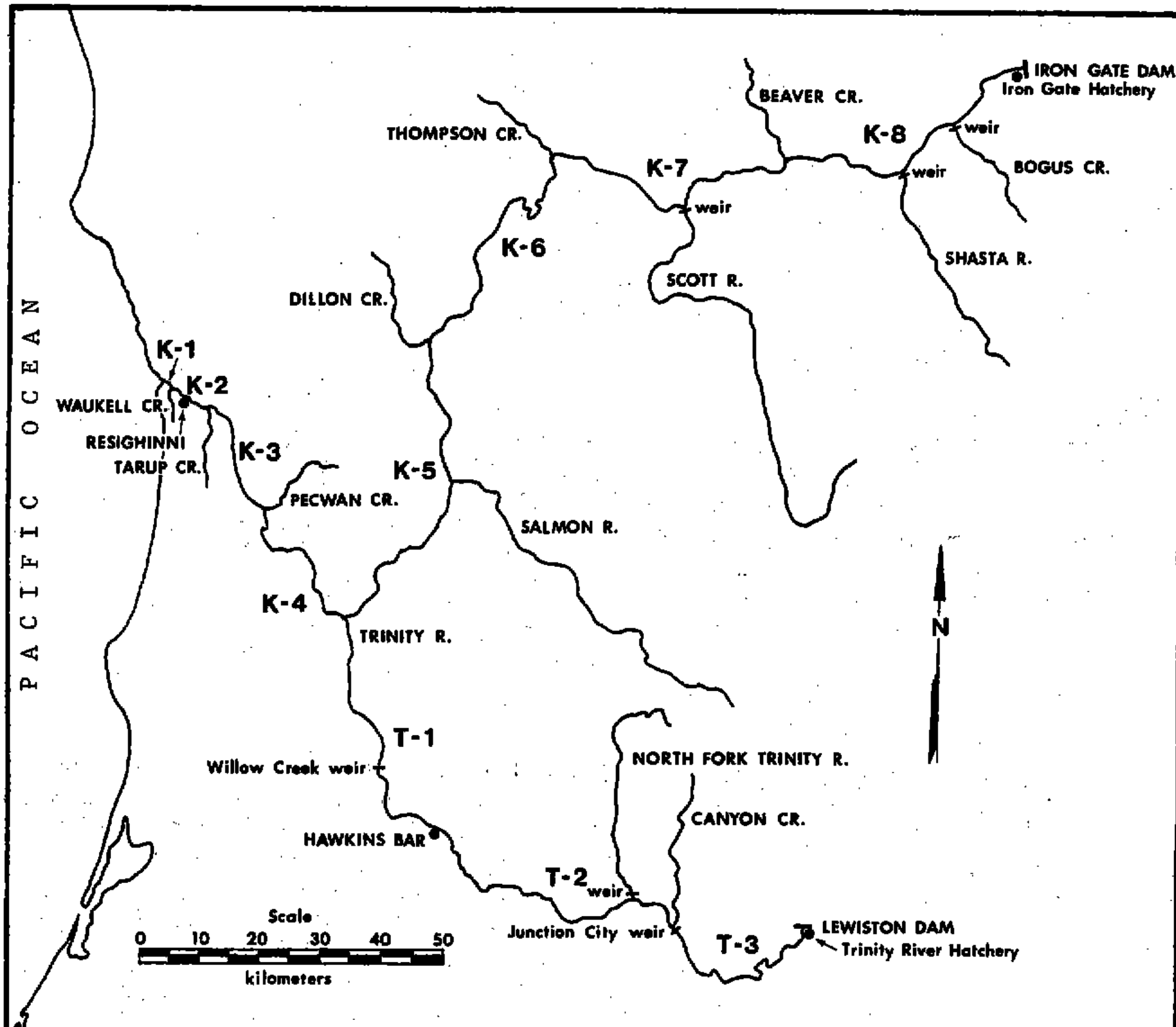
INTRODUCTION

FAO-Arcata biologists conducted mark-recapture studies on fall chinook salmon returning to the Klamath River system during the 1979, 1980 and 1982 seasons. No mark-recapture study was conducted in 1981. The purpose of these studies, as described in previous annual reports, was to collect information on run sizes and migration behavior within the basin (USFWS 1979a, Rankel 1980). While attempts at estimating run sizes from the tagging data have proven relatively unsuccessful, the studies have provided considerable information on migration patterns. This report will summarize previously unpublished information available on Klamath River fall chinook migration behavior collected during the 1979, 1980 and 1982 field seasons.

METHODS

Methods of capture and handling of fall chinook for tagging are described in the beach seining section of this report. Sequentially numbered spaghetti tags in 1979, and metal band tags in 1980 and 1982 were applied immediately posterior to the dorsal fin and to the lower right mandible, respectively, of each fish selected for tagging. Tagged fall chinook were recaptured in various manners throughout the Klamath River system, including: (a) USFWS beach seining at the Klamath River mouth; (b) California Department of Fish and Game (CDFG) beach seining at Waukell Creek; (c) Indian gill netting throughout the reservation; (d) CDFG weirs on Bogus Creek, Shasta River, Scott River, North Fork Trinity River, and the Trinity River at Willow Creek and Junction City; (e) returns to Iron Gate (IGH) and Trinity River (TRH) hatcheries; (f) CDFG spawning ground surveys; and (g) sport fishing.

The success of the recovery program was therefore largely dependant on the cooperation and assistance of the CDFG, Indian net fishers, and sport anglers within the basin. Since sample sizes of recorded information at certain sites during some years were low, and since no great differences in migration patterns were apparent between years, data from the 3 seasons were combined in order to provide documentation of general migration behavior during the 1979-1982 period. Similarly, since grilse tag recovery sample sizes were occasionally low, and since no major trends appeared to emerge which differed between grilse and adult sample components, grilse and adult data were combined during analysis. The combined tag recovery data from the 3 years was divided into groups based upon the recapture location. Much of the recovery data occurred at the hatcheries and at several specific upstream weir sites in the basin. The Klamath River was further divided into 8 general recovery areas and the Trinity River into 3 for data summary purposes. A map locating the sites of the hatcheries, weirs and 11 general recovery areas is presented in Figure 30. Migration time (number of days between tagging and recapture) and migration rate (average number of kilometers traveled per day from the tagging site) were calculated for each recovery site in the basin.



AREA	
K-1	Mouth of Klamath River to Waukell Creek (km 5)
K-2	Waukell Creek to Tarup Creek (km 13)
K-3	Tarup Creek to Pecwan Creek (km 41)
K-4	Pecwan Creek to Trinity River (km 70)
K-5	Trinity River to Dillon Creek (km 136)
K-6	Dillon Creek to Thompson Creek (km 198)
K-7	Thompson Creek to Beaver Creek (km 259)
K-8	Beaver Creek to Iron Gate Dam (km 306)
T-1	Trinity River mouth to Hawkins Bar (km 134)
T-2	Hawkins Bar to Canyon Creek (km 197)
T-3	Canyon Creek to Lewiston Dam (km 249)

FIGURE 30. Overview map of the Klamath-Trinity basin delineating recovery areas for chinook tagged during 1979-1982 mark-recapture studies.

RESULTS AND DISCUSSION

Totals of 1,016, 2,363 and 1,018 fall chinook were tagged and released during beach seining operations in the Klamath River estuary in 1979, 1980 and 1982 respectively. A total of 669 tags were recovered during the 3 seasons, for an overall recovery rate of 0.152 (Table 18). Recovery rates during 1979 and 1980, 0.155 and 0.141 respectively, were somewhat lower than that of 1982, 0.175. This appears in part attributable to the placement of weirs on Bogus Creek and the Scott River by the CDFG during the 1981 and 1982 seasons. Of the 669 tags recovered, only 394 tags included sufficient information (tag number, recovery date and recovery location) to be used in calculating migration times and rates for the various recovery areas (Tables 19, 20 and 21). Data from tags recovered from salmon carcasses (i.e. spawning ground surveys) did not appear appropriate for computing migration times or rates since it would be difficult to estimate how long each fish had been holding in the area.

TABLE 18. Recovery data from 4,397 chinook salmon tagged by the U. S. Fish and Wildlife Service on the Klamath River during 1979-1982.

Source	Number Recovered			
	1979	1980	1982	Total
Gill net fishery	14	111	46	171
USFWS beach seining	22	67	14	103
Shasta River weir	50	21	19	90
Sport fishery	14	43	13	70
Trinity River Hatchery	18	32	16	66
Iron Gate Hatchery	23	14	20	57
CDFG spawning ground surveys	7	25	1	33
Bogus Creek weir	--	--	22	22
Willow Creek weir	5	6	8	19
CDFG beach seining	4	11	3	18
Scott River weir	--	--	8	8
Junction City weir	0	2	0	2
North Fork Trinity River weir	--	--	1	1
Others	0	1	8	9
TOTALS	157	333	179	669

TABLE 19. Migration data from 394 recoveries of tagged fall chinook salmon within the Klamath-Trinity basin during 1979-1982.

Area	Kilometers From River Mouth	Tag Recoveries	Migration Time(days) Range	Mean	Migragion Rate(km/day) Range	Mean
K-1	0-5	66	1-32 1/	8.2 1/	N/A	N/A
K-2	5-13	67	1-38	11.9	0.2-5.1	1.0
K-3	13-41	14	6-39	16.9	0.7-4.1	2.4
K-4	41-70	9	9-40	19.4	1.2-5.1	3.4
K-5	70-136	5	19-52	28.4	2.0-5.6	4.0
K-6	136-198	0	---	---	---	---
K-7	198-259	9	31-73	49.0	3.2-7.5	5.2
K-8	259-306	61	27-70	48.9	4.1-10.6	6.3
IGH	306	56	32-75	52.57	4.1-9.6	6.1
T-1	70-134	25	9-54	21.7	1.9-11.9	5.3
T-2	134-197	9	20-64	46.8	2.3-6.9	4.0
T-3	197-249	8	38-82	53.9	1.8-5.3	4.4
TRH	249	65	27-91	60.2	2.7-9.2	4.5

1/ Does not include chinook that were recaptured on the same day they were tagged.

The data in Tables 19-21 present a general picture of upstream migration behavior of fall chinook within the Klamath River system. Chinook of all stocks enter the river and proceed upriver slowly at first, spending considerable time in the lower 8 km, the area of major tidal influence. They may hold in these areas during an extended period of physiological adjustment from the cooler, highly saline water present in the ocean and in deeper holes in the estuary, to the warmer freshwater present in the river and in the estuary above the saltwater wedge. It is interesting to note that 39 chinook tagged by CDFG at Waukell Creek were recaptured 3.6 to 5.2 km downriver in the estuary by USFWS beach seining or in the Indian gill net fishery. It is unknown whether this is a natural occurrence or a result of the stress from capture and tagging. Far more common, however, were tag recoveries from chinook which continued upstream once having passed the area of tidal influence. Migration time from the mouth to Resighinni, 8.1 km upstream, varied from 3 to 38 days, averaging 11.9 days. Once past the tidewater area, the rate of upstream migration appears to begin a gradual acceleration.

Chinook destined for Klamath River terminal sites travelled at average rates of 1.0 to 6.3 km/day, increasing with distance upstream. Time to recapture varied from 1 to 73 days. Least squares linear regression showed significant positive relationship between migration rate and distance travelled upstream ($b = 0.017$; $r^2 = 0.76$).

TABLE 20. Tag recovery and migration data for specific recovery sites in the Klamath basin during 1979, 1980 and 1982.

Site	Km From River Mouth	No. Recoveries	Migration Time (days) Range	Mean
CDFG Seine Waukel Cr.	5.2	16	1-17	6.81
CDFG Weir Willow Cr.	107	10	9-33	21.50
CDFG Weir Scott River	231	7	31-73	51.86
CDFG Weir Shasta River	285	39	27-70	48.31
CDFG Weir Bogus Cr.	300	17	35-66	50.29
IGH	306	56	32-75	52.57
TRH	249	65	27-91	60.23

TABLE 21. Migration data summarized by study year for fall chinook tagged in the Estuary and returning to IGH and TRH.

	IGH			TRH		
	1979	1980	1982	1979	1980	1982
Number of Recoveries	22	14	20	20	29	16
Migration Time (days)						
Range	39-68	34-67	32-75	27-78	35-91	42-76
Mean	53.5	50.9	51.5	53.4	65.7	58.7
Migration Rate (km/day)						
Range	4.5-7.8	4.6-9.0	4.1-9.6	3.2-9.2	2.7-7.1	3.3-5.9
Mean	5.9	6.2	6.2	5.1	4.1	4.4

Chinook destined for the Trinity River showed trends varying from those of Klamath River chinook. Maximum rate of upstream migration observed within the Trinity River was 5.3 km/day with time to recapture varying from 9 to 91 days. Least squares linear regression for the Trinity data showed no significant positive relationship between migration rate and distance travelled upstream ($b = -0.004$; $r^2 = 0.03$). The source of this poor relationship seems to be in data from area T-2, between 134 and 197 kilometers upstream. Chinook tagged at the river mouth appear to head upstream at a steady rate, and upon entering the Trinity River are travelling at an average rate of 5.3 km/day. This compares closely with the migration rate observed for Klamath destined fish at a similar distance upstream. The data from area T-2, however, indicated a deceleration in migration rate to an average of 4.0 km/day. Once past area T-2, the rate once again accelerates and this trend continues to the upstream terminus at Lewiston Dam. The cause of the apparent deceleration in area T-2 is not immediately clear.

The data presented seem to indicate a difference in migration rate between fall chinook in the Trinity and those in the Klamath above Weitchpec. This trend may best be visualized by noting the difference between average migration rates of 6.1 km/day and 4.5 km/day observed for fall chinook reaching IGH and TRH, respectively. Perhaps the physical environment in the Trinity River itself causes slower passage and/or the Klamath destined fish must travel faster since they have a greater overall distance to cover in a similar period of time.

In addition to the general migration data previously discussed for Klamath and Trinity River stocks, several noteworthy trends appeared during analysis. One major trend apparent in the data is a difference in timing of entry into the river between stocks returning to various upriver areas. Data from tagged chinook at specific recovery sites, such as IGH, TRH, Shasta River, Scott River and Bogus Creek, may be assumed to represent migration patterns inherent in these specific spawning stocks. Using the date of tagging as an estimate for date of river entry, catagorization of recapture data by terminal recovery site can be used to indicate major differences in timing of river entry between these stocks. Total recoveries of tagged fall chinook at each terminal site during the 3 years were divided into percentages tagged by calendar week. These percentages were then multiplied by the total number of grilse and adult fall chinook returning to each terminal recovery site during 1979, 1980 and 1982 combined (PFMC, 1983) in order to provide an index of relative abundance of these stocks in the basin during the study period. This information was graphed to represent relative timing of river entry and proportional occurrence through time in the estuarine beach seine sample for stocks returning to the 5 terminal sites listed (Figure 31). Considerable overlap in timing of river entry between the stocks is apparent, however, some trends did appear. The 3 highest consecutive weeks of relative abundance within the 11 week sample period were selected for each stock as best representing peak entry into the river. Among the 3 naturally spawning stocks represented, chinook returning to the Shasta appeared to have the earliest river entry pattern, with 80% entering during the last 3 weeks of August. Bogus Creek chinook appeared to have a somewhat later river entry pattern, with 66% entering during the last 2 weeks of August and first week of September. Scott River chinook tended to be the latest to enter the river, with 62% entering during the last week of August and first 2 weeks of September. Considering the hatchery origin stocks, fall chinook returning to IGH tended to have an earlier entry pattern than TRH fall chinook with 66% entering during the last 3 weeks of August. Chinook returning to TRH peaked later with 51% entering during the last week of August and the first 2 weeks of September. Differences in river entry timing between the 2 hatchery stocks were also apparent in 1982 data on recovery of ventral and Ad-CWT clipped chinook of hatchery origin (see beach seine, harvest monitoring and CWT sections of this report).

A second major trend apparent in the data is that fall chinook stocks entering the river later in the run tended to exhibit a greater rate of upstream migration than stocks entering earlier. Plots of least squares linear relationships between migration rate and tagging date for the 5 stocks illustrate this trend in Figure 32.

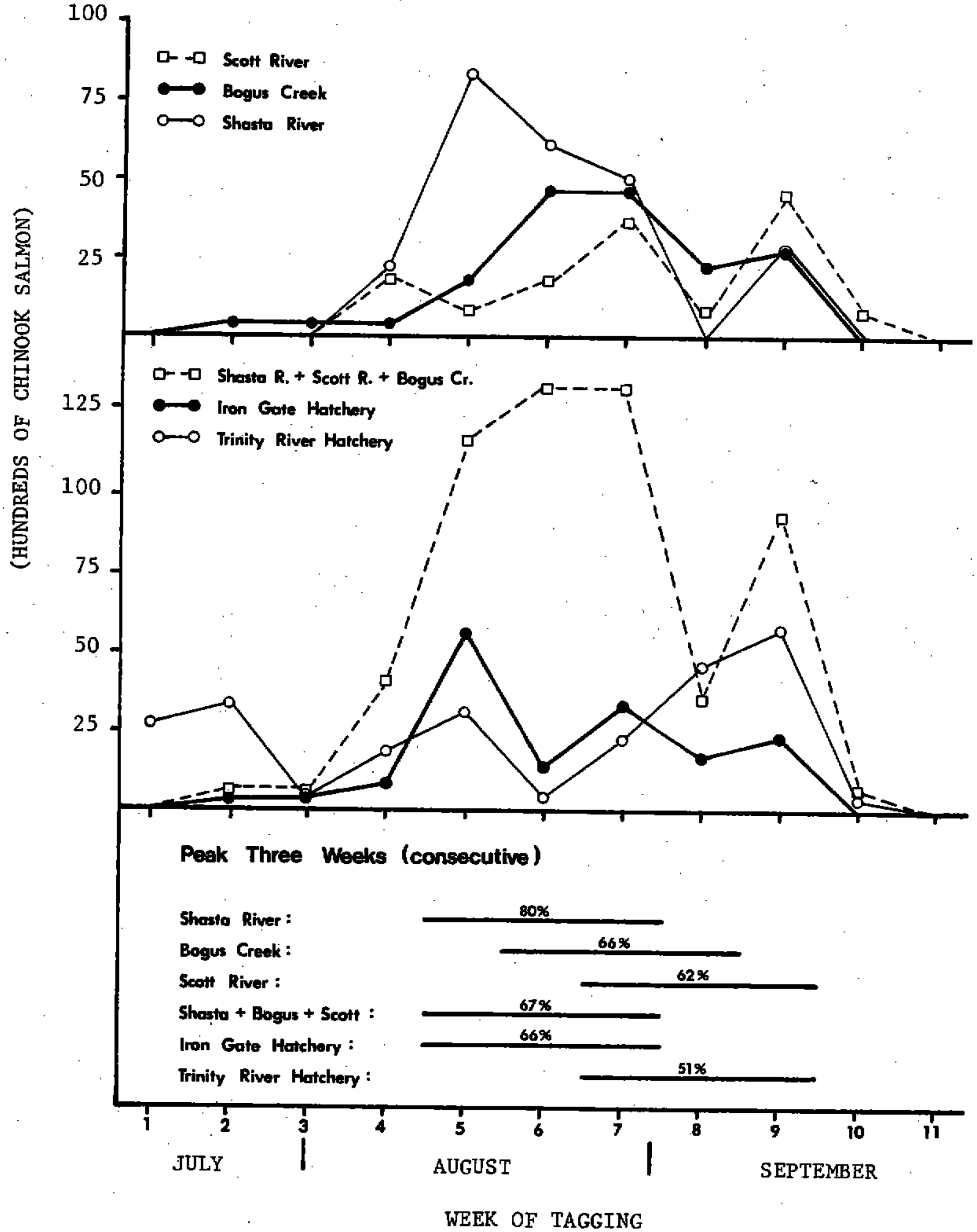


FIGURE 31. Weekly indices representing timing of river entry for tagged fall chinook destined for 5 terminal recovery sites in the Klamath-Trinity basin during 1979-1982.

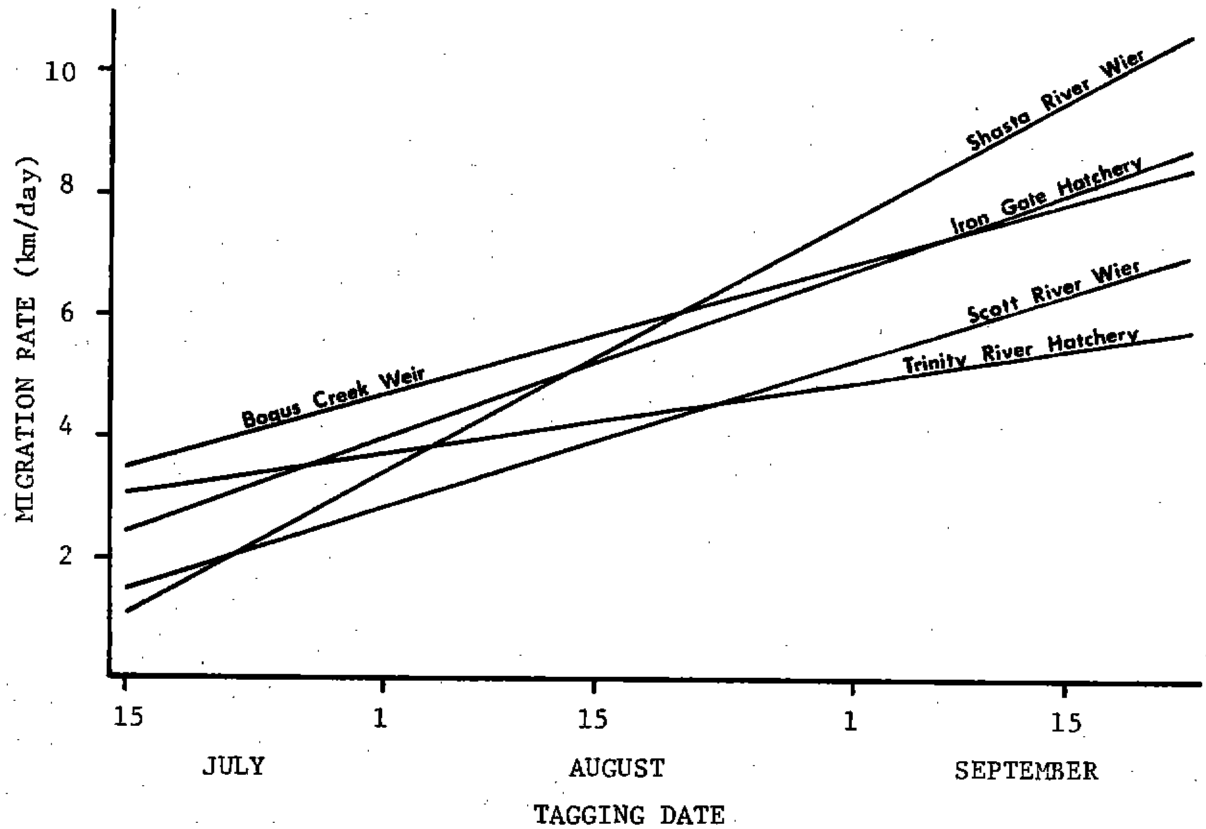


FIGURE 32. Least squares linear regressions of tagging date vs migration rate for fall chinook destined for 5 terminal sites in the Klamath-Trinity basin during 1979-1982.

For all Klamath River stocks regardless of entry date, the rate of upstream migration tended to increase with distance travelled upstream. Least squares linear regression lines, fitted between recapture distance upstream and migration rate for chinook tagged during successive periods of river entry, are presented in Figure 33. Chinook ultimately destined for the Trinity River did not generally follow this trend, as previously discussed.

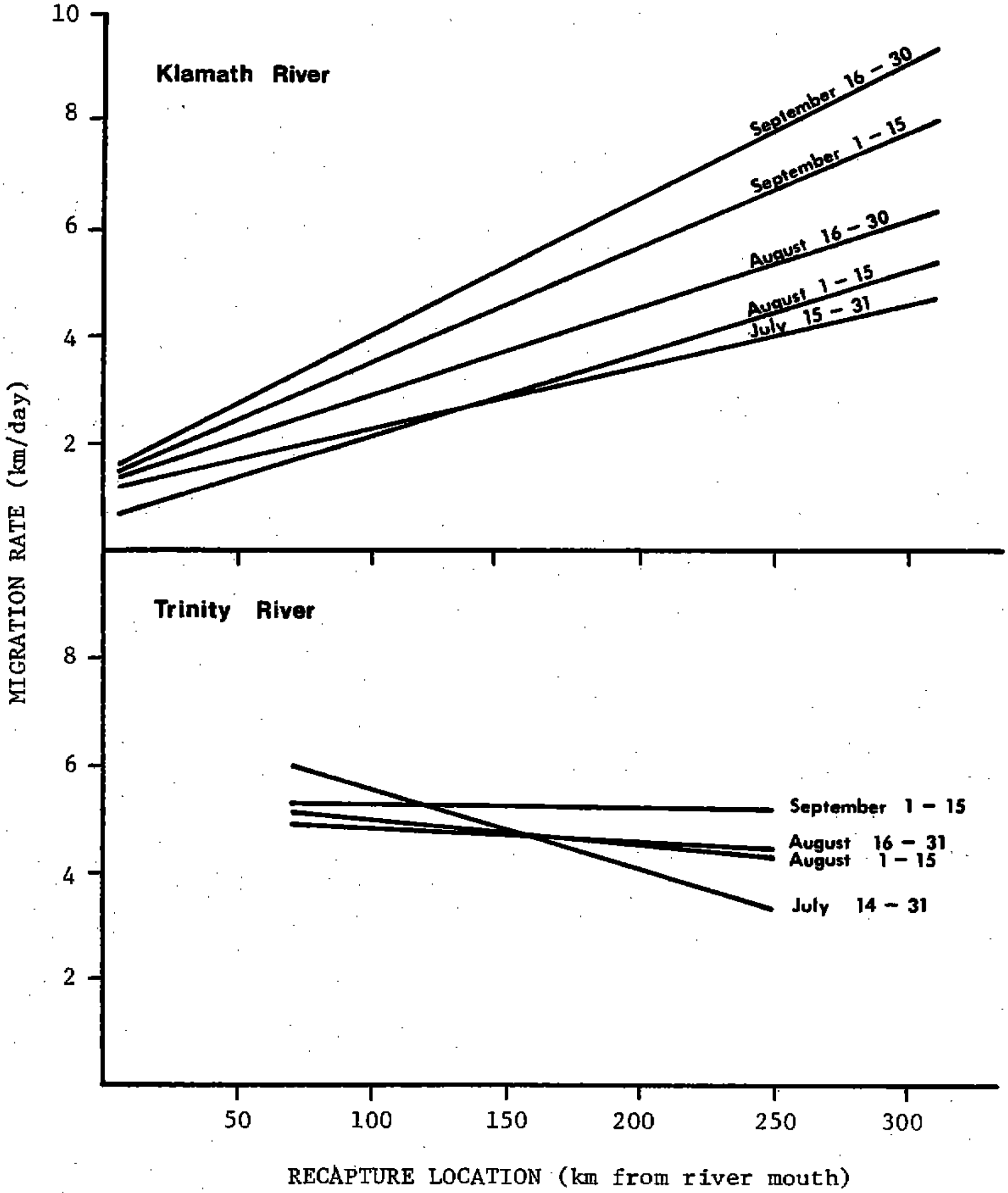


FIGURE 33. Least squares linear regressions of recapture location vs migration rate for Klamath and Trinity River fall chinook tagged during various river entry periods in 1979-1982.

HOOK SCARRING AND GILL NET MARKING INVESTIGATIONS

INTRODUCTION

Klamath River chinook salmon often bear distinctive markings or scars indicating previous contact with and escape or release from gill nets and fish hooks. In recent years, considerable attention has been paid to the collection of data on occurrence frequency of such scars and marks. It is believed that these data are useful as general indicators of the impact of fisheries on the population. FAO-Arcata began collecting such information with the inception of beach seining activities near the mouth of the Klamath River in 1979. In 1981, efforts were expanded to more accurately describe and detail the data and to collect data at additional sites to provide a means of comparison. All 1982 data are presented herein, and a more detailed report addressing the significance of such data is in preparation.

METHODS

Chinook salmon captured during 1982 beach seining operations were examined closely for gill net markings and hook scars. Identified wounds, scars and marks were classified as described in USFWS 1982 (Plates 9 and 10, and Table 22). Additional data were collected at Iron Gate Hatchery (IGH), Trinity River Hatchery (TRH) and at the Shasta River weir. Detailed observations were recorded in conjunction with length frequency information on specially prepared data forms for both beach seine and Shasta River samples. Length frequency information was not recorded during sampling at the hatcheries, although grilse and adults were separated in these samples.

RESULTS AND DISCUSSION

Gill Net Markings

Markings directly attributed to previous contact with gill nets were observed on 0 of 650 grilse (0%) and 7 of 1,596 adult (0.44%) chinook salmon examined during 1982 beach seining activities in the Klamath River estuary. The adult marking frequency observed, 0.44%, was down 93% from the 6.2% observed in the 1981 beach seining program. The fact that gill net harvest of adult chinook in the estuary dropped 80%, from 23,097 in 1981 to 4,547 in 1982 seems to indicate that there is a relationship between rate of harvest in this area and marking rate observed.

Marking rates observed on adult fall chinook at TRH, IGH and at the Shasta weir were 3.0%, 1.4% and 1.4% respectively (Table 23). It appears reasonable that the overall marking rate of 1.8% observed in upriver adult samples would be higher (4.2 times) than in the estuary since 70% of the total adult 1982 net harvest occurred above the estuary. The overall adult marking rate observed in 1981 at TRH and IGH, 11.1%, was 1.8 times the 6.2% observed in beach seining. During 1981, only 30% of the total adult net harvest occurred above the estuary. A potential relationship is clear here as well. Sample sizes of gill net marked fish at all sites were too small in 1982 to permit meaningful analysis of length frequency information.

TABLE 23. Observations of gill net markings on fall chinook salmon at 4 locations in the Klamath basin during 1982.

Date	Sample Site	Grilse n	Grilse GNM	Grilse %	Adults n	Adults GNM	Adults %	Total n	Total GNM	Total %
July-Sept	beach seine	650	0	0	1,596	7	0.44	2,246	7	0.31
Oct-Nov	TRH	717	0	0	334	10	2.99	1,051	10	0.95
Sept-Oct	IGH	217	1	0.46	590	8	1.36	807	9	1.11
Sept-Oct	Shasta River	58	0	0	286	4	1.40	344	4	1.16

Reservations concerning the collection and potential use of gill net marking data on Klamath River chinook were stated in a previous Annual Report (USFWS 1982a). Actual frequencies observed in recent years have varied sharply between agencies involved, personnel involved and sample site. However, it is believed that meaningful data can be obtained under carefully controlled conditions. The general relationship apparent in the 1981 and 1982 data between marking rate observed and estimated harvest, considering similar adult run sizes in these years, appears to attest to the relative accuracy of the data. However, the utility of such information beyond provision of a very general index of net harvest rate in the basin may still be questioned. The potential application of such data in addressing noncatch mortality in the net fisheries due to gill net dropout and fallout is being persued. There appears reason to urge caution in attempts to collect such information under anything but the most carefully controlled conditions.

Hook Scars

Scars or wounds directly attributable to hooks were observed on 372 of 650 grilse (57.2%) and 926 of 1,596 adult (58.0%) chinook salmon examined during 1982 beach seining activities in the Klamath River estuary for an overall frequency of 57.8% (Table 22, Table 24 and Plates 9 and 10). Fresh hook scars were more common than healed (37.5% vs 20.3% and moderate-major scars were more common than minor (32.3% vs 25.5%). Two or more scars attributed to separate hooking incidents were observed on 8.9% of all chinook examined. Hooks were found imbedded in 10 of 2,246 (0.4%) chinook examined. Twenty-seven of 2,246 chinook (1.2%) had been blinded in one eye from a hooking incident.

TABLE 22. Categorization of hook scars observed during 1982 beach seining operations in the Klamath River estuary.

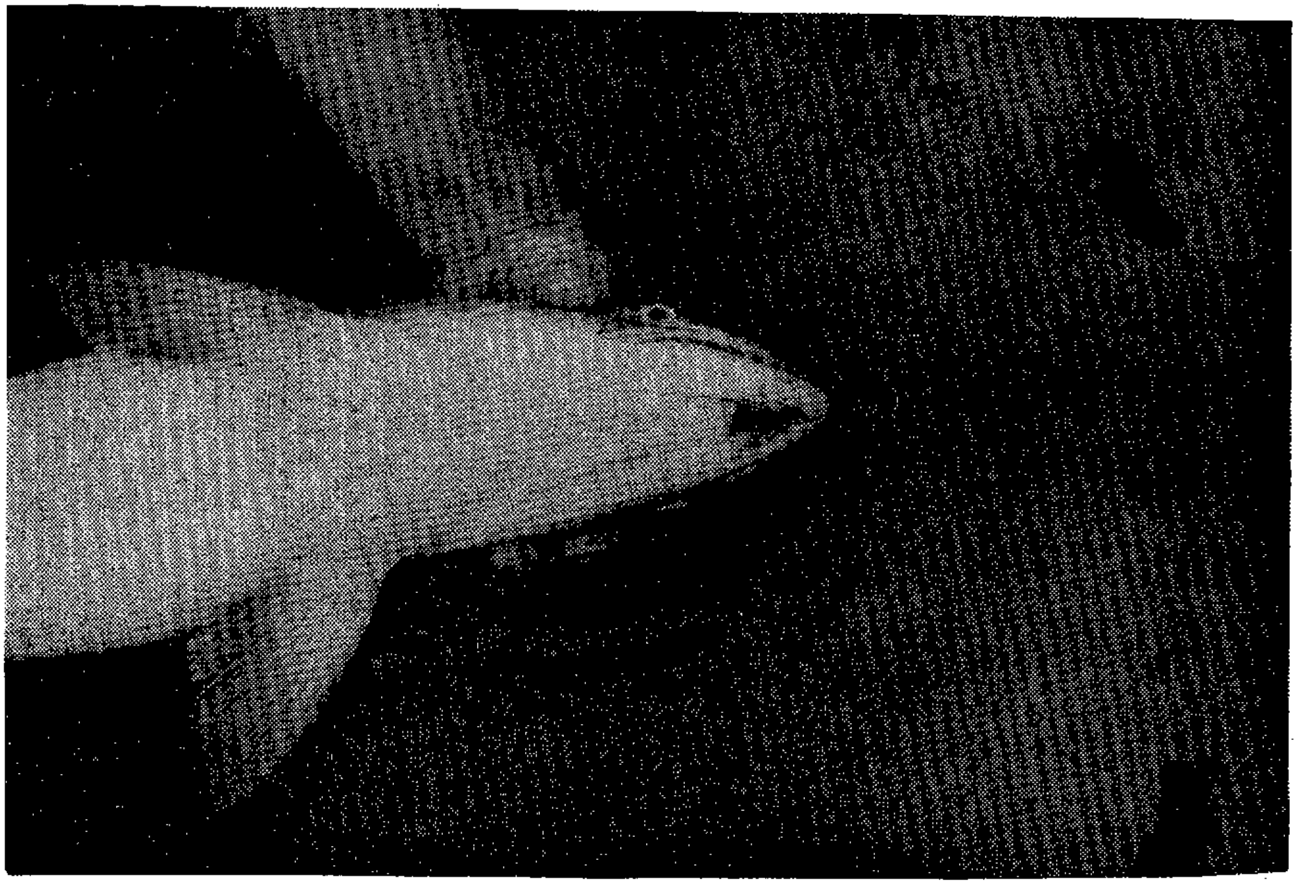
Characteristic	Classification	Criteria for Classification
Freshness	Fresh	Open wound, whether bleeding or not. No substantial healing exhibited.
	Healed	Completely healed scar, or open wound exhibiting a state of near total healing.
Severity	Minor	Obvious wound or scar, but not extensive or deep.
	Moderate	Extensive or deep wound or scar. Major vital structures intact.
	Major	Extensive or deep wound or scar. Vital structures missing or shredded. Debilitating damage (e.g., blindness).
Location	Upper Jaw Lower Jaw Eye & Orbit Opercle Isthmus All other head areas	

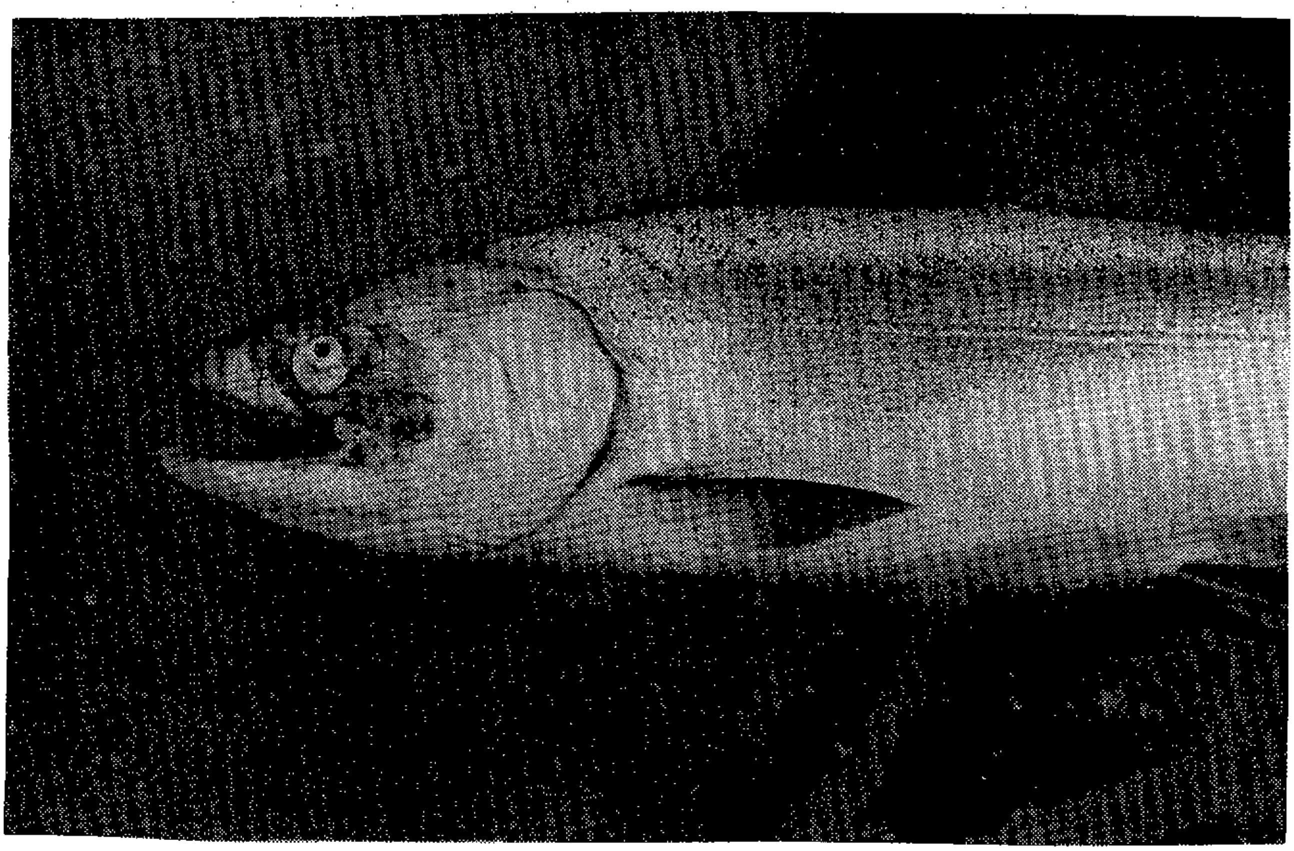
TABLE 24. Percentage occurrence of hook scars observed on 2,246 Klamath River chinook salmon sampled through 1982 beach seining operations.

TYPE OF SCAR	RUN COMPONENT		
	GRILSE	ADULTS	ALL CHINOOK
Fresh Hook Scar	45.5	34.2	37.5
Healed Hook Scar	11.7	23.8	20.3
Minor Hook Scar	19.1	28.0	25.5
Moderate-Major Hook Scars	38.1	30.0	32.3
Single Hook Scar 1/	57.2	58.0	57.8
Two Hook Scars 2/	6.0	10.1	8.9
Three Hook Scars	0.5	0.6	0.5
Questionable Hook Scars	0.6	1.3	1.1
Hook Imbedded	0.0	0.4	0.4
Blind In One Eye	2.0	0.9	1.2

1/ All fish exhibiting one or more hook scars included in this category.

2/ All fish exhibiting 2 or more hook scars caused by separate hooking incidents included in this category.





PLATES 9 & 10. Hook scars classified as fresh-moderate on the lower jaw (above) and healed-major on the eye (below) during 1982.

TABLE 25. Categorical frequencies of hook scars within a total sample of 1,510 scars observed during 1982 beach seine activities.

LOCATION	HEALING STAGE	SEVERITY MINOR	MODERATE	MAJOR	TOTAL
Upper Jaw	Fresh	14.5	13.4	0.8	28.7
	Healed	7.1	12.2	0.8	20.1
	Total	21.6	25.6	1.6	48.8
Lower Jaw	Fresh	9.3	6.9	0.9	17.1
	Healed	4.5	2.8	0.3	7.7
	Total	13.8	9.7	1.2	24.8
Eye & Proximity	Fresh	0.3	2.2	1.2	3.7
	Healed	0.5	1.0	0.4	1.9
	Total	0.7	3.2	1.6	5.6
Opercle	Fresh	1.6	2.4	0.06	4.1
	Healed	1.5	1.7	----	3.2
	Total	3.1	4.1	0.06	7.3
Isthmus & Proximity	Fresh	1.2	4.5	0.2	6.0
	Healed	0.7	1.0	0.1	1.7
	Total	1.9	5.5	0.3	7.7
Other Head Areas	Fresh	1.9	2.1	0.2	4.2
	Healed	0.5	1.0	0.1	1.5
	Total	2.4	3.1	0.3	5.7
All Head Areas Combined	Fresh	28.9	31.4	3.4	63.8
	Healed	14.8	19.8	1.6	36.2
	Total	43.7	51.2	5.0	100.0

Within the 1982 total sample of 1,510 scars, 48.8% were found on the upper jaw and 24.2% were found on the lower jaw. This compares closely with the 1981 sample of 583 scars within which 49.6% and 24.2% were observed on upper and lower jaw structures, respectively. Table 25 presents recorded occurrence frequencies for respective catagories within the total sample of 1,510 scars. These frequencies do not directly convert to occurrence frequencies of scarring within the total sample of 2,246 chinook as 200 multiple scarred chinook are represented by 412 individual scars. The incidence of hook scarred fish in the 1982 beach seine sample period increased at a rate of 4.29% per week, the slope of the regression equation being found significant (F test, $p < 0.05$, Figure 34).

Length frequency distributions of scarred and non-scarred chinook captured during 1982 beach seining activities are presented in Figure 35. Mean length of hook scarred adults, 76.2 cm, was found significantly smaller than mean length of non-scarred adults, 78.8 cm (t-test, $p < 0.05$). This is believed due

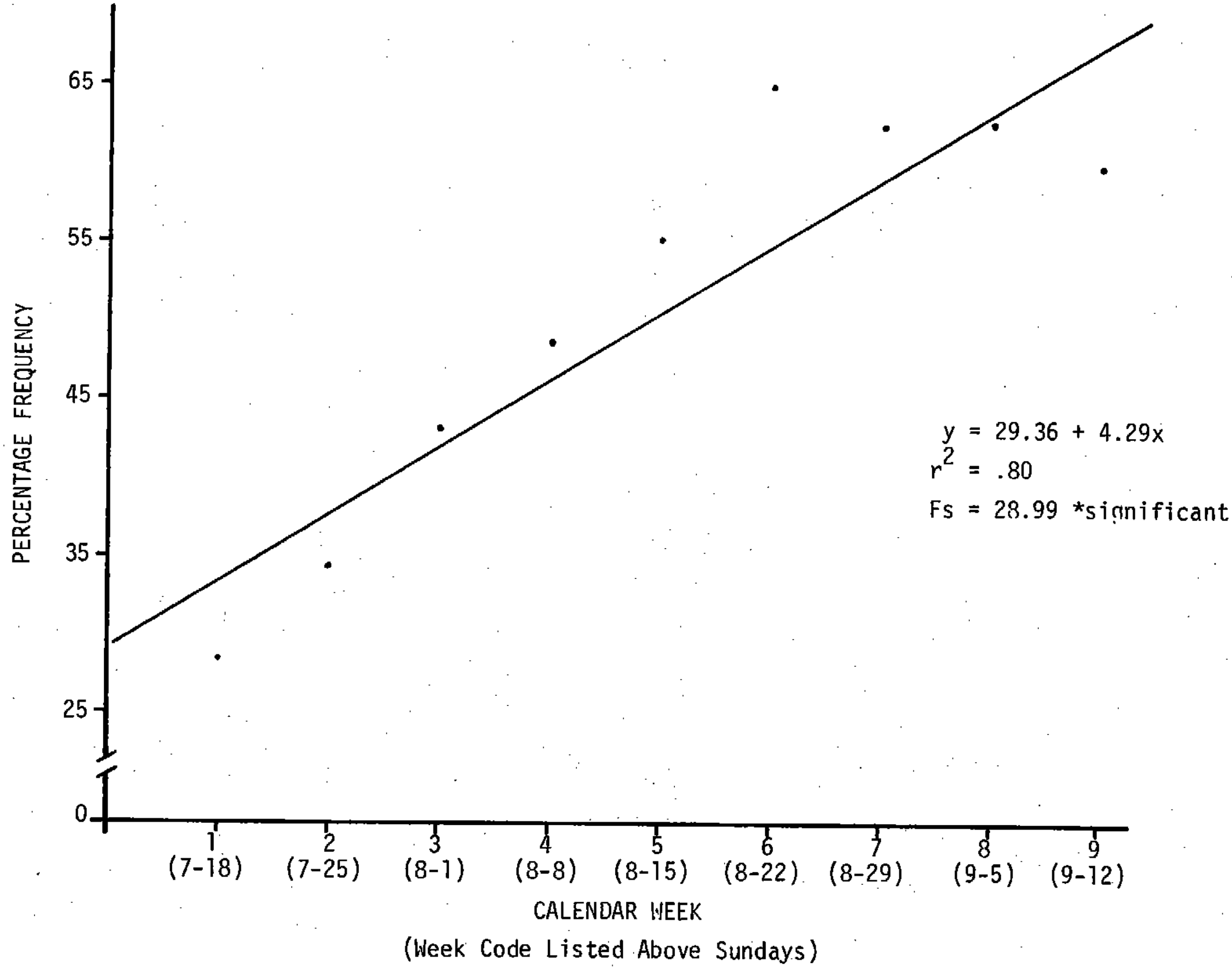


FIGURE 34. Least squares linear regression of hook scar frequency for chinook salmon by calendar week in the 1982 beach seine sample (* = significant F-test, $p \quad 0.05$).

to growth interruptions caused by hooking incidents. Documentation of this is being pursued through scale analysis. Similar results were presented for 1980 and 1981 hook scarring data. Mean length of hook scarred grilse, 49.3 cm, was found significantly greater than mean length of non-scarred grilse, 47.4 cm ($p < 0.05$). It is believed that this reflects inability of smaller chinook to survive a hooking incident. This trend was also present in 1980 and 1981 data.

Seasonal hook scarring incidences for adult and grilse chinook combined have risen steadily since inception of data collection programs in 1979 (Figure 36). Part of the trend between 1979-1981 may be explained by increasingly closer examination of fish during handling. However, with observation methods being standardized in 1981, increases in scarring incidences between 1981 and 1982 as well as most of the increases from 1979-1981 appear due to harvest patterns in the fisheries. While in previous seasons it has been apparent that ocean scarring accounted for the great majority of scars observed, there is some evidence that in 1982 a greater (though still minor) portion of scars in the fresh minor category was received through the in-river sport fishery. First, 2 sport hooks were removed from captured fish. Second, occurrence of scars in the fresh-minor category appeared correlated with numbers of sport boats fishing in the vicinity of the operation, although statistical documentation of this correlation is lacking. Third, sport effort and catch in the estuary increased substantially in 1982 over past seasons.

In order to provide a means of comparison, scarring incidence was also observed at TRH, IGH and the Shasta weir in 1982. Since chinook reaching these areas are usually in a physically deteriorating condition, it was judged that minor scars would be difficult to recognize accurately and therefore only data on moderate and major scars would be recorded for comparison with that portion of the beach seining data. Combined moderate-major hook scar frequencies observed at TRH, IGH and Shasta, 32.9%, 32.6% and 36.6% respectively, are remarkably similar to the 32.3% observed in the beach seine (Table 26). Length frequency information on scarred and non-scarred chinook observed at the Shasta River indicate similar trends as apparent in the beach seine data, although differences were not significant ($p > 0.05$) primarily due to sample size inadequacy (Figure 37). Differences between mean lengths of scarred and non-scarred chinook observed at the Shasta River were, however, significant at $p < 0.20$ (t-test). As a matter of interest, none of 344 chinook examined in the Shasta River sample bore hatchery fin-clips.

TABLE 26. 1/ Observations of hook scarring frequencies on fall chinook salmon at 3 locations in the Klamath basin during 1982.

DATE	SAMPLE SITE	GRILSE			ADULTS			TOTAL		
		n	HS	%	n	HS	%	n	HS	%
Oct-Nov	TRH	717	212	29.6	334	134	40.1	1,051	346	32.9
Sept-Oct	IGH	217	76	35.0	590	187	31.7	807	263	32.6
Sept-Oct	Shasta River	58	18	31.0	286	108	37.7	344	126	36.6

1/ Moderate and major severity scars only were recorded at upriver sites.

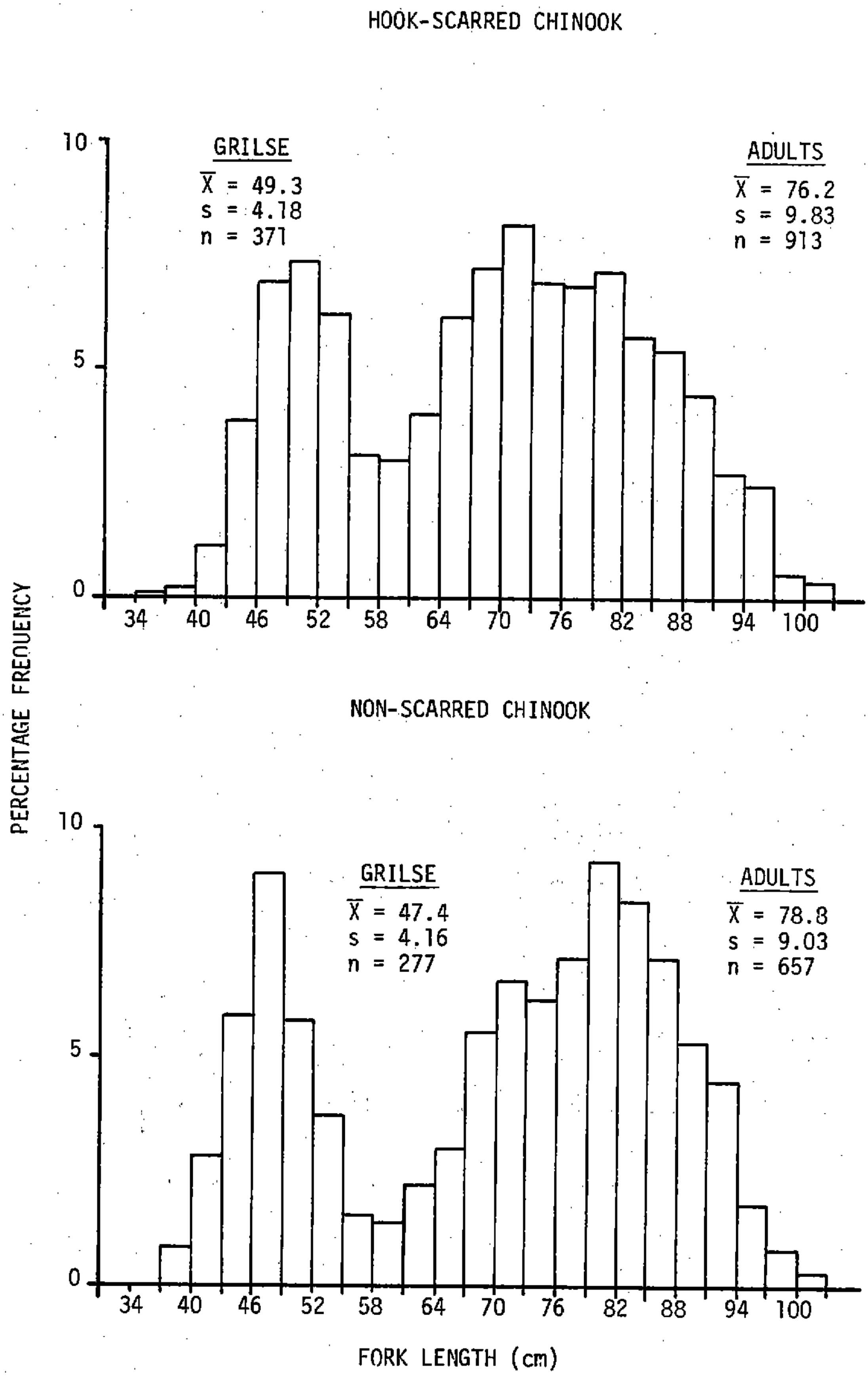


FIGURE 35. Length frequency distributions of hook-scarred and non-hook-scarred chinook in the 1982 beach seine sample.

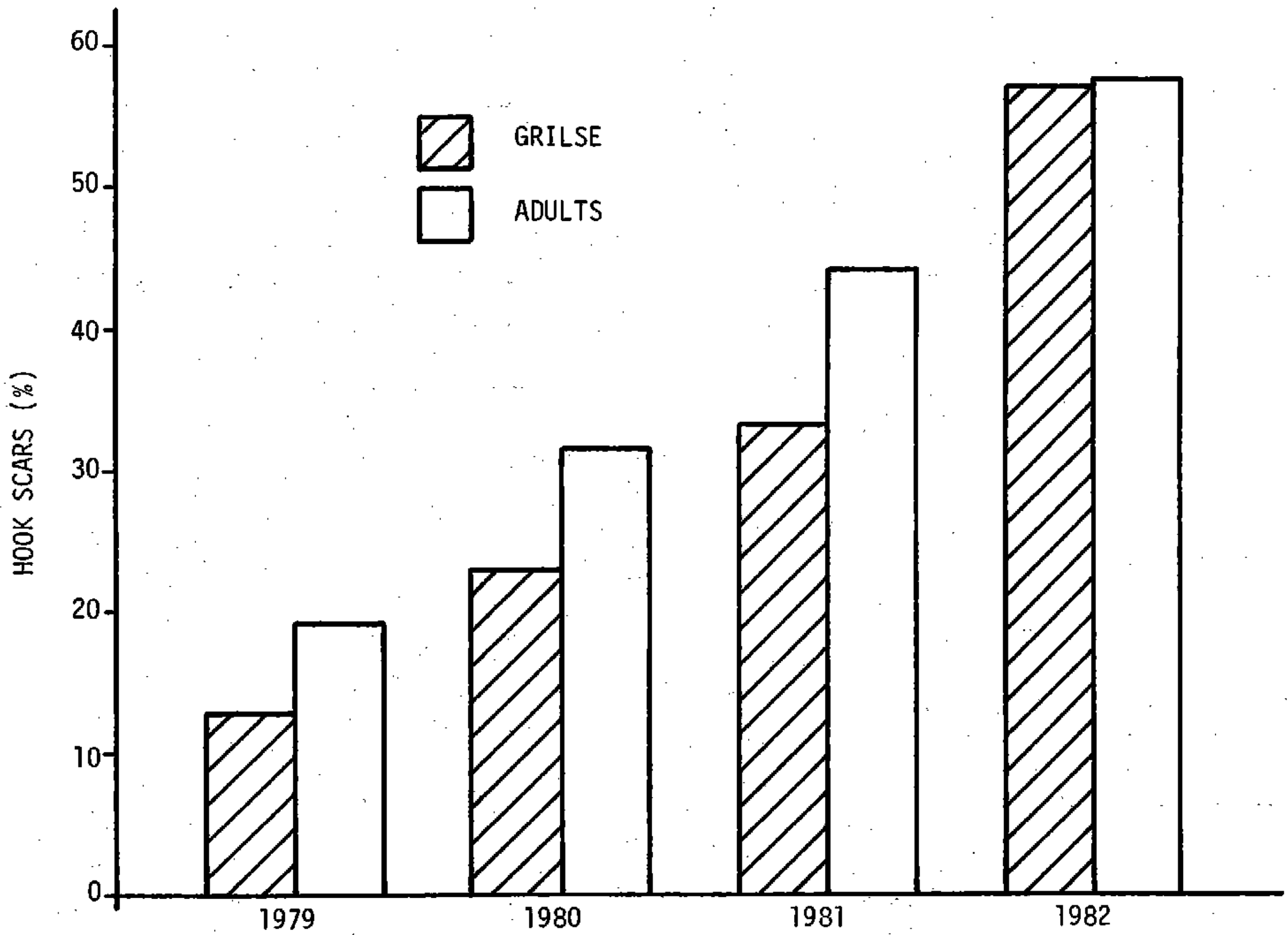


FIGURE 36. Grilse and adult chinook salmon hook scarring rates observed during 1979, 1980, 1981 and 1982 beach seining operations in the Klamath River.

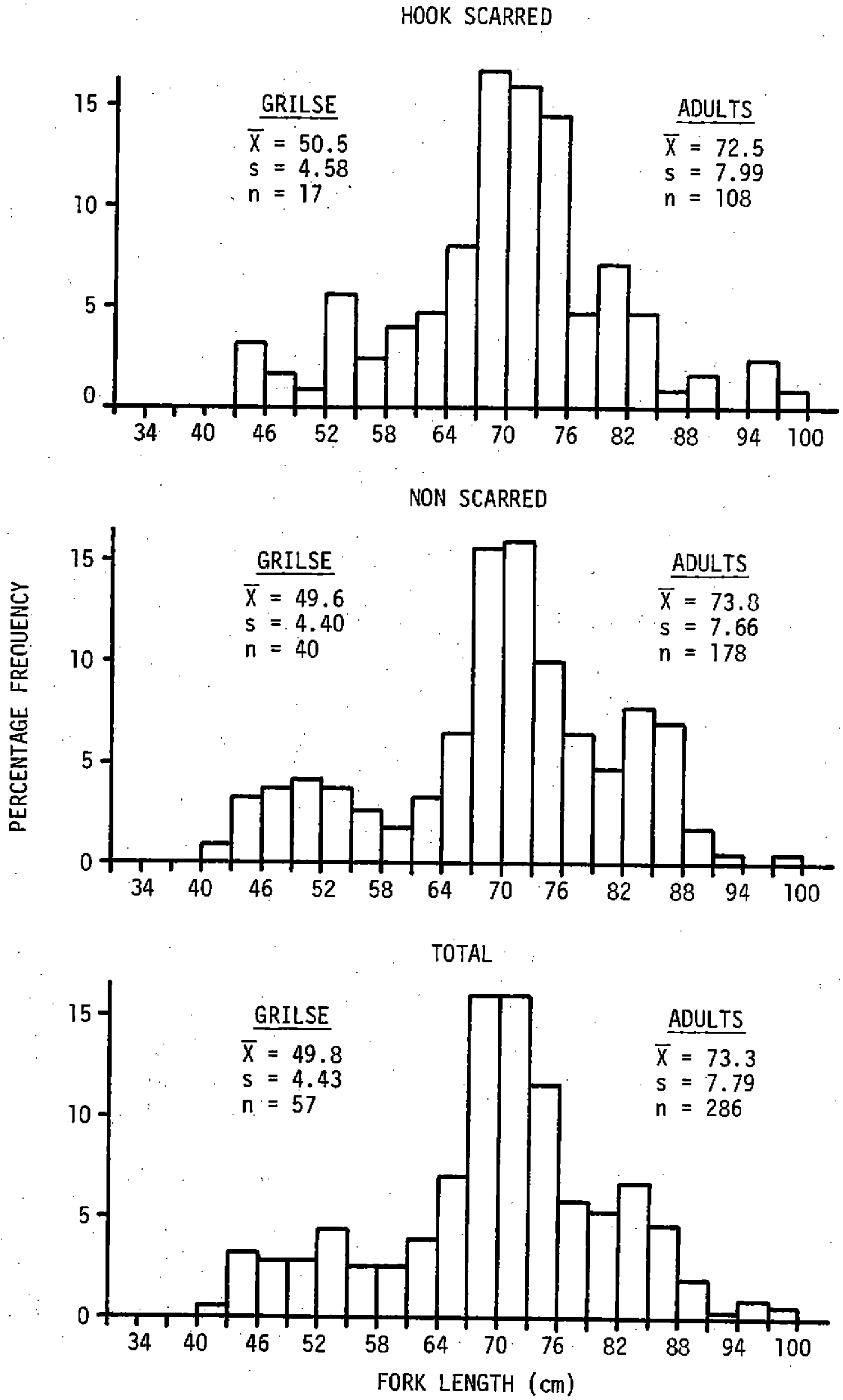


FIGURE 37. Length frequency distributions of hook scarred (top), non-scarred (middle) and total (bottom) chinook salmon examined at the Shasta racks on 6 sampling dates in 1982.

CODED-WIRE TAG RECOVERY INVESTIGATIONS

INTRODUCTION

Two California Department of Fish and Game (CDFG) operated hatcheries are located in the Klamath River basin. Trinity River Hatchery (TRH), at the base of Lewiston Dam, lies 249 river kilometers from the mouth of the Klamath River. Located near the base of Iron Gate Dam on the Klamath River, Iron Gate Hatchery (IGH) lies 306 river kilometers from the mouth. In recent years, these hatcheries have released on-site (at the hatchery) 3 basic groups of coded-wire tagged (CWT) juvenile chinook salmon; fingerlings in June, yearlings in October, and yearlings-plus in March. Additionally, TRH has trucked CWT fingerlings 137 to 156 river kilometers downriver to release at off-site (away from the hatchery) locations. Since these 4 release programs differ as to site, time and size at release, differing environmental conditions prevailing between release and maturity result in varying biological characteristics upon return, including abundance, size and age at maturity, and time of return. These variations between groups must be analyzed in order to evaluate the effectiveness of the hatchery release programs and the impacts of fisheries operating on the stocks. In conjunction with 1982 net harvest monitoring activities, FAO biologists again conducted CWT recovery efforts involving the Indian fishery on the Hoopa Valley Reservation.

METHODS

Coded-wire tags were dissected from chinook salmon utilizing a magnetic field detector and read with the aid of a Nikon 104 dissecting scope. Recovery data for each CWT group were expanded to estimate total contribution to the net harvest by area and time employing a procedure similar to that used by personnel of the Oregon Department of Fish and Wildlife (ODFW) in estimating contributions of CWT groups to the Oregon troll fishery. The first part of the expansion adjusts for the non-recovery of tags from adipose fin-clipped fish in the mark-sample and the second part adjusts for the portion of net harvest not mark-sampled.

$$(1)\quad \text{Tag Recovery Rate} = \frac{\text{Number of tags recovered}}{\text{Number of adipose fin-clipped chinook observed}}$$

$$(2)\quad \text{Harvest Sampling Rate} = \frac{\text{Number of chinook examined for marks}}{\text{Total estimated net harvest}}$$

For each CWT group recovered, the 2 derived rates were multiplied to yield an Expanded Tag Factor, which was then divided into the respective recovery data to produce the total contribution estimate.

Harvest estimates of CWT groups were generally derived monthly (April 1 - June 30) or semimonthly (July 1 - October 30), by area, except when low sampling rates or abbreviated sampling schedules called for deviations from these time periods. Annual estimates of net harvest involving each tag group were derived by summing time period estimates for each area and then summing the 4 area estimates.

RESULTS AND DISCUSSION

Fall Chinook Salmon

Coded-wire tag recoveries from fall chinook in the 1982 Indian net harvest totaled 357, of which 347 were obtained through our mark-sampling program (Table 27) and 10 through voluntary returns by Indian fishers. The mark-sampled recoveries expand to an estimated harvest of 1,466 CWT fall chinook representing 17 release groups from Iron Gate and Trinity River hatcheries in the Klamath basin and Cole Rivers Hatchery in the Rogue River system.

Fall chinook contribution rates[1/] of Trinity River Hatchery CWT release groups harvested during the 1980-1982 Indian fisheries (Table 28) varied with the type and site of release. Generally, for on-site hatchery releases, the highest contribution rates occurred for yearlings-plus (0.314%), followed by yearlings (0.173%) and fingerlings (0.031%). For on-site to off-site comparisons, fingerlings planted off-site contributed (0.072%) at over twice the rate of on-site releases (0.031%). However, a higher rate of straying may occur with these off-site releases. Although such a trend was not apparent in the 1982 net fishery, a high rate of straying for the 6-61-10 off-site release was noted in the 1981 net fishery (USFWS 1982a). Straying into another coastal river system by a TRH off-site release was noted by Waldvogal (1983), in which recoveries of marked fish from the Smith River sport fishery showed a high percentage of strays from the Trinity River Hatchery with the 6-61-17 off-site group comprising over 35% of the total CWT's recovered.

Iron Gate Hatchery CWT releases generally appear to contribute to the Indian net fishery at a higher rate than releases from TRH[2/]. Two years of adult returns from IGH's first CWT release (6-59-01) show a contribution rate (0.402%) twice that of any comparable TRH CWT group. For 1979 brood year releases, a fingerling IGH CWT group (6-59-03) contributed at a higher rate (0.048%) than the 2 TRH fingerling groups (6-61-16 @ 0.003%/6-61-17 @ 0.038%) and the TRH yearling group (6-6-09 @ 0.046%). However, IGH yearling release (6-59-02) did contribute at a lower rate (0.028%) than the comparable TRH group (6-6-09 @ 0.046%).

1/ Contribution rate (%) = number harvested/number released X 100

2/ Comparisons between IGH and TRH releases are based upon recoveries from only the fishery operating on the main stem of the Klamath Rivere where both hatcheries have the same probabilities of contribution to the harvest. Because 1980 CWT harvests from the net fishery were not broken down by area, the estimated harvest number for each group was decreased by 18% to correct for the Trinity River component. This 18% estimate is based upon the mean percentage of the Trinity CWT component for 1981-1982.

TABLE 27. Actual and expanded (underlined) CWT groups recovered during mark-sampling of fall chinook salmon in the 1982 gill net fishery on the Hoopa Valley Reservation.

Tag Code	Brood Year	Hatchery 1/ Of Origin	Release 2/ Type	RESERVATION MONITORING AREA								All Areas	
				Estuary		Resighinni		Upper Klamath		Trinity			
6-61-02	1977	TRH	F	0	0	0	0	1	10	0	0	1	10
6-59-01	1978	IGH	Y	48	181	30	99	45	237	0	0	123	517
6-61-15	1978	TRH	Y+	14	65	13	39	10	58	16	53	53	215
6-61-14	1978	TRH	Y	9	42	7	23	4	20	7	21	27	106
6-61-10	1978	TRH	F 3/	2	9	0	0	1	13	2	6	5	28
6-61-08	1978	TRH	F	0	0	0	0	0	0	4	12	4	12
7-18-53	1978	CRH	Y	1	5	0	0	0	0	0	0	1	5
6-61-17	1979	TRH	F 4/	4	17	4	13	8	44	25	92	41	166
6-61-20	1979	TRH	Y+	2	10	4	14	9	53	14	50	29	127
6-59-03	1979	IGH	F	6	27	7	22	8	49	0	0	21	98
6-61-09	1979	TRH	Y	2	10	2	7	4	25	5	16	13	58
6-59-02	1979	IGH	Y	4	17	2	6	1	5	1	4	8	32
6-61-16	1979	TRH	F	0	0	0	0	1	5	3	9	4	14
6-61-21	1980	TRH	Y	0	0	2	6	3	18	4	14	9	38
6-61-18	1980	TRH	F	0	0	0	0	1	6	2	14	3	20
6-59-05	1980	IGH	F	1	3	1	3	1	5	0	0	3	11
6-59-16	1980	IGH	F 5/	0	0	1	4	1	5	0	0	2	9
TOTALS				93	386	73	236	98	553	83	291	347	1466

1/ CRH - Cole Rivers Hatchery (Rogue River system)
TRH - Trinity River Hatchery
IGH - Iron Gate Hatchery

2/ F (Fingerling) - May or June release
Y (Yearling) - Late September to November release
Y+ (Yearling-plus) - March release

3/ Offsite release at Trinity River Kilometer 20.0

4/ Offsite release at Trinity River Kilometer 40.0 (Willow Creek)

5/ Indian Creek Ponding program offsite release

TABLE 28. Fall chinook contribution rates to the Indian net fishery of age 3 and 4 adults of the four types of Trinity River Hatchery releases.

Release Type	Tag Code	6-61-02	6-61-08	6-61-16	Total
	Age(s) at Harvest	3&4	3&4	3	
Fingerling on-site	Number Harvested[1/]	71	93	14	178
	Number Released[2/]	189,215	191,374	191,019	571,608
	Contribution Rate (%)[3/]	.038	.049	.007	.031
	Tag Code	6-61-03	6-61-10	6-61-17	Total
Fingerling off-site	Number Harvested	59	192	166	417
	Number Released	192,014	193,808	196,650	582,472
	Contribution Rate (%)	.031	.099	.084	.072
	Tag Code	6-61-05	6-61-14	6-61-09	Total
Yearling	Number Harvested	471	326	58	855
	Number Released	192,014	209,161	91,821	492,996
	Contribution Rate (%)	.245	.156	.063	.173
	Tag Code	6-61-07	6-61-15	6-61-20	Total
Yearling plus	Number Harvested	717	550	127	1,394
	Number Released	195,080	163,749	84,503	443,332
	Contribution Rate (%)	.368	.336	.150	.314

1/ Estimated CWT harvest (assumes 0% tag loss)
2/ Includes ad-clipped fish that shed tag before release. Data obtained from CDFG.
3/ Contribution rate (%) = number harvested / number released X 100

The first CWT group from TRH (6-61-01) deserves special note because it is not typical of any subsequent releases. Individuals of this group originated from eggs taken at IGH and transferred to TRH for rearing and release as yearlings. Consequently, this group's genetic background is more similar to IGH than TRH fish. This similarity is further indicated by the group's 1979-1980 (6-61-01) contribution rate (0.250%)[3/] which is much higher than any other yearling TRH group and closer to the IGH yearling group (6-59-01 @ 0.402%). Because of the genetic dissimilarity, comparisons between this group and other TRH groups should be carefully examined.

The age composition of CWT fall chinook salmon harvested in the 1981 Indian net fishery was 0.6% 5-year-olds, 50.8% 4-year-olds, 42.9% 3-year-olds and 5.7% 2-year-olds. Age class composition changed from mostly 4-year-olds in the estuary fishery to mainly 3-year-olds in the Trinity River (Figure 38). Two-year-olds were more prominent in the upriver fisheries but relatively unimportant in all areas. Five-year-olds were almost non-existent in the catch with only a single recovery in the upper Klamath fishery. Since differences in age structure could be a function of variations in numbers released, the percentages are corrected for unequal release sizes. This was accomplished by summing individual CWT group contribution rates and then determining the relative percentage contribution of groups in each age glass.

Iron Gate Hatchery CWT groups appeared to enter the lower river fisheries earlier than TRH groups (Figure 39). From mid July to the third week in August, the bulk of the CWT harvest consisted of IGH codes. By September 7, the TRH CWT harvest had increased to almost equal that of IGH. Harvest of CWT's during the last 2/3 of September was almost exclusively TRH. Differences between entry time of the individual CWT groups were not evident in the 1982 fishery.

As in past years, CWT groups from both hatcheries showed an inverse relationship between hatchery release times (i.e., earlier releast = more ocean growth time available) and mean length at harvest from the fishery (Table 29). Within each age class, the mean length at harvest decreases from fingerling to yearlings to yearlings-plus releases. However, because of small sample sizes, only 2 comparisons (3-year-old fingerlings vs yearlings-plus and 4-year-old yearlings vs yearlings-plus) were significant. Between age class comparisons for each hatchery revealed a significant ($p < 0.05$) decrease in mean lengths as expected, from 4 to 3 to 2-year olds for all cases. On-site and offsite fingerling releases from TRH were combined, since no significant difference in mean length was found and tested against other release types.

3/ A different method of determining CWT harvest in the 1979 fishery was required since CWT's were not recovered from the 1979 net fishery. Based upon a 1.5% ad-clip rate for adults in the 1979 beach seine mark-sample and a total estimated adult net harvest of 13,650, the total number of ad-clipped fish in the harvest would be 205. Assuming that all adult ad-clipped fish were of the 6-61-01 group (the only adult CWT group returning) and subtracting out the estimated Trinity component (18%), the estimated 1979 harvest of 6-61-01 CWT group in the Klamath River fisheries would be 168.

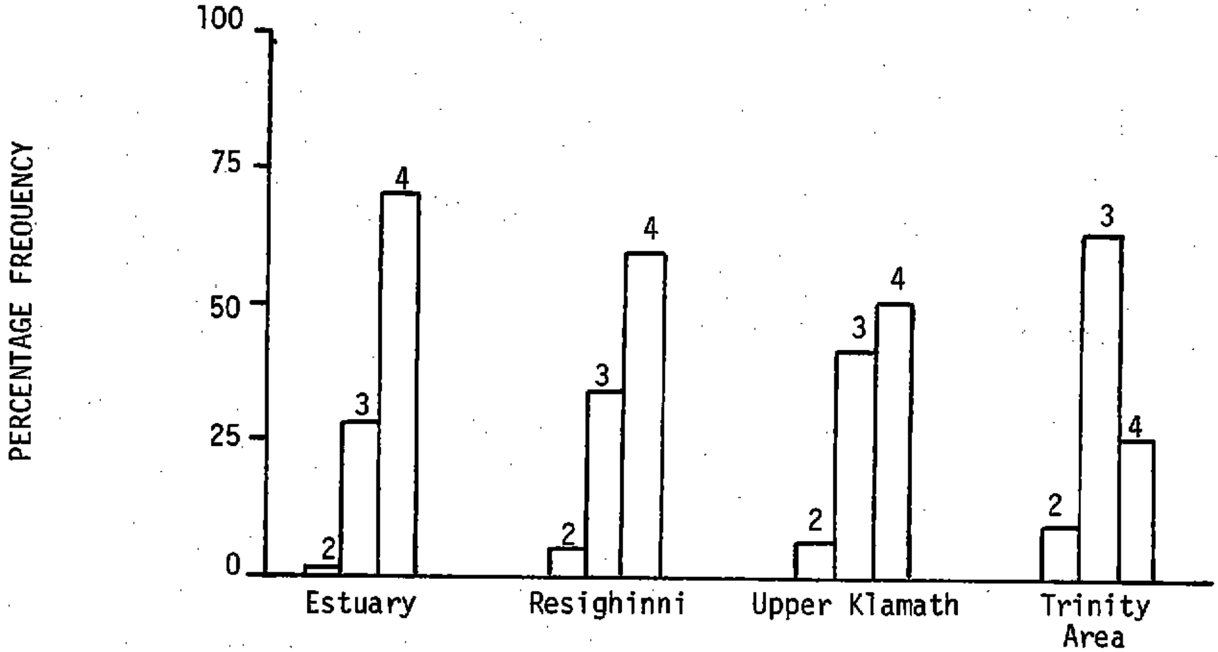


FIGURE 38. Age composition of Trinity River and Iron Gate hatchery groups harvested in the 4 monitoring areas of the Hoopa Valley Reservation in 1982 (percentages corrected for unequal sizes of CWT release groups in their respective brood years).

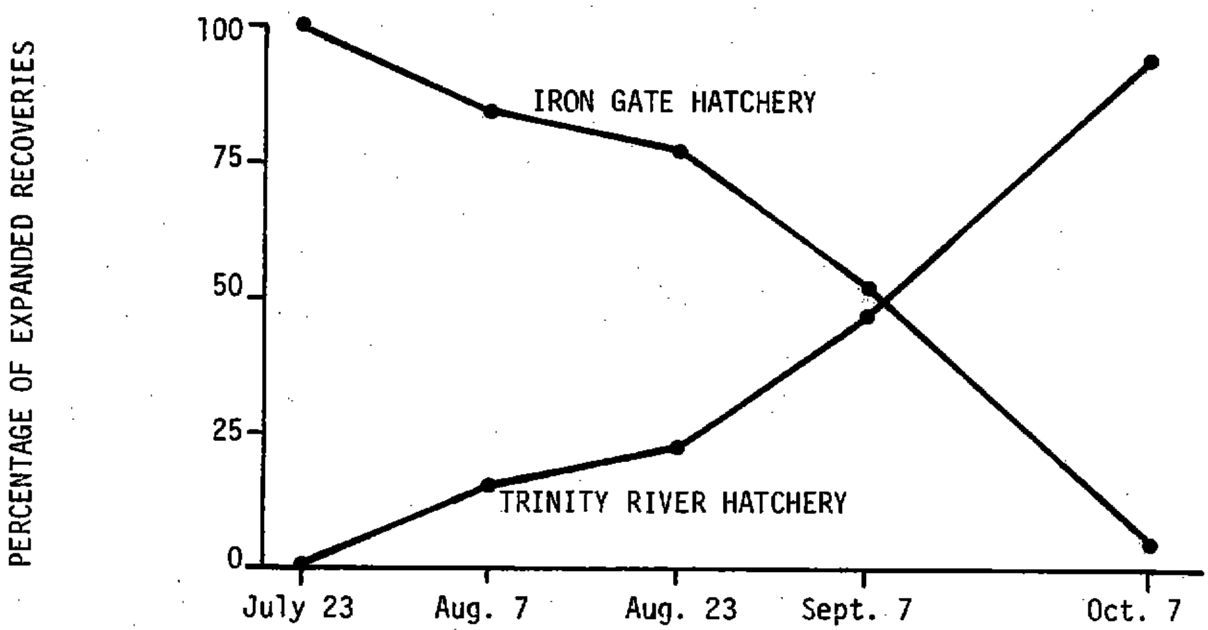


FIGURE 39. Percentage contribution of CWT groups by hatchery to the estimated lower Klamath fall chinook CWT net harvest in 1982.

TABLE 29. Mean fork length, standard deviation, and number of recoveries for 11 fall chinook CWT groups harvested at the 4 monitoring areas of the Hoopa Valley Reservation in 1982.

Tag Code	Brood Year	Hatchery[1/] Of Origin	Release[2/] Type	HARVEST MONITORING AREA Estuary	Resighinni	Upper Klamath	Trinity	All Areas
6-61-08	1978	TRH	F	--- [4/] --- [5/] 0 [6/]	---- ---- 0	---- ---- 0	83.3 3.59 4	83.3 3.59 4
6-61-10	1978	TRH	F[3/]	88.5 10.60 2	---- ---- 0	70.0 ---- 1	87.0 7.07 2	84.2 10.20 5
6-59-01	1978	IGH	Y	85.1 7.70 48	82.7 7.15 30	83.2 7.61 45	---- ---- 0	83.8 7.54 123
6-61-14	1978	TRH	Y	83.7 3.64 9	79.7 6.47 7	81.8 9.18 4	80.0 4.20 7	81.4 5.53 27
6-61-15	1978	TRH	Y+	80.5 4.69 14	79.3 5.81 13	79.0 6.62 10	75.9 5.63 16	78.5 5.80 53
6-59-03	1979	IGH	F	73.0 2.90 6	73.5 4.99 7	71.9 3.27 8	---- ---- 0	72.8 3.73 21
6-61-17	1979	TRH	F[3/]	75.0 4.00 4	69.7 3.40 4	68.1 4.91 8	69.3 4.90 25	69.7 4.94 41
6-59-02	1979	IGH	Y	68.8 4.99 4	62.0 5.66 2	80.0 ---- 1	68.0 ---- 1	68.4 6.80 8
6-61-09	1979	TRH	Y	63.0 8.49 2	74.5 0.71 2	65.3 6.29 4	62.2 8.79 5	65.1 7.80 13
6-61-20	1979	TRH	Y+	60.5 4.95 2	59.7 5.50 4	63.1 6.37 9	61.1 4.35 14	61.6 5.06 29
6-61-21	1980	TRH	Y	---- ---- 0	47.5 0.71 2	43.7 2.52 3	47.7 2.52 3	46.1 2.80 8

1/ TRH - Trinity River Hatchery
IGH - Iron Gate Hatchery

2/ F (Fingerling) - May or June release
Y (Yearling) - Late Sept. to Nov. release
Y+ (Yearling-plus) - March release

3/ Offsite release

4/ Mean fork length

5/ Standard deviation

6/ Number in sample

Coded-wire tagged recoveries from groups of the age 4 class were generally of a greater mean length in 1982 than 1981, while age 3 groups were generally smaller. Significant ($p < 0.05$) mean length increases for 4-year-olds in 1982 were eivdent for 2 of 3 comparable groups: a 4.8 cm significant increase for yearlings (6-61-05 vs 6-61-14), a 2.8 cm significant increase for yearlings-plus (6-61-07 vs 6-61-15), and a 4.5 cm non-significant increase for fingerlings (6-61-2/3 vs 6-61-8/10). For age 3, although all comparable groups showed a decrease in mean length from 81 to 82, only one was significant: a 2.4 cm significant decrease for fingerlings (6-61-8/10 vs 6-61-16/17), a 2.2 cm non-significant decrease for TRH yearlings (6-61-14 vs 6-61-09), a 2.0 cm non-significant decrease for IGH yearlings (6-59-01 vs 6-59-02), and a 1.7 cm non-significant decrease for yearlings-plus (6-61-15 vs 6-61-20). Comparisons for age 2 groups could not be made because of insufficient sample sizes.

Coded-wire tagged groups harvested in the lower river fishery in 1982 were generally of a greater mean length than 1980. Even though 3 of 4 comparable groups showed an increase, only one was significant ($p < 0.05$): a 5.2 cm significant increase for age 3 fingerlings (6-61-2/3 vs 6-61-16/17), a 4.7 cm non-significant increase for age 3 yearlings (6-61-05 vs 6-61-09), a 3.8 cm non-significant increase for age 4 yearlings (6-61-01 vs 6-61-14), and a non-significant 1.4 cm decrease for age 3 yearlings-plus (6-61-07 vs 6-61-20). Comparisons were prepared for lower river fisheries only, since 1980 CWT recoveries did not include upper river sample areas.

Spring Chinook Salmon

Of 286 CWT's obtained from spring chinook salmon in the 1982 net fishery, 229 were acquired through our mark-sampling program (Table 30) and 57 through volunteer returns by Indian fishers (Table 31). The mark-sampled CWT recoveries expand to an estimated harvest of 1,641 CWT spring chinook representing 8 release groups from Trinity River and 4 groups of Rogue River origin. An additional 5 Rogue River groups that were present in the volunteer returns were not observed in the mark-sampled recoveries.

Contribution rates of age 3 and 4 adults of TRH spring chinook CWT release groups harvested during the 1980-1982 Indian fisheries (Table 32) varied with the type and site of release. For groups released on-site, the highest contribution rates were for yearlings at 0.281%, followed closely by yearlings-plus at 0.278% with fingerling releases contributing at 0.031%. Generally, the availability to the size selective net fishery of age 3 yearlings-plus and yearlings is likely limited because of their small size. Yearlings-plus, usually released in March, have just over a year of ocean growth before returning to the river in May. Yearlings released in October, also have a limited ocean growth phase of about 18 months. Off-site fingerling releases contributed over 4 times that of on-site fingerling releases. As with fall chinook, a high rate of straying may occur with off-site releases. An off-site fingerling release (6-61-33) was the most abundant CWT group harvested in the 1982 Trinity River fishery (41%) but was relatively unimportant to Klamath River fisheries (4%). This suggests that the group may have quickly passed the lower Klamath River fisheries and then delayed when nearing the off-site release area at Trinity River km 40.0.

TABLE 30. Actual and expanded (underlined) CWT groups recovered during mark-sampling of spring chinook salmon in the 1982 gill net fishery on the Hoopa Valley Reservation.

Tag Code	Brood Year	Hatchery[1/] Of Origin	Release[2/] Type	RESERVATION MONITORING AREA Estuary		Resighinni		Upper Klamath		Trinity		All Areas	
6-61-30	1978	TRH	Y	8	112	19	221	34	337	12	40	73	710
6-61-31	1978	TRH	Y+	2	6	12	161	23	251	16	52	53	470
6-61-11	1978	TRH	F[3/]	1	3	1	11	4	41	4	12	10	67
7-18-54	1978	CRH	Y+	0	0	1	11	3	29	1	3	5	43
6-61-12	1978	TRH	F	0	0	0	0	1	13	0	0	1	13
7-19-32	1978	CRH	Y	0	0	1	11	0	0	0	0	1	11
7-19-35	1978	CRH	Y	1	3	0	0	1	6	0	0	2	9
6-61-33	1979	TRH	F[4/]	2	6	5	29	2	11	39	130	48	176
6-61-34	1979	TRH	Y	3	9	1	4	3	38	15	42	22	93
6-61-32	1979	TRH	F	0	0	0	0	0	0	10	30	10	30
7-22-36	1979	CRH	Y	0	0	1	11	0	0	0	0	1	11
6-61-36	1979	TRH	Y+	0	0	0	0	0	0	3	8	3	8
TOTALS				17	139	41	459	71	726	100	317	229	1641

1/ CRH - Cole Rivers Hatchery (Rogue River system)
TRH - Trinity River Hatchery

2/ F (Fingerling) - May or June release
Y (Yearling) - Late September to early December release
Y+ (Yearling-plus) - March release

3/ Offsite release at Trinity River Kilometer 20.0

4/ Offiste release at Trinity River Kilometer 40.0 (Willow Creek)

TABLE 31. Volunteer returns by Indian fishers of spring chinook salmon CWT groups during the 1982 gill net fishery on the Hoopa Valley Reservation.

Tag Code	Brood Year	Hatchery[1/] Of Origin	Release[2/] Type	RESERVATION MONITORINA AREA Estuary	Resighinni	Upper Klamath	Trinity	All Areas
9-16-19	1976	CRH	Y	1				1
6-61-30	1978	TRH	Y			20	1	21
6-61-31	1978	TRH	Y+	1		17	2	20
6-61-12	1978	TRH	F			3		3
7-18-54	1978	CRH	Y+			2		2
6-61-11	1978	TRH	F[3/]			1		1
7-19-31	1978	CRH	Y			1		1
7-19-32	1978	CRH	Y			1		1
7-19-34	1978	CRH	Y			1		1
7-19-36	1978	CRH	Y			1		1
7-19-38	1978	CRH	Y			1		1
6-61-33	1979	TRH	F[4/]			2	1	3
6-61-32	1979	TRH	F			1		1
TOTALS				2	0	51	4	57

1/ CRH - Cole Rivers Hatchery (Rogue River system)
TRH - Trinity River Hatchery

2/ F (Fingerling) - May or June release
Y (Yearling) - Late September to early December release
Y+ (Yearling-plus) - March release

3/ Offsite release at Trinity River Kilometer 20.0

4/ Offsite release at Trinity River Kilometer 40.0 (Willow Creek)

TABLE 32. Spring chinook contribution rates to the Indian net fishery of age 3 and 4 adults of the four types of Trinity River Hatchery releases.

		Age(s) at Harvest			
		3&4	3&4	3	
Release Type	Tag Code		6-61-12	6-61-32	Total
Fingerling on-site	Number Harvested 1/		87	30	117
	Number Released 2/		188,313	190,349	378,662
	Contribution Rate (%) 3/		.046	.016	.031
	Tag Code		6-61-11	6-61-33	Total
Fingerling off-site	Number Harvested		384	176	560
	Number Released		200,000	186,544	386,544
	Contribution Rate (%)		.192	.094	.145
	Tag Code	6-61-04	6-61-30	6-61-34	Total
Yearling	Number Harvested	101	902	93	1,096
	Number Released	99,301	204,166	86,594	390,061
	Contribution Rate (%)	.102	.442	.107	.281
	Tag Code		6-61-31	6-61-36	Total
Yearling plus	Number Harvested		495	8	503
	Number Released		144,206	36,845	181,051
	Contribution Rate (%)		.343	.022	.278

1/ Estimated CWT harvest (assumes 0% tag loss)
2/ Includes ad-clipped fish that shed tag before release. Data obtained from CDFG.
3/ Contribution rate (%) = number harvested / number released X 100

The age composition of mark-sampled CWT spring chinook salmon in the 1982 Indian net harvest was 81% 4-year-olds and 19% 3-year-olds. There were no recoveries of 2-year-old release groups.

Rogue River spring chinook contribution to the 1982 estimated CWT harvest appeared to decrease from 1980 and 1981 levels. The 1982 Rogue River CWT harvest in the Klamath was approximately 5% of the total CWT harvest, whereas in 1980 and 1981, a respective 48% and 11% incidence was noted. However, the number of groups recovered increased from 5 in 1980 and 1981 to 9 in 1982. Recoveries in 1982 of Rogue River fish tended to occur early in each monitoring area, but with only 10 mark-sample recoveries, more specific timing of entry trends could not be determined. The first documented straying of a Rogue River fish into the Trinity River occurred with a single recovery relatively early in the 1982 fishery. The occurrence of a 1976 brood year Rogue River spring chinook group (9-16-19) represented the first and only 6-year-old coded-wire tagged spring or fall chinook salmon ever recovered from the Hoopa Valley Reservation net fisheries.

As was the case for fall chinook, an inverse relationship for spring chinook generally existed between TRH release time and mean length in the net harvest (Table 33). Within the 2 age classes, mean length at harvest for the 3 release types showed some unusual trends. Four-year-old fingerlings (6-61-11/12) and yearlings (6-61-30) were about the same size at harvest and significantly larger than yearlings-plus (6-61-31). For 3-year-old groups, the fingerlings (6-61-32/33) and yearlings groups were again about the same size. Because of the protracted nature of the fishery (about 4½ months), these trends may indicate either a difference in timing of entry into the river of the CWT groups, or a biased sampling effort towards an area and/or time period. Between age class comparisons revealed that groups returning as 4-year-olds were significantly ($p < 0.05$) larger than 3-year-old groups for most cases. Comparison involving the 3-year-old yearlings-plus group (6-61-36) with other 4-year-old groups, were inconclusive due most likely to the small sample size of the yearlings-plus group. On-site and off-site fingerlings releases were combined, since no significant difference was found, and tested against other release types.

In-River Net versus Ocean Fisheries

Overall annual ratios of ocean (commercial and sport troll combined) to Indian gill net harvest of Klamath River CWT fall chinook for 1980-1982 were 7.8:1, 3.0:1 and 6.8:1 respectively (Table 34). In 1981 and 1982 the ratios were lower for TRH CWT groups than comparable IGH groups, possibly because of additional harvest pressure from the Trinity River fishery. Ratios for 3-year-olds returning in 1982 were highest (17.6:1 average) of any of the 3 years. This could be the result of a combination of increased ocean harvest and decreased net harvest in 1982. Grilse CWT groups contributed little to the ocean landings and net fisheries.

As in previous years, Klamath River CWT fall chinook groups contributed primarily to fisheries operating between Fort Bragg, California and Coos Bay,

TABLE 33. Mean fork length, standard deviation, and number of recoveries for 7 spring chinook CWT groups harvested at the 4 monitoring areas of the Hoopa Valley Reservation in 1982.

Tag Code	Brood Year	Hatchery[1/] Of Origin	Release[2/] Type	HARVEST MONITORING AREA Estuary	 Resighinni	 Upper Klamath	 Trinity	 All Areas
6-61-11	1978	TRH	F	74.0[4/] ---[5/] 1[6/]	74.0 ---- 1	77.3 2.63 4	75.3 5.56 4	75.8 3.79 10
6-61-30	1978	TRH	Y	77.0 3.59 8	73.3 5.80 19	76.2 6.38 34	76.3 4.86 12	75.5 5.81 73
6-61-31	1978	TRH	Y+	82.5 3.53 2	70.8 3.10 12	72.5 4.66 23	70.0 6.33 16	71.8 5.37 53
7-18-54	1978	CRH	Y+	---- ---- 0	72.5 ---- 1	69.3 2.52 3	74.0 ---- 1	70.8 2.77 5
6-61-33	1979	TRH	F[3/]	71.5 0.71 2	67.6 6.07 5	77.0 4.24 2	67.2 6.03 39	67.8 6.12 48
6-61-32	1979	TRH	F	---- ---- 0	---- ---- 0	---- ---- 0	64.6 4.55 10	64.6 4.55 10
6-61-34	1979	TRH	Y	71.3 8.50 3	71.0 0 1	66.7 2.08 3	66.8 5.14 15	67.6 5.30 22

1/ CRH - Cole Rivers Hatchery (Rogue River system)
TRH - Trinity River Hatchery

2/ F (Fingerling) - May or June release
Y (Yearling) - Late Sept. to Dec. release
Y+ (Yearling-plus) - March release

3/ Offsite release

4/ Mean fork length

5/ Standard deviation

6/ Number in sample

TABLE 34. Estimated contributions of Klamath River fall chinook CWT groups to the 1980-1982 ocean and Indian gill net fisheries.

Tag Code	Brood Year	Return Year	Ocean Harvest 1/	Gill Net Harvest	Harvest Ratio Ocean/Gill Net
6-61-01	1976	1980	2,547	329	7.7:1
		1981	84	67	1.3:1
		1982	0	0	-----
6-61-02	1977	1980	356	25	14.2:1
		1981	88	46	1.9:1
		1982	3	10	0.3:1
6-61-03	1977	1980	326	27	12.1:1
		1981	144	32	4.5:1
		1982	0	0	-----
6-61-05	1977	1980	811	109	7.4:1
		1981	828	363	2.3:1
		1982	2	0	-----
6-61-07	1977	1980	1,028	160	6.4:1
		1981	1,539	557	2.8:1
		1982	3	0	-----
6-59-01	1978	1981	2,405	302	8.0:1
		1982	1,802	517	3.5:1
6-61-08	1978	1981	144	81	1.8:1
		1982	15	12	1.3:1
6-61-10	1978	1981	498	164	3.0:1
		1982	35	28	1.3:1
6-61-14	1978	1981	530	220	2.4:1
		1982	176	106	1.7:1
6-61-15	1978	1981	532	335	1.6:1
		1982	679	215	3.2:1
6-59-03	1979	1981	5	9	0.6:1
		1982	1,759	98	17.9:1
6-59-02	1979	1981	0	0	-----
		1982	1,026	32	32.1:1
6-61-16	1979	1981	8	6	1.3:1
		1982	187	14	13.4:1
6-61-17	1979	1981	4	54	0.1:1
		1982	2,279	166	13.7:1
6-61-09	1979	1981	14	0	-----
		1982	1,234	58	21.3:1
6-61-20	1979	1981	0	14	0.0:1
		1982	607	129	4.8:1
Jacks 2/	1980	1982	75	78	1:1
TOTALS AND OVERALL RATIOS		1980	5,068	650	7.8:1
		1981	6,823	2,250	3.0:1
		1982	9,882	1,461	6.8:1

1/ Combined troll and sport returns in Oregon and California compiled from preliminary data provided by the CDFG and ODFW.
2/ Includes tag codes 6-59-5,6 & 16 and 6-61-18 & 21.

Oregon. Relative contribution indices[4/] of tagged Klamath River fall chinook at each port in 1982 (Figure 40) indicated that the 1982 harvest distribution was more concentrated towards the northern ports than in 1981.

The overall annual ratio of ocean to gill net harvest of CWT Klamath River spring chinook in 1982 of 1.8:1, decreased from 3.2:1 and 2.6:1 in 1981 and 1980 respectively (Table 35). However, the ratios for 3-year-olds were much higher in 1982 (7.9:1, 1979 brood year) than in 1981 (3.4:1, 1978 brood year) while 4-year-olds in 1982 (0.3:1, 1978 brood year) were much lower than in 1981 (1.5:1, 1977 brood year). This may reflect a lower ocean harvest of maturing 4-year-olds and higher harvest of immature 3-year-olds in 1982 relative to 1981. Commercial troll harvest at Crescent City and Eureka ports from May 1 to June 15, where the greatest impact on maturing spring chinook 4-year-olds would occur, was down 35% in 1982 from 1981 (PFMC, 1983). These reduced springtime catches contrast with an overall 30% increase in total 1982 chinook landings in southern Oregon and northern California ports, where the greatest impact on immature 3-year-olds would occur. As was the case with fall chinook, spring chinook grilse CWT groups contributed little to the ocean and net fisheries.

4/ Derived by dividing Klamath River CWT ocean harvest estimates by the total chinook harvest estimates at each port and multiplying the respective results by 1,000.

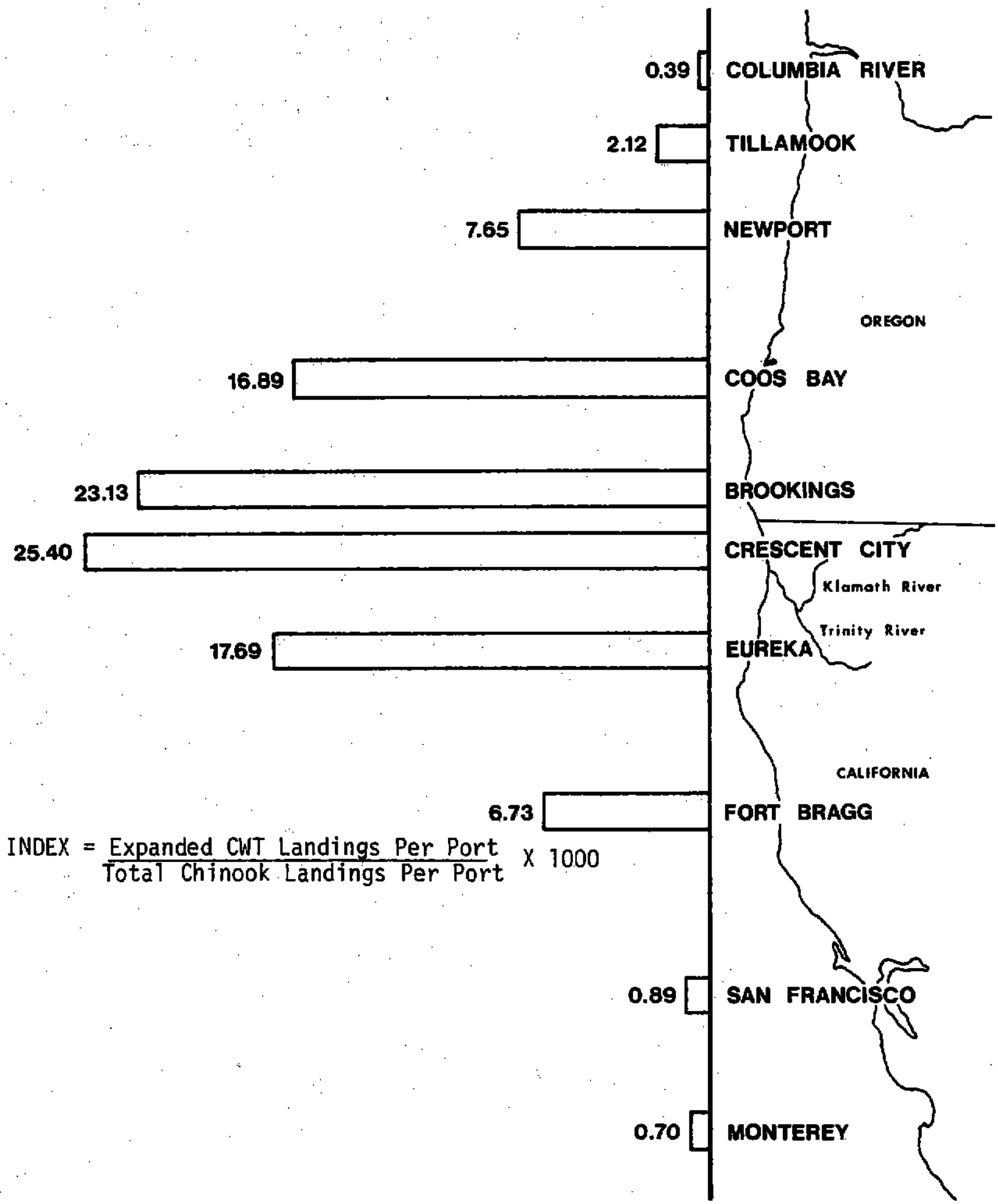


FIGURE 40. Relative contribution indices of CWT Klamath River fall chinook (Brood Years 1977-1979) to 1982 ocean landings at each California and Oregon port (calculated from preliminary data provided by CDFG, ODFW, and PFMC).

TABLE 35. Estimated contributions of Klamath River spring chinook CWT groups to the 1980-1982 ocean and Indian gill net fisheries.

Tag Code	Brood Year	Return Year	Ocean Harvest 1/	Gill Net Harvest	Harvest Ratio Ocean/Gill Net
6-61-06	1976	1980	469	206	2.3:1
		1981	70	12	5.8:1
		1982	0	0	-----
6-61-04	1977	1980	119	19	6.3:1
		1981	126	82	1.5:1
		1982	0	0	-----
6-61-11	1978	1981	626	317	2.0:1
		1982	13	67	0.2:1
6-61-12	1978	1981	275	74	3.7:1
		1982	11	13	0.8:1
6-61-30	1978	1981	993	192	5.1:1
		1982	178	710	0.3:1
6-61-31	1978	1981	178	25	7.1:1
		1982	143	470	0.3:1
6-61-32	1979	1981	13	0	-----
		1982	162	30	5.4:1
6-61-33	1979	1981	2	7	0.3:1
		1982	1,440	176	8.2:1
6-61-34	1979	1981	0	5	0.0:1
		1982	810	93	8.7:1
6-61-36	1979	1981	0	0	-----
		1982	26	8	3.3:1
6-61-39	1980	1982	10	0	-----
TOTALS AND OVERALL RATIOS		1980	588	255	2.6:1
		1981	2,273	714	3.2:1
		1982	2,793	1,567	1.8:1

1/ Combined troll and sport returns in Oregon and California compiled from preliminary data provided by CDFG and ODFW.

CHINOOK SALMON HARVEST OVERVIEW

The 1982 California ocean commercial troll fishery was regulated through in-season closures occurring June 16-30 below Pt. Arena and June 8-30 above Pt. Arena. The total of 764,000 chinook landed in 1982 represents an increase of 39% over 1981 and was the fifth largest since 1951. North coast landings (Fort Bragg, Eureka, Crescent City ports) of 344,200 chinook were 18% greater than 1981 landings and 15% over the 1971-1975 average. California 1982 ocean recreational landings of 139,400 chinook were up 67% over 1981 landings, including north coast landings of 20,900 up 85% over 1981.

The 1982 Oregon ocean commercial troll fishery was regulated through various in-season closures and gear restrictions. Landings for the year totaled 232,800 chinook, an increase of 45% above 1981 and 12% above the 1971-1975 average. Landings in 1982 south of Coos Bay totaled 178,900 chinook, an increase of 62% over 1981. Oregon 1982 ocean recreational landings totaled 38,700 chinook, 34% greater than 1981, but 22% below the 1971-1975 average. However, 1982 recreational landings south of Coos Bay totaled 25,600 chinook a 97% increase over 1981.

The Klamath River 1982 sport fishery harvest of 19,800 fall chinook was 50% above 1981 and the largest catch since 1978 (PFMC, 1983). The 1982 adult harvest of 7,686 was also the largest since 1978 and comprised 12% of the total in-river adult run. In-river fall chinook sport fishery harvest levels have risen every year since 1978 with yearly increases averaging 54%.

Klamath River Indian gill net harvest in 1982 has previously been discussed in this report.

Several estimates of the contribution rate of Klamath River chinook to the ocean fisheries operating between Fort Bragg, California and Coos Bay, Oregon have been used by the Pacific Fishery Management Council (PFMC) and California Department of Fish and Game (CDFG) to analyze the influence of offshore regulations on Klamath River stocks during recent years - 40% (CDFG, 1980), 30% (PFMC, 1982) and 21% (CDFG, 1983). Additionally, coded-wire tag return data suggest that about 90% of the total ocean harvest of Klamath River chinook occurs in this area. Noncatch mortality of chinook in the ocean fishery has been reported by Ricker, 1976 and others and appears to approximate 40 to 50% of the legal harvest. Using the various estimates and assumptions available, the 1979-1982 ocean fisheries appear to have accounted for approximately 246,500 Klamath River chinook annually (Table 36).

Annual Klamath River sport and Indian gill net harvests have averaged approximately 12,250 and 21,700 respectively since 1979 while chinook run size and spawner escapement in the basin have averaged a respective 91,400 and 55,350 annually. These data result in mean annual ratios of 2.7:1 ocean fishing losses to river returns, and 5.1:1 total fishing losses to spawner escapement (Table 37; Figure 41). This information is offered merely to provide a general overview of Klamath River chinook salmon harvest patterns.

TABLE 36. Estimated numbers of Klamath River chinook salmon lost through ocean fisheries in 1979-1982.

Year	Total Chinook Landings[1/] N.CA Troll	S.OR Troll	N.CA Sport	S.OR Sport	Sub Total	Number of[2/] Klamath R Chinook Landed in N.CA and S.OR	Total[3/] Ocean Landings of Klamath R Chinook	Noncatch[4/] Mortality	Total Number of Klamath R Chinook Lost Through the Ocean Fisheries
1979	438,200	192,500	14,000	10,900	655,600	196,680	218,530	87,410	305,940
1980	299,000	143,200	8,000	10,100	460,300	138,090	153,430	61,370	214,800
1981	292,600	110,400	11,300	13,000	427,300	128,190	142,430	56,970	199,400
1982	344,200	178,900	20,900	25,600	569,600	170,880	189,870	75,950	265,820
$\bar{X}$ 1979-82	343,500	156,250	13,550	14,900	528,200	158,460	176,070	70,420	246,490

1/ Landings in N.CA (Northern California) include Fort Bragg, Eureka and Crescent City ports and in S.OR (Southern Oregon) include Brookings and Coos Bay.
2/ Contribution of Klamath River chinook assumed to be 30 percent of landings between Fort Bragg, CA and Coos Bay, OR.
3/ Ninety percent of ocean landings of Klamath River chinook assumed to occur between Fort Bragg, CA and Coos Bay, OR.
4/ Shaker incidence = legal incidence
Shaker mortality rate = 0.40
Legal size non-catch mortality rate = Ø

TABLE 37. Contribution estimates of Klamath River chinook salmon (adults and grilse) to the ocean, inland sport and Indian gill net fisheries in 1979-1982.

Year	Losses to[1/] Ocean Fisheries	Run Size[2/] in Klamath R	Klamath R[2/3/] Sport Catch	Indian[3/] Gill Net Catch	Spawner[2/] Escapement	Ratio Between Ocean Fishing Losses and River Returns	Ratio Between Total Fishing Losses and Spawner Escapement
1979	305,940	68,730	5,620	15,000	42,620	4.5:1	8.8:1
1980	214,800	82,120	7,590	14,000	58,580	2.6:1	4.0:1
1981	199,400	110,570	15,380	38,360	56,080	1.8:1	4.5:1
1982	265,820	104,300	20,420	19,480	64,120	2.5:1	4.8:1
$\bar{X}$ 1979-82	246,490	91,430	12,250	21,710	55,350	2.7:1	5.1:1

1/ From Table
2/ Preliminary data from PFMC (1983) and CDFG (personal communication).
3/ Noncatch mortality rate assumed for inside fisheries = Ø.

NOTE: Contributions to ocean and Indian fisheries include spring and fall chinook. Run size, spawner escapement and sport catch values include basin-wide estimates for fall chinook, and spring chinook estimates for Trinity River above Junction City.

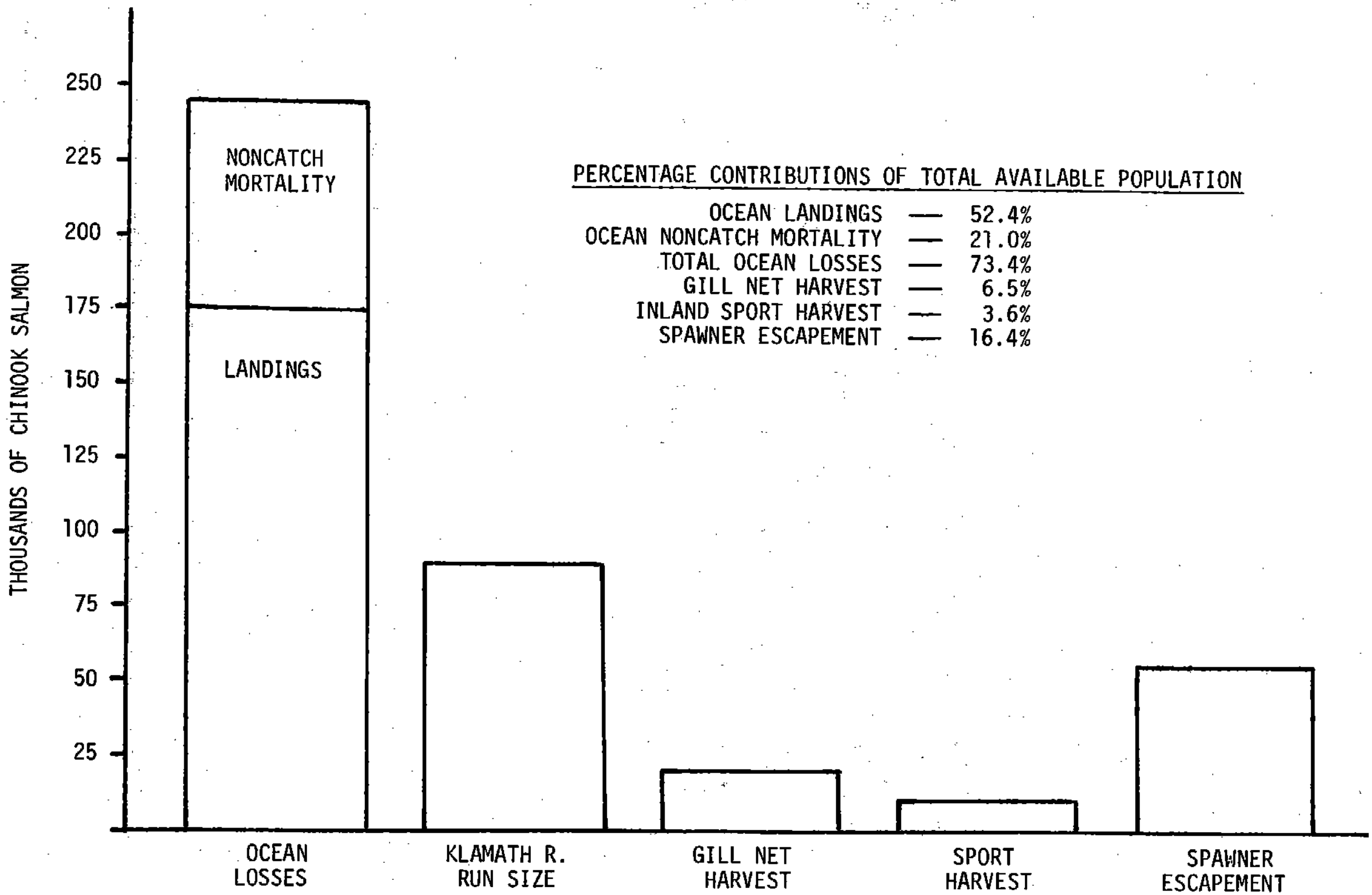


FIGURE 41. Estimated mean annual contributions of Klamath River chinook salmon (adult and grilse combined) to the ocean, inriver sport, and Indian gill net fisheries during 1979-1982.

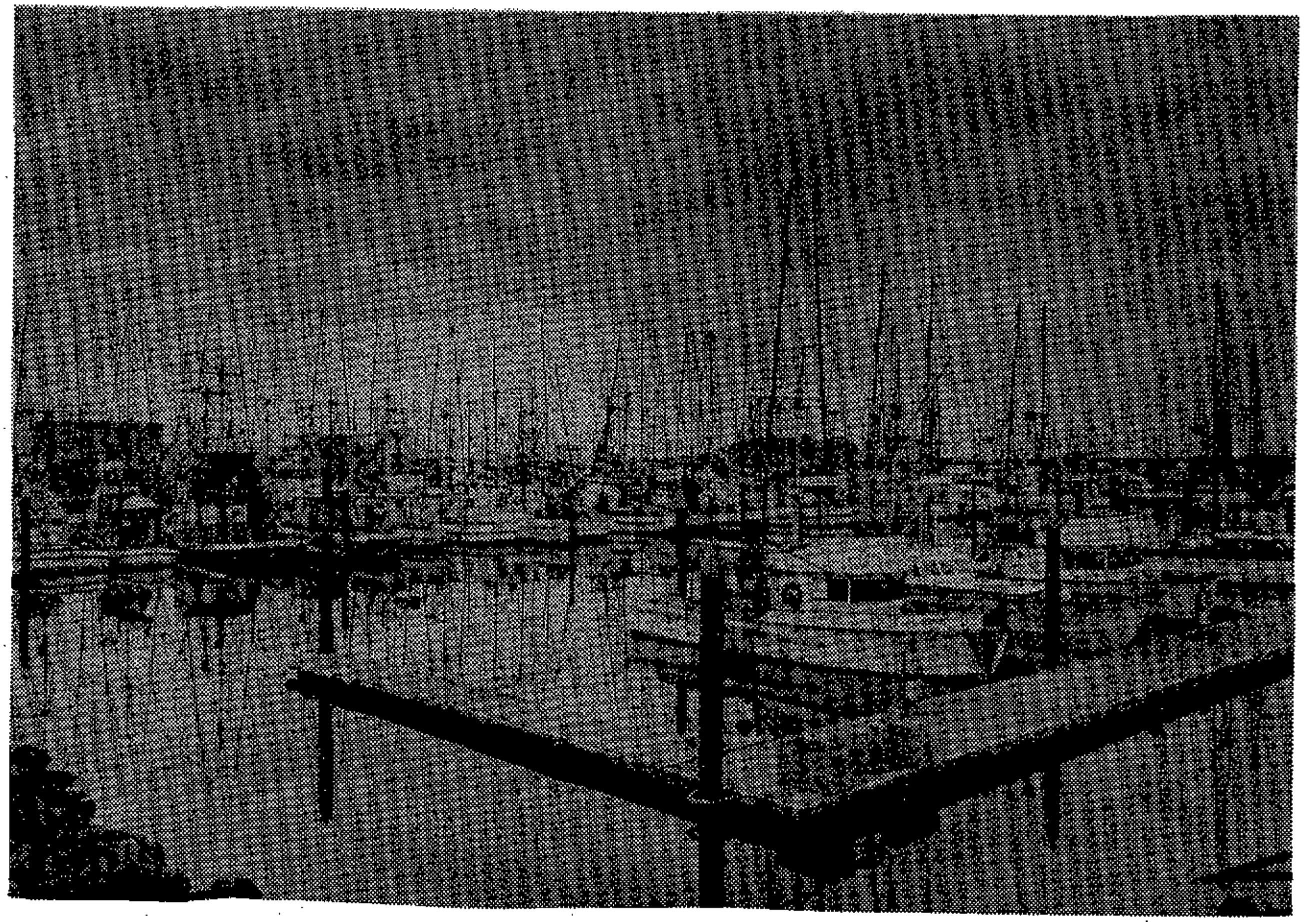


PLATE 11, Ocean commercial fishing vessels in harbor.

COHO SALMON INVESTIGATIONS

ABSTRACT

A total of 13 coho salmon, including 7 grilse, were captured during 1982 beach seining operations in the Klamath River estuary. An estimated 49 grilse and 951 adult coho salmon were harvested in the Indian gill net fishery on the Hoopa Valley Reservation in 1982. Adipose fin-clipped coho comprised 47% of the harvest sample, and 62 coded-wire tags representing 9 release groups were recovered. Coho salmon in their third year (1979 brood) represented 98.9% of the estimated harvest of tagged groups. The Klamath River coho salmon population appears primarily of hatchery origin, and remains of lesser importance to the net fishery than stocks of chinook and green sturgeon.

COHO SALMON

INTRODUCTION

The 1982 coho salmon run in the Klamath River was monitored through previously described net harvest monitoring and beach seining programs. Although a target species for some Indian fishers, coho salmon remain relatively unimportant to the net fishery as the bulk of the run enters the river when many fishers have curtailed fishing activity for the season. Because of relatively late timing of entry into the river, few coho were captured in the 1982 beach seining operation.

METHODS

Methods utilized in collecting and treating net harvest, coded-wire tag (CWT) return, and beach seining data involving coho salmon are the same as described for chinook salmon in previous sections of this report.

RESULTS AND DISCUSSION

Beach Seining

A total of 13 coho salmon were captured during 1982 beach seining operations in the Klamath River estuary, including 7 grilse (54 cm fork length). Coho captured in the seine ranged from 35 to 69 cm, and mean lengths of grilse and adults were 44.3 cm and 60.7 cm respectively. One of 13 bore an adipose clip (7.7%). Eleven of 13 bore hook scars (84.6%). Jaw tags were placed on 8 of 13, and one of these was recaptured at Trinity River Hatchery (TRH) on November 12, 64 days after tagging.

Net Harvest Monitoring

Coho salmon first entered the net fishery in August, and were observed in the harvest through October. Peak harvest occurred during the first half of October (Table 38). Based on over 2,000 contacts, reservation-wide net harvest was estimated at 1,000 coho salmon, with grilse (54 cm) comprising 4.9% of the catch.

TABLE 38. Semi-monthly harvest estimates of coho salmon captured in the 1982 Indian gill net fishery on the Hoopa Valley Reservation.

Time Period		Reservation Monitoring Area				Semi-Monthly Total	Cumulative Total
		Estuary	Resighinni	Upper Klamath	Trinity		
Aug	1-15	5	0	0	0	5	5
	16-31	0	0	0	0	0	5
Sep	1-15	10	5	5	0	20	25
	16-30	10	45	45	25	125	150
Oct	1-15	0	175	200 1/	250	625	775
	16-31	0	0	100 1/	125	225	1000
TOTAL		25	225	350	400	1000	
PERCENTAGE		2.5	22.5	35.0	40.0	100.0	

1/ Based on scattered reports.

In the lower Klamath fisheries (Estuary and Resighinni areas), 98% of the coho salmon harvest was taken from September through the first half of October with weekly catch per net-night values not exceeding 1.0 coho during any week. An estimated 250 coho salmon, including 14 grilse, were harvested in the Estuary and Resighinni areas, these fisheries accounting for 2.5 and 22.5% of the estimated reservation-wide harvest (Table 38).

An estimated 350 coho, including 18 grilse, were harvested in the Upper Klamath fishery during September and October, representing 35.0% of the reservation-wide harvest. However, little monitoring of the catch in the Upper Klamath Area occurred in October and semi-monthly harvest estimates during this month should be viewed as more speculative than other coho estimates.

Coho salmon harvest in the Trinity Area occurred primarily during a 5-week period extending from September 23 to October 27, with weekly catch per net-night values ranging from 0.1 to 1.7. An estimated 400 coho salmon were harvested in the Trinity fishery, representing 40.0% of the reservation-wide harvest. Grilse comprised 4.1% of the observed Trinity Area harvest.

A total of 184 coho salmon, including 9 grilse, were sampled during 1982 net harvest monitoring operations. Adult coho harvest in the 1982 net fishery were significantly smaller (t-test; $p < 0.05$) than fish taken in either 1981 or 1980 (Figure 42).

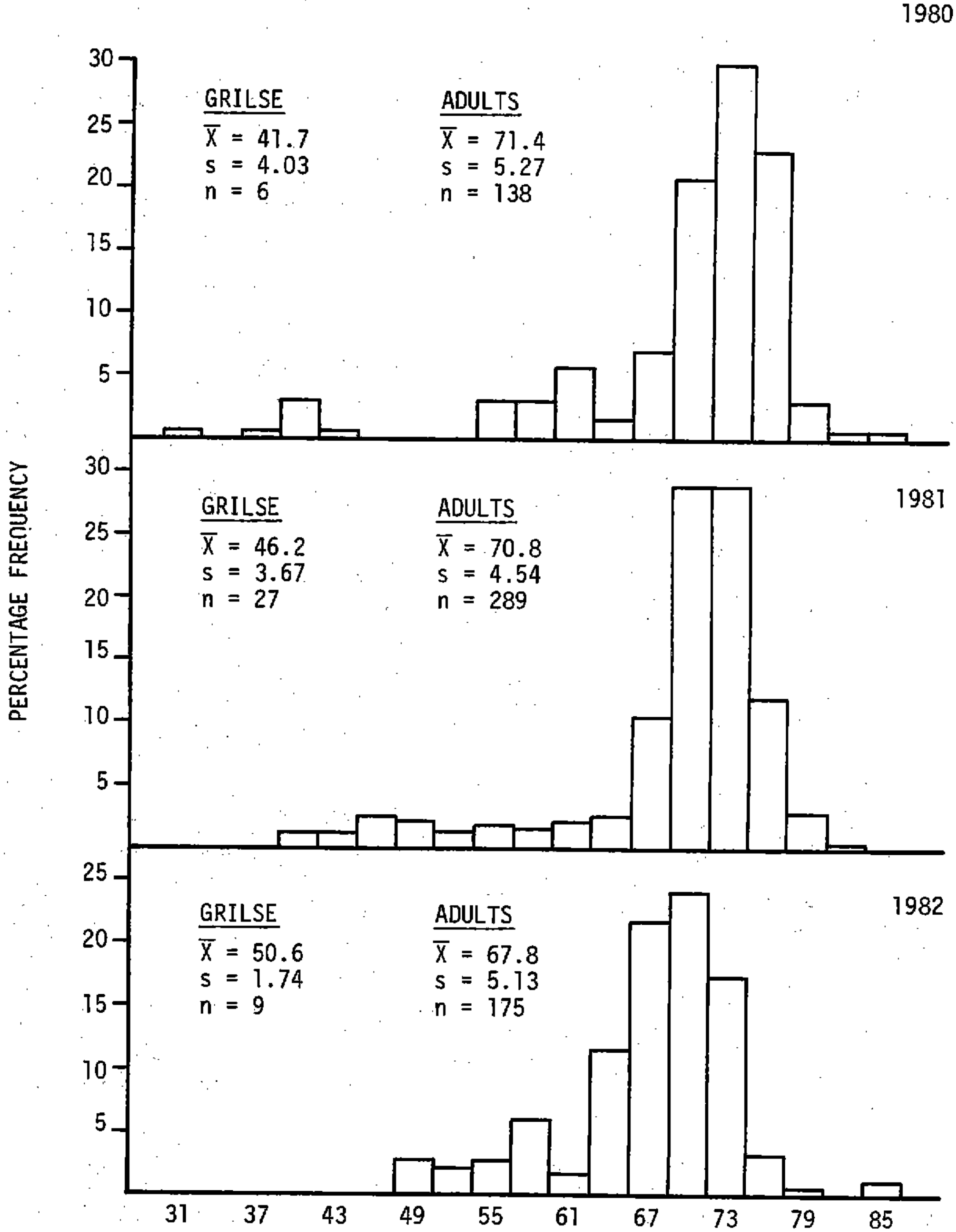
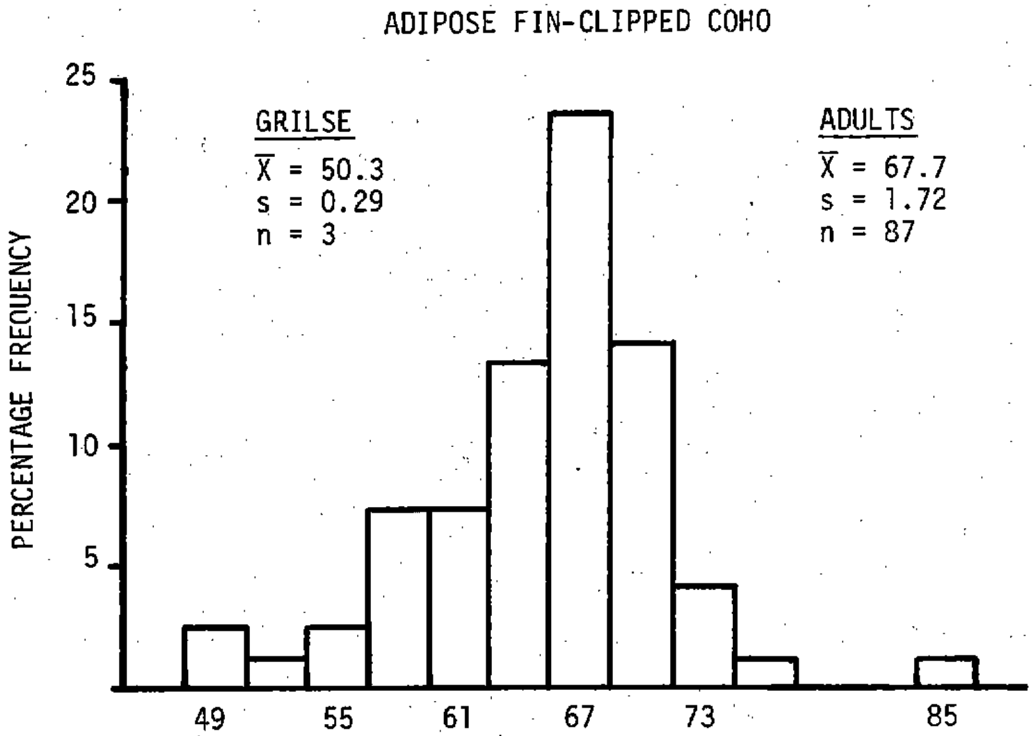


FIGURE 42. Length-frequency distributions of coho salmon harvested by Indian gill netters on the Hoopa Valley Reservation in 1980, 1981, and 1982. (NOTE: In 1980, only the Estuary and Resighinni Areas were sampled).

Adipose fin-clipped coho comprised 47% of the 1982 harvest sample, including 45 and 48% in the combined lower Klamath areas and the Trinity Area, respectively. As in 1981, fin-clipped adults and grilse in the 1982 sample did not differ significantly ($p > 0.05$) in mean length from non-clipped fish (Figure 43).

Of 63 CWT's recovered from coho salmon in the 1982 Indian net fishery, 62 were obtained through our mark-sample program and one through a voluntary return by an Indian fisher. The mark-sampled recoveries expand to an estimated harvest of 451 CWT coho representing 6 release groups from TRH and 3 from Iron Gate Hatchery (IGH) (Table 39). Coho returning in their third year (1979 brood) comprised 99% of the estimated harvest of CWT groups with the remaining 1% representing grilse (1980 brood). Contribution rates of various CWT release groups show that TRH contributed at over twice the rate of IGH (Table 40). This may be due, in part, to additional harvest pressure on TRH groups in the Trinity Area net fishery. Mean lengths of the CWT groups (Table 41) ranged from 49.0 (6-61-62) to 68.5 cm (6-61-55) with no significant difference ($p > 0.05$) occurring between groups.



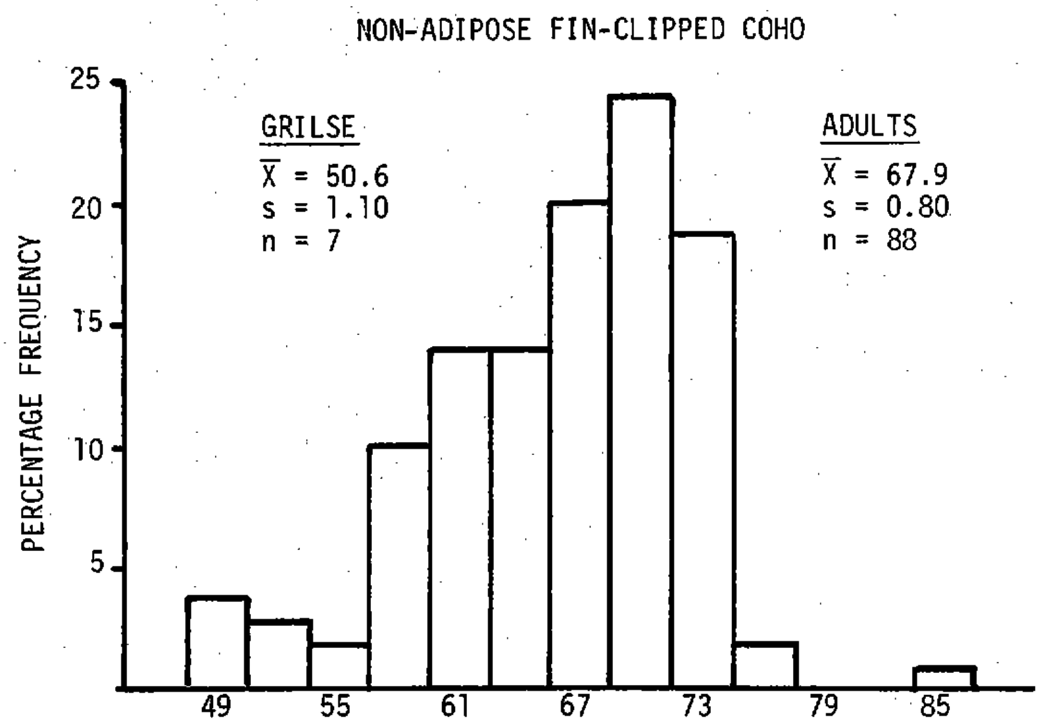


FIGURE 43. Length-frequency distributions of adipose fin-clipped and non-adipose fin-clipped coho salmon harvested by Indian gill netters on the Hoopa Valley Reservation in 1982.

TABLE 39. Actual and expanded (underlined) CWT groups recovered during mark-sampling of coho salmon in the 1982 gill net fishery on the Hoopa Valley Reservation.

Tag Code	Brood Year	Hatchery[1/] Of Origin	RESERVATION MONITORING AREA: Estuary		Resighinni		Upper Klamath		Trinity		All Areas	
6-61-59	1979	TRH	1	6	2	13	3	53	8	42	14	114
6-61-57	1979	TRH	1	6	3	20	1	18	9	48	14	92
6-61-56	1979	TRH	0	0	1	7	2	35	6	32	9	74
6-61-55	1979	TRH	0	0	4	27	0	0	7	37	11	64
6-61-58	1979	TRH	1	6	1	7	1	18	5	26	8	57
6-59-45	1979	IGH	0	0	1	7	1	18	0	0	2	25
6-59-47	1979	IGH	0	0	2	13	0	0	0	0	2	13
6-59-44	1979	IGH	0	0	1	7	0	0	0	0	1	7
6-61-62	1980	TRH	0	0	0	0	0	0	1	5	1	5
TOTALS			3	18	15	101	8	142	36	190	62	451

1/ All fish released as yearlings from February through May from:

TRH - Trinity River Hatchery
IGH - Iron Gate Hatchery

TABLE 40. Coho contribution rates to the 1982 Indian net fishery of 9 release groups from Trinity River and Iron Gate hatcheries.

Tag Code	Number[1/] Harvested	Number[2/] Released	Contribution[3/] Rate %
6-61-59	114	43,740	.261
6-61-57	92	53,824	.171
6-61-56	74	44,478	.166
6-61-55	64	49,910	.128
6-61-58	57	44,753	.127
6-59-45	25	24,795	.101
6-59-47	13	25,600	.051
6-59-44	7	25,100	.028
6-61-62	5	50,375	.010

1/ Estimated CWT harvest (assumes 0% tag loss)

2/ Includes ad-clipped fish that shed tag before release. Data obtained from CDFG

3/ Contribution rate (%) = number harvested / number released X 100

TABLE 41. Mean fork lengths of 9 coho CWT groups netted on the Hoopa Valley Reservation in 1982.

Tag Code	Brood Year	Hatchery[1/] Of Origin	Mean FL (SD)	Sample Size
6-59-44	1979	IGH	67.0 (-)	1
6-59-45	1979	IGH	68.5 (6.36)	2
6-59-47	1979	IGH	67.0 (1.41)	2
6-61-55	1979	TRH	68.5 (5.70)	11
6-61-56	1979	TRH	68.1 (4.01)	9
6-61-57	1979	TRH	67.1 (7.11)	14
6-61-58	1979	TRH	65.1 (4.45)	8
6-61-59	1979	TRH	66.2 (5.65)	14
6-61-62	1980	TRH	49.0 (-)	1

1/ IGH - Iron Gate Hatchery; TRH - Trinity River Hatchery

STEELHEAD TROUT INVESTIGATIONS

ABSTRACT

A total of 299 fall steelhead, including 240 adults and 59 half-pounders, were captured during 1982 beach seining operations in the Klamath River estuary. Adult fall steelhead averaged 48.0 cm fork length and half-pounders 35.8 cm in the beach seine sample. Peak capture in the beach seine occurred from mid August to mid September. An estimated 352 adult and 48 half-pounder fall steelhead were harvested in the Indian gill net fishery on the Hoopa Valley Reservation in 1982. Adult fall steelhead averaged 52.8 cm fork length and half-pounders 32.8 cm in the 1982 net harvest sample.

STEELHEAD TROUT

INTRODUCTION

The 1982 fall steelhead trout run in the Klamath River was monitored through the previously described net harvest monitoring and beach seining programs. Primarily because of the concurrent run of fall chinook, fall steelhead are seldom targeted by Indian netters, and what little net harvest occurs is generally considered incidental to the chinook salmon fishery. Similarly, fall steelhead have not been the target species of FAO-Arcata beach seine operations in the estuary.

METHODS

Methods utilized in collecting and treating net harvest nad beach seine data involving steelhead trout are the same as described for chinook salmon in previous sections of this report.

RESULTS AND DISCUSSION

Beach Seining

A total of 299 steelhead trout, including 240 adults and 59 half-pounders (40 cm), were captured during 1982 beach seining operations. This represents a mean catch of 1.15 steelhead per seine haul, similar to catch/effort values occurring in the beach seine during 1979, 1980 and 1981 (Table 42).

TABLE 42. Numbers of steelhead captured during beach seining operations from 1979 to 1982. Catch per seine haul in parenthesis.

Year	Half Pounders (40 cm)		Adults		Total	
1979[1/]	318	(.81)	345	(.88)	663	(1.69)
1980[2/]	87	(---)	547	(---)	758	(1.18)
1981	174	(.56)	238	(.77)	412	(1.34)
1982	59	(.22)	240	(.92)	299	(1.15)

1/ Includes data from 2 sites: south spit - 12 half-pounders 48 adults
north spit - 306 half-pounders 297 adults

2/ Total includes 124 fish released unmeasured or not identified as to size groups (i.e. half-pounder, adult).

Length-frequency distributions of fall steelhead taken in the 1980, 1981 and 1982 beach seining operations are presented in Figure 44. The mean length of adult steelhead captured in 1982 was significantly smaller (t-test; $p < 0.05$) than those captured in 1981 seining activities, but showed no significant length difference from those captured in 1980. Half-pounders captured in the 1982 seining activities showed no significant mean length difference ($p > 0.05$) from those taken in 1981, but were significantly smaller ($p < 0.05$) than those captured in 1980. As might be expected, mean lengths of adult steelhead captured in the net fishery were significantly greater ($p < 0.05$) than those taken in the beach seine during each of the 3 years presumably due to the size selectivity of the gill nets for larger steelhead. In contrast, mean length of half-pounders were significantly greater ($p < 0.05$) for fish caught in the beach seine than in the gill net fishery. This may be a result of the practice of releasing smaller half-pounders captured in the beach seine unsampled, in attempt to minimize stress, which would artificially inflate the mean length of the sample. This practice is necessitated by the occurrence of large numbers of fall chinook in the beach seine, which often physically damage the smaller steelhead due to sheer size. Length information on steelhead half-pounders occurring in the seine should therefore be viewed with caution.

Steelhead were captured throughout the seining operation (mid-July to late September) with sample occurrence characterized by pulses of fishing entering at varying intervals of time. A specific peak run period was difficult to identify (Figure 45).

While analyzing steelhead capture data from beach seining operations during 1979, several distinct patterns of behavior emerged. During 1979, seine effort had been applied at 2 estuarine sites - one on the north spit characterized by a broad shallow flat bottom of mud/sand and one on the south spit characterized by a deep channel with a sand bottom and strong current (see Figure 2, page 8). Catch per seine haul values during 1979 proved 17.1 and 70.4 times greater for adult and half-pound steelhead, respectively at the north spit than at the south. Upon entry into the river, then, both adult and half-pound steelhead appeared to turn immediately upstream and cross the shallow north spit area rather than following the deeper meandering channel which follows the south spit before turning upstream. This trend was considerably stronger for half-pound than adult steelhead, as evidenced by the catch per seine haul values. It is interesting to note that catch per seine haul values during 1979 proved 1.5 and 2.1 times greater for adult and grilse fall chinook salmon respectively at the south spit than at the north. Steelhead therefore appeared to follow a different migration pattern than fall chinook upon entering the Klamath River estuary. Since no beach seining was conducted on the north spit during 1980-1982, no such trends were documented in these years. This data may however be of interest to researchers wishing to target on steelhead and chinook salmon in the Klamath River estuary during future seasons.

Net Harvest Monitoring

Fall steelhead were observed in the net fishery from July to October,

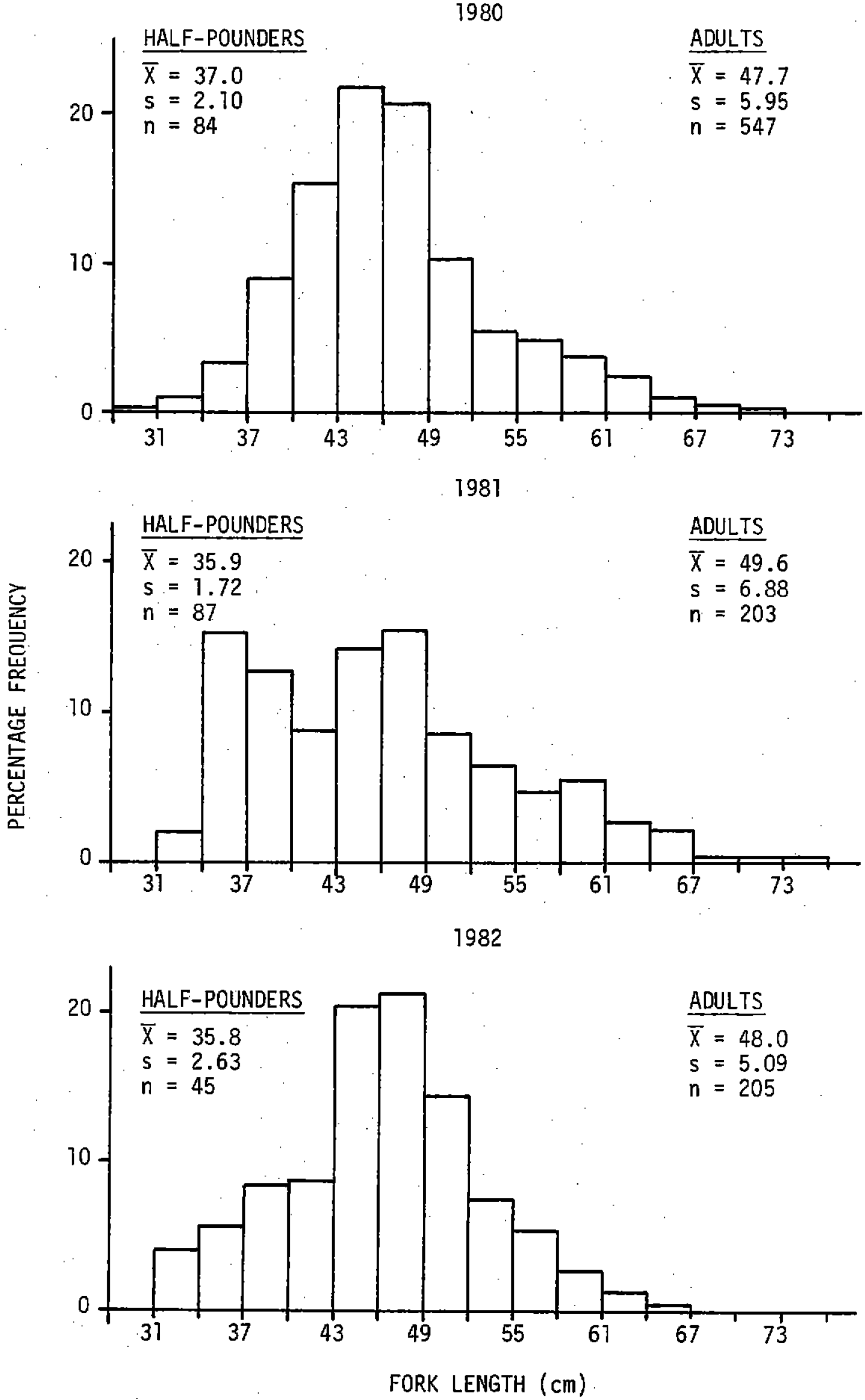


FIGURE 44. Length-frequency distributions of steelhead captured during beach seining operations in the Klamath River estuary in 1980, 1981 and 1982.

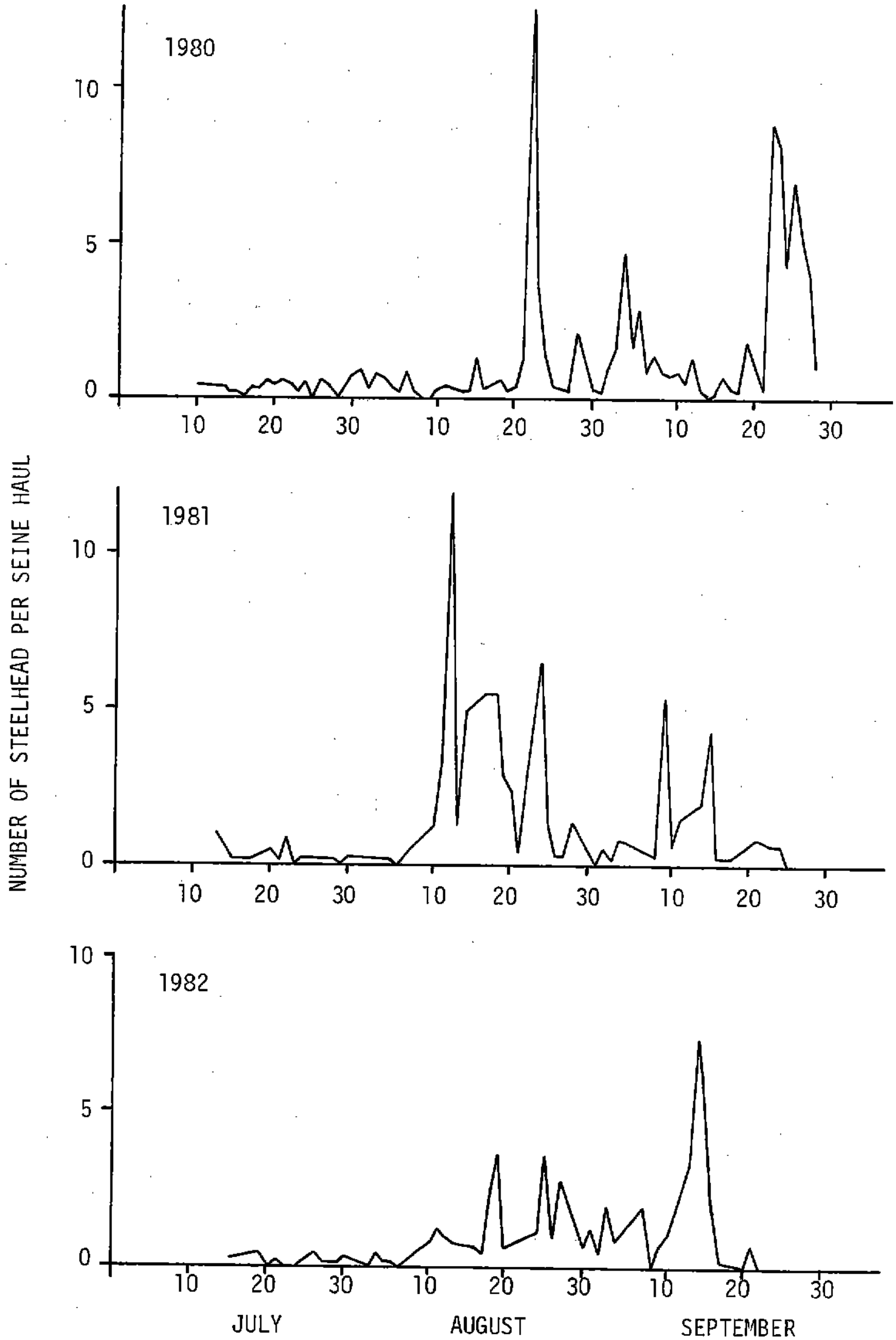


FIGURE 45. Daily numbers of steelhead captured per beach seine haul in the Klamath River estuary in 1980, 1981 and 1982.

with the highest catch occurring in September (Table 43). Reservation-wide harvest of fall steelhead in 1982 approximated 400 fish, with half-pounders (40 cm) comprising 12% of the catch. The proportion of half-pounders in the harvest was highest in the Upper Klamath Area, where 22% of the sampled harvest consisted of early-returning immature fish. Half-pounders represented 12, 6 and 0% of the respective steelhead harvest samples in the Estuary, Resighinni and Trinity areas.

Adult steelhead harvested in the 1982 net fishery were significantly smaller (t-test; $p < 0.05$) than fish taken in either 1981 or 1980 (Figure 46). Half-pounders sampled from the net fishery in 1982 did not differ significantly ($p > 0.05$) in mean length from half-pounders sampled in 1981 or 1980.

TABLE 43. Semi-monthly harvest estimates of fall steelhead captured in the 1982 Indian gill net fishery on the Hoopa Valley Reservation.

Time Period		Reservation Monitoring Area				Semi-Monthly Total	Cumulative Total
		Estuary	Resighinni	Upper Klamath	Trinity		
Jul	1-15	1	--	--	--	1	1
	16-31	3	--	--	--	3	4
Aug	1-15	5	6	10	--	21	25
	16-31	14	5	25	4	48	73
Sep	1-15	30	36	57	1	124	197
	16-30	4	47	54	9	114	311
Oct	1-15	--	8	40 1/	15	63	374
	16-31	--	--	10 1/	16	26	400
TOTAL		57	102	196	45	400	
PERCENTAGE		14.2	25.5	49.0	11.3	100.0	

1/ Based on scattered reports.

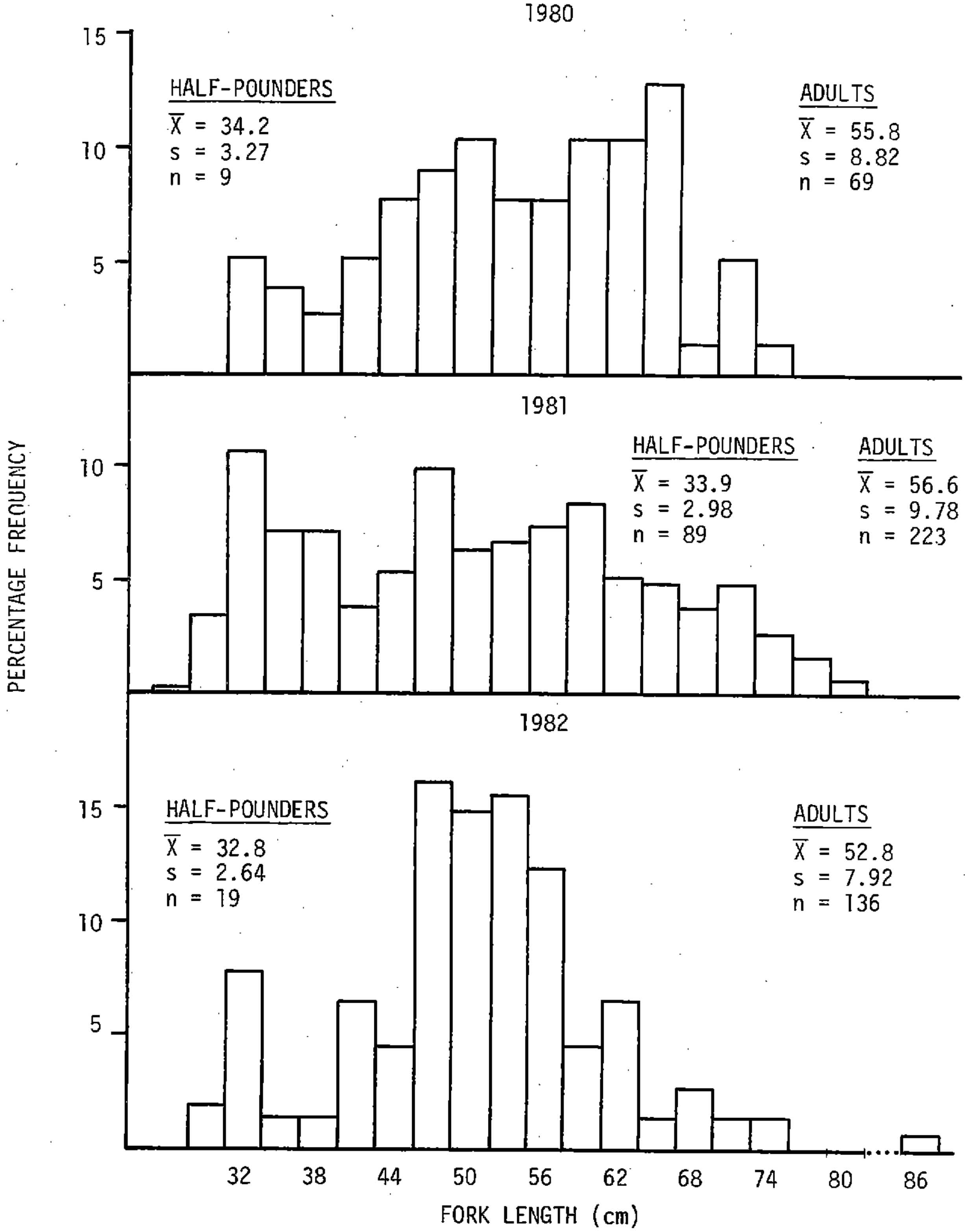


FIGURE 46. Length-frequency distributions of fall steelhead trout harvested by Indian gill netters on the Hoopa Valley Reservation in 1980, 1981 and 1982. (NOTE: During 1980, only the lower Klamath areas were sampled).

STURGEON INVESTIGATIONS

ABSTRACT

An estimated 15 white and 455 green sturgeon were harvested on the Hoopa Valley Reservation in 1982, the majority being taken in the Indian gill net fishery. Peak harvest occurred in the spring during the annual upstream spawning migration. As in previous years, females were less numerous and larger in size than males in the run. Mean round weight of green sturgeon in the net harvest was 29.8 kg, ranging from 10.9 to 47.6 kg. Analysis of 208 pectoral fin ray samples collected from green sturgeon during 1979-1982 indicates ages of spawning fish ranged from 15 to 40 years, averaging 27.7 for females, 21.0 for males and 24.1 overall. A von Bertalanffy growth equation for Klamath River green sturgeon between the ages of 1 and 30 years is presented. Age analysis of 7 pectoral ray samples collected from white sturgeon during 1980-1982 is also presented.

STURGEON INVESTIGATIONS

INTRODUCTION

A sturgeon investigation program initiated by FAO-Arcata in 1979 to gather baseline data on population characteristics and harvest within the Klamath basin continued during 1982. Results of investigations during the period 1979-1981 were included in previous Annual Reports (USFWS 1981a, USFWS 1982a). During 1982, as in previous years, green sturgeon *(Acipenser medirostris)* were far more numerous than white sturgeon *(A. transmontanus)* within the Klamath basin. Historical information indicates that green sturgeon have long outnumbered white sturgeon in the drainage.

METHODS

The majority of sturgeon sampling in 1982 occurred through net harvest monitoring program activities conducted from April through October. The net harvest monitoring program has previously been described (see pages 25-31) and methods of contacting fishermen for sturgeon data were essentially the same as those for the various salmonid species. Sturgeon were also sampled in 1982 through a beach seining program conducted near the mouth of the Klamath River (see pages 7-10).

Sturgeon net harvest estimates were derived in a similar fashion to those for fall chinook. Inverviews with fishers as well as net counts and actual observations of catches per net were placed under consideration.

Illegal harvest of sturgeon by snagging occurred on the Hoopa Valley Reservation (HVR)in 1982. Illegal activities appeared to be concentrated in a stretch of the river below the mouth of Coon Creek (river kilometer 58), although incidents were also observed at other locations on the reservation. Activity in the vicinity of Coon Creek was observed on numerous dates during May and June 1982. Estimates of illegal hook and line harvest of sturgeon on the Hoopa Valley Reservation in 1982 are approximations based on occasional observation only, and should be considered of a lesser accuracy than those for net harvest. Only one green sturgeon was actually sampled through observations of illegal snag harvest during 1982.

Sturgeon were identified to species by lateral scute count, measured, weighed and examined for any distinguishing marks or tags. When possible, sex and sexual maturity condition were noted, stomach contents were examined and gonadal weight was recorded. Egg subsamples were taken to provide fecundity information and a section from the proximal end of the lead ray of one pectoral fin of each sturgeon was excised for use in age analysis. Disc-dangler tags were applied immediately anterior to the dorsal fin of all sturgeon captured and released during beach seining activities.

RESULTS AND DISCUSSION

Harvest

An estimated 15 white and 455 green sturgeon were harvested on the Hoopa Valley Reservation in 1982, the majority being taken in the Indian gill net fishery (Table 44). All of the white and all of the immature green sturgeon (under 130 cm total length) were captured in the lower 6 km of the Klamath River, and were apparently coastal migrant rather than spawning migrant. Some of these may have been individuals originating from other river systems.

An estimated 347 adult green sturgeon were netted on the reservation in 1982 with the harvest of upstream migrants during the April-July period accounting for most of the harvest (Plate 12). Most of the adult green sturgeon netted in the lower 6 km of the river during the August-October period were apparently downstream migrant post-spawners. This figure is down 57.2% from the net harvest of 810 adults in 1981 and up 15.7% from the harvest of 300 adults in 1980 (Table 45). No harvest data is available for years prior to 1980.

The illegal snag fishery accounted for approximately 50 adult green sturgeon in 1982, down slightly from the estimate of 70 in 1981, and down considerably from the estimate of 400 in 1980. As in previous years, the majority of the harvest occurred below Coon Creek Falls although several other isolated pools along the Klamath and Trinity rivers within the HVR were also snag fished. Snag fishermen have become increasingly cautious since attention has been drawn to illegal activities and associated law enforcement efforts have intensified. As a result, illegal snagging activities are becoming more difficult to observe. It is hoped that this is an indication of less illegal activity occurring on the river rather than a situation where fishermen have merely become more adept at escaping attention. As a note of possible interest, sportsmen fishing treble-hook set-ups for fall chinook near the mouth of the Klamath occasionally contact sturgeon and may unintentionally enter the illegal fishery as well.

Illegal snag harvest of green sturgeon below Coon Creek Falls has been a recurring problem since a debris slide created the migration obstacle in 1977. When the magnitude of the problem became apparent from observations of illegal activities in the area during the spring of 1980, FAO-Arcata staff recommended that a study into the feasibility of removing the obstacle be undertaken. As reported in the FAO-Arcata 1981 Annual Report (USFWS 1982a), an on-site examination occurred on May 7, 1981. In August of 1981, the in-river obstacle was blasted in a cooperative effort between the California Department of Fish and Game (CDFG), Bureau of Indian Affairs (BIA) and U. S. Fish and Wildlife Service (USFWS). Examinations during 1982 indicated that these efforts were only partially successful in removing the debris. Moreover, high water conditions during the spring of 1982 made it difficult to assess exactly what the success of the blasting operation was. It is believed that the operations have facilitated sturgeon passage somewhat, but that further attention should be paid to this problem area.

TABLE 44. Harvest estimates for green and white sturgeon on the Hoopa Valley Reservation in 1982.

FISHERY AND MONITORING AREA		HARVEST PERIOD, SPECIES, AND RUN COMPONENT											
		April-July				August-October				Season			
		White		Green		White		Green		White		Green	
		Juv	Adult	Juv	Adult	Juv	Adult	Juv	Adult	Juv	Adult	Juv	Adult
Gill Net	Estuary	0	0	4	39	5	2	41	6	5	2	45	45
	Resighinni	0	0	0	65	5	3	8	42	5	3	8	107
	Upper Klamath	0	0	0	165	0	0	0	10	0	0	0	175
	Trinity	0	0	0	20	0	0	0	0	0	0	0	20
	All Areas	0	0	4	289	10	5	49	58	10	5	53	347
Snag	All Areas	0	0	0	30	0	0	5	20	0	0	5	50
	TOTAL	0	0	4	319	10	5	54	78	10	5	58	397

TABLE 45. Harvest estimates for green and white sturgeon on the Hoopa Valley Reservation, 1980-1982.

	White			Green		
	Juv	Adult	Total	Juv	Adult	Total
1980						
Gill Net	10	3	13	30	300	330
Snag	0	2	2	0	400	400
TOTAL	10	5	15	30	700	730
1981						
Gill Net	10	5	15	25	810	835
Snag	0	0	0	0	70	70
TOTAL	10	5	15	25	880	905
1982						
Gill Net	10	5	15	53	347	400
Snag	0	0	0	5	50	55
TOTAL	10	5	15	58	397	455

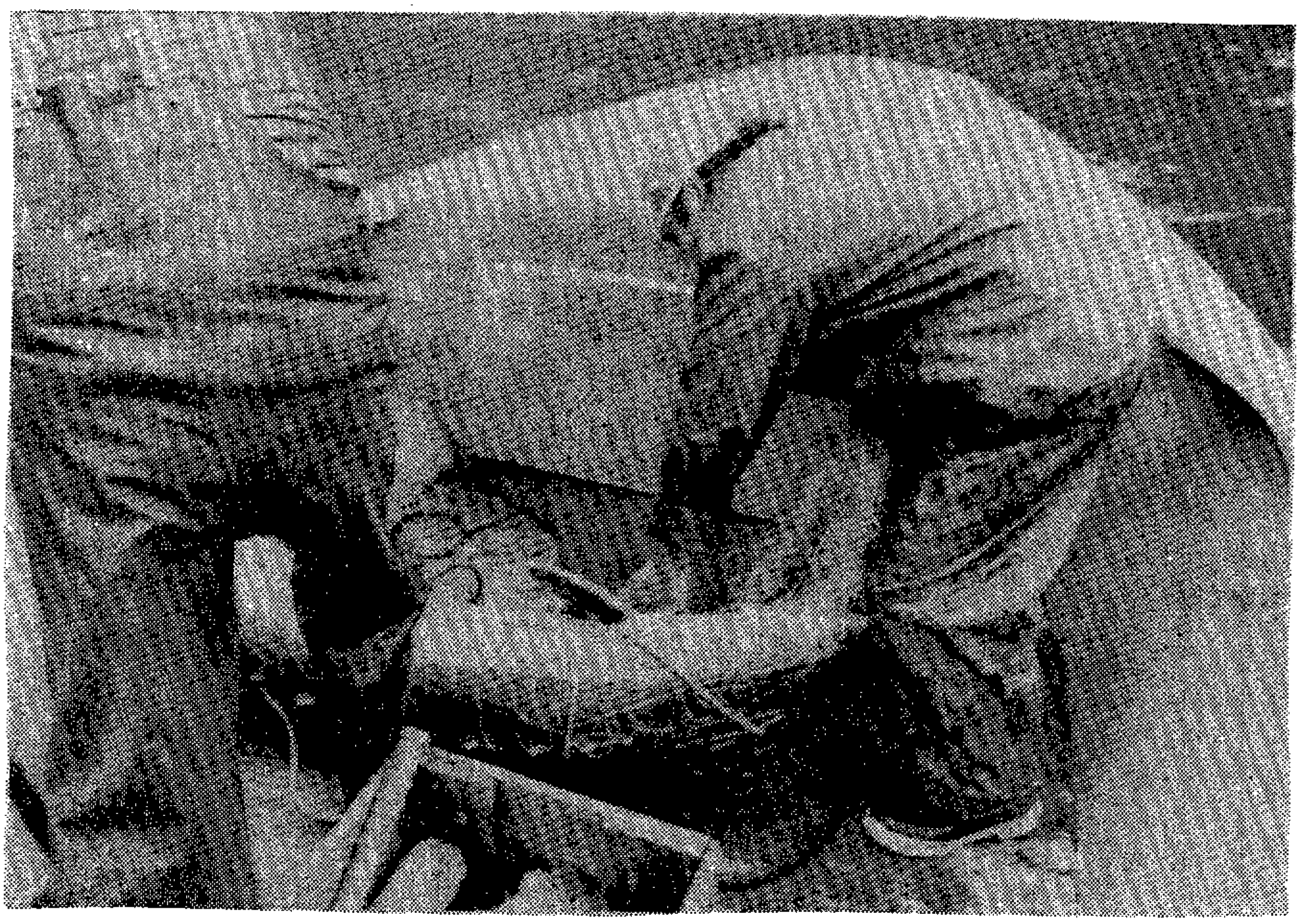


PLATE 12. Indian fishermen removing a green sturgeon from a gill net on the Klamath River during 1982.

FAO-Arcata biologists observed no legal hook and line harvest of sturgeon on the HVR during 1982. The extent of legal hook and line fisheries for sturgeon in the Klamath basin is unknown.

The total 1982 harvest of 455 green sturgeon on the HVR, including all legal and illegal methods, was down 49.7% from 1981 and 37.7% from 1980. It is believed that high flow conditions during the springtime spawning run period may have had a major impact on the success of these fisheries.

Population Characteristics

Green Sturgeon

With high springtime 1982 flows and associated lower harvest rates, data on the 1982 spawning run also proved more difficult to obtain. In previous annual reports, data were exhibited describing upstream spawning migrations of adult green sturgeon commencing in late March and peaking in late April during 1981, and commencing in mid April and peaking in mid May during 1980 (see USFWS 1982a). Downstream migration of post-spawners was also described during both seasons as occurring over a prolonged period of time extending well into the fall and early winter months. Data available indicate that the 1982 spawning migration fits the general descriptions for 1980 and 1981, with the timing of upstream migration being more similar to that of 1980. Scarcity of information on sexual maturity of green sturgeon sampled during 1982 precludes a more accurate delineation of run timing for this season.

For the third consecutive year, female green sturgeon were less numerous and larger than males in the known sex sample. For all 3 years, total length differences between sexes were significant ($p < 0.05$) by t-test for sample means and by chi-square analysis for frequency classes (Figure 47). Mean total length of all adults sampled in 1982, 170.7 cm proved significantly different ($p < 0.05$) by t-test than that in 1981, 176.3 cm, but not significantly different than that in 1980, 173.0 cm (Figure 48). It is believed that the differences in mean lengths between years reflect larger numbers of males in the 1980 and 1982 samples. Linear interpolation of mean length data from known sex and total adult samples (sex was not determined for all sturgeon examined) yield male : female ratio estimates of 2.0:1, 1.1:1 and 2.4:1 in 1980, 1981 and 1982 respectively. Adult green sturgeon sampled in 1982 ranged between 10.9 and 47.6 kg round weight, averaging 29.8 kg (n=27).

Fecundity estimates, results of stomach content analysis, total length-fork length relationship, and length-weight relationships for Klamath River green sturgeon were presented in the 1981 Annual Report (USFWS 1982a).

Little data was collected on outmigration of Klamath River green sturgeon yearlings and young-of-the-year during 1982. As discussed in previous reports, green sturgeon appear to migrate to sea by the end of their second summer. This migration appears to begin in upriver areas in June and peak in the lower river areas during September (Healy, 1970; USFWS 1981a; USFWS 1982a). Only one green sturgeon outmigrant was observed in the 1982 sample. This individual, of 21 cm total length, was captured by gill

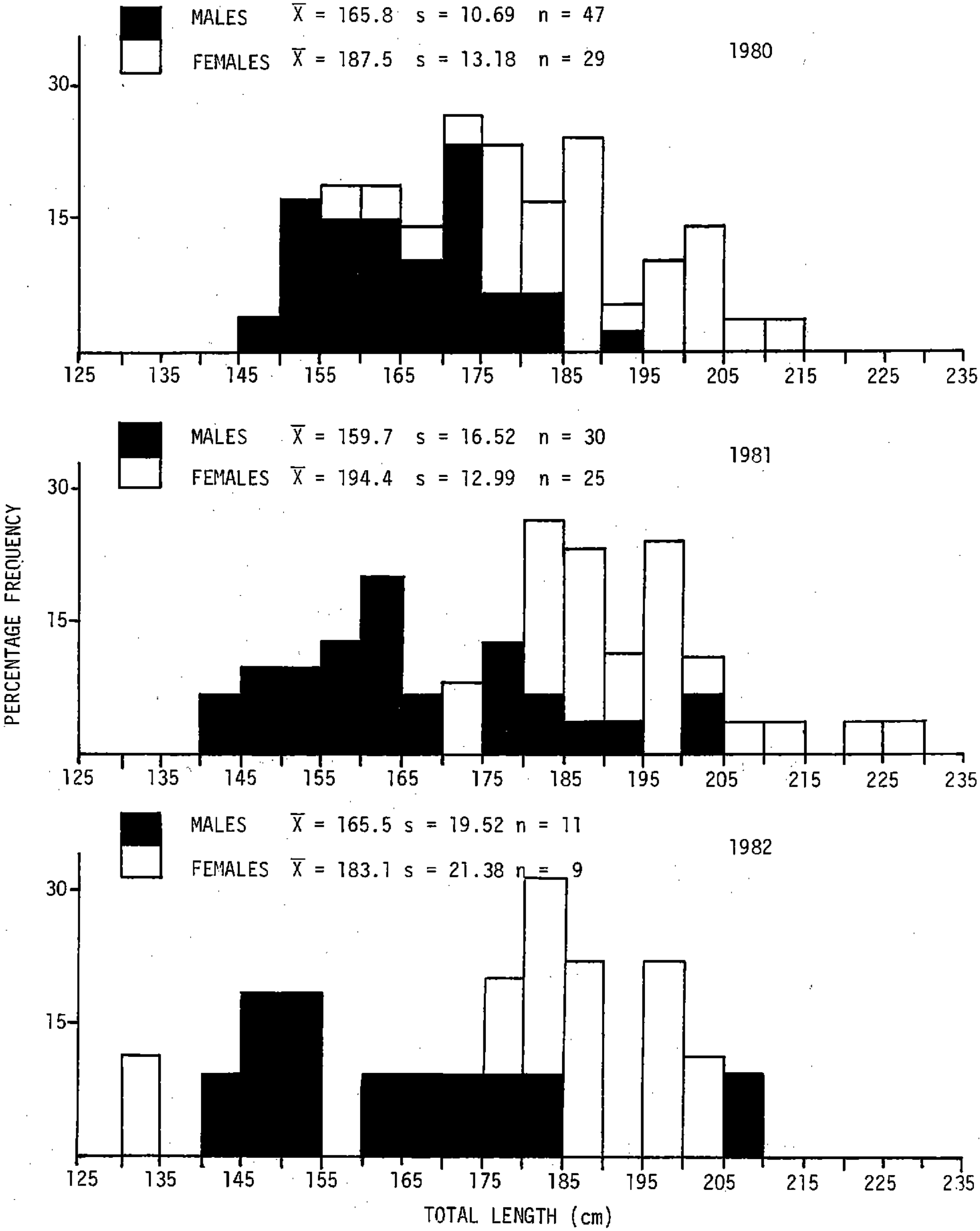


FIGURE 47. Length-frequency distributions of Klamath River adult male and female green sturgeon captured by beach seine, gill net and hook and line during 1980-1982.

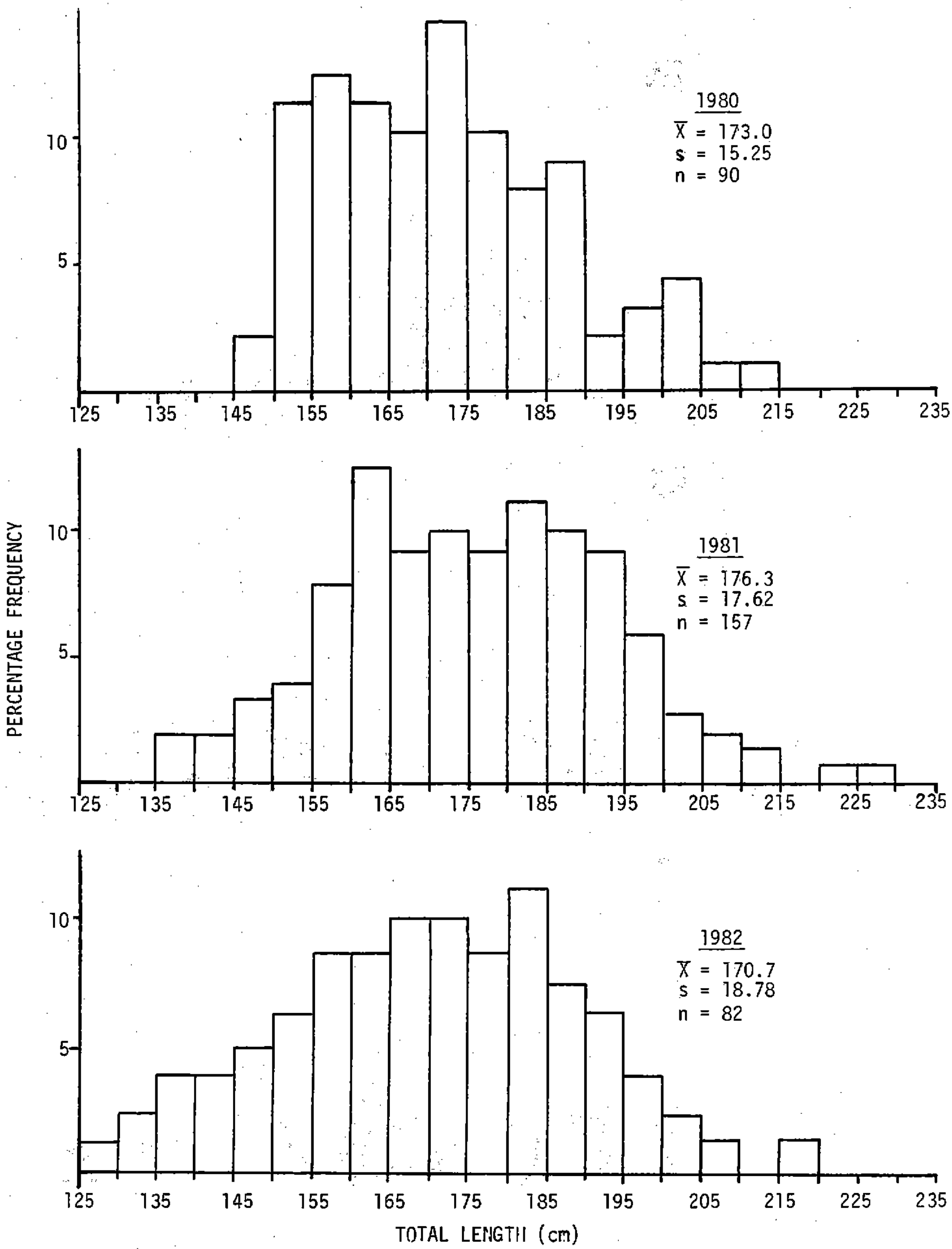


FIGURE 48. Length-frequency distributions of Klamath River adult green sturgeon captured by beach seine, gill net and hook and line during 1980-1982.

net in the lower 6 km of the Klamath River on September 20, 1982. The CDFG, which occasionally captured outmigrant green sturgeon during beach seining operations at Waukell Creek (river km 5.3), encountered none during 1982 (J. Hopelain, personal communication). Whether this is an indication of poor production from 1981 and 1982 spawning runs is difficult to assess. It was reported last year (USFWS 1982a) that large numbers of yearling outmigrants were encountered in the lower river during September 1981, possibly indicating strong production from the 1980 spawning run. Again during 1982, high water conditions may have made sampling of outmigrant green sturgeon more difficult.

In 1982, as in 1979-1981, numerous coastal migrant marine resident immature green sturgeon were encountered in the lower 6 km of the river. These ranged between 48 and 125 cm total length, averaging 90.0 cm (Figure 49). Mean length of immature green sturgeon captured in the lower river increased annually from 1979 to 1981, but remained static between 1981 and 1982. It appears that while this study has followed the growth of one or more strong year classes through this period, these groups may have approached the point at which green sturgeon begin to sexually mature and may increasingly avoid the riverine environment until ready to enter the spawning population. Very little recruitment of younger individuals was evident in 1980 and 1981. The 1982 data may be encouraging as it appears to document the existence of younger age groups in the population than were in evidence during 1981. What portion of these individuals is of Klamath origin is unknown, however, the obvious strength of the overall Klamath green sturgeon population would lead toward the conclusion that most were of Klamath origin. None of 50 spaghetti or disc-dangler tags placed on individuals since 1979 have been recovered more than 38 days after the date of tagging. None of 4 disc tags applied in 1982 were recovered. It has become clear during the course of this study, and from literature review, that coastal migratory behavior of this type is quite common for immature green sturgeon. The continental shelf as well as most coastal bays and estuaries throughout the Pacific Northwest appear to serve as habitat for individuals during this portion of their life history. Once sexual maturity is reached at a minimum of 130 to 140 cm in total length, green sturgeon may rarely occur in freshwater except to enter the spawning population. Whether adults not in spawning condition occasionally accompany sexually mature individuals into freshwater areas during the spawning migration is a matter for speculation. Length frequency information on a total of 568 green sturgeon captured within the Klamath River basin since 1979 reveal clearly the portions of life history during which individuals are most likely to be found in the freshwater-estuarine environments (Figure 50). For additional information on green sturgeon migration behavior, see Roedel 1941; Norris 1957; Miller 1972; USFWS 1981a and USFWS 1982a.

A total of 208 pectoral ray sections have been collected from green sturgeon since 1979 for age analysis. Transverse sections approximately 0.5 mm thick were cut from each sample using an electrically powered rotary saw blade lubricated with water. Sections were mounted on glass slides using clear nail polish and viewed under a 10X objective dissecting scope and a 17 mm objective microfiche jacket reader for age analysis. Two readers made 2 age readings each, one under dissecting scope and one on microfiche projector. On the basis of these blind readings and all associated data from the sample, ages were assigned where possible on a fish by fish basis during a final viewing.

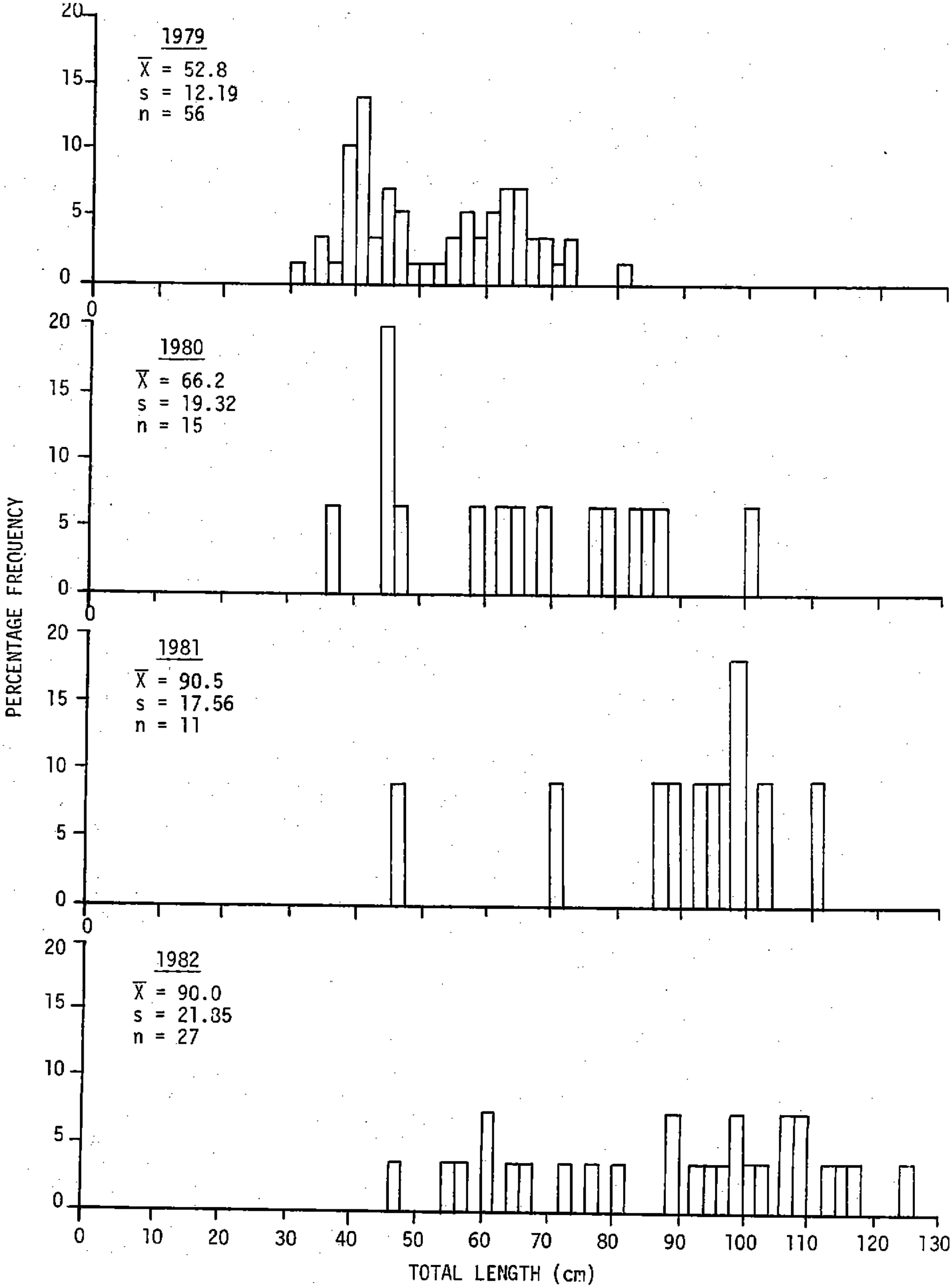


FIGURE 49. Length-frequency distributions of coastal migrant marine resident immature green sturgeon captured by beach seine and gill net in the Klamath River estuary during 1979-1982.

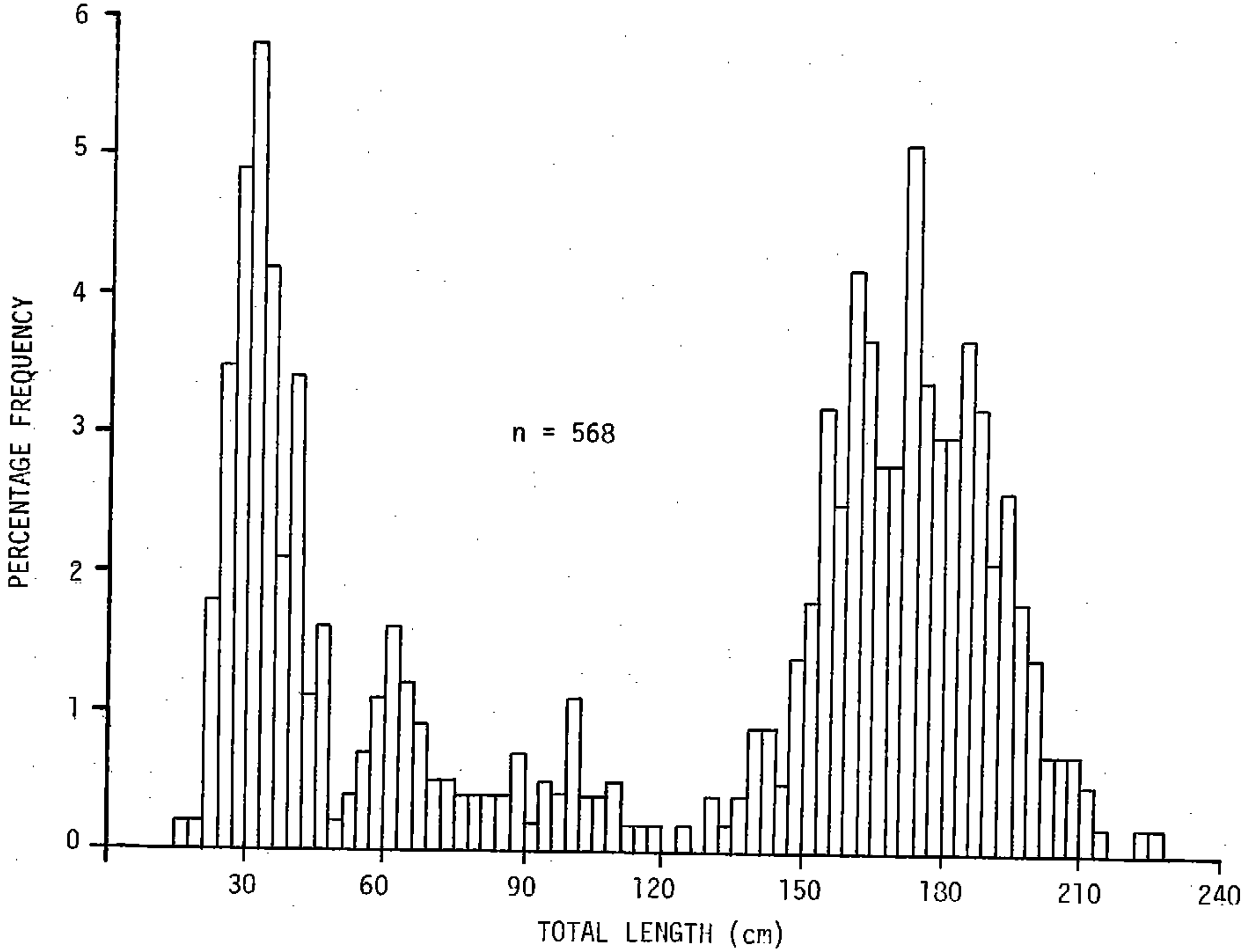


FIGURE 50. Combined length-frequency distribution of Klamath River green sturgeon captured during 1979-1982 by beach seine, gill net and hook and line.

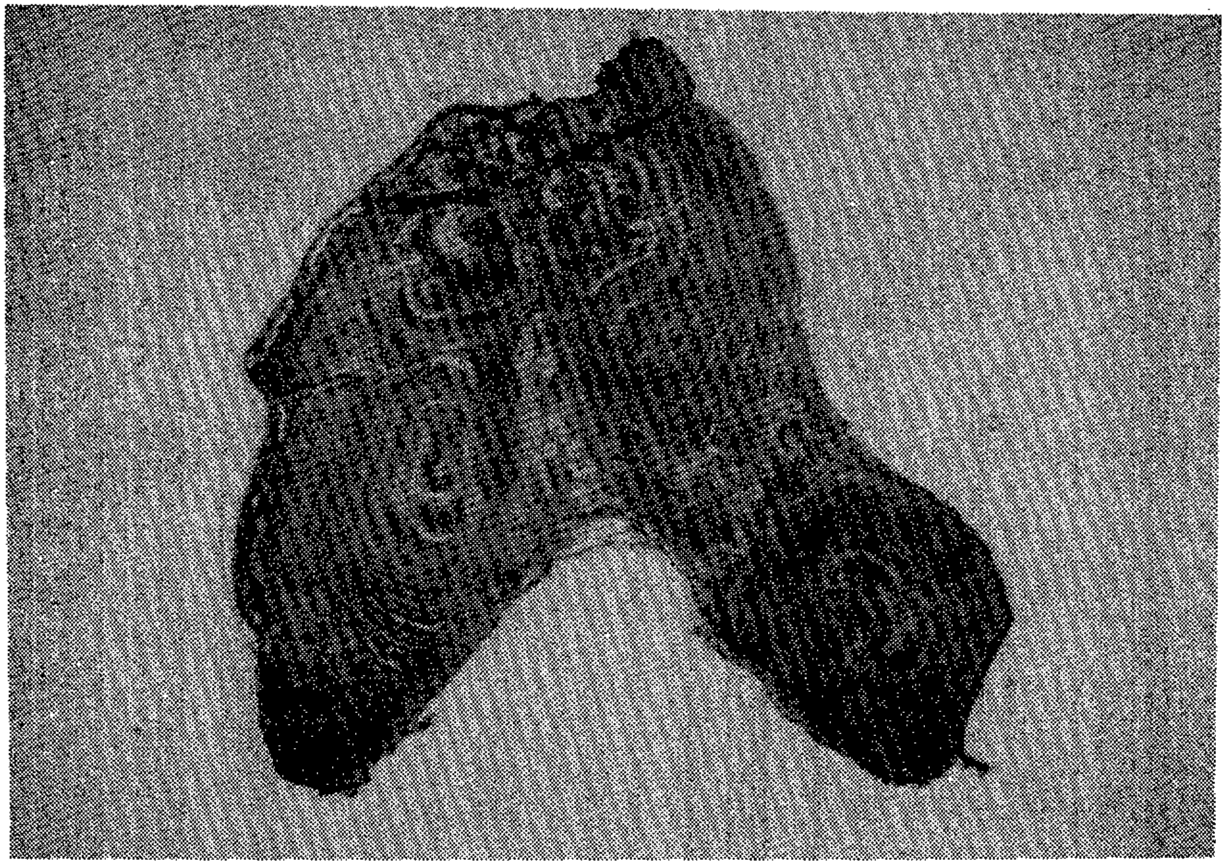
While processing the prepared samples, it became apparent that green sturgeon would be difficult to age with absolute accuracy as annuli are often quite irregularly shaped and even unrecognizable in some instances (Plate 13). However, considering that no age information is presently available on the species, it is believed that at this point age approximations would be of great value. To this end, samples for which the mean deviation of the 4 blind readings exceeded 10% of their mean value were generally eliminated from the set. It is believed that the age data presented are therfore of sufficient (i.e. $\geq$ 90%) accuracy in representing the population.

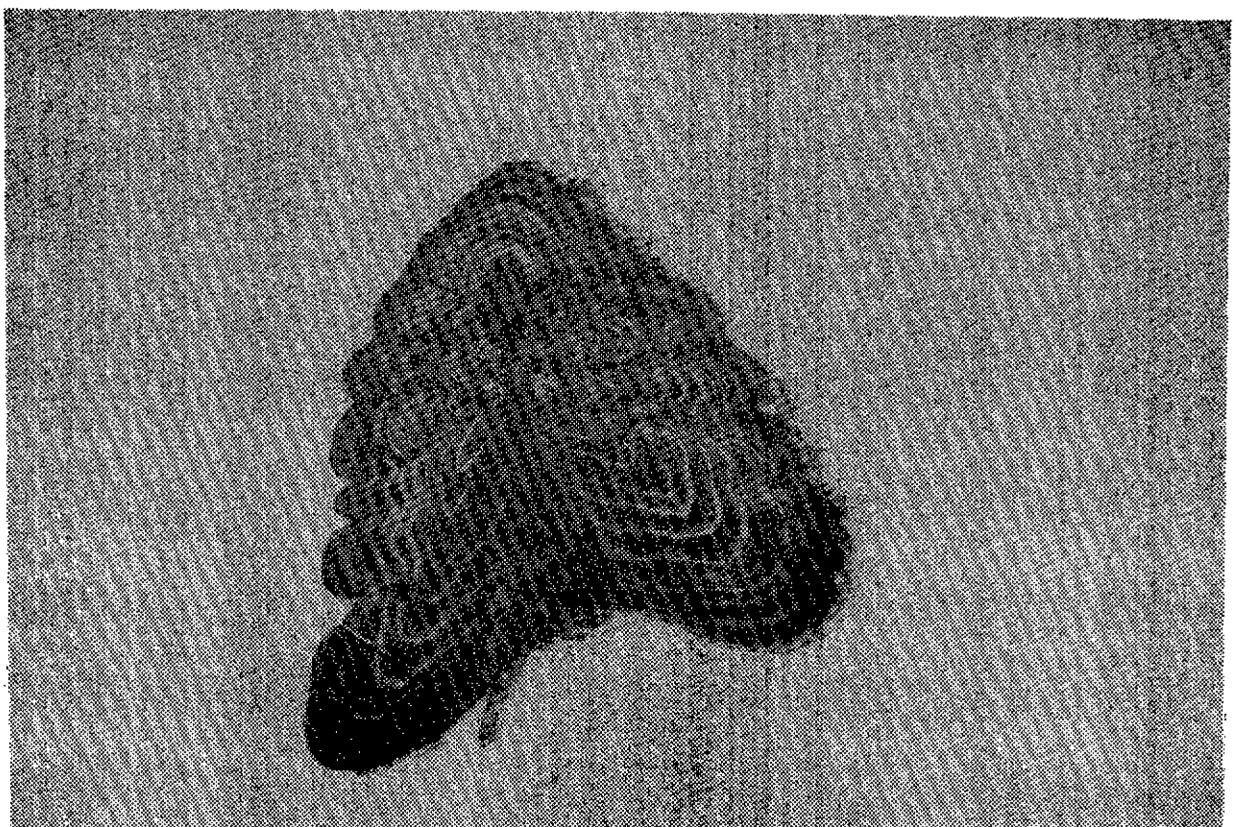
Under this general guideline, age assignments were made for 122 of 156 (78.2%) adult green sturgeon and 51 of 52 (98.1%) immature green sturgeon sampled during the study period (Plates 15 and 16). For the sample of 122 adult green sturgeon, mean deviations of the individual 4-reading-sets ranged from 0 to 3.5 years, averaging 1.92 years per set. Average variation of the 4-reading-set mean deviations from the final age assigned was 7.80% for the 122 adults. Ages of adults ranged from 15 to 40 years and of immature individuals from 0+ to 11 years (Figure 51). Females were generally older than males, as anticipated through length frequency information. Mean assigned age of 122 adults was 24.07 years, of 44 adult females 27.73 years and of 54 adult males 21.02 years. Sex was not determined for 24 adult green sturgeon for which age assignments were made. Linear regressions representing growth of adult male and female green sturgeon between age 15 and 38 show anticipated differences in slope reflecting differences in age observed in the sample (Figure 52). Linear regressions were also fitted for males and females between ages 20 and 30, where differences in age representation in the sample are minimal. No significant differences ($p < 0.05$) were apparent here, indicating that sexes could be combined during calculation of an overall population growth curve. Total length and age data were therefore utilized to generate the following von Bertalanffy growth equation for ages 1 to 30 in the 1979-1982 sample (see also Figure 51):

$$l_t = 238.35 \quad 1 - e^{-.05322\,(t + 1.9943)}$$

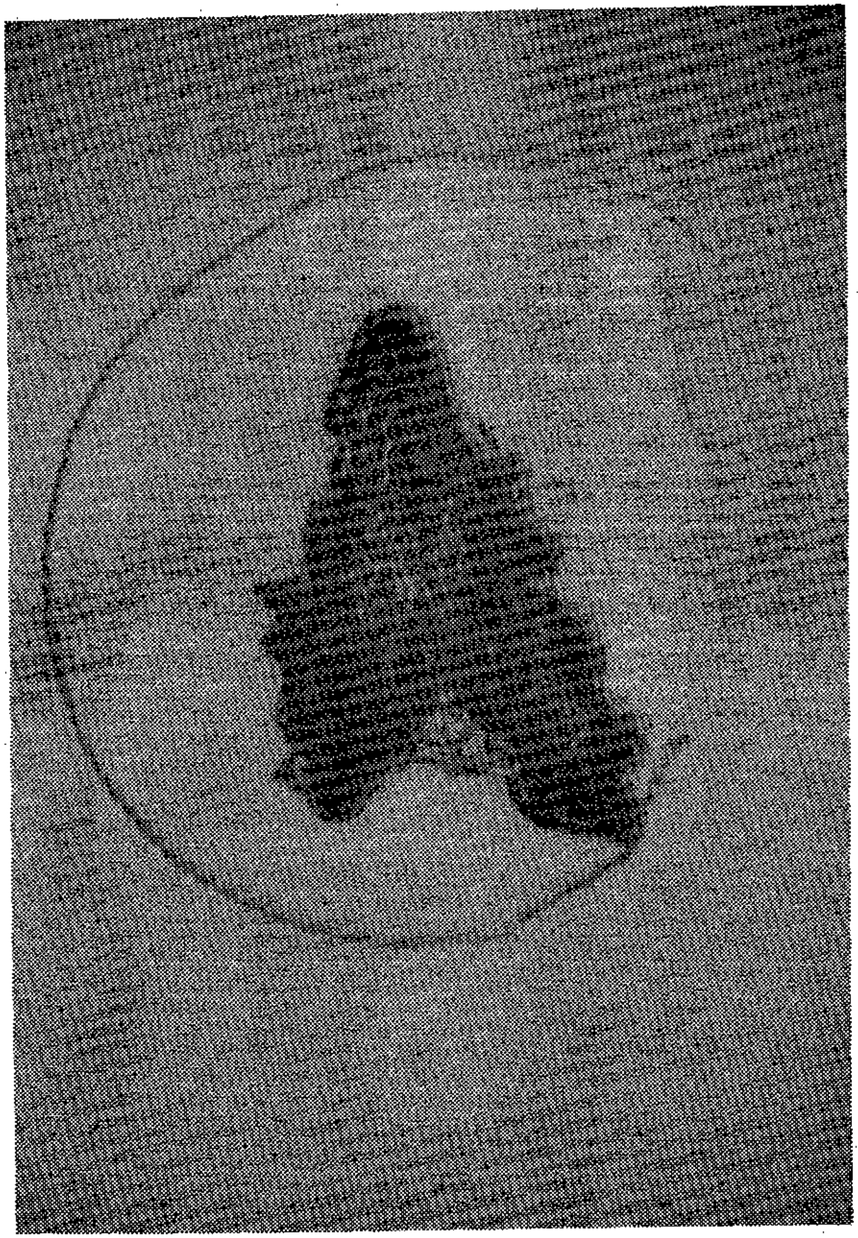
$$r = -.9941 .$$

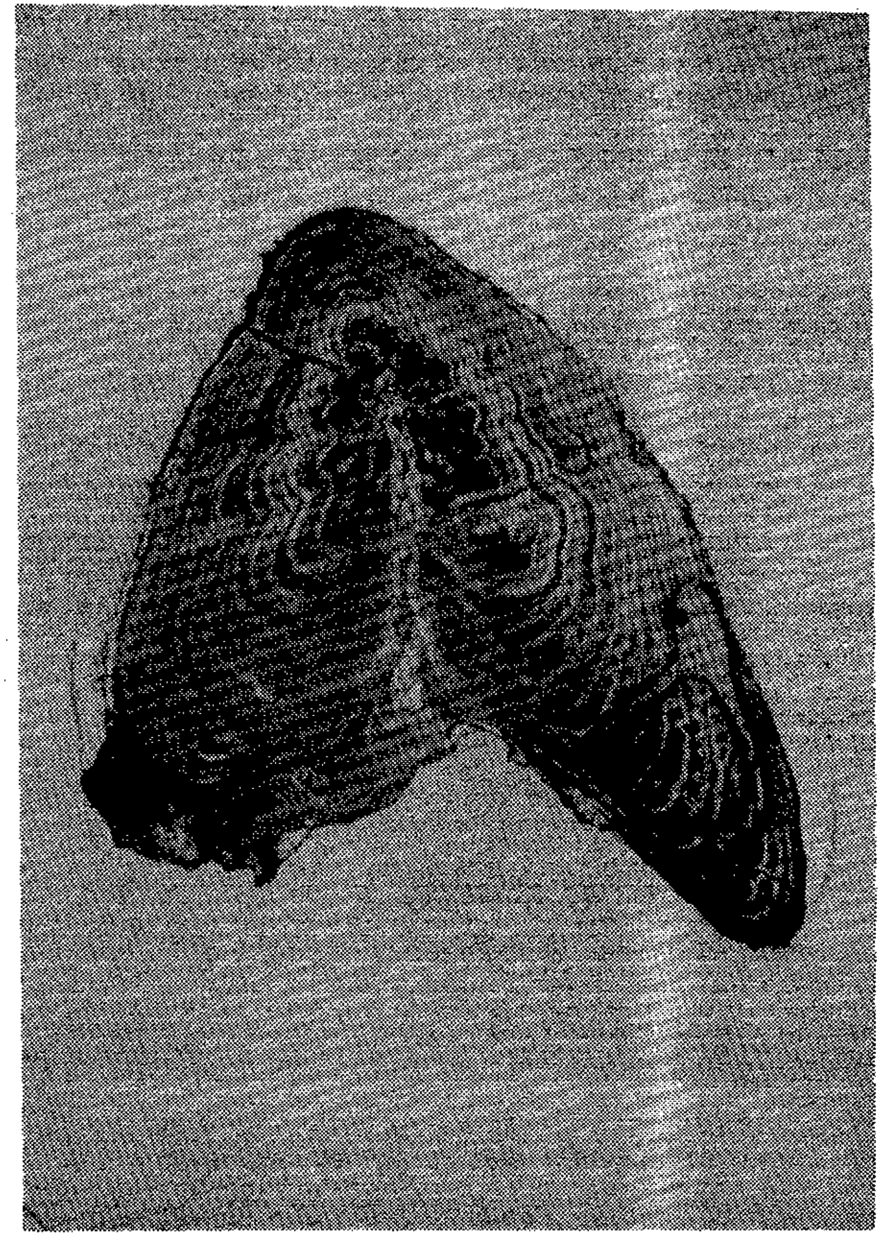
As an additional measure of variability in adult green sturgeon age readings and assignments, a record was kept on the performance of the 2 readers and their equipment during analysis of adult samples. The mean age of readings made by microfiche viewing averaged 2.55 years greater than that by dissecting scope for reader #1 and 2.39 years greater than that by dissecting scope for reader #2. This is believed due to the fact that greater magnification power available through the microfiche, combined with greater ease of viewing, made sub-annuli and/or incomplete annuli more easily observed and some of these may therfore have been incorrectly counted during aging. Both viewing methods were used during final assignment in attempt to minimize potential of either 'missing' or 'inventing' annuli. The mean of readings assigned by reader #2 was 3.07 years greater than that of reader #1 for microfiche viewing, and 2.25 years greater for dissecting scope viewing. This appears to reflect a greater tendency of one reader to count sub-or-incomplete-annuli during age readings. The larger difference recorded for microfiche readings again seems to reflect the greater visibility of detail in the pectoral ray sections which apparently has affected a greater variability in resultant readings. Final age assignments tended to be in between those of the 2 readers again in attempt to minimize





PLATES 13 & 14. Pectoral fin ray cross sections from green sturgeon (above) were generally more difficult to analyze than those collected from white sturgeon (below) in the 1979-1982 sample.





PLATES 15 & 16. Pectoral fin ray sections from Klamath River green sturgeon assigned ages 3 (left) and 20 (right) during the 1979-1982 sample.

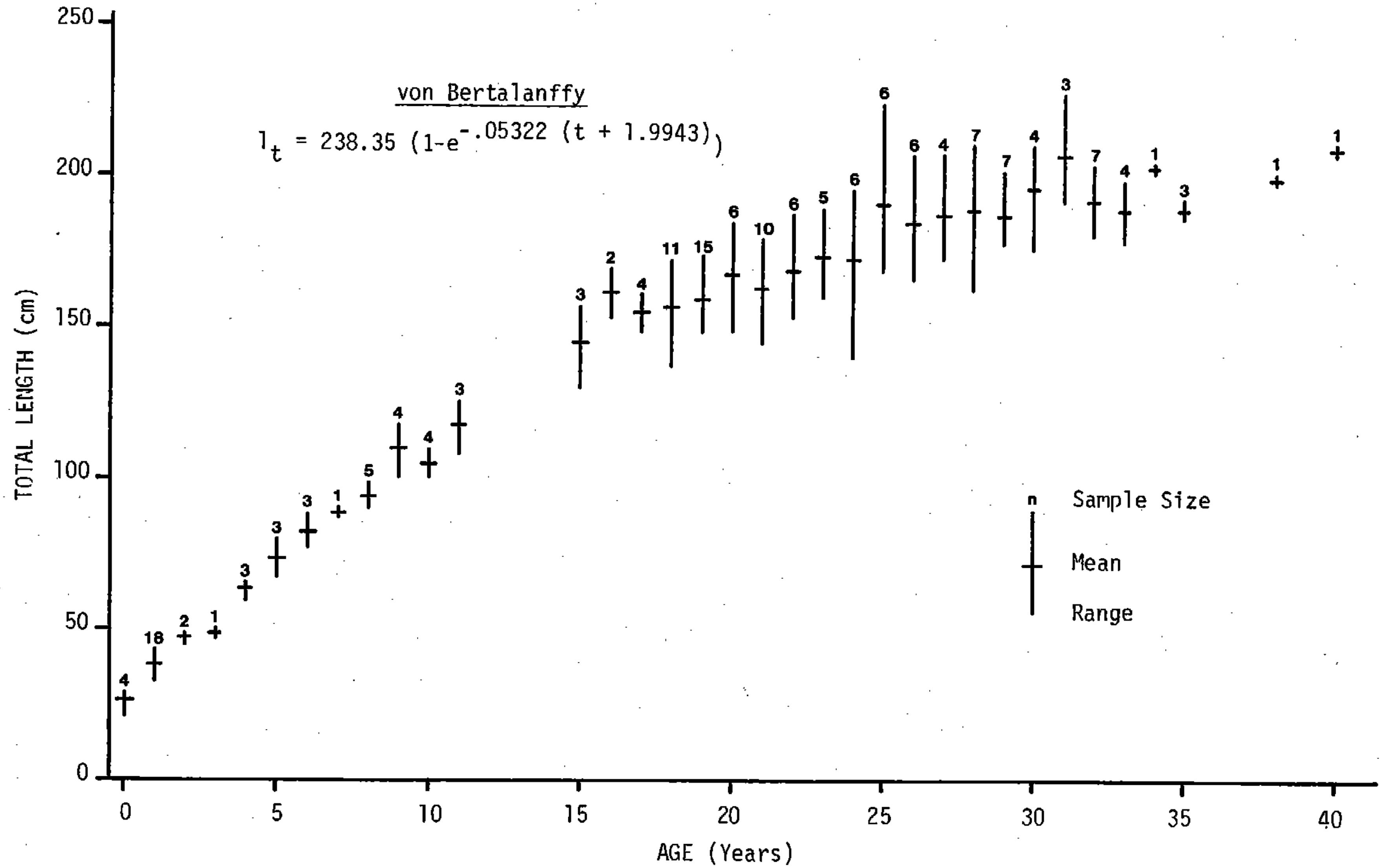


FIGURE 51. Length-age relationship of 173 Klamath River green sturgeon sampled during 1979-1982, including a von Bertalanffy growth equation for ages 1-30.

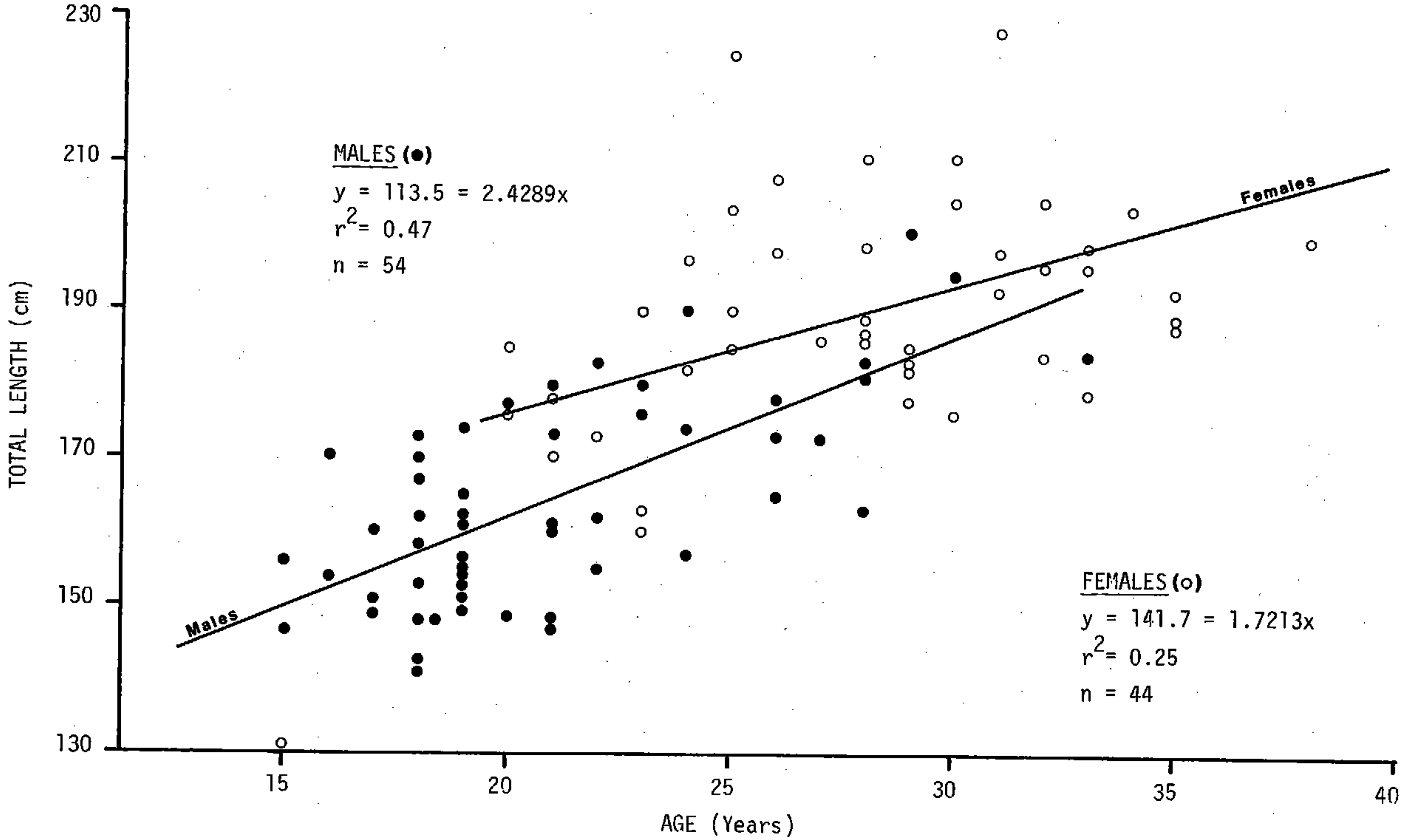


FIGURE 52. Length-age relationship depicting growth of adult male and female Klamath River green sturgeon sampled during 1980-1982, including linear regression equations for each sex.

error due to individual bias. The following is a summary of the variability in 156 adult multiple age readings:

(Microfiche vs Dissecting Scope)

	Reader #1	Reader #2
% of times readings matched	22.5	10.2
% of times readings were within 1 year	45.0	35.2
% of times readings were within 2 years	63.0	55.7
% of times readings were within 3 years	78.7	76.2
% of times readings differed by 4 or more years	21.3	23.8
Maximum difference between readings, years	14	6

Performance record of both readers improved markedly upon elimination of the 34 adult samples for which readings varied most. No correlation was apparent between age of fish and tendency to discard the sample.

White Sturgeon

A total of 11 white sturgeon have been encountered during sampling programs in the Klamath basin since 1979. These ranged between 81 and 156 cm total length, averaging 113.2 cm (Figure 53). Of these, 2 individuals appeared to be of a size at which they may be considered adults. The remainder were probably sexually immature. It is interesting that 9 of 11 whites observed appeared to be immature marine resident coastal migrants, for if white sturgeon behavior bears resemblance to that of green sturgeon, it would be during this phase of life history that individuals would be least likely to occur in their natal stream. It therefore seems likely that many of these may have been from other stocks. Whether the 2 adults observed were actually in spawning condition and therefore presumably of Klamath origin is unknown. There is evidence that limited white sturgeon spawning may occur in the Klamath, as is commonly believed. On 2 occasions since 1979, reliable sources have indicated the harvest of extremely large white sturgeon well above the area of tidal influence within the Klamath basin. One was purported to weigh 350 pounds and another, apparently caught about 55 kilometers above the ocean, was estimated at 500 pounds and 12 feet in length. Photographs of this latter individual have been examined by FAO-Arcata biologists and would appear to attest to the relative accuracy of this report. However, considering production in the basin, no white sturgeon outmigrants have yet been observed.

Pectoral fin ray sections were excised from 7 of 11 white sturgeon observed, and these were analyzed by the same methods as described for green sturgeon. Annuli on these sections appeared considerably more consise than those of green sturgeon, and positive age assignment appeared possible in each instance (Plate 14). Age assignments on these individuals ranged from 11 to 19 years.

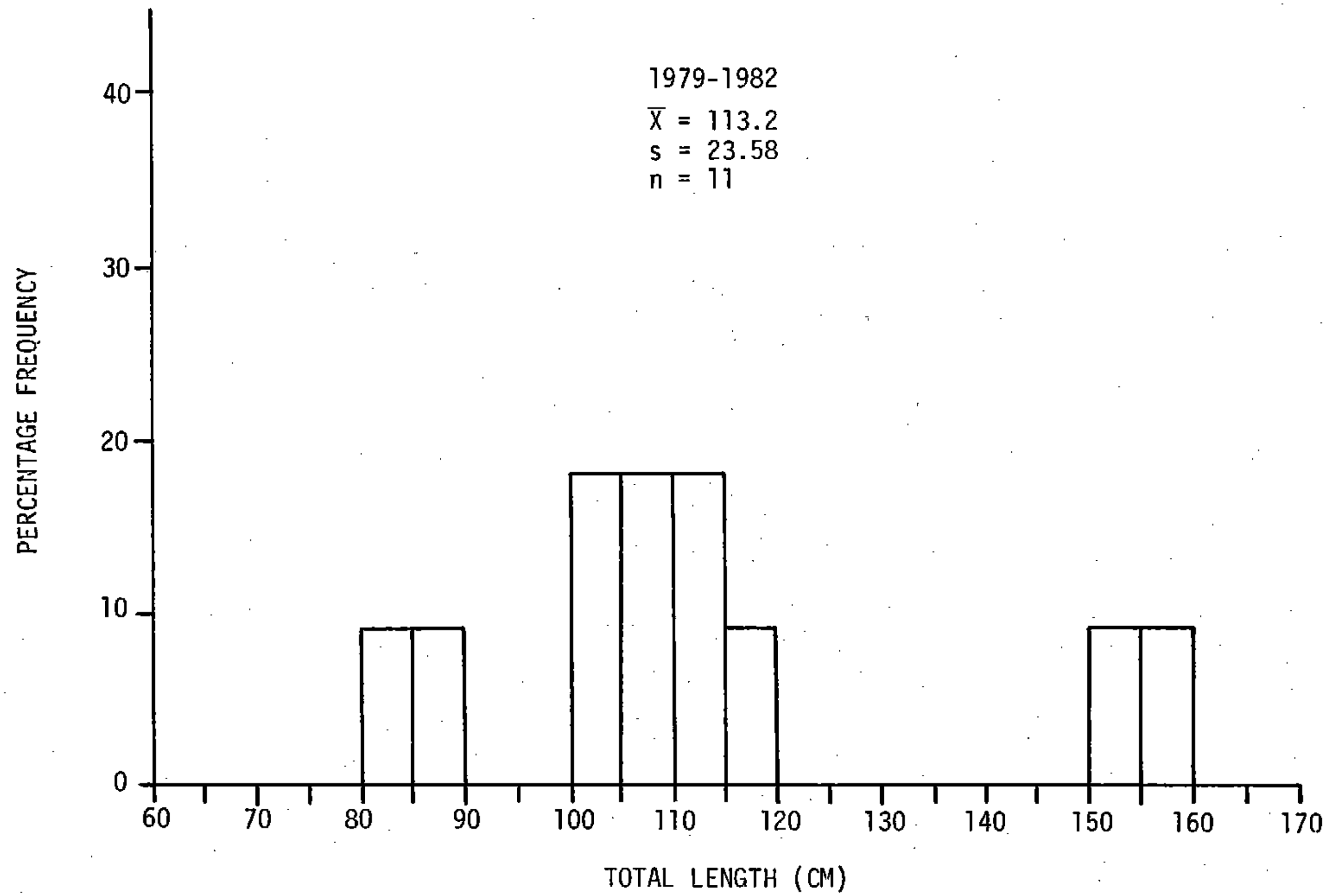


FIGURE 53. Length frequency distribution of white sturgeon captured by beach seine and gill net in the lower Klamath River, 1979-1982.

OTHER SPECIES OBSERVED

ABSTRACT

A total of 37 species of fish have been observed in beach seine, trawl, push net and gill net samples in the Klamath River since 1979. These species are listed by scientific and common name in order to document their occurrence for inclusion in the total data base on Klamath River stocks. Brief descriptions of several species are included in the narrative. Species of unusual occurrence include chum salmon *(Oncorhynchus keta)*, striped bass *(Morone saxatilis)*, Pacific hake *(Merluccius productus)*, white shark *(Carcharodon carcharias)*, bay pipefish *(Syngnathus leptorhynchus)* and saddleback gunnel *(Pholis ornata)*.

OTHER SPECIES OBSERVED

Since the establishment of beach seining operations in 1979, live individuals representing 23 species of fish have been captured in the Klamath River estuary (Table 46). According to Moyle (1976), 2 species, the saddleback gunnel *(Pholis ornata)* and bay pipefish *(Syngnathus leptorhynchus)* were considered questionable visitors or not occurring in the lower Klamath River. Four species were represented by only one individual captured - bay pipefish, walleye surfperch *(Hyperprosopon argenteum)*, striped surfperch *(Embiotoca lateralis)* and butter sole *(Isopsetta isolepis)*.

Northern anchovy *(Engraulis mordax)*, considered of rare occurrence in the Klamath estuary, were actually abundant during 1981 and 1982. Long time residents of the lower river claim that large numbers of anchovy generally occur in the Klamath every 10 to 15 years. However, no documentation of such an incidence prior to 1981 has been found.

In addition to the 23 species observed in the beach seine operation, 14 other species have been observed in the Klamath-Trinity basin by FAO-Arcata biologists (Table 46). These 14 species were observed in the gill net harvest or in either push net, midwater trawl or 0.6 cm mesh beach seine used during juvenile salmonid investigations.

Some of the most unusual observations in the Indian gill net harvest include: 3 striped bass *(Morone saxatilis)*, one of which was captured 70 km upstream near Weitchpec; a chum salmon *(Oncorhynchus keta)* captured at Resighinni; and a great white shark *(Carcharodon carcharias)* captured just inside the mouth of the river on the evening of September 15, 1982 (Plate 17).

TABLE 46. Fish species observed in the Klamath River estuary, 1979-1982, and method(s) of capture.

SPECIES	Gill Net 1/	Beach Seine 2/	Juvenile Seine 3/	Push Net 4/	Trawl 5/	Occurrence 6/
chinook salmon *(Oncorhynchus tshawytscha)*	X	X	X	X	X	C
silver salmon *(Oncorhynchus kisutch)*	X	X			X	C
pink salmon *(Oncorhynchus gorbuscha)*	X	X				R
chum salmon *(Oncorhynchus keta)*	X					R*
steelhead trout *(Salmo gairdneri)*	X	X	X	X	X	C
cutthroat trout *(Salmo clarkii)*	X	X	X	X		C
brown trout *(Salmo trutta)*	X	X	X			R
green sturgeon *(Acipenser medirostris)*	X	X				C
white sturgeon *(Acipenser transmontanus)*	X	X				R
Pacific lamprey *(Lampetra tridentata)*	X	X		X	X	C
river lamprey *(Lampetra ayresi)*					X	R*
spiny dogfish *(Squalas acanthias)*	X	X				R
white shark *(Carcharodon carcharias)*	X					R*
American shad *(Alosa sapidissima)*	X	X		X	X	C
northern anchovy *(Engraulis mordax)*	X	X	X	X	X	R
longfin smelt *(Spirinchus thaleichthys)*			X	X	X	C
surf smelt *(Hypomesus pretiosis)*			X	X	X	C
jacksmelt *(Atherinopsis californiensis)*					X	R
topsmelt *(Atherinops affinis)*			X			R
Pacific hake *(Merluccius productus)*	X	X				R
bay pipefish *(Syngnathus leptorhynchus)*	X	X				R*
staghorn sculpin *(Leptocottus armatus)*			X	X		C
prickly sculpin *(Cottus asper)*		X	X	X	X	C
redtail surfperch *(Amphistichus rhodoterus)*	X	X	X			C
walleye surfperch *(Hyperprosopon argenteum)*		X				R*
shiner surfperch *(Cymatogaster aggregata)*		X	X	X	X	C
striped surfperch *(Embiotoca lateralis)*		X				R*
striped bass *(Morone saxatilis)*	X					R
saddleback gunnel *(Pholis ornata)*		X				R
butter sole *(Isopsetta isolepis)*		X				R*
starry flounder *(Platichthys stellatus)*	X	X	X		X	C
speckled sanddab *(Citharichthys stigmaeus)*		X				R
speckled dace *(Rhinichthys osculus)*			X	X		C
golden shiner *(Notemigonus crysoleucas)*			X			R*
Klamath smallscale sucker *(Catostomus rimiculus)*			X	X	X	R
threespine stickleback *(Gasterosteus aculeatus)*			X	X	X	C
green sunfish *(Lepomis cyanellus)*			X			R*

1/ Variable net dimensions and mesh sizes.
2/ 150 meters by 6 meters, 8.9 cm stretched mesh.
3/ 30.5 meters by 1.8 meters, 0.6 cm mesh.
4/ 1.8 meters by 1.8 meters, 0.6 cm mesh (USFWS 1982a).
5/ 6.7 m^2 mouth, 0.6 cm mesh (USFWS 1981a).
6/ C = common, R = rare, * = one individual captured.

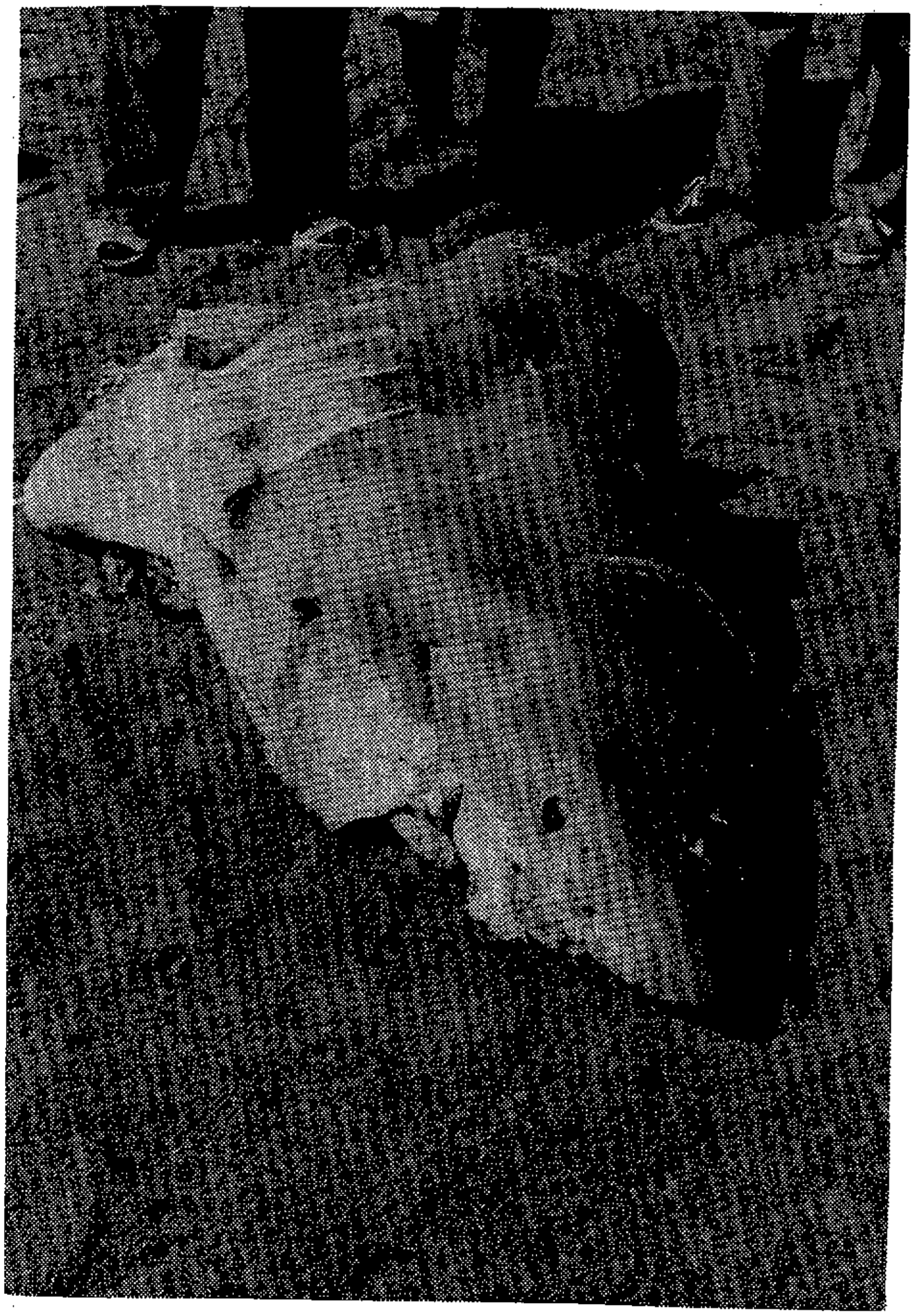


PLATE 17. The head of a great white shark captured by gill net in the Klamath River estuary in September, 1982.

PROGRAM PLANNING, DIRECTION, AND COORDINATION

INTRODUCTION

The course of the Klamath River Fisheries Investigation Program, and the role of FAO-Arcata in addressing resource-related issues involving the Klamath River basin, have evolved in response to Departmental direction through pertinent Memoranda of Understanding (MOU's) and the Critical Issues Management System (CIMS), the USFWS Management By Objectives (MBO) program, and a variety of other departmental and external factors. Further direction has recently been received through Bureau of Indian Affairs (BIA) planning processes involving fisheries resources of the Hoopa Valley Indian Reservation and the adoption of a Regional Resources Plan by the USFWS Region 1 directorate (USFWS 1982b).

DEPARTMENTAL DIRECTION

In order to carry out the Interior Secretary's resource and Indian trust responsibilities with regard to the Klamath River basin and Hoopa Valley Reservation, MOU's between the Assistant Secretaries of Indian Affairs and Fish, Wildlife, and Parks have been reached providing for: (1) promulgation of Indian fishing regulations and necessary emergency and in-season adjustments thereto, based on the best run size and catch information available, and designed with the objective of ensuring adequate spawning escapement in a manner consistent with Indian rights; (2) a cooperative enforcement program with regard to Indian fishing regulations, involving the USFWS and BIA; and (3) a fisheries investigation program, the subject of this report. Through the submittal of annual study and budget proposals, the FAO-Arcata program has been funded by the BIA in accord with the MOU's.

SERVICE DIRECTION - THE MBO PROCESS

Through the MBO process, Service direction from the Central Office (CO) in the form of fisheries resource priorities, missions, goals, and objectives has been provided through the *Important Resource Problems Source Document* (USFWS 1980a), the *Service Management Plan* (USFWS 1980b), and the *Fishery Resource Program Management Document* (USFWS 1980c). National goals and objectives with particular relevance to the Klamath River basin include: (1) the development, collection, interpretation, and dissemination of information and analysis related to all aspects of fishery resource condition, management, use and protection; (2) the development of studies to acquire, develop, and disseminate information in order to determine the effects of harvest management strategies on the stability of fishery resources; (3) the promotion of land and water use and fishery management practices, to insure that fishery resources are protected and restored in all situations where the Service provided technical assistance or has legislative responsibility; and (4) the provision of technical fishery management assistance for fishery resources found on trust lands, in cooperation with the BIA and tribal governments, and as defined in MOU's.

Program direction from the Regional Office (RO) in the form of resource priorities, goals, objectives, policies, and guidance has been provided through the *Region 1 Program Management Brief for Hatcheries and Fisheries Resources* (USFWS 1980d), the *Region 1 Policy Book* (USFWS 1979b), and most recently the *Regional Resource Plan* (USFWS 1982b). Regional policies with particular relevance to the Klamath River fishery resource, and with regard to issues dealt with by the Pacific Fisheries Management Council (PFMC) concerning this include:

(1) Emphasize the welfare of the resource over special interest user groups.

(2) Support selective stock fisheries over mixed stock fisheries.

(3) Support harvest of mature fish over juveniles.

(4) Encourage quantification of escapement needs on a stock by stock basis.

(5) Support sufficient escapement to provide for the historical Native American fisheries, traditional sport fisheries, and recruitment needs.

(6) Encourage individual stock assessment and management contribution information on habitat status, needs, production potentials and other pertinent data.

(7) Support the preservation and maintenance of all existing races, runs, or stocks of ocean fishes with emphasis toward significant spawning stocks.

(8) Encourage limited entry of commercial and charter boats as a control on fishing pressure.

(9) Encourage special methods and means for reducing the mortality of juvenile fish in the sport, commercial and Indian fisheries.

Individual strategies involved with implementation of these policies are discussed in detail in the *Regional Resource Plan*. Further information on the Plan is available through FAO-Arcata and through the USFWS Region 1 directorate in Portland, Oregon.

EXTERNAL FACTORS INFLUENCING PROGRAM DIRECTION

A variety of external factors generally beyond the control of the Service and Department, including harvest patterns, resource allocation, habitat degradation, jurisdictional questions, and socio-economic and political constraints, continue to influence how resource problems of the Klamath River basin are addressed. Further elaboration of these factors, and how they have influenced the direction of the Klamath River Fisheries Investigation Program, is contained in the 1979, 1980 and 1981 FAO-Arcata annual reports (USFWS 1979a, 1981a, 1982a), in a review of the history and status of anadromous fishery resources of the Klamath River basin and Hoopa Valley Reservation (USFWS 1979c), and in a paper presented by the former Project Leader, FAO-Arcata to the American Fisheries Society in 1980 (Rankel 1980).

The Klamath River Fisheries Investigation Program has been conducted taking into account the involvement in resourse problems of the basin by a variety of governmental agencies, multi-agency management groups, user groups, interest groups, and elected representatives of federal, state and local government. In addition to the BIA and USFWS, other agencies with jurisdictional authority over harvest management policy formulation affecting Klamath River stocks include the U.S. Department of Commerce, through the PFMC and National Marine Fisheries Service (NMFS), the California Department of Fish and Game (CDFG) and the Oregon Department of Fish and Wildlife (ODFW). Principal agencies and entities with resource and land management responsibilities in the Klamath River basin include the U. S. Forest Service (USFS), CDFG, BIA, U. S. Bureau of Reclamation (USBR), U. S. Bureau of Land Management (BLM), California Department of Forestry (CDF), California Department of Water Resources (CDWR), and the Trinity River Basin Fish and Wildlife Task Force (TRTF). Primary user groups associated with anadromous fisheries resources of the Klamath River basin, and their principal representative organizations, include: (1) ocean commercial fishermen, represented by the Pacific Coast Federation of Fishermen's Associations, Inc. (PFCCA), Salmon Unlimited, and various fishermen's marketing associations; (2) ocean sport fishermen, represented by a number of charter boat organizations; (3) interior sport fishermen, represented by the Klamath/Trinity River Coalition, Northwest Steelheaders Association, Trout Unlimited, California Trout, and other groups; and (4) interior Indian fishermen, represented by the BIA, Hoopa Valley Business Council, the Karok Tribe, and the Rek-Woi Indian Community Association.

Elected representatives of government have conducted public hearings on the Klamath River and introduced legislation into the U. S. House of Representatives and California Senate and Assembly which was intended to create a California Council separate from the PFMC, ban gill nets on the Klamath River, create various allocation systems involving Klamath River stocks and transfer jurisdiction over Indian fishing on the Hoopa Valley Reservation to the State of California. California Senate Bill No. 872, approved by the Governor of California on September 23, 1981 required the CDFG Director to appoint a Klamath-Trinity Salmon Restoration Advisory Committee (representing Indians of the Klamath River, the ocean commercial salmon fishery, the recreational salmon fishery, and major land owners in the Klamath River basin) to advise the CDFG on restoration programs and assist in the establishment and coordination of these programs. This advisory committee has met on several occasions to discuss matters concerning the Klamath River fishery resource and is in the process of developing a list of important issues to be addressed. Through passage of several resolutions, the American Fisheries Society has expressed its concerns about Klamath River salmon, and the Sierra Club and Friends of the River have publicly expressed views regarding anadromous fisheries problems of the Klamath River. Coordination of the Klamath River Fisheries Investigation Program with the various agencies, entities, and individuals involved with the resource has been complicated by: (1) the unsettled nature of the Indian fishing rights question in northern California; (2) the socio-economic implications of reduced salmon stock abundance on the north coast economy; (3) continued differences of opinion over the appropriate implementation of fishery management policy as it relates to natural stock protection on the one hand and providing for maximum ocean harvests on the other; and (4) the wide variety of interests, opinions and responsibilities surrounding the issues involved in the Klamath situation.

BIA PLANNING PROCESSES INFLUENCING PROGRAM DIRECTION

In an attempt to develop a unified cooperative working relationship between concerned agencies and interest groups in addressing fisheries resource problems of the Klamath River basin, personnel of the BIA and Office of the Assistant Secretary for Indian Affairs drafted a *Concept Paper for a Klamath-Trinity Rivers Basin Fishery Resource Plan* (BIA 1981). A contract has been awarded to CH_2M Hill, a private consulting firm, for preparation of a Klamath River Fisheries Resource Plan. An 18 month work schedule toward completion of the final Plan has been prepared, and a group of technical representatives of 11 agencies having specific involvement in affairs influencing fisheries resources within the basin has been created to participate in a series of workshops designed to provide the contractee with input on various aspects of the Plan. The USFWS has been identified for involvement in the technical workshops, and the Project Leader at FAO-Arcata has been designated as representative. Further information regarding the preparation of this Plan is available through BIA contract representatives located at the CH_2M Hill offices in Portland, Oregon and at the Hoopa Agency, Hoopa, California.

In August, 1981, an agreement was reached between the BIA and the National Park Service (NPS) to engage a NPS study team to prepare an Environmental Impact Statement (EIS) concerning a proposal to modify Indian fishing regulations authorizing the commercial harvesting of anadromous fish on the Hoopa Valley Reservation. The Project Leader, FAO-Arcata, designated to represent the USFWS on the study team, participated in the scoping process and in subsequent meetings of the team. A series of 12 public scoping sessions was held in northern California to gather public input on the EIS. As anticipated, representative Indian and non-Indian opinion concerning the proposal was divided. Of 245 people attending the sessions, 101 made statements. From a prepared transcript, the NPS team has identified approximately 130 issues raised during the sessions. The team completed a scoping report in May, 1982. Since this time, little progress has been made toward actual preparation of the draft EIS. Further work by the team on this project is expected to begin by October of 1983.

LONG-TERM PLANNING

The various factors influencing the direction of the Klamath River Fisheries Investigation Program (KRFIP) are numerous and complex. Considering such complexity and with the currently prevailing climate of uncertain funding for FAO operations within the USFWS, long term planning has become a difficult task. Still, future direction of office activities must be anticipated if goals and objectives are to be achieved. Alternative courses of action must also be considered in the eventuality of changes in funding levels or program direction received.

Certain priorities have been identified and are not expected to change radically in the near future. Anadromous fishes of the Klamath-Trinity basin have been identified as high priority and have been listed in order of preference for investment in restoration (USFWS, 1982b). The KRFIP has and will continue to focus on 5 of these stocks - fall chinook, spring chinook, fall steelhead, coho salmon and green sturgeon. These have been recognized as best fitting the criteria of being depressed stocks largely of natural origin with high value to fisheries and good restoration potential. Should program operations expand to cover additional species, summer and winter steelhead, white sturgeon and coastal cutthroat trout would be priority choices.

For the priority species, FAO-Arcata programs will continue to center on (1) collection of necessary baseline information on population characteristics, (2) monitoring of annual adult spawning migrations and juvenile populations and (3) monitoring of in-river net harvest levels, in cooperation with other groups and agencies involved with the Klamath River fishery resouce.

The KRFIP was initiated through the USFWS in 1977 at the request of the BIA, in order to provide data necessary for management of the Klamath River fishery resource, in context of the expanding in-river net fishery. The USFWS was selected for program initiation because of recognized expertise in fisheries management, there being no such capability within the BIA or local Indian groups at that time. It should be recognized that at such time as fisheries expertise is developed among local Indians, or within the BIA, part or all of existing FAO-Arcata programs would be transferred to these groups. Such transfer of programs appears to be underway with the establishment in 1981 of the Hoopa Valley Business Council Fisheries Department, and the hiring of 2 biologists by the Tribe. It is therefore difficult to place a time span on FAO-Arcata activities. However, current office programs are considered of an on-going monitoring nature and are expected to continue within the USFWS the BIA or local Indian groups for some time. With this in mind, a major aspect of FAO-Arcata operations has and will continue to be the training and education of local Native Americans in fisheries science. Specific directions anticipated for FAO-Arcata field activities in the near future are as follows:

(1) Beach Seining Operations are considered of a monitoring nature and should be continued on a yearly basis. Primary emphasis will remain with fall chinook. In-season fall chinook run strength indices derived from beach seine

catch/effort data appear to have potential in management of the in-river fisheries and research into their development and use should continue. Monitoring of fall chinook migration patterns within the basin by mark and recapture studies also appears useful in management and should continue. Collection of scales for age analysis of fall chinook provides critical information on this important species and should continue on a yearly basis. Because of the size selective nature of the gill net fishery, an unbiased scale sample cannot be taken from this source. Collection of data on a variety of other population characteristics is also seen as valuable and should continue through beach seining operations.

(2) Harvest Monitoring Operations provide the only presently available estimates of Indian gill net harvest within the Klamath River portion of the Hoopa Valley Reservation and collection of this critical information should continue. Research should proceed into methods of improving the accuracy of harvest estimates and into the possibility of generating estimates in such a manner that they can be placed within statistical confidence limits. Care should be taken, however, that alteration of methodology does not jeopardize comparability with past estimates. Collection of a variety of base line biological data from the net harvest, including recaptures of fish tagged during beach seine operations, appears valuable and should continue. Research into the development of a model for use of harvest data in in-season fall chinook run strength indexing should continue. Recoveries of coded-wire tags (CWT) through monitoring of the net fishery is important to management of the fisheries and of hatchery stocks within the basin and should continue.

(3) Sturgeon Investigations during the 1979-1982 period have provided much needed base line information on green sturgeon within the Klamath-Trinity basin. The initial base line period having been completed, future direction should tend toward continued monitoring of annual spawning migrations and net harvest levels. Major questions remaining unanswered include definition of population levels occurring within the basin and location of major spawning areas. Consideration should be given to radio-tagging or similar studies in attempt to address these questions.

(4) Juvenile Salmonid Investigations were discontinued after FY 82 due to lack of funding. Monitoring of juvenile populations of priority species in the basin, however, provides important information for management. At present, only limited studies on juvenile populations are being conducted by the CDFG and the Hoopa Tribe in the basin and information is incomplete. Expansion of such studies would provide needed information on migration, production, growth, survival, hatchery-natural interactions and other characteristics of juvenile populations in the basin. It is recommended that such studies be expanded through FAO-Arcata and/or other groups researching the Klamath.

(5) Program Planning, Direction and Coordination will remain essential and on-going parts of FAO-Arcata activities. Coordination of programs with and dissemination of information to other groups involved with the Klamath-Trinity fishery resource are recognized as high priorities. It is therefore recommended that FAO-Arcata obtain data and word processing equipment to aid in streamlining analysis and transmittal of information collected through field programs. Such capabilities would greatly facilitate office functions in the role of providing fisheries assistance.

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