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KLAMATH RIVER FISHERIES INVESTIGATION PROGRAM

Annual Report - 1986

ANNUAL REPORT

KLAMATH RIVER FISHERIES INVESTIGATION PROGRAM

1986

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Craig Tuss, Tom Kisanuki, James Larson,
Joseph Polos and Thomas Frazer

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

Page

LIST OF FIGURES

Figure | Page

LIST OF TABLES

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FORWARD

The Klamath River watershed drains approximately 14,400 sq km in Oregon and 26,000 sq km in California. The majority of the watershed in California is within the boundaries of the Six Rivers, Klamath and Shasta-Trinity National Forests (Figure 1). The Hoopa Valley Indian Reservation (HVR), 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 tributaries 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 (km 306) and Lewiston Dam on the Trinity River (km 249) 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 as 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% of commercial chinook salmon landings in northern California and southern Oregon, landings which have averaged approximately 400,000 chinook 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 USFS lands in the Klamath River basin in excess of $20 million, and mean annual net economic values per kilometer of chinook salmon, coho salmon (Oncorhynchus kisutch), and steelhead trout habitat in the basin of $15,600, $1,400 and $2,800, respectively (USFS 1977, USFS 1978). In 1980, the Department of the Interior included the Klamath and Trinity Rivers in the National Wild and Scenic Rivers System. 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.

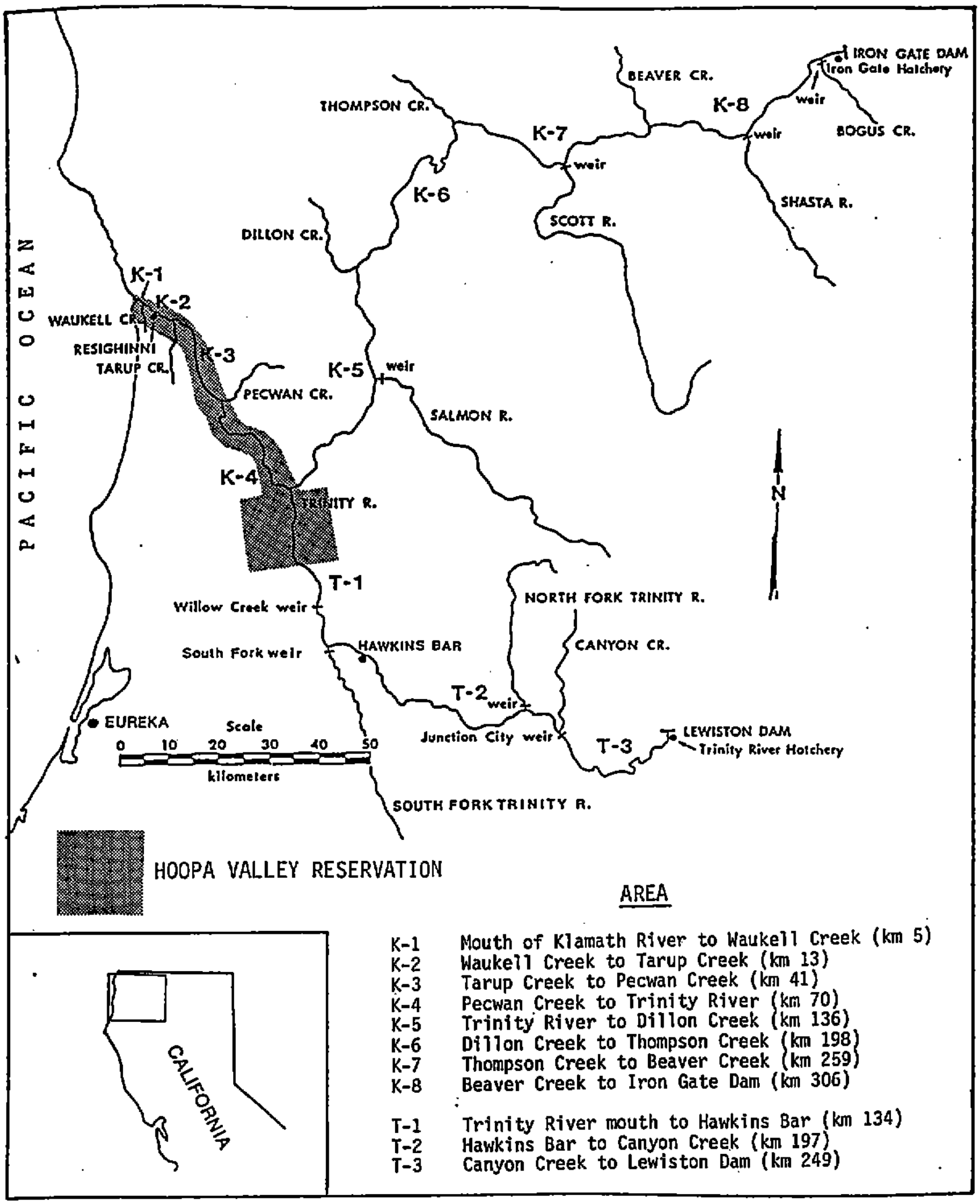

FIGURE 1. Overview map of the Klamath-Trinity River basin and Hoopa Valley Indian Reservation delineating recovery areas for chinook salmon tagged during 1979-1986 beach seine operations.

In response to habitat problems resulting from the Trinity River Division project, the Congress enacted P.L. 98-541, the Trinity River Basin Fish and Wildlife Management Program (TRBFWMP) on October 24, 1984. This action directs the Secretary of the Interior to restore fish and wildlife populations in the Trinity basin to levels approximating those which existed immediately before the start of construction on that project. An office administered jointly by the U.S. Bureau of Reclamation and U.S. Fish and Wildlife Service (USFWS) was recently opened to oversee work under P.L. 98-541.

In 1985 CH_2M Hill, a consulting firm, completed a document entitled "Klamath River Basin Fisheries Resource Plan" (KRBFRP), through contract with the Department of the Interior, Bureau of Indian Affairs (USDI 1985). This plan details restoration actions for the remainder of the Klamath basin which are similar to those included in the TRBFWMP described above.

Since passage of the Fishery Conservation Management Act of 1976 and the promulgation of the first set of Federal fishing regulations governing Indian fishing on the HVR in 1977, considerable attention has also focused on the fisheries operating on the depressed chinook salmon runs, notably the ocean troll fisheries and the Indian gill net fishery on the Klamath and Trinity Rivers. During 1985 a new organization of particular relevance to the management of the combined fisheries operating on Klamath River chinook stocks was formed. As described in the organization's charter, the Klamath River Salmon Management Group (KRSMG):

> "is an interagency mechanism to coordinate a comprehensive review of the salmon resource of the Klamath-Trinity River system and to recommend to the Pacific Fishery Management Council, U.S. Department of the Interior, State of California, and the Klamath-Trinity Tribes the following management issues:
>
> 1. spawning escapement goals;
> 2. rebuilding schedule to meet the adopted escapement goals, including production goals;
> 3. methods for harvest sharing between recreational, Indian, and commercial users; and
> 4. short and long-range data needs to meet the above goals."

In 1986, the KRSMG provided recommendations concerning allowable levels of harvest for all Klamath stock fisheries.

On October 27, 1986 the Congress enacted P.L. 99-552, the Klamath River Fish and Wildlife Restoration Act (KRFWRA). This action authorizes the Secretary of the Interior to restore the anadromous fish populations to optimum levels in both the Klamath and Trinity Rivers through a habitat restoration program and formation of the Klamath River Fishery Management Council which will take over the duties of the KRSMG.

The Assistant Secretaries of Indian Affairs and Fish, Wildlife and Parks, in addressing Departmental resource and Indian Trust responsibilities concerning the Klamath River basin resource and Hoopa Valley Reservation, have entered into annual fiscal Interagency Agreements (IA) 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 HVR. This is the eighth 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 Fiscal Year 1986 IA.

The program consists of four major groupings of related activities:

(1) Beach Seining Operations focus on:

(a) the provision of age composition data required to forecast annual Klamath River chinook ocean population abundance; 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 information on run timing and migration patterns.

(2) Harvest Monitoring and Evaluation Efforts focus on:

(a) the annual estimation of the Indian net harvest levels on the Hoopa Valley Reservation involving chinook salmon (spring and fall runs), steelhead trout (fall run), coho salmon, and green sturgeon (*Acipenser medirostris*);

(b) 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; 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.

(3) Technical Assistance involves:

(a) participation in various technical committees including the Department of Interior technical team and the Technical Advisory Team to the Klamath River Salmon Management Group;

(b) the provision of general technical assistance, as requested, to the California Department of Fish and Game, Bureau of Indian Affairs, Hoopa Valley Business Council Fisheries Department, other branches of the USFWS and various other groups and agencies; and

(c) the conduct of various other field studies in the Klamath River basin as is deemed appropriate.

(4) Program-Planning, Direction, and Coordination involves:

(a) keeping abreast of program planning and direction in conjunction with guidance received from the USFWS and Interior Department;

(b) annual budgeting and other administrative functions; and

(c) 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 1986 through these program activities are detailed in sections summarizing data collected on chinook salmon, coho salmon, steelhead trout, and sturgeon. Abstracts covering the primary points precede each of the major sections of this report. During 1983 the Hoopa Valley Business Council Fisheries Department assumed responsibility for harvest monitoring programs covering the Trinity River portion of the HVR, formerly a part of FAO-Arcata responsibilities. This responsibility remained with the Hoopa Tribe during 1986. It should, therefore, be realized that harvest data presented in this report, unless otherwise noted, are not strictly comparable with harvest data presented in certain previous reports since the area of coverage has changed as described.

CHINOOK SALMON INVESTIGATIONS

ABSTRACT

A total of 6,149 chinook salmon were captured in 332 sets during 1986 seining operations in the Klamath River estuary. Tags were applied to 1,475 chinook for migration analysis. Scales were collected from 2,126 chinook for age analysis. Adipose fin-clipped chinook comprised 13.4% of the sample, and 1.3% and 21.9% of the chinook examined exhibited gill net marks and hook scars, respectively.

Age analysis from scale samples indicated the dominance of 3-year-olds in 1986.

Gill net harvest on the Klamath River portion of the Hoopa Valley Reservation during 1986 was estimated at 20,887 fall and 706 spring chinook.

A total of 200 CWT, representing 34 fall and 4 spring chinook release groups, were recovered during mark sampling of the 1986 net fisheries on the Klamath River portion of the Hoopa Valley Reservation. These recoveries expanded to a total estimated harvest of 1,438 CWT fall and 159 CWT spring chinook in the 1986 net fisheries.

An estimated 2.8 Klamath River fall chinook were harvested through the ocean fisheries for each one harvested by the in-river fisheries and an estimated 1.1 Klamath River fall chinook was harvested in the combined ocean and river fisheries for each one spawning in the basin in 1986.

BEACH SEINING PROGRAM

INTRODUCTION

A beach seining program was initiated by FAO-Arcata biologists in 1979 to develop in-season and post-season run size estimates utilizing catch/effort and mark-recapture techniques, and to collect biological data on Klamath River fall chinook salmon. Problems encountered during the 1980 season in satisfying the requirements of mark-recapture methodology resulted in the discontinuation of the mark-recapture post-season population estimation program. An in-season run-size prediction model which utilized beach seine catch/effort (C/E) data was also developed. However, C/E was influenced by environmental factors, and tended to be independent of run size strength. Consequently, emphasis was shifted towards collection of age composition data, run timing, hook scarring, and other basic biological data.

At present, this program provides the only available estimates of age composition of the total Klamath River fall chinook run. These data have proven valuable in estimating ocean stock size of 3- and 4-year-old Klamath River fall chinook, and therefore in management of the ocean and in-river fisheries. The 1986 season marks the eighth consecutive year of beach seine sampling of fall chinook salmon near the mouth of the Klamath River.

METHODS

Beach seining operations were conducted within the Klamath River estuary from July 16 to September 30, 1986. Two sites were selected, a primary site on the South Spit, and an alternate site on the North Spit. These sites were chosen to sample the fall chinook run prior to sustaining impacts of the various size-selective, in-river fisheries. The selection of the South Spit site was based on previous observations which indicated that fall chinook tend to migrate through the deep channel of cool, highly saline water. A hydro-acoustic survey was conducted during July 1986 to obtain depth profile transects to locate this channel (Figure 2). The alternate site was chosen to test whether the site location influenced the age composition data, and if segregation by size or species was occurring.

Methods utilized in 1986 were similar to those of previous years, with exceptions as noted. Seining was conducted five days per Julian week during daylight hours by a seven-person crew of biologists and technicians. The South Spit site was sampled four days during each Julian week; the alternate site was sampled once per Julian week. Six and eight sets were conducted each sampling day at the south and north spits, respectively. Sampling dates were selected by randomly choosing two consecutive days not to be sampled; the remaining five days constituted available sampling days. To allow sampling of different tidal stages during daylight hours, daily start times were staggered alternately (early (10 AM), late (12 PM)) for the main site throughout the sampling season. Sampling times (approx. 10 AM - 4 PM) were fixed on the alternate site. A 150 m long by 6 m deep seine net (8.9 cm stretched mesh) was set from a Valco river boat and retrieved to shore using gas powered winches.

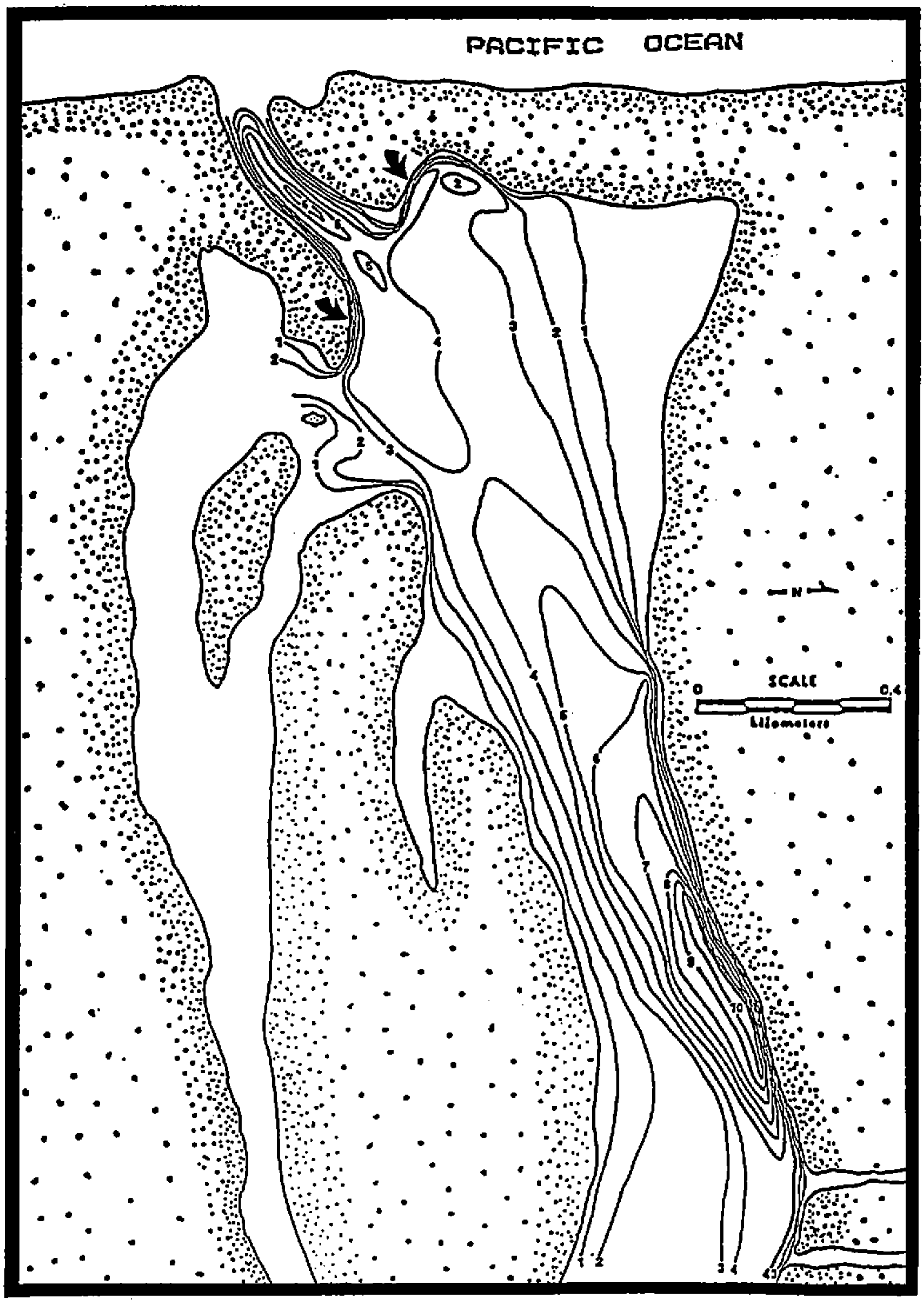

FIGURE 2. Depth contours (expressed in meters below mean high tide) of the Klamath River estuary during 1986. Arrows depict seining sites.

Captured fish were transferred into holding cages, and then individually examined for fin-clips, hook scars, predator wounds, tags, gill net marks and other distinguishing characteristics. Examination of fish for hook scars and gill net markings is part of a continuing effort to collect information on fisheries impacts on the Klamath River chinook salmon populations. Identified wounds and scars attributable to hooking incidences were classified as described in Table 1. Salmonids were measured to the nearest centimeter fork length and all measured salmonids received a 9.5 mm or 6.4 mm hole punch placed in the upper caudal fin lobe for recapture identification. In addition, a numbered aluminum or monel-metal jaw tag band was applied to the left mandible of every other chinook sampled throughout the season for evaluation of migration timing and patterns. Scale samples were taken from every other chinook sampled. The post-season jack-adult cutoff length was determined by examining scales from 197 chinook in the length range of 50 to 61 cm.

Sets with large numbers of fish captured (> 40) were subsampled to minimize handling time and reduce stress to fish. Fish not sampled were identified as to species and size class (i.e. jack or adult) prior to release, for inclusion in catch/effort data. Statistical tests (chi-square) were conducted on the proportion of jack/adult represented from the subsampled sets to insure that their inclusion would not bias data presented herein. Recaptures were eliminated from analyses to minimize bias from any tendency of chinook to linger in the sampling site area after capture.

Beach seine C/E data is represented by chinook sampled and those released unsampled. C/E analyses are presented by tidal stage and hour of day. All 1986 analyses (age composition, length-frequency, C/E, fin-clips, etc.) were based upon data collected from July 16 to September 30, 1986. Statistical tests were limited to t-tests, unless otherwise specified.

RESULTS AND DISCUSSION

During the 1986 field season, 6,149 chinook salmon (including 49 recaptures) were captured in 332 seine sets at both sites. Jaw tags were applied to 1,475 chinook and 2,126 scale samples were collected. At the primary site, 5,667 chinook (including 42 recaptures) were caught in 252 seine hauls. Of this total, 2,552 (1,854 adults and 698 jacks) were sampled and 3,073 (2,302 adults and 771 jacks) were released unsampled. Data from all fall race period sets were included in bio-analyses, as no subsampling bias was detected.

The age composition, and run timing catch trends of the chinook captured on the north spit was similar to those from the primary site. Segregation of chinook by age class was not apparent between the two sites (see Age Composition section). However, mean length of jacks sampled at the South Spit were significantly smaller ($p<0.05$) than jacks captured at the North Spit site. There was no statistical difference ($p>0.05$) in mean lengths of adults between the two sites. Unless noted, all subsequent analyses and results presented are from the primary (South Spit) site.

The jack/adult cutoff (largest jack) was determined to be 56 cm fork length. The mean length of jacks (45.5 cm) was identical to that of 1984,

TABLE 1. Categorization of hook scars observed during 1986 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 and Orbit Opercle Isthmus All Other Head Areas (Includes nose, inside mouth and top of head)	

while the mean length for adults (71.5 cm) was significantly less ($p<0.05$) than observed in 1982 and 1985 (Figure 3). The shorter mean length for adults reflects the strength of the 3-year-old age class. Jacks and adults were significantly larger ($p<0.05$) than observed in 1983. More detailed information on fall chinook age and size at maturity is presented in the Age Composition section of this report.

Fin-clips were observed on 408 (15.9%) of the 2,552 chinook salmon sampled. Adipose fin-clips representing various hatchery coded-wire tag (CWT) release groups occurred on 10.3% of the jacks and 14.6% of the adults (Table 2). Left ventral (LV) fin-clips on chinook, representing release groups reared at Iron Gate Hatchery (IGH) occurred on 2.9% of the sampled adults and none of the jacks. Right ventral (RV) fin-clips on chinook, representing release groups reared at Trinity River Hatchery (TRH) occurred on 0.7% of the sampled adults and none of the jacks.

Mean length of adipose fin-clipped jacks, 45.9 cm, and non-clipped jacks, 45.5 cm, did not differ statistically ($p>0.05$). Mean length of adipose fin-clipped adult chinook salmon, 71.3 cm, did not differ from that of non-clipped adults, 71.6 cm ($p>0.05$). In four of the five previous years, adipose fin-clipped adults were smaller ($p<0.05$) than non-clipped adults (1981, 1982, 1984, 1985); no difference was observed in 1983. Mean length of adipose fin-clipped jacks did not differ from non-clipped jacks in prior years, except in 1981 when adipose fin-clipped jacks were smaller ($p<0.05$). Possible explanations for differences in adult mean lengths may be due to differing maturity schedules between hatchery and natural stocks, or from effects of the fin-clipping process.

LV and RV fin-clips have allowed comparisons in run timing between fish of IGH and TRH origins. As in previous years, IGH reared chinook have exhibited earlier river entry timing than chinook of TRH origin. In 1986, the mean weighted time of entry (capture date) for LV and RV fin-clipped chinook were 228.9 and 233.6 Julian days, respectively. However, these comparisons between IGH and TRH fish were based on only 56 LV fin-clipped fish, and 12 RV fin-clipped fish, respectively. The small sample size of RV-marked fish may limit meaningful comparisons.

Beach seine data from 738 aged fall chinook taken during the fall run period were stratified into three equal time periods and the resultant age-class frequencies were subjected to a Pearson two-way chi-square analysis. Significant ($p<0.05$) run timing differences by age were noted (Table 3). Age 3 chinook were the dominant age class throughout the three sampling periods, particularly during the third time interval, constituting 71.2% of the composition. Two-year-old fish were the next most abundant age class; occurrence remained relatively constant over time. Four-year-old chinook contributed 15.1% and 18.8% during the first and second run periods, respectively. The contribution of age 4 chinook decreased to 7.9% during the latter run interval.

The early entry of age 4 chinook observed in previous years was not apparent in 1986. The 3-year-old age class dominated the run throughout the entire sampling period, possibly masking any early entry of the numerically fewer 4-year-old chinook that may have occurred.

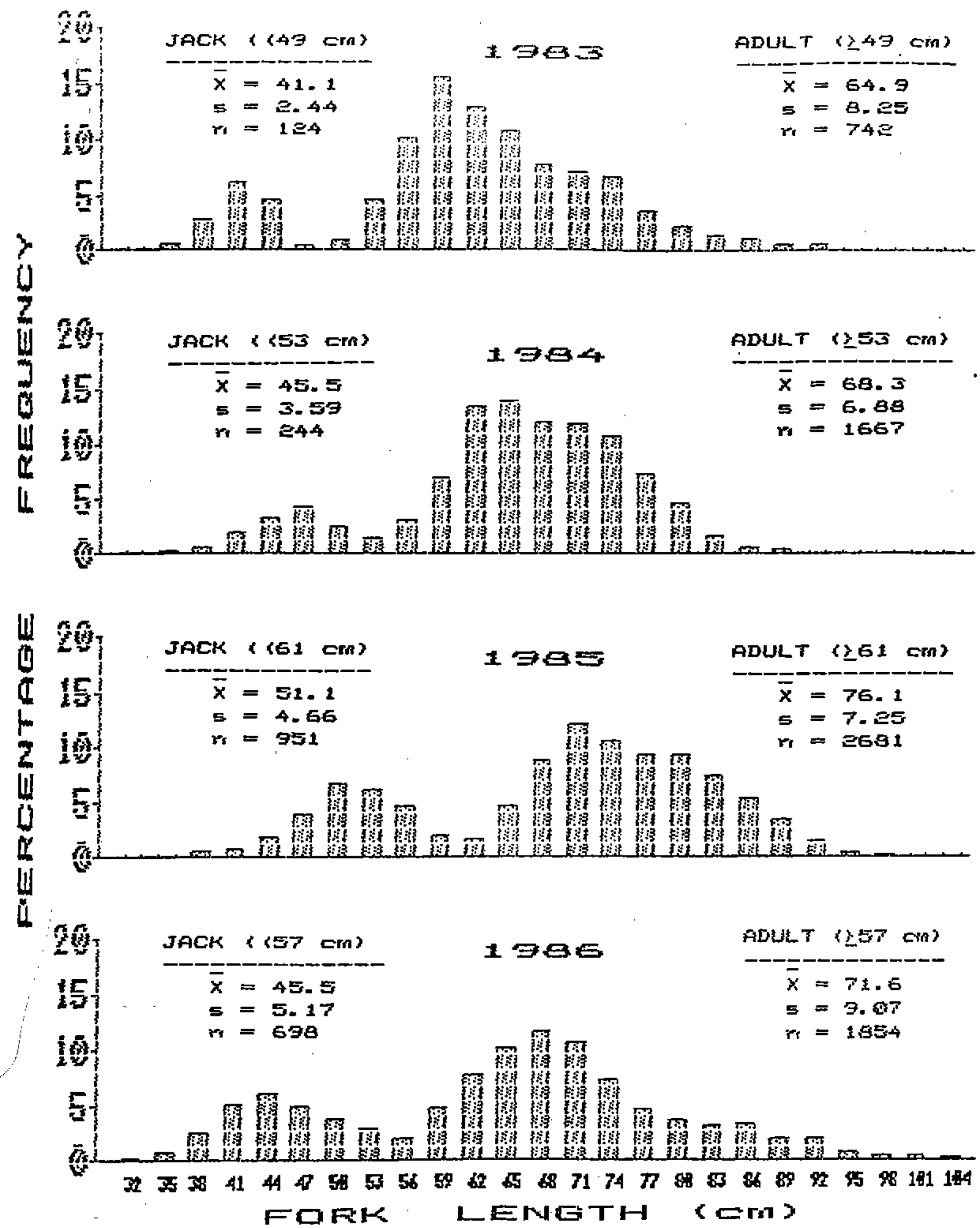

FIGURE 3. Length-frequency distributions of chinook salmon captured during beach seining operations in the Klamath River estuary during 1983-1986 (3 cm groupings with midpoints noted).

TABLE 2. Mean length ($\overline{X}$) in centimeters, standard deviation (s), and sample size (n) of fin-clipped chinook captured during the 1986 beach seining operation. (Percent relative to total jacks and adults sampled).

Fin Clips	JACKS (<57cm) $\overline{X}$	s	n	%	ADULTS ($\geq$57cm) $\overline{X}$	s	n	%
Adipose	45.9	6.3	72	10.3	71.3	10.3	270	14.6
Left Ventral	--	--	0	0.0	83.3	6.7	54	2.9
Right Ventral	--	--	0	0.0	81.9	10.4	12	0.7
Left Pectoral	--	--	0	0.0	83.1	5.9	14	0.8
Right Pectoral	--	--	0	0.0	75.0	1.0	3	0.2
Number Fin-Clipped:			72	10.3			353	19.0
Number Non-Clipped:			626	89.7			1,501	81.0
Total Sampled:			698	100.0			1,854	100.0

TABLE 3. Age class contribution (%) of fall chinook salmon during three equal time intervals in the 1986 Klamath River beach seine sample, determined through scale analysis.

	RUN TIMING			
Age	7/16 - 8/10	8/11 - 9/5	9/6 - 9/30	Total
2	21 (24.4%)	57 (27.5%)	91 (20.4%)	169
3	51 (59.3%)	107 (51.7%)	317 (71.2%)	475
4	13 (15.1%)	39 (18.8%)	35 (7.9%)	87
5	1 (1.2%)	4 (1.9%)	2 (0.5%)	7
Total	86 (100.0%)	207 (100.0%)	445 (100.0%)	738

Gill Net Marking and Hook Scarring Investigations

Gill Net Marking

Markings attributable to previous contact with gill nets were observed on 34 of 1,854 (1.8%) adult chinook salmon and none of the 698 jacks examined for an overall marking rate of 1.3%. The increase in adult and total gill net marking rate over 1985 marking rates, 0.5% and 0.4%, respectively, can be attributed to an increase in the estuary gill net harvest which increased 62.7% for adults and 62.3% overall. The marking rate and estuary gill net harvest in 1986 was the highest observed since 1981.

Gill net marking rates were also examined at IGH, TRH, and the Shasta River weir for comparison to rates observed in beach seine data. In past years data the trend of increased gill net marking at up-river sampling locations when compared to beach seining data has been noted and attributed to the majority of the in-river harvest occurring between these sampling areas. Gill net marks were observed on 51 of 2,001 (2.5%) adult chinook salmon and none of 275 jacks examined at IGH. At TRH, markings were observed on 13 of 928 (1.4%) adults and none of 196 jacks. Two of 31 (6.5%) adults and none of 12 jacks exhibited gill net markings at the Shasta River weir. Average gill net marking rates for 1981-1986 are 0.1% for jacks and 1.2% for adults in beach seine data; 0.2% for jacks and 2.6% for adults at IGH; 0.7% for jacks and 4.6% for adults at TRH; and 1.2% for jacks and 1.9% for adults at the Shasta River weir. In 1986 adult chinook salmon sampled at IGH exhibited a near average gill net marking rate, while at TRH the adult gill net marking rate was 69.5% below average. This can be attributed in part to the estuary fishery being closed before the majority of the Trinity River fall chinook had entered the river.

Reservations concerning the use of this data as an index of gill net harvest rate have been presented in a previous report (USFWS 1982a). The use of total (jacks and adults) gill net marking rate at the hatcheries is especially suspect due to the hatchery practice of sorting out jacks which may lead to an overestimate of net marking rates.

Hook-Scarring

Scars or wounds directly attributable to hooking incidents were observed on 67 of 698 jack (9.6%) and 493 of 1,854 adult (26.6%) fall chinook salmon examined during 1986, for an overall occurrence of 21.9% (Table 4). Healed scars were more common than fresh (16.0% vs. 6.9%), and occurrence of minor scars were similar to moderate-major (11.7% vs. 11.3%) scars. Two or more scars caused by separate hooking incidents were observed on 25 (0.9%) of all chinook examined.

Categorical frequencies within the 1986 total sample of 584 scars are presented in Table 5. These frequencies do not directly convert to scarring frequencies within the total sample of 2,552 chinook as 25 multiple hook scarred fish are represented by 51 individual scars. Frequency of scars in other locations in 1986 varied from 3.6% for the opercle area to 18.8% for the other head areas category. By category, for all head areas combined, minor scars (51.0%) were most prevalent, followed by moderate (30.8%) and major scars (18.2%).

A significant difference was found between mean lengths for hook-scarred (47.0 cm) and non-scarred (45.3 cm) jack chinook in 1986 ($p<0.05$). Similar results have been noted for all previous sampling seasons except 1983. This difference may result from size dependent, differential rates of shaker mortality in the ocean troll fishery (smaller jacks may be less likely to survive a hooking incidence than their larger counterparts), which would elevate the mean length of jacks surviving hooking incidents. The observed size difference in 1986, may suggest substantial size dependent hooking mortality, despite the low (9.6%) hook-scarring rate for jacks. Mean length of hook-scarred adults (70.2 cm) was significantly less ($p<0.05$) than non-scarred adults (72.0 cm) in 1986. Hook-scarred adults were found to be significantly smaller than non-scarred adults during three of seven previous sampling seasons. Hook-scarred adults were significantly larger than non-scarred adults in 1985. No significant differences were noted in the other three years.

In 1985, the larger size of hook-scarred fish was believed to result from inflation of mean lengths by 4- and 5-year-old fish; these older fish exhibited higher rates of hook-scarring. In 1986, hook-scarred adults were smaller. In past years, the smaller mean length of hook-scarred adults has been attributed to growth interruptions caused by hooking incidents. Any tendency of 4- and 5-year-old fish inflating the mean length of hook-scarred adults in 1986 appears unlikely since 3-year-old fish dominated the 1986 run.

The 1986 hook scarring rate (21.9%) increased substantially from the 12.7% observed in 1985. By occurrence, healed scars increased from 8.1% in

TABLE 4. Percentage occurrence of hook scars observed on 2,552 Klamath River fall chinook salmon sampled during 1986 beach seining operations.

Type of Scar	RUN COMPONENT Jack	Adult	All Chinook
Single Hook Scar 1/	9.6	26.6	21.9
Two Hook Scars 2/	0.1	1.2	1.0
Three Hook Scars	0.0	0.1	0.1
Fresh Hook Scar	3.9	8.1	6.9
Healed Hook Scar	5.9	19.9	16.0
Minor Hook Scar	5.2	14.1	11.7
Moderate-Major Hook Scars	4.4	13.8	11.3

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

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

TABLE 5. Categorical frequencies (%) of hook scars within a total sample of 584 scars observed on 2,552 Klamath River fall chinook during 1986 beach seining operations.

		SEVERITY			
Location	Stage	Minor	Moderate	Major	Total
Upper Jaw	Fresh	7.4	2.7	1.2	11.3
	Healed	12.2	7.4	8.4	27.9
	Total	19.6	10.1	9.6	39.2
Lower Jaw	Fresh	3.8	2.7	0.5	7.0
	Healed	9.8	6.7	1.5	18.0
	Total	13.6	9.4	2.0	25.0
Eye and Proximity	Fresh	0.3	0.0	0.5	0.9
	Healed	0.7	1.0	1.2	2.9
	Total	1.0	1.0	1.7	3.8
Opercle	Fresh	0.7	0.5	0.3	1.5
	Healed	1.2	0.7	0.2	2.1
	Total	1.9	1.2	0.5	3.6
Isthmus and Proximity	Fresh	1.7	0.7	0.0	2.4
	Healed	3.1	2.4	1.7	7.2
	Total	4.8	3.1	1.7	9.6
Other Head Areas	Fresh	3.8	2.6	0.5	6.9
	Healed	6.5	3.4	2.1	12.0
	Total	10.3	6.0	2.6	18.9
All Head Areas Combined	Fresh	17.6	9.3	3.1	30.0
	Healed	33.4	21.6	15.1	70.0
	Total	51.0	30.9	18.2	100.0

1985 to 16.0% in 1986. The marked difference may reflect the higher ocean fishery effort off northern California waters during 1986, and the commercial closure during 1985. In contrast, percentage occurrence of fresh hook-scars was 5.6% in 1985, and 6.9% in 1986 (Figure 4).

Regulations governing the fishery mandated the use of barbless hooks in northern California beginning in 1983. The influences of this regulation on scarring rates observed in this study are not yet clearly understood.

Mark-Recapture Analysis

In 1986, 1,475 jaw tags were applied to fall chinook during beach seine operations (both sites). A total of 147 tags were recovered within the Klamath-Trinity River basin for a recovery rate of 0.099 (Table 6). This rate is the lowest observed during seven (1979-1980, 1982-1986) seasons of tagging efforts. This low return rate may be related to the low percentage of tags applied (<1.0%) relative to the in-river run size (228,782 CDFG estimate) of fall chinook.

During 1986, 94 of 147 recovered tags were accompanied with sufficient data to be used in migration analyses. The majority of these tags came from TRH (34) and IGH (27). Mean migration times from the estuary to IGH and TRH were 44 and 58 days, respectively, and fall within ranges noted in previous seasons. Due to low numbers of tag recoveries within the Klamath-Trinity River basin, delineated river segments (Figure 1) were grouped into three areas: K-1 thru K4; K-5 thru K-8; and T-1 thru T-3. Migration timing and rates of chinook to these areas were similar to findings of previous seasons (Table 7), particularly the highly variable migration rates within the Trinity River basin.

The peak adult catch from the beach seine operation has been used in past seasons as an indicator of run timing to the river mouth. The 1984 annual report (USFWS, 1985a) detailed how in-river migration rates to IGH and peak beach seine catch date are directly correlated, whereby faster migration rates occurred during years when later run timings (estuary entry) occurred. The 1986 peak adult catch occurred on September 11 (Julian Day 254), the second latest run timing observed since 1983, when the peak catch occurred on Julian Day (J.D.) 259. The mean J.D. for peak adult catch from the past six seasons (1979-1980, 1982-1985) was 238. The 1986 mean migration rate of chinook to IGH was 6.98 km/day, second highest to the corresponding rate of 8.13 km/day observed in 1983.

Catch/Effort and Run Timing Analysis

Catch per unit effort (C/E), a standard measure of sampling success, may be used to show general run timing. C/E data must be used with caution when comparing between years since biases can influence the data. Annual variations in physical characteristics and environmental conditions in the Klamath River estuary and seining site locations may affect the efficiency of the sampling gear. There appears to be no wholly reliable way to evaluate or standardize these sources of potential bias when comparing run and seine catch characteristics between years. Annual variations in the application of sampling effort may also introduce bias into resulting C/E data. Therefore,

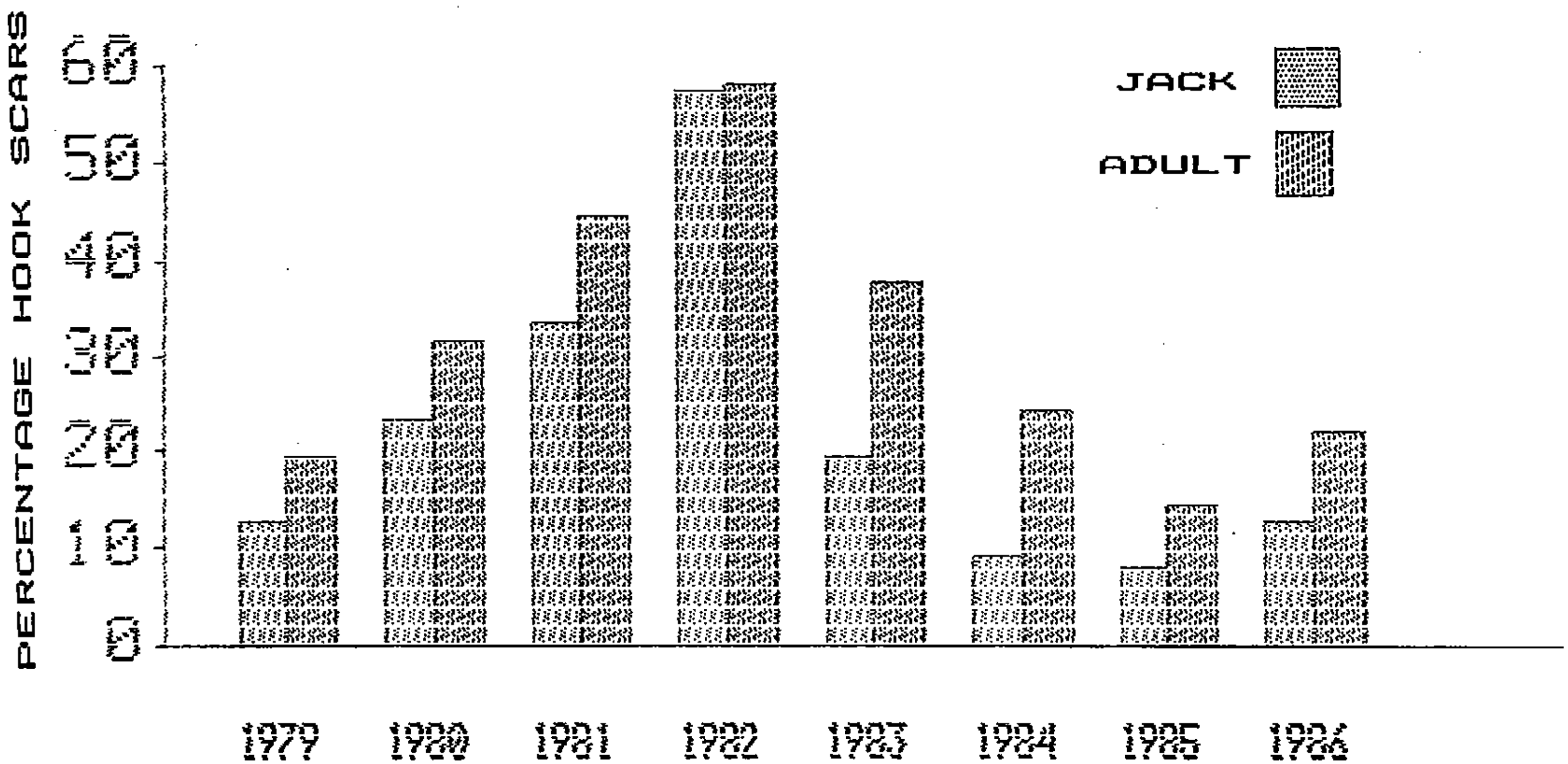

FIGURE 4. Jack and adult chinook salmon hook scarring rates observed during 1979-1986 beach seining operations in the Klamath River estuary.

TABLE 6. Recovery data from 9,213 fall chinook salmon tagged by the U.S. Fish and Wildlife Service on the Klamath River during 1980-1986 beach seining operations (no tags were applied in 1981).

Source1/	NUMBER RECOVERED 1979	1980	1982	1983	1984	1985	1986	Total
Gill Net Fishery	14	111	46	14	31	35	8	259
USFWS Beach Seine	22	67	14	7	20	36	28	194
Shasta River Weir	50	21	19	0	3	3	1	97
In-River Sport Fishery	14	43	13	11	7	23	13	124
Trinity River Hatchery	18	32	16	14	20	72	34	206
Iron Gate Hatchery	23	14	20	12	14	85	30	198
Spawning Ground Surveys	7	25	1	0	4	5	3	40
Bogus Creek Weir	-	-	22	1	8	21	4	56
Willow Creek Weir	5	6	8	4	11	22	8	64
CDFG Beach Seine	4	11	3	-	12	5	7	42
Scott River Weir	-	-	8	2	2	4	2	18
Junction City Weir	0	2	0	-	4	3	2	11
South Fork Trinity Weir	-	-	-	-	1	1	0	2
North Fork Trinity Weir	-	-	1	0	0	-	-	1
Salmon River Weir	-	-	-	-	-	4	0	4
Ocean	0	1	0	0	1	0	0	2
Other	0	0	8	4	1	13	7	33
Totals	157	333	179	69	139	332	147	1,351
Number Tagged	1,016	2,363	1,018	588	1,007	1,746	1,475	9,213
Recovery Rate	0.155	0.141	0.176	0.117	0.138	0.190	0.099	0.147

1/ Listed weirs were not in operation during years where no recovery number is presented.

TABLE 7. Migration data from 94 recoveries of jaw tagged fall chinook salmon within the Klamath-Trinity basin during 1986[1/]. Areas delineated in Figure 1.

Area	Kilometers From River Mouth	Tag Recoveries	MIGRATION TIME (Days)		MIGRATION RATE (Km/Day)	
			Range	Mean	Range	Mean
K1-K4	0-70	7	4-32	18.86	0.14-1.41	0.68
K5-K8	70-306	8	32-71	45.50	2.30-7.22	5.32
IGH[2/]	306	27	32-67	43.79	4.57-9.56	6.98
T1-T3	70-249	18	7-61	37.80	2.94-15.98	7.15
TRH[3/]	249	34	41-88	57.70	2.83-6.07	4.31

1/ Does not include chinook that were recaptured on the same day they were tagged, or chinook found dead on spawning grounds.

2/ IGH = Iron Gate Hatchery

3/ TRH = Trinity River Hatchery

while C/E data for previous years is presented, no detailed comparisons between years are attempted.

The 1986 beach seine fall chinook C/E analyses were based on 5,196 salmon caught in 247 seine hauls. Five hauls were excluded from the analyses due to possible sampling bias. Mean numbers of jack and adult salmon captured per seine haul were 5.5 and 15.4, respectively.

Analyses of C/E data with respect to time and tidal stage failed to reveal any significant trends. Although in some cases these values appear to be significantly different, the apparent differences were a function of daily catch regardless of time and tide. C/E data collected during the 1981-1986 sampling are presented in Table 8. These data include all chinook salmon captured, whereas, previous annual reports used only adults for this analysis.

Daily number of chinook per seine haul varied greatly throughout the season with the majority of the run entering the estuary between September 2 and September 15 (Figure 5). Average weekly C/E values for chinook salmon entering the Klamath River during 1983-1986 are presented in Figure 6 to show general run timing trends. The 1986 run timing was similar to that of 1983 with the majority of the fish entering the river after the first week of September.

Run-Size Estimation

Since 1980, the USFWS had developed a in-season run size prediction model which utilized C/E indices from USFWS beach seine data, and CDFG run size estimates. The validity of using C/E-derived data for estimating in-season abundance relied on certain assumptions which were detailed in the 1983 annual report (USFWS, 1984). The C/E results from the 1985 season did not support the assumed relationship whereby C/E levels, between years, are comparable in relative representation to the run size.

Data presented here and in previous reports have described the problems encountered in estimating in-season run abundance by this method. The influences of river mouth morphology/seine site location, and abnormal run entry timing have been significant in affecting C/E values derived and limited the utility of the in-season abundance prediction model. For these reasons, run-size estimation by this method has been discontinued. Development of alternative in-season run prediction models are not anticipated at this time.

TABLE 8. Chinook salmon catch per seine haul by time of day and tidal stage, during 1981-1986 beach seining operations in the Klamath River estuary (number of sets in parentheses).

		HOURS OF DAY			
Year	Tidal Stage	0800-1100	1100-1400	1400-1700	All Hours
1986	Outgoing	51.9 (23)	19.4 (37)	11.0 (27)	25.4 (87)
	Low Slack	13.0 (3)	9.5 (2)	0.0 (0)	11.6 (5)
	Incoming	15.5 (33)	19.1 (84)	23.0 (32)	19.2 (149)
	High Slack	1.0 (1)	10.8 (4)	2.0 (1)	7.7 (6)
	ALL TIDES	29.1 (60)	18.8 (127)	17.3 (60)	22.9 (247)
1985	Outgoing	61.6 (31)	36.6 (53)	47.3 (31)	46.2 (115)
	Low Slack	133.3 (12)	166.7 (10)	66.0 (1)	144.9 (23)
	Incoming	27.9 (17)	37.6 (56)	27.1 (11)	34.3 (84)
	High Slack	0.0 (3)	39.9 (8)	0.0 (1)	26.6 (12)
	ALL TIDES	63.2 (63)	47.5 (127)	41.6 (44)	50.6 (234)
1984	Outgoing	1.0 (23)	11.5 (70)	17.1 (53)	11.9 (146)
	Low Slack	0.0 (2)	12.6 (12)	50.5 (6)	22.7 (20)
	Incoming	2.9 (8)	9.8 (76)	17.2 (52)	12.2 (136)
	High Slack	0.0 (0)	8.0 (8)	1.0 (3)	6.1 (11)
	ALL TIDES	1.4 (33)	10.6 (166)	18.5 (114)	12.5 (313)
1983	Outgoing	9.8 (12)	4.8 (59)	4.0 (54)	4.9 (125)
	Low Slack	0.0 (0)	8.0 (9)	0.3 (3)	6.1 (12)
	Incoming	2.0 (12)	1.5 (99)	2.9 (48)	1.9 (159)
	High Slack	0.0 (1)	0.5 (4)	1.0 (3)	0.6 (8)
	ALL TIDES	5.6 (25)	2.9 (171)	3.3 (108)	3.3 (304)
1982	Outgoing	31.6 (8)	7.6 (44)	19.7 (50)	15.4 (102)
	Low Slack	22.3 (3)	14.6 (9)	27.0 (2)	18.1 (14)
	Incoming	9.6 (12)	9.1 (79)	6.2 (35)	8.4 (126)
	High Slack	0.0 (1)	1.2 (13)	1.0 (1)	1.1 (15)
	ALL TIDES	18.1 (24)	8.3 (145)	14.3 (88)	11.3 (257)
1981	Outgoing	2.0 (10)	7.3 (39)	10.2 (21)	7.4 (70)
	Low Slack	0.8 (12)	3.3 (29)	16.6 (14)	6.2 (55)
	Incoming	1.1 (27)	6.8 (78)	4.6 (49)	5.1 (154)
	High Slack	0.3 (4)	4.2 (17)	10.4 (5)	4.7 (26)
	ALL TIDES	1.1 (53)	6.0 (163)	8.2 (89)	5.8 (305)

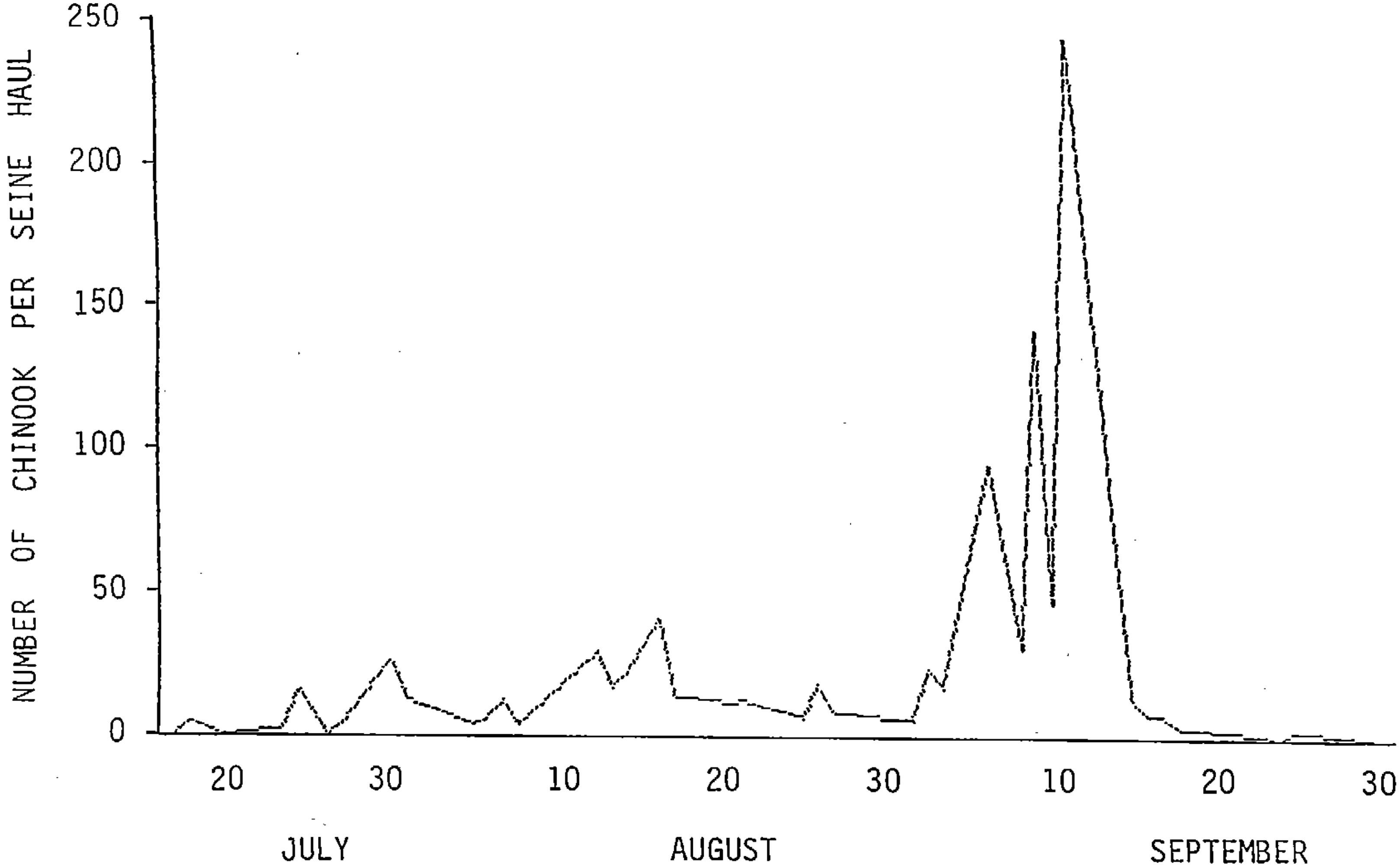

FIGURE 5. Daily numbers of chinook salmon captured per beach seine haul in the Klamath River estuary during 1986.

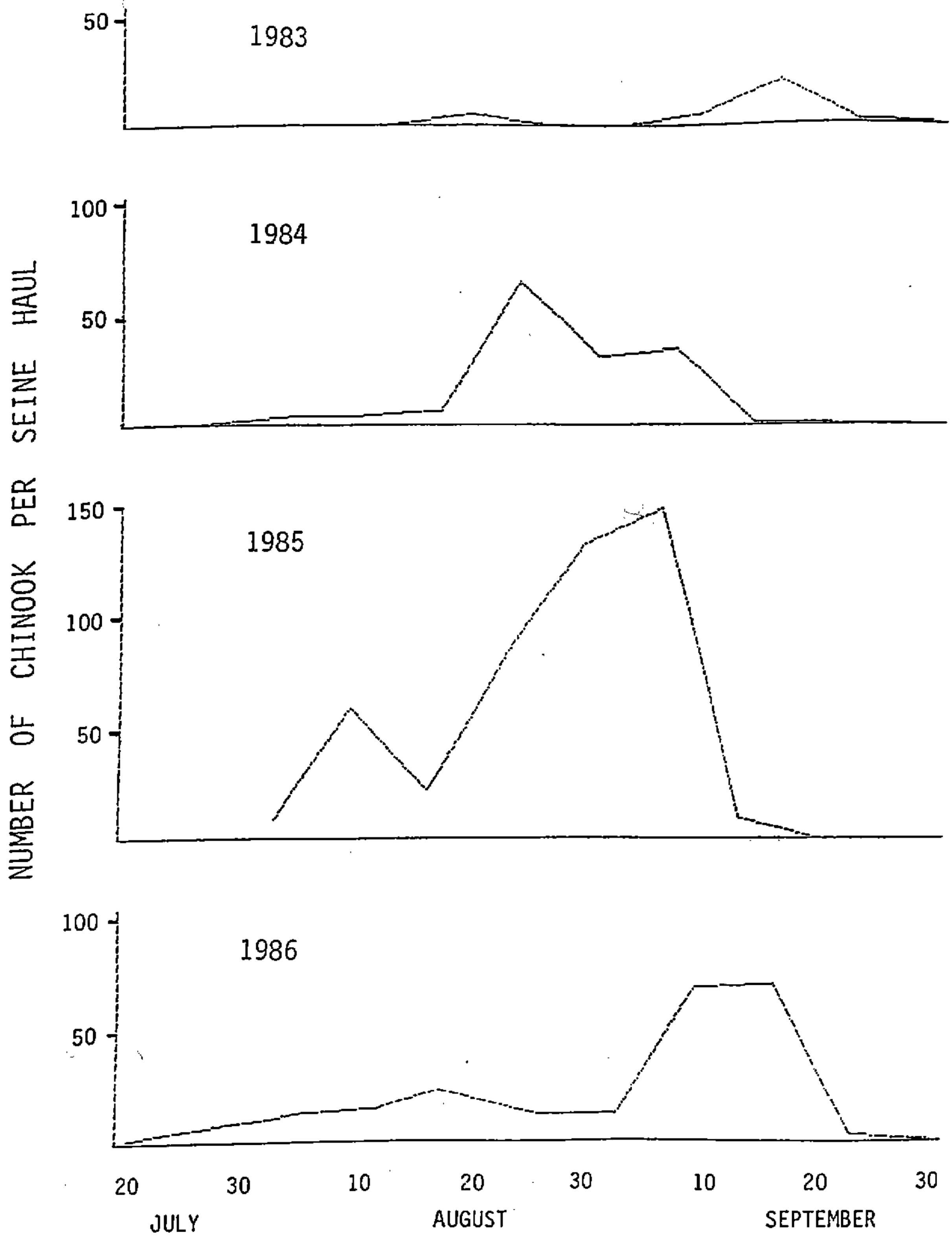

FIGURE 6. Weekly averages of the number of chinook salmon captured per seine haul in the Klamath River estuary during 1983-1986.

AGE COMPOSITION

INTRODUCTION

Continuous monitoring of the age composition of a fish stock impacted by major fisheries is essential to sound resource management. Age data, in combination with length and weight measurements, provide information on stock composition, age at maturity, mortality, growth and production. Such information may be used in setting pre-season management goals and regulations. Analyses of these parameters are also useful in judging the results and effectiveness of management practices employed. As part of a continuing effort to evaluate age composition of chinook salmon runs in the Klamath basin, scales were again collected from fall chinook salmon sampled through a beach seining program near the mouth of the Klamath River. A summary of age information collected on fall chinook entering the Klamath since 1979 is presented herein.

METHODS

Age structure of the 1986 fall chinook run was determined through analysis of scale samples collected in beach seining operations from the south spit seining site between July 16 and September 30. Employing statistical analyses involving the hypergeometric distribution (Dixon and Massey 1969), it was determined that a subsample of 729 scales would estimate the age-class percentages of 2-, 3- and 4-year-old fall chinook at the 95% level of precision for a predicted run size of 125,000 (Pacific Fishery Management Council (PFMC) 1986), assuming the least abundant age class to constitute 12% of the total cohort run. A total of 750 scale samples were selected for analysis in order to ensure the desired level of precision and account for some unreadable scales. The California Department of Fish and Game's (CDFG) post-season estimate of 1986 Klamath River fall chinook in-river run-size is 228,782 (PFMC 1987). A run of this size would require a subsample of 731 scales to accurately predict the age composition of the run, therefore the selected sample size meets the desired level of precision.

A weighted stratified random sampling method was utilized to select a 750 scale subsample from the total of 1,718 samples collected at the south spit seining site. Differential weighting was applied to compensate for an uneven scale collection pattern relative to weekly beach seine catch. This method produced a sample which was distributed through time proportionately to the total catch and assumed to be representative of the entire 1986 Klamath River fall chinook run.

Age composition of scales collected from the north spit seining site (See Beach Seine Methods) was determined from 406 scale samples. Comparison with the south spit scale sample was done using Pearson's Chi-Square analysis.

Cellulose acetate impressions of fall chinook scales were made utilizing a Carver Model "C" hydraulic laboratory press equipped with variable temperature heating elements. Impressions were viewed on a Bell and Howell ABR-1020 dual lens projector. Scales were analyzed independently by two interpreters, with a third group reading which included an additional interpreter when the initial two readings differed. Scales not aged with confidence after the third reading were excluded from the cohort analysis. Scales from known age fish (coded-wire tag recoveries) were used to assist in age determination.

Estimates of age group contribution were derived by applying USFWS age composition data to CDFG run size estimates. Statistical analyses of data were limited to the t-test unless otherwise noted. The data were compared at the 95% confidence level.

RESULTS AND DISCUSSION

The majority of Klamath River fall chinook returning in 1986 were age 3 (64.4%), followed by age 2 (22.9%), age 4 (11.8%) and age 5 (0.9%) (Table 9). The 1986 run showed an increased proportion of age 3 fish (38.0% to 64.4%) and a decrease in proportion of age 2 (25.7% to 22.9%), age 4 (29.6% to 11.8%), and age 5 fish (6.7% to 0.9%) compared to the 1985 run. The percentage of 3-year-old chinook in 1986 exceeds those of previous years while the percentages of 4- and 5-year-old chinook were the lowest for the same time period. The age composition of the 1986 Klamath River fall chinook run is similar to the 1981 run when 3-year-old fish dominated the run while the percentages of 4- and 5-year-old fish were below average. The dominance of the 3-year-old cohort may be attributed to the strength of the Trinity River fall run chinook which are believed to mature at an earlier age than Klamath River stocks.

Sampling at two different sites was conducted to test whether the site location influenced age composition data. This was brought about due to the discrepancies between USFWS and CDFG 2-year-old age class percentages in 1985, 25.7% and 52.1%, respectively. Age composition of the north spit seining site was 18.0% age 2, 66.5% age 3, 14.8% age 4, and 0.7% age 5. Age composition of the north spit seining site did not differ significantly from that of the south spit seining site, and it was therefore concluded that there was no segregation by age between the two sites.

Age group contribution to fall chinook in-river runs derived from USFWS age composition data and CDFG run size estimates allow consistent comparison of cohort groups through brood year cycles. Although USFWS and CDFG estimates of jack and adult components differ, the decision to use USFWS age composition data is based on the rationale that (1) data collected through beach seining operations are the only available estimates of age composition representing the entire Klamath River fall chinook run and (2) these data have proven to be valuable in estimating ocean stock size of 3- and 4-year-old Klamath River fall chinook (PFMC 1985, 1986, 1987). These estimates are presented solely for comparative purposes and are not intended to supplant those generated by CDFG.

Estimated returns of 2- and 3-year-olds (52,391 and 147,336, respectively) greatly exceeded those of previous years while 4-year-old returns (26,996) were slightly above average and 5-year-olds (2,059) below average (Table 10). Although the percentage of 4-year-old chinook was below

TABLE 9. Percentage age composition of Klamath River fall chinook derived from scale analysis and length-frequency information during the 1979-1986 return years.

Return Year	AGE 2	3	4	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
1983	12.9	54.3	31.4	1.4
1984	13.0	40.0	45.0	2.0
1985	25.7	38.0	29.6	6.7
1986	22.9	64.4	11.8	0.9
87	10.5	38.4	48.2	2.9
1979-1986 Average	26.1	41.6	29.0	3.3
79-87 Avg.	24.4	41.3	31.1	3.3

1/ Includes some 6-year-old fish.

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

TABLE 10. Estimated number of fall chinook by age entering the Klamath River during the 1979-1986 return years.

Return Year	AGE 2	AGE 3	AGE 4	AGE 5	Total
1979	8,867	20,197	28,695	3,818	61,577
1980	47,021	14,430	15,484	4,135	81,070
1981	34,567	56,315	12,608	1,576	105,066
1982	30,316	33,338	37,609	2,917	104,180
1983	7,967	33,536	19,393	865	61,761
1984	6,801	20,928	23,544	1,046	52,319
1985	31,824	47,056	36,654	8,297	123,831
1986	52,391	147,336	26,996	2,059	228,782
1987	23,437	85,711	107,586	6,473	223,207
1979-1986 Average	27,469	46,642	25,123	3,089	102,323
79-87 Avg.	27,021	50,983	34,285	3,465	115,754

By brood	2	3	4	5	TOTAL
	79,651	134,858	106,587	17,875	338,971
%	23.5	39.8	31.4	5.3	

82 brood 94,227 fish

the 1979-1986 average, the number of 4-year-old chinook returning in 1986 was slightly above average but masked due to the large return of 3-year-olds.

Contribution by the 1983 brood year has already exceeded those of previous years with only two age classes having returned (Figure 7). Contribution of 2-year-olds from the 1984 brood year was similar to that of the 1978 brood year. However, the 1984 adult spawning escapement was only 22,666, compared to 71,451 in 1978. The recent increase in the number of chinook returning for a given brood year can be attributed to a combination of factors including productive ocean conditions and reduction in harvest rates on Klamath River chinook stocks.

The number of 2-year-olds returning has generally been a good indicator of the strength of a given brood year. This was evident for the 1977-1980 brood years but not for the 1981 and 1982 brood years. This deviation from the observed trend was attributed to reductions in the ocean troll fishery and favorable environmental conditions. Contribution by the 1983 brood year did not follow this trend with the number of 3-year-olds returning greatly exceeding what was expected. With the number of 2-year-olds returning in 1986, it appears that the 1984 brood year is strong and the 1987 fall run will have a strong 3-year-old component.

Average age composition of chinook returning to the Klamath River for brood years 1979-1981 is 29.8% age 2, 36.7% age 3, 30.0% age 4, and 3.5% age 5. The average age at maturity of chinook from the 1977, 1978, 1979, 1980, and 1981 brood years are 3.2, 2.9, 2.9, 3.1, and 3.5, respectively, with an overall average of 3.1 for the 1977-1981 brood years.

Mean lengths of fall chinook returning at age in 1979-1986 return years are presented in Table 11. Chinook returning as 2-, 3-, 4-, and 5-year-olds in 1986 were similar in length to those returning in 1982. Two- and three-year olds were significantly larger ($p<0.05$) than those returning in 1983 and 1984 but were significantly smaller than those returning during 1979-1982 and 1985. Four-year-old chinook were significantly larger ($p<0.05$) than those returning during 1979, 1981, and 1983-1985 and did not differ significantly ($p>0.05$) from 1982 returns. Mean length of age 5 fish was significantly larger ($p<0.05$) than those returning during 1983-1985 but did not differ ($p>0.05$) from 1979-1982 mean lengths.

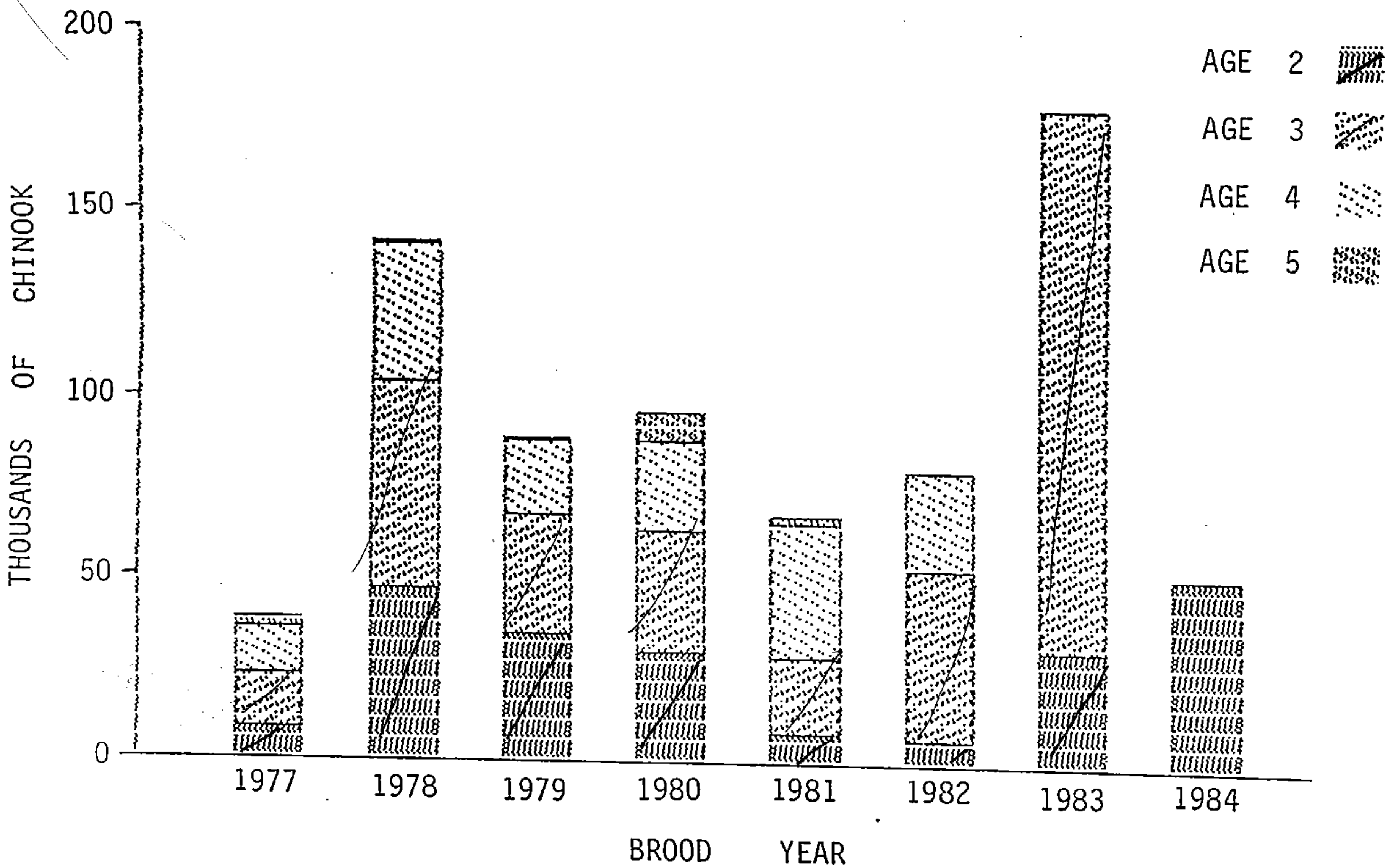

FIGURE 7. Brood year contribution by age of fall chinook salmon to the 1979-1986 Klamath River returns.

TABLE 11. Mean length ($\overline{X}$) cm, standard deviation (s) and sample size (n) of fall chinook returning at age in 1979 and 1981-1986 return years.

Return Year		AGE AT RETURN 2	3	4	5
1979	$\overline{X}$	**48.8**	**70.1**	**80.3**	**88.7**
	s	6.54	5.78	5.69	6.48
	n	97	221	314	42
1981	$\overline{X}$	**50.2**	**68.1**	**80.5**	**89.0**
	s	4.95	6.85	6.09	5.95
	n	176	287	64	8
1982	$\overline{X}$	**48.3**	**69.3**	**83.2**	**87.2**
	s	4.25	6.51	7.02	7.48
	n	161	177	200	13
1983	$\overline{X}$	**41.9**	**60.3**	**71.5**	**82.2**
	s	3.73	4.82	6.07	6.77
	n	80	338	195	9
1984	$\overline{X}$	**45.4**	**62.9**	**72.6**	**81.1**
	s	3.89	3.96	4.78	7.89
	n	123	379	426	19
1985	$\overline{X}$	**51.0**	**70.5**	**81.0**	**84.7**
	s	4.99	4.23	5.60	5.32
	n	126	186	145	32
1986	$\overline{X}$	**46.6**	**66.9**	**83.9**	**92.7**
	s	5.37	5.71	6.87	5.06
	n	169	475	87	7

NET HARVEST MONITORING PROGRAM

INTRODUCTION

Hoopa, Karok and Yurok Indian peoples living along the Klamath and Trinity Rivers have traditionally fished for salmon, steelhead, sturgeon and other species using a variety of fishing gear including weirs, dip nets, spears, and gill nets. Historically, salmon consumption by these people exceeded 907,000 kg (2 million pounds) annually (Hoptowit 1980). For historical accounts of the Indian fisheries see Hoptowit (1980), Bearss (1981) and USFWS (1981).

Regulations governing recent Indian fishing on the Hoopa Valley Reservation (HVR) were first published by the Department of the Interior in 1977, and FAO-Arcata biologists began monitoring net harvest levels on the Reservation in 1978 (USFWS 1981), with efforts focused on fall chinook salmon. Further progress was made in ascertaining net harvest levels with the establishment of a net harvest monitoring station in the lower Klamath River in 1980. Net harvest monitoring operations were expanded upriver beginning in 1981 for Reservation-wide coverage of the net fishery. Since 1983, FAO-Arcata biologists have focused monitoring efforts solely on the Klamath River portion of the Reservation, operating three monitoring stations based near Requa, Omagar Creek and Johnson. Responsibility for monitoring net harvest levels on the Trinity River portion of the HVR was taken over by the Hoopa Valley Business Council (HVBC) Fisheries Department in 1983.

Beginning in 1984, FAO-Arcata biologists employed a stratified random sampling methodology to assess fall season net harvest levels for chinook salmon, coho salmon, steelhead trout, and sturgeon on the Klamath River portion of the HVR in an attempt to improve the accuracy and gauge the precision of the harvest estimates. The techniques employed during former seasons yielded point estimates without associated measures of variance. Although they are considered reasonably reliable and accurate, no quantifiable measure of precision can be calculated for estimates made prior to 1984.

Allocation between the various users of Klamath River fall chinook resource (ocean commercial, ocean sport, river sport and Indian gill net) that allowed harvest of the chinook resource and yet provided for the rebuilding of the chinook populations was agreed upon in 1986. Toward this goal, the Department of Interior (DOI) enacted regulations designed to meet the harvest quota established by the allocation agreement for the Indian gill net fishery.

METHODS

Net harvest monitoring data were collected and compiled from three contiguous areas (Estuary, Middle Klamath and Upper Klamath) of the Klamath River portion of the HVR in 1986 (Figure 8). The Estuary Area was defined as the lower 6 km of the river from the mouth to the crossing of the Highway 101 bridge. The Middle Klamath comprised the next 27 km of river from the crossing of the Highway 101 bridge to Surpur Creek, 33 km upstream from the

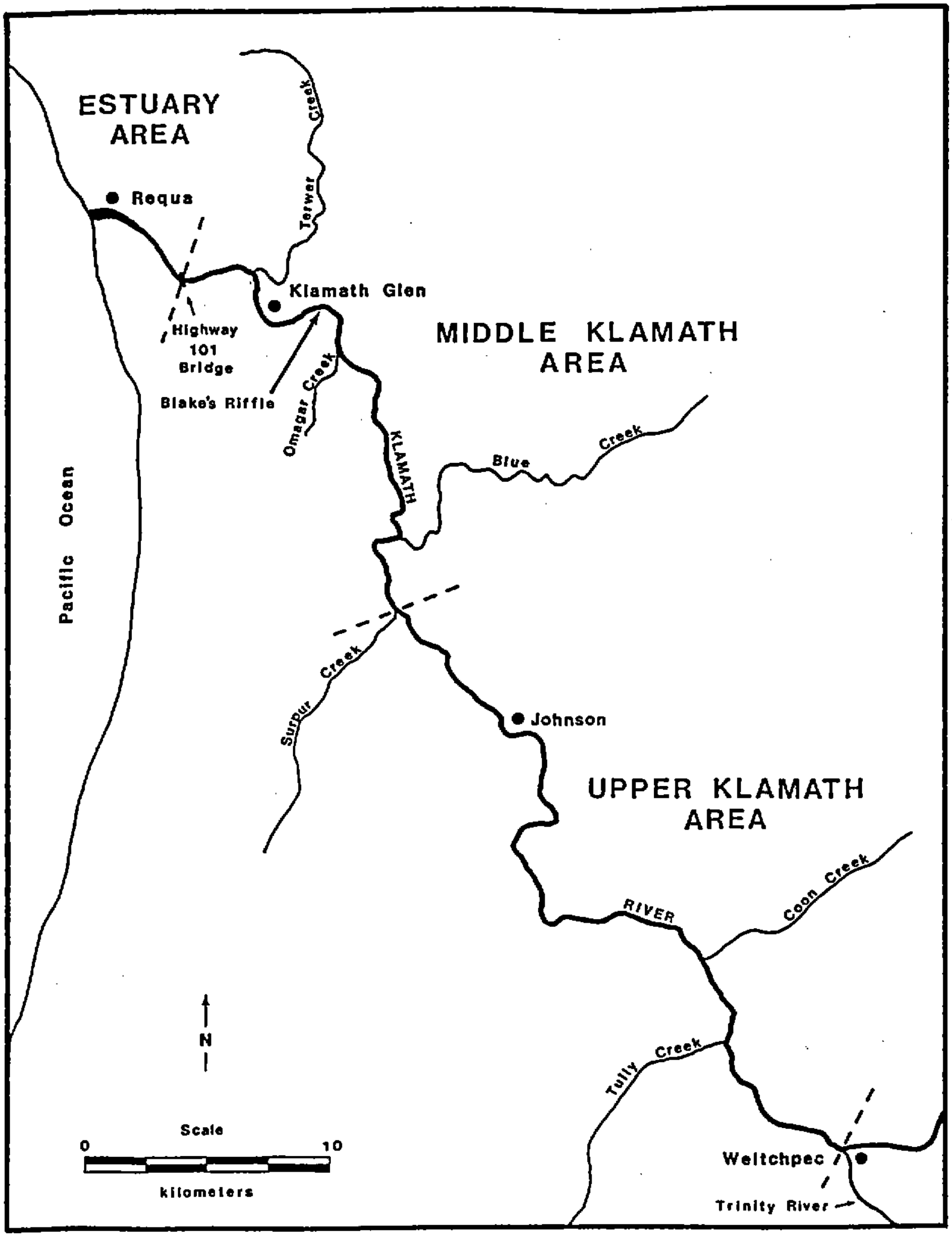

FIGURE 8. Net harvest monitoring areas for the Klamath River portion of the Hoopa Valley Reservation in 1986.

mouth. The Upper Klamath Area included the next 37 km stretch of river from Surpur Creek to Weitchpec. During the 1986 fall chinook fishery, DOI regulations divided the reservation into three management zones that differ from the above areas. These zones, coupled with time closures were designed to allow equitable distribution of harvest throughout the HVR and yet to allow fishing through the fall chinook season. Area I included the portion of Klamath River from the mouth to Blake's Riffle (River km 16). Area II began at Blake's Riffle and continued upriver to the confluence of the Trinity River (River km 70). Area III consisted of the Trinity River portion of the HVR. FAO-Arcata biologists monitored the harvest in Management Areas I and II while the HVBC Fisheries Department was responsible for estimating the harvest in Management Area III. In order to keep the data as comparable to previous years as possible, data in this report will be analyzed with regard to the three monitoring areas utilized in previous years. Still, much of the data collected in 1986 will not be comparable to previous years because of the harvest restrictions imposed on the Indian net fishery and their effect on catch and effort.

Fall Fishery

The design employed by FAO-Arcata biologists to estimate harvest in 1986 involved a stratified random sampling technique with an optimum allocation of sampling effort based on the available data and associated variances. The actual estimate is comprised of two parts: an estimate or count of total effort and an estimate of average catch per net for each area and net type. Each part of the estimate has an associated variance estimate. These variances are combined to give an estimated daily variance. The daily estimates of catch and variance are expanded to total estimates of catch variance by area, net type and time period, usually semi-monthly. Following are the methodologies utilized for monitoring fall chinook harvest in each area and for subsequent data analyses.

Estuary Area

One field crew, consisting of one biologist and two Indian technicians, monitored the Estuary Area fishery from July 11 to September 30. Under preseason DOI regulations, the Estuary (part of DOI Management Area I) was open to gill net fishing weekly from Thursday at noon until Sunday at noon from July 15 to September 15. However, in-season adjustments, including liberalizing and closing the season, did occur. The crew monitored the estuary fishery every day the fishery was open between July 11 and September 30. In order to improve 1986 harvest and variance estimates, the Estuary Area was subdivided into two sections. Section 1 included the area from the mouth to Panther Creek and Section 2 included the area from Panther Creek to the Highway 101 Bridge (Figure 9).

Section 1 was a high effort area where nets were fished for varied lengths of time throughout the 24 hour day. Because the harvest rate varied widely in this section during a 24 hour period, each day was stratified into three 8 hour time periods: Day (10 AM - 6 PM), evening (6 PM - 2 AM) and morning (2 AM - 10 AM). Field crews conducted total net counts every 2 hours when monitoring the fishery. Indian fishers were interviewed to obtain information on number of fish caught, species identification and number of nets and hours fished. Indian fishers not contacted on the river were

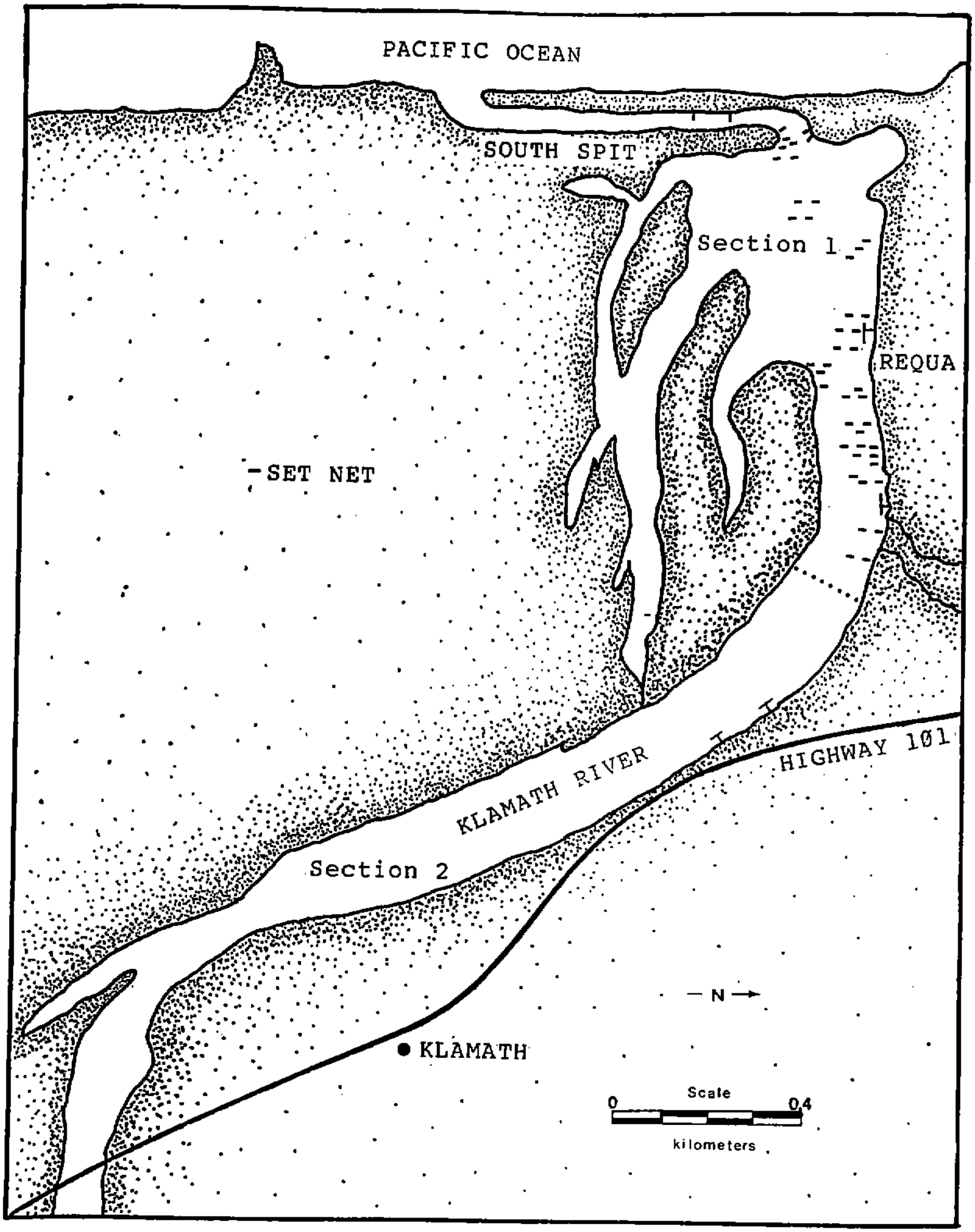

FIGURE 9. Section delineation and typical set net placement in the Estuary Area during the 1986 fall chinook salmon run.

interviewed later at their residences or camps. From this information, harvest and variance estimates were generated for each time strata.

Section 2 was characterized as having very low effort and nets were generally fished for a constant length of time (overnight). A single net count was conducted at dark each evening open to fishing. If nets were observed, the fishers were contacted the next morning at their camps. A single harvest and variance estimate was made daily. Interviews were conducted in a like manner to those in Section 1.

In addition to gathering catch data, fall chinook were bio-sampled in the estuary net fishery. Sampled fish were measured to the nearest centimeter fork length, examined for tags and fin-clips, and inspected for seal or otter-bite damage. Snouts were removed from adipose fin-clipped fish for subsequent coded-wire tag (CWT) identification. A subsample of chinook in the Estuary Area were weighed to the nearest pound and these weights were then converted to kilograms. Because weight samples could not be collected from the entire fall chinook run, additional fish were weighed during beach seine operations to insure a representative sample.

Middle Klamath Area

One field crew consisting of one biologist and one Indian technician, working from a camp near Omagar Creek, monitored the Middle Klamath Area (Figure 10) from July 25 to October 19. Under pre-season DOI regulations the Middle Klamath Area below Blake's Riffle was part of Management Area I and as such was open to gillnetting during the same period as the Estuary Area. The Middle Klamath Area above Blake's Riffle was part of Management Area II and was open for fishing under pre-season DOI regulations six days per week, beginning Tuesday at 5 PM and continuing until Monday at 9 AM from August 15 to September 30. In-season adjustments to the season occurred in that portion of the Middle Klamath Area within the DOI Area I management zone, however, no in-season adjustment was necessary for that part in the DOI Management Area II. The fishery was monitored 4 to 5 days per week from July 25 to October 19. To monitor the set net fishery, a total net count was conducted by boat after dark over the entire section of river. At dawn, the crew contacted Indian fishers and sampled the set net harvest.

To monitor the drift net fishery, total net counts were conducted by boat between 8 PM and 1 AM when drift netting typically occurs. The harvest was sampled either that evening or the following morning. Interviews with drift and set net fishers were conducted in a like manner to those in the Estuary Area.

Upper Klamath Area

One field crew, consisting of one biologist and one Indian technician working out of a camp at Johnson, monitored the Upper Klamath Area from August 1 to October 31 (Figure 11). Under DOI regulations, the Upper Klamath Area was included in Management Area II and as such was open during the same period as the Middle Klamath Area above Blake's Riffle. The crew monitored the fishery 4 to 5 days per week from August 1 to October 31. The sampling methodologies for set and drift net fisheries were the same as in the Middle Klamath Area.

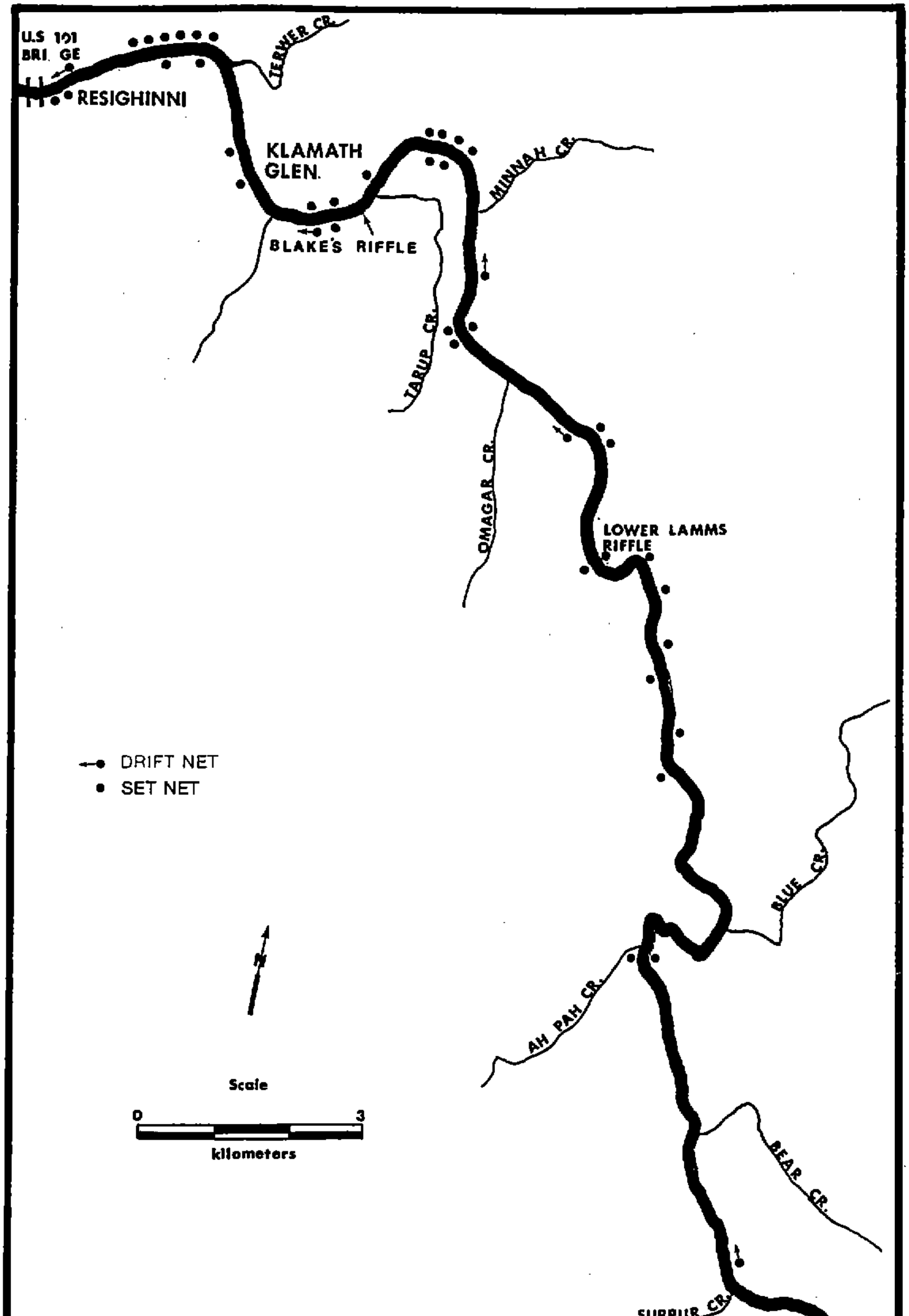

FIGURE 10. Typical net placement pattern in the Middle Klamath Area during the 1986 fall chinook salmon run.

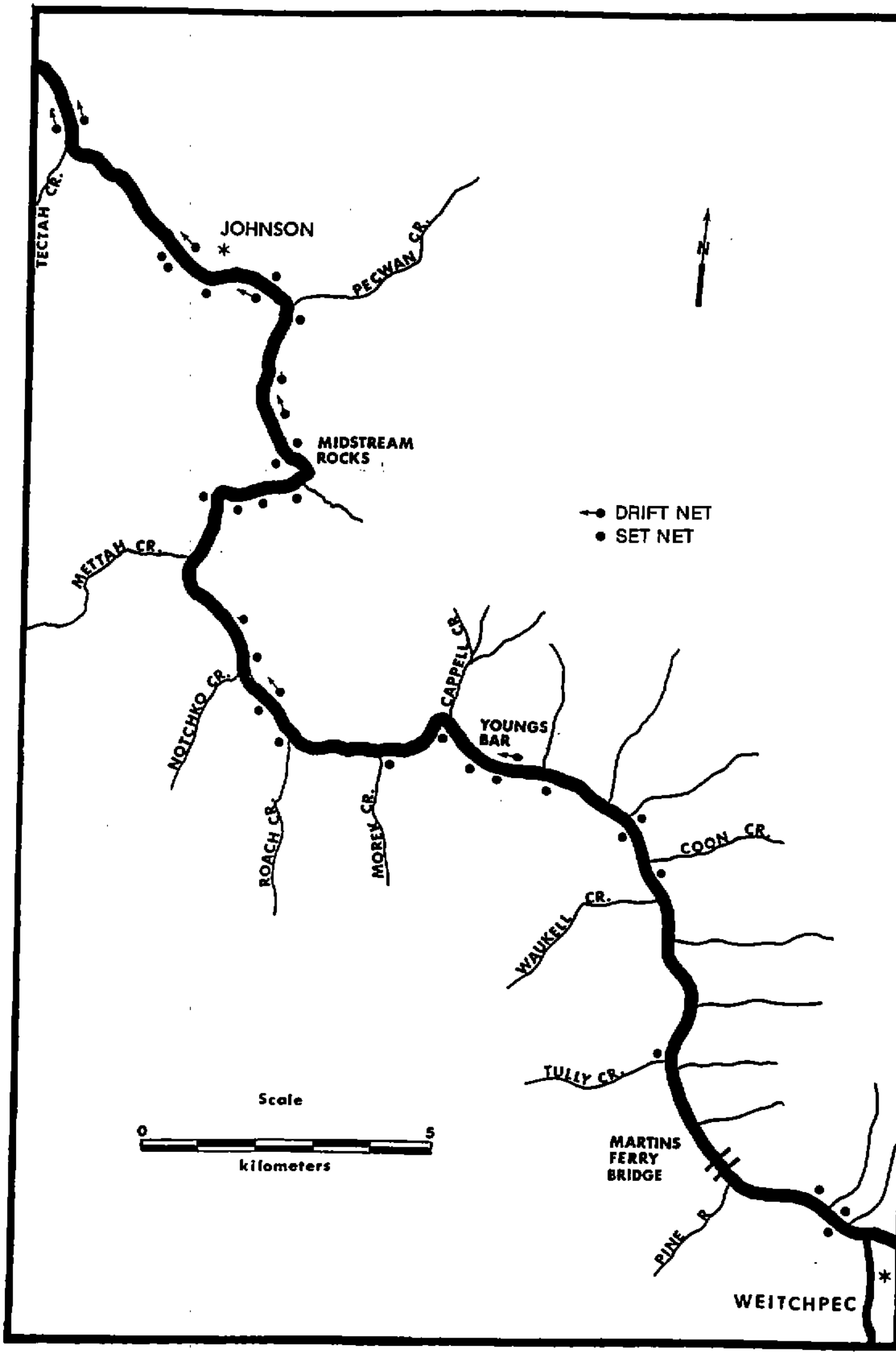

FIGURE 11. Typical net placement pattern in the Upper Klamath Area during the 1986 fall chinook salmon run.

Harvest Estimate and Associated Variance Calculations

Definitions and notations for all equations presented herein are summarized as follows:

a = Number of fishing days available in the time period.

$\overline{C}$ = Daily mean catch per net.

$\hat{C}_i$ = Estimated catch for the ith day.

$\hat{C}_{is}$ = Estimated catch for the sth strata in the ith day.

$\hat{C}_p$ = Estimated catch for the pth period.

s = Number of days sampled in the time period.

t = t value at the 95% level.

Y = Daily total number of nets fished.

y = Daily number of nets sampled.

$\hat{Y}_{is}$ = Estimated daily total number of nets fished.

$\hat{V}(\hat{C}_i)$ = Estimated variance of daily catch.

$\hat{V}(\hat{C}_{is})$ = Estimated variance for the sth strata in the ith day.

$V(\overline{C})$ = Variance of the mean catch per net.

$\hat{V}(\hat{C}_p)$ = Estimated variance of catch for the pth period.

$V(C_s)$ = Daily variance of catch.

$\hat{V}(\hat{Y})$ = Estimated variance of daily total number of nets fished.

Estuary (section 1) estimates ($\hat{C}_{is}$) of catch by strata and species were calculated by multiplying mean catch per net values by the respective estimated total number of nets fished in the strata:

$$(1a)\quad \hat{C}_{is} = (\hat{Y}_{is})(\overline{C}_{is})$$

Daily estimates of harvest by species were calculated by summing the three strata harvest estimates.

Estuary (section 2), Middle Klamath and Upper Klamath Areas estimates ($\hat{C}_i$) of catch by species were calculated by multiplying mean catch per net values by the respective total net count:

(1b) $\hat{C}_i = (Y)(\overline{C}_i)$

Since the harvest was not sampled every day fishing occurred, the harvest was estimated for time periods using the equation:

$$(2) \quad \hat{C}_p = (\hat{C}_i) \frac{a}{s}$$

These estimates of catch were summed to yield the season harvest estimate.

The variance associated with each Estuary (section 1) strata harvest estimate was calculated by using the equation (Goodman 1960):

$$(3a) \quad \hat{V}(\hat{C}_i) = (\overline{C})^2 [\hat{V}(\hat{Y})] + (\hat{Y})^2 [V(\overline{C})] - [\hat{V}(\hat{Y})] [V(\overline{C})]$$

The daily estimate of variance was calculated by summing the three strata estimates of variance.

The variance associated with daily harvest estimates in the Estuary (section 2), Middle Klamath and Upper Klamath Areas was calculated by using the equation:

$$(3b) \quad \hat{V}(\hat{C}_i) = V(\hat{C})(Y / y)$$

Because the catch variance is estimated on a daily basis, it must be expanded to include days fished but not sampled. The variance associated with the catch estimate for a time period is calculated by the equation (Cochran 1977):

$$(4) \quad \hat{V}(\hat{C}_p) = \frac{a(a-s) \quad (\hat{C}_i - \overline{C})^2}{s(a-1)} + \frac{a [\ \hat{V}(\hat{C}_s)]}{s}$$

Once the estimate and associated variance were calculated for a period, the corresponding 95% confidence interval was calculated by:

$$(5) \quad \text{95\% Confidence Interval} = \pm (t_{.975}) \frac{\hat{V}(\hat{C}_p)}{a}$$

Spring Fishery

FAO-Arcata personnel, operating from a camp at Requa, monitored the fishery from the mouth to Coon Creek (River km 60), (including the Estuary Area, Middle Klamath Area and a portion of the Upper Klamath Area), on a periodic basis from April 15 to June 15.

During the spring monitoring period, Indian fishers were contacted while in their boats, at their riverside camps, or at boat landings in the area. Information obtained included number of fish caught, species identification, mesh size, and number of nets fished. River surveys, including net counts, were scheduled to coincide with hours when fishers typically checked their nets. Indian fishers not contacted on the river were later interviewed at their residences. Chinook were bio-sampled in the spring net fishery in the same manner previously described for the fall fishery.

Procedures used in estimating net harvest for the three Klamath monitoring areas during the 1986 spring fishing period 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 (2) dividing these respective sums by the estimated percentage of net harvest these sums were judged to represent. These judgements were based on net counts, a network of contacts on the reservation and on intimate knowledge of the net fisheries. Spring chinook harvest estimates were determined monthly for each of the three areas.

Statistical analysis of data was limited to the t-test unless otherwise noted. The data were compared at the 95% confidence level.

RESULTS AND DISCUSSION

Fall Chinook

Of the fall chinook salmon harvested by Indian fishers on the Klamath River portion of the HVR in 1986, FAO-Arcata biologists sampled 5,047 fall chinook for tags and fin clips. Of these mark sampled salmon, 3,402 were measured to fork length. Net harvest in the Klamath River portion of the reservation was estimated at 20,887 ± 1,062 fall chinook salmon (Table 12), including 20,319 adults (97.3%) and 568 jacks (<57 cm). Among the three monitoring areas, 75.2% (15,286) of the adult harvest occurred in the Estuary Area. Jacks comprised 1.2% (191) of the total 1986 estuary catch. The Middle Area fishery comprised 12.3% (2,501) and the Upper Klamath fishery 12.5% (2,532) of the total 1986 adult harvest. Jacks accounted for 6.6% (176) and 7.4% (201) of the total Middle and Upper Klamath Area catches (Table 13). Corresponding 1986 fall chinook harvest estimates for the management areas established by the DOI are 16,308 adults and 263 jacks in Management Area I and 4,011 adults and 305 jacks in Management Area II.

TABLE 12. Semi-monthly net harvest estimates of fall chinook salmon captured in the three Klamath River monitoring areas of the Hoopa Valley Reservation under Department of Interior promulgated regulations in 1986.

Time Period	Estuary	Middle Klamath	Upper Klamath	Semi-Monthly Totals (All Areas)	Cumulative Seasonal Total
	NET HARVEST MONITORING AREA				
July 1 - 15	**32** 1/ 12 2/ 37.5% 3/ 15 4/	**0** - - -	**0** - - -	**32**	**32**
July 16 - 31	**415** 32 7.7% 151	**1** 1 100% 1	**0** - - -	**416**	**448**
August 1 - 15	**1,732** 97 5.6% 727	**53** 7 13.2% 35	**120** 9 7.5% 46	**1,905**	**2,353**
August 16 - 31	**8,977** 240 2.7% 3,989	**1,049** 62 5.9% 621	**650** 37 5.7% 314	**10,676**	**13,029**
September 1 - 15	**4,321** 262 6.1% 2,142	**1,317** 133 10.1% 693	**1,438** 81 5.6% 558	**7,076**	**20,105**
September 16 - 30	**0** - - -	**251** 41 16.3% 105	**416** 20 4.8% 203	**667**	**20,772**
October 1 - 15	**0** - - -	**6** 4 66.7% 3	**92** 8 8.7% 48	**98**	**20,870**
October 16 - 31	**0** - - -	**0** - - -	**17** 2 11.8% 9	**17**	
Area Season Total	**15,477** 664 4.3% 7,024	**2,677** 245 9.2% 1,458	**2,733** 157 5.7% 1178		**20,887** 1,066 5.1% 9,660

1/ Harvest estimate.
2/ 95% Confidence interval.
3/ Confidence interval percentage.
4/ Accounted number of fall chinook.

TABLE 13. The number and percentage of jack and adult fall chinook caught in the net fishery on the Klamath River portion of the HVR under Department of Interior promulgated regulations in 1986.

Area	Jack	(%)	Adult	(%)	Total	(%)
Estuary	191	(1.2%)	15,286	(98.8%)	15,477	(74.1%)
Middle Klamath	176	(6.6%)	2,501	(93.4%)	2,677	(12.8%)
Upper Klamath	201	(7.4%)	2,532	(92.6%)	2,733	(13.1%)
Total All Areas	568	(2.7%)	20,319	(97.3%)	20,887	(100.0%)

Most of the salmon harvested in the Estuary Area were taken between August 19 and September 7 with peak harvest occurring on September 6 (Figure 12). Under DOI regulations, the Estuary Area was open to fishing four days per week. In mid August the fishery was opened to fishing six days per week because it appeared the harvest would not reach the predetermined quota. On September 1, the fishery was restricted to the original opening of four days per week because of conflicts with the estuary sport fishery. The run peak extended longer than predicted and Management Area I reached it's quota on September 7. Subsequently, fishing was prohibited between September 8 and September 25. Very few fall chinook were caught after the estuary reopened on September 25. During the time period the estuary was open, daily catch estimates for fall chinook ranged from 0 to 1,753 compared to an estimated peak daily catch of 2,364 in 1985.

Comparison of 1986 catch per net night indices and peak harvest with those of seasons prior to 1985 are not possible because similar data were not collected each year owing to the different methods used to estimate the fishery. However, river flow continues to be the primary factor influencing total Estuary Area net fishery success. Annual seasonal net fishery catch per effort levels observed are inversely proportional to mean Klamath River summer flows (USFWS 1985). Higher flows impact the net fishery by creating more turbulent currents which reduce the amount of time a net will properly fish without being pulled out of the vertical fishing position or pulled off the bottom. The increase in the volume of water in the estuary during high flow periods presumably also make it less likely for fish to encounter the nets. During 1986, lower than average summer flows, 3,675 cfs as compared to the average summer flow of 4,281 cfs, appear to have influenced the daily catches observed.

The Middle and Upper Klamath Areas were also managed using time closures and quotas. However, in-season adjustment of the season was not necessary in

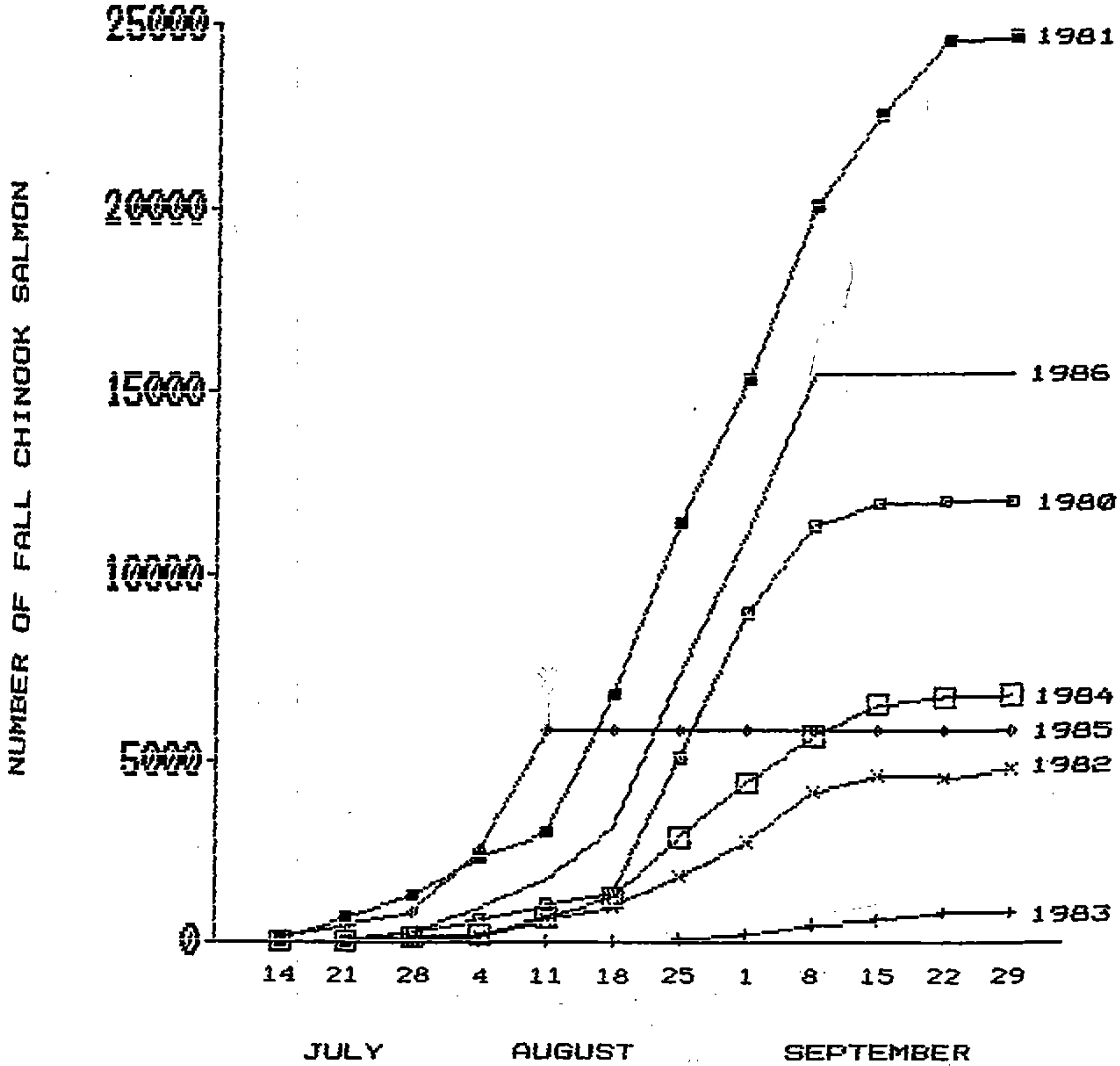

FIGURE 12. Cumulative estimated number of fall chinook salmon caught by Indian fishers in the Estuary Area of the Klamath River during 1980-1986.

1986, except for that portion of the Middle Klamath Area within DOI Management Area I. The portion of the Middle Klamath Area below Blake's Riffle (within DOI Management Area I) reopened to chinook harvest on September 25. Some chinook were harvested in this area after September 25, but the harvest rate was low.

Most of the fall chinook harvest in the Middle Klamath net fishery took place from August 16 to September 13 when 88% of the harvest occurred. In the Upper Klamath net fishery, the majority of the harvest occurred from August 18 to September 21 when 89% of the chinook were taken.

River flow does not appear to be a major influencing factor in the success of the upriver net fisheries. Annual seasonal catch per effort levels for the Indian fishers in the Middle and Upper Klamath Areas show no correlation with mean summer flows (USFWS 1985).

The length-weight relationship $\text{Log } W=-3.032 + 2.195 \text{ Log } L$ was determined from a sample of 171 chinook salmon ranging in fork length from 44 to 91 cm and in weight from 1.2 to 9.1 kg (Figure 13). Chinook jacks taken in the 1986 Klamath River net fishery averaged 47.9 cm fork length and 2.0 kg in weight, and adults averaged 76.2 cm and 5.7 kg. Combining jack and adult samples, the average fall chinook salmon captured in the Klamath River net fishery in 1986 measured 75.5 cm fork length and weighed 5.5 kg.

Based on annual length-weight regressions, a 75 cm chinook would on the average have weighed 5.5 kg in 1986. For comparison, a 75 cm chinook would have weighed 6.3 kg in 1985, 6.9 kg in 1984, 5.6 kg in 1983, 6.1 kg in 1982 and 6.3 kg in 1981.

Length-frequency comparisons of fall chinook harvested in the Estuary Area fishery over the last four years (Figure 14), show the 1986 fall chinook adult mean length, 78.1 cm, to be significantly greater ($p<0.05$) than the respective mean length of adults in the 1984 and 1983 but not significantly different ($p>0.05$) than the mean length in 1985. The mean length of jacks harvested in the Estuary Area in 1986 (47.9 cm) was significantly greater ($p<0.05$) than in 1983, but not significantly different ($p>0.05$) than in 1984 and 1985.

Length-frequency comparisons of adult fall chinook harvested in the three Klamath Areas in 1986 show that mean fork length in the Estuary was significantly greater ($p<0.05$) than the Upper and Middle Klamath Areas (Figure 15). In addition, a mean fork length comparison of adult chinook taken in the up-river fisheries showed Middle Klamath Area adult fall chinook were significantly larger ($p>0.05$) than Upper Klamath Area fish. Jacks displayed no significant differences ($p>0.05$) in mean fork length between Estuary and Middle areas. Jacks caught in the Middle Klamath Area were significantly larger ($p>0.05$) than jacks caught in the Upper Klamath Area.

Length-frequency distributions of fall chinook measured in the 1983-1986 combined net fisheries on the Klamath River portion of the HVR are presented in Figure 16. Mean lengths of adult chinook sampled in 1986 were significantly greater ($p<0.05$) than in 1983 and 1984, but were significantly smaller ($p<0.05$) than in 1985. Mean lengths of jacks sampled in 1986 were

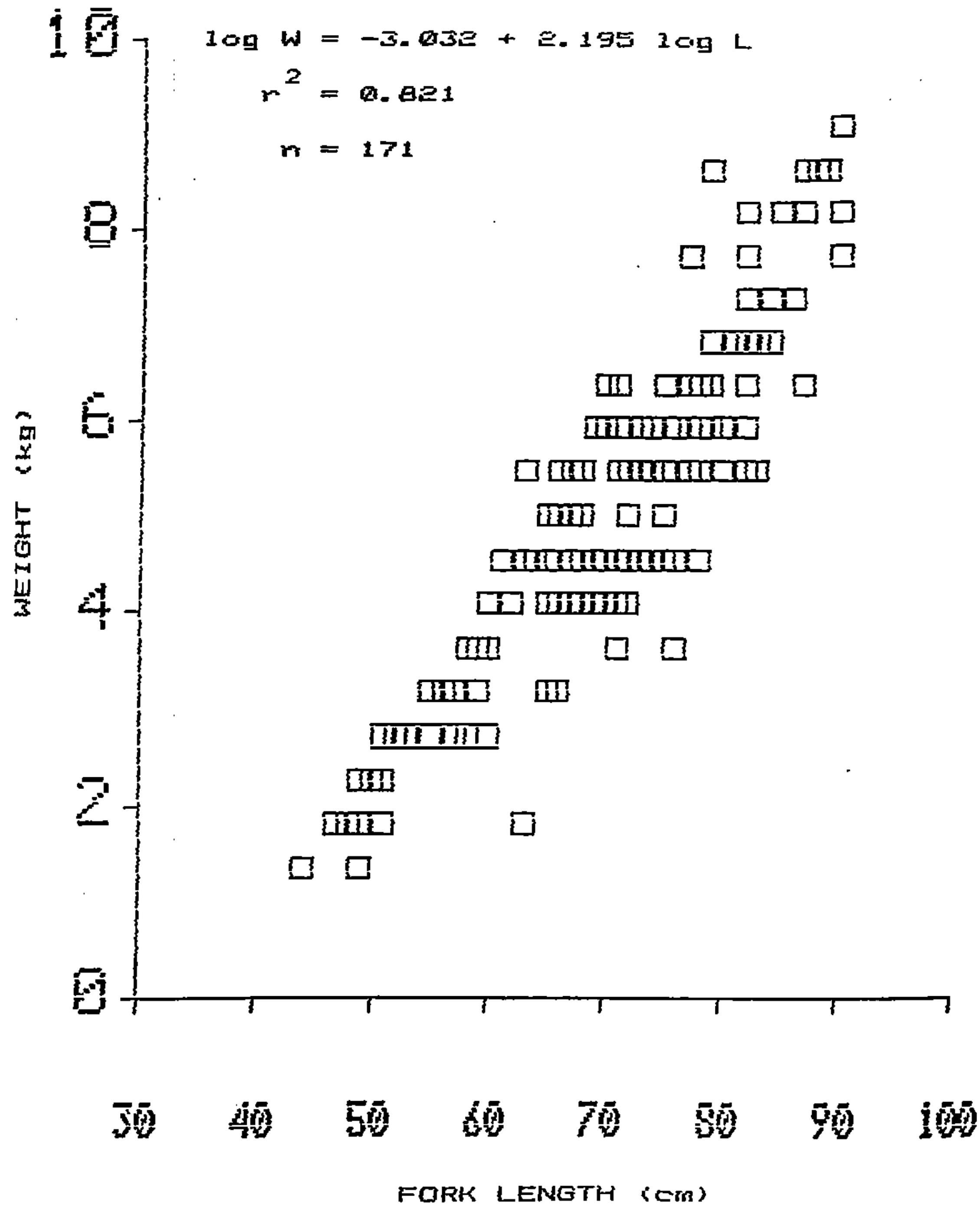

FIGURE 13. Length-weight relationship of fall chinook salmon caught by Indian fishers on the Lower Klamath River in 1986.

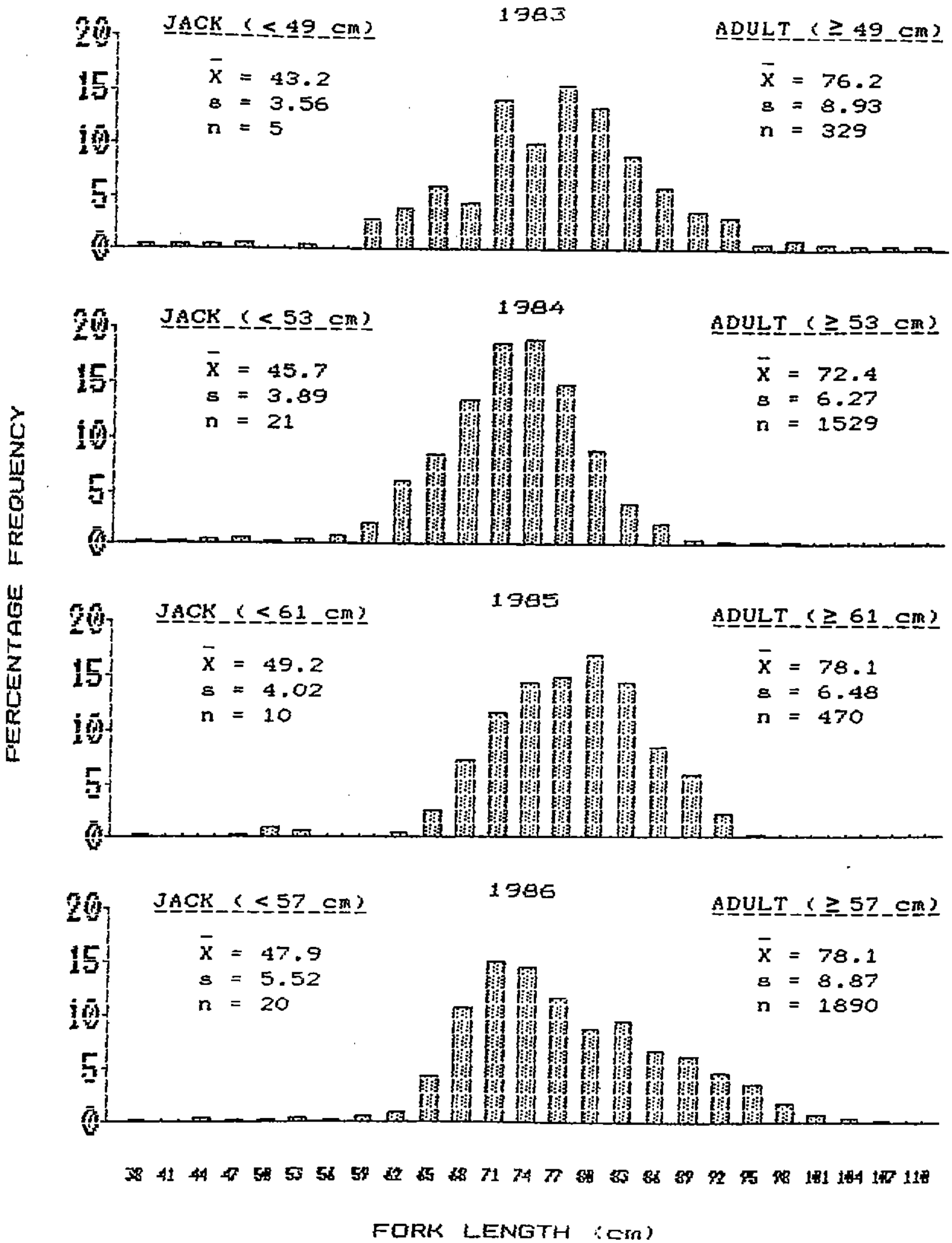

FIGURE 14. Length frequency distributions of fall chinook salmon caught by Indian gill net fishers in the Estuary Area during 1983-1986 (3 cm groupings with midpoints noted).

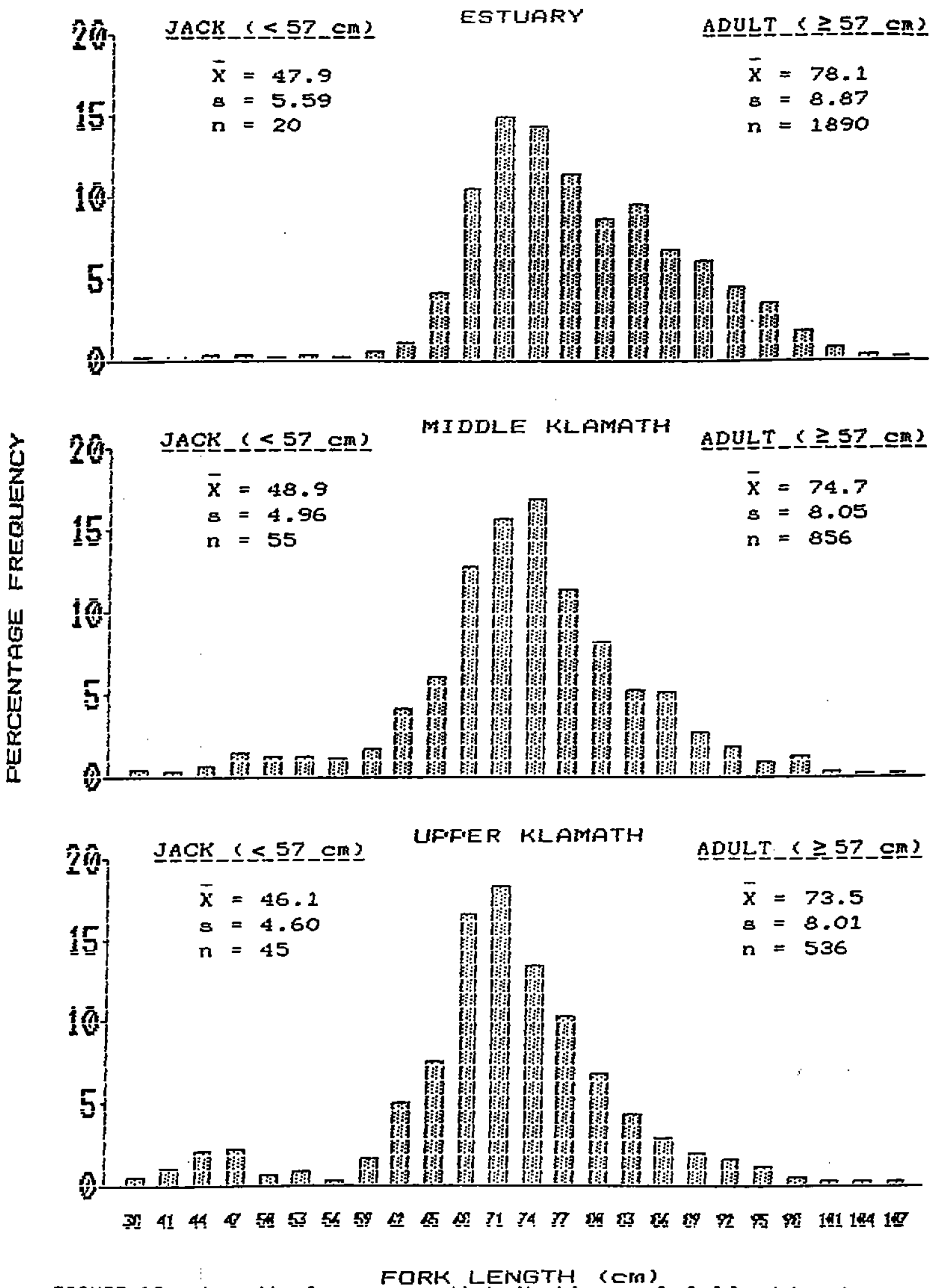

FIGURE 15. Length frequency distributions of fall chinook salmon caught by Indian gill net fishers in the Estuary, Middle Klamath, and Upper Klamath Areas in 1986 (3 cm groupings with midpoints noted).

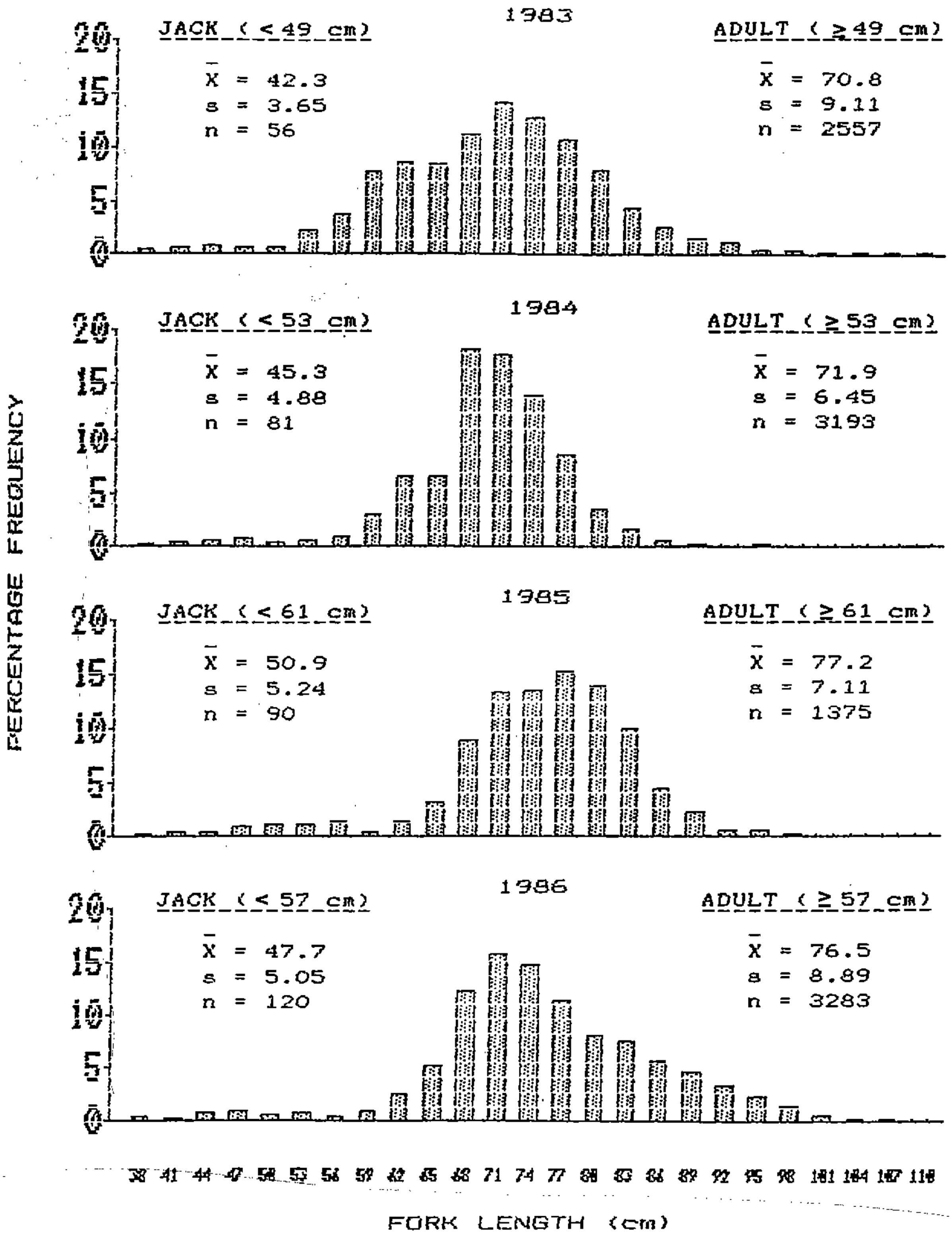

FIGURE 16. Length frequency distributions of fall chinook salmon caught by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1983-1986 (3 cm groupings with midpoints noted).

significantly greater ($p<0.05$) than in 1983 and 1984 but were significantly smaller ($p<0.05$) than in 1985.

Chinook exhibiting adipose fin-clips, representing various hatchery CWT release groups, comprised 9.2% of the total 1986 fall chinook net harvest in the Klamath River portion of the HVR (Table 14). Adipose fin-clipped adult chinook averaged 77.9 cm fork length and were significantly larger ($p<0.05$) than non-fin clipped adult chinook, which had a mean length of 75.9 cm.

TABLE 14. Fin-clipped fall chinook salmon observed in the 1986 Indian gill net fishery on the Klamath River portion of the Hoopa Valley Reservation.

		FIN CLIPS					
		AD		LV		RV	
Area	Mark Sample	N	%	N	%	N	%
Estuary	3,500	304	8.7	104	3.0	26	0.7
Middle Klamath	911	91	10.0	10	1.1	4	0.4
Upper Klamath	636	68	10.7	6	0.9	3	0.5
Total	5,047	463	9.2	120	2.4	33	0.7

Right and left ventral (RV and LV) fin-clipped fall chinook, representing a constant fractional marking program for Trinity River (TRH) and Iron Gate (IGH) hatcheries, entered the net fishery as 4- and 5-year-olds in 1986. Totals of 120 LV (IGH) and 33 RV (TRH) clipped chinook were sampled in the 1986 Klamath River net harvest (Table 14). In 1986, mean lengths of RV-clipped adult chinook sampled in the net fishery were not significantly different ($p>0.05$) than LV-clipped adults.

Seal and otter depredation of chinook salmon taken in the Klamath River net fisheries continues to be a problem. In the Estuary Area 5.6% of the sampled 1986 fall chinook harvest was observed with seal (Phoca vitulina) or sea lion (Zalophus californianus and Eumetopias jubatus) bites. This is about twice the percentage observed in 1985 and probably reflects the reduced time available for fishing in 1985. With reduced fishing time, fishers tended their nets more closely than in 1986 which reduced the availability of chinook for depredation. Seal bites were also observed in the upper river areas, but these could have occurred while the fish were in the lower river. It should be noted that depredation percentages presented here represent minimum values, since they do not take into account fish removed from nets by predators or severely damaged fish discarded and not reported by Indian fishers. It should also be pointed out that most of the fish that exhibit seal bites are fully utilized by the Indian fishers and do not represent a "lost fish".

In the Middle and Upper Klamath Areas, 2.4% and 6.3% of the sampled 1986 fall chinook salmon netted exhibited bite marks, apparently from river otter Lutra canadensis. These are comparable to previous years percentages and should also be considered minimums. Netted fish were also reported being removed and eaten by black bear Ursus americanus.

Spring Chinook

The spring chinook 1986 net harvest on the Klamath River portion of the HVR was estimated at 706, including 692 adults and 14 jacks (<52 cm). Harvest of spring chinook began in April and continued through July with the majority of the catch occurring in May. The Upper Klamath Area fishery accounted for 70.5% of the Klamath River harvest, followed by the Middle Klamath Area (23.7%) and the Estuary Area (5.8%) fisheries (Table 15). The mean length of adult spring chinook harvested in the net fishery in 1986 (74.0 cm) was not significantly different ($p>0.05$) than that of fish harvested in 1983-1985 (Figure 17).

In 1986, adipose fin-clipped salmon comprised 17.3% of the 52 spring chinook salmon sampled during spring time net harvest monitoring. The ad-clip rate in the net fishery reflected the percentage of tagged 1982 brood spring chinook released from the Trinity River Hatchery. The similarity of ad-clip rates appears to indicate that the Indian gill net fishery was primarily supported by hatchery produced spring chinook.

TABLE 15. Monthly net harvest estimates of spring chinook salmon captured in the three Klamath River monitoring areas of the Hoopa Valley Reservation in 1986.

Month	NET HARVEST MONITORING AREA			Cumulative Monthly Total (All Areas)	Seasonal Total
	Estuary	Middle Klamath	Upper Klamath		
April	5	54	98	157	157
May	6	37	76	119	276
June	15	71	169	255	531
July	15	5	155	175	706
TOTAL	41	167	498	706	
PERCENTAGE	5.8%	23.7%	70.5%		

Table 16 summarizes spring and fall chinook harvest estimates for the years 1977-1986.

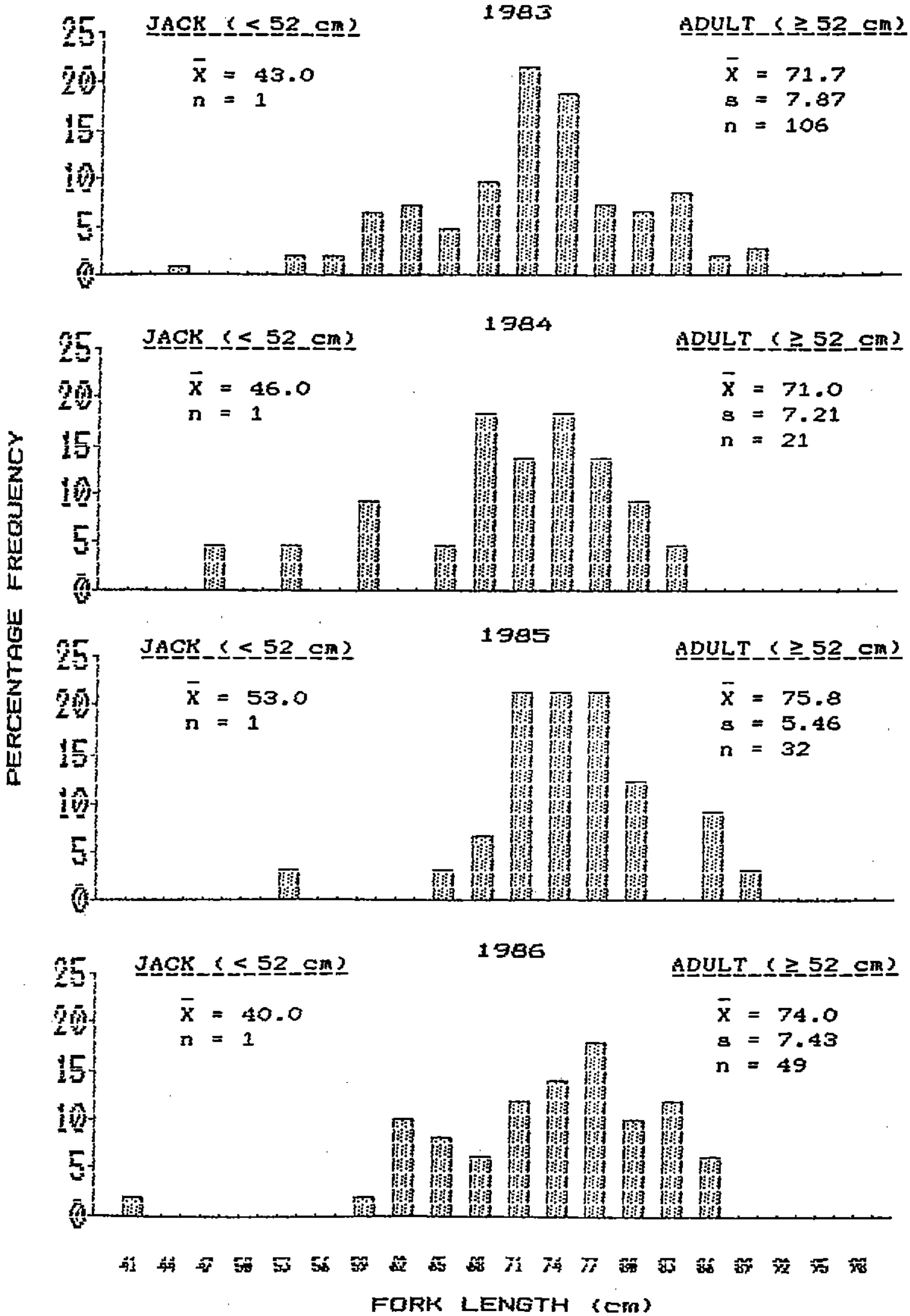

FIGURE 17. Length frequency distributions of spring chinook salmon caught by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1983-1986 (3 cm groupings with midpoints noted).

TABLE 16. Harvest estimates of spring and fall chinook salmon taken in the net fishery on the Hoopa Valley Reservation during 1977-1986[1/].

	SPRING CHINOOK			FALL CHINOOK		
Year	Jacks	Adults	Total	Jacks	Adults	Total
1977	--	--	--	2,700	27,300	30,000
1978	--	--	--	1,800	18,200	20,000
1979	--	--	--	1,350	13,650	15,000
1980	20	980	1,000	987	12,013	13,000
1981	57	2,807	2,864	2,465	33,033	35,498
1982	45	3,155	3,200	1,799	14,482	16,281
1983	10	585	595	163	7,890	8,053
1984	12	627	639	455	18,670	19,125
1985	160	2,074	2,234	1,555	11,566	13,121
1986	95	2,714	2,809	854	25,127	25,981

1/ Estimates for 1983-1986 Trinity River net fishery were obtained from the Hoopa Valley Business Council, Fisheries Department. All other harvest estimated by the U.S. Fish and Wildlife Service by methods described in previous annual reports.

CODED-WIRE TAG RECOVERY INVESTIGATIONS

INTRODUCTION

Two hatcheries operated by the California Department of Fish and Game (CDFG) 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 (Figure 1). Three release strategies are represented by groups of coded-wire tagged (CWT) juvenile chinook salmon at the two hatcheries: fingerlings in June, yearlings in October and yearling-plus in March. In addition, several fingerling and yearling groups are released at off-site (away from the hatchery) locations. In 1983, CDFG began to implant natural spawned fingerling chinook with CWT's as part of their natural stock assessment program. The number of tagged fish is small relative to CWT hatchery releases. However, recoveries of these CWT fish were made in 1986 and future contributions to the Klamath River fishery are anticipated.

Different release strategies introduce variation that must be analyzed in order to evaluate their individual effectiveness. Information must also be gathered to assess fishery related impacts acting on existing fish stocks. With this realization, FAO biologists conducted CWT recovery efforts in conjunction with 1986 net harvest monitoring activities on the Klamath River portion of the Hoopa Valley Reservation.

METHODS

Methods of acquiring CWT samples during net harvest monitoring field activities were previously described in this report. Coded-wire tags from the field samples were recovered from salmon heads with the aid of a magnetic field detector. Tags were then decoded with the aid of an American Optical 507 dissecting scope. If no tag was detected, the head was dissolved in a potassium hydroxide (KOH) solution for 48 hours. A magnet was then stirred through the resultant slurry to recover tags that did not activate the magnetic field detector.

Recovery data for each CWT group were expanded to estimate contribution to the net harvest by time and area. Contribution estimates are the product of actual observed tag codes and an expanded tag factor. The expanded tag factor varies with each sampling period and is the product of three ratios:

(1) $$\text{Sampling Ratio} = \frac{\text{Estimated Net Harvest}}{\text{Number of Fish Examined for Ad-Clips}}$$

(2) $$\text{Head Recovery Ratio} = \frac{\text{Number of Ad-Clipped Fish Observed}}{\text{Number of Heads Recovered}}$$

(3) Lost Tag Ratio = $\frac{\text{Number of Heads with Tags}}{\text{Number of Tags Decoded}}$

The expansion adjusts for that portion of the harvest not sampled, the non-recovery of heads from observed adipose fin-clipped fish and tags lost during dissection. Tag codes originating from outside the river basin were expanded at a rate of 1:1. The number of heads dissected from which tags were not recovered were expanded using a no-tag expansion factor. The no-tag expansion factor is the product of the Harvest Sampling Ratio (1) and the Head Recovery Ratio (2).

Contribution rates of individual CWT groups to the Indian net fishery were calculated and expressed as a percentage:

(4) Contribution Rate (%) = $\frac{\text{Estimated CWT Harvest}}{\text{Number of Tagged Fish Released}} \times 100$

The contribution rate compensates for unequal release-size bias and allows for comparison of different release strategies.

Statistical analysis of data was limited to the t-test unless otherwise noted. The data were compared at the 95% confidence level.

RESULTS AND DISCUSSION

Fall Chinook

Coded-wire tag recoveries from fall chinook in the 1986 Indian net harvest totaled 178, all of which were obtained through the net harvest monitoring program (Table 17). The mark-sampled recoveries expanded to an estimated 1,438 fall chinook representing 34 release groups: 19 from TRH, 12 from IGH, 2 of natural origin and 1 from Cole Rivers Hatchery of the Rogue River. Additionally, an estimated 362 (20.1%) of the ad-clipped fall chinook harvested did not contain CWT's and could not be assigned to a rearing origin.

Contribution rates of CWT groups vary with type and site of release (Table 18). Juveniles released as yearlings at both IGH and TRH contribute to the net fishery at higher rates than those released as fingerlings. Differences between on-site and off-site releases are only evident in those groups of TRH origin. Off-site releases at TRH contribute to the Indian gill net fishery at significantly ($p<0.05$) higher rates than on-site releases. Basin-wide comparisons are not valid because of differences in tag shedding rates at the two hatchery facilities.

In general, releases from IGH contribute to the gill net fishery at higher rates than those from TRH. At present, this difference is thought to be the result of different maturation schedules and gill net selectivity of the two stocks. TRH stocks, which appear to be dominated by three-year-old fish, may be less susceptible to capture in the net fishery than fish of IGH origin, which appear to be dominated by four-year-old chinook.

TABLE 17. Actual and expanded (underlined) CWT groups recovered during mark sampling of fall chinook salmon in the 1986 gill net fishery on the Klamath River portion of the Hoopa Valley Reservation.

Tag Code	Brood Year	Hatchery[1] of Origin	Release[2] Type	RESERVATION MONITORING AREA: Estuary (actual)	Estuary (expanded)	Middle Klamath (actual)	Middle Klamath (expanded)	Upper Klamath (actual)	Upper Klamath (expanded)	All Areas (actual)	All Areas (expanded)
06-50-10	1982	IGH	Y	12	111	2	7	0	0	14	118
05-50-11	1982	IGH	Y	10	99	3	42	2	6	15	147
06-56-07	1982	TRH	F[3]	2	21	0	0	0	0	2	21
06-56-08	1983	TRH	F[3]	1	10	1	3	3	12	5	25
06-56-09	1982	TRH	Y[3]	2	21	0	0	0	0	2	21
06-56-10	1982	TRH	Y[3]	1	6	0	0	1	7	2	13
06-56-11	1982	TRH	Y[3]	3	23	1	2	2	13	6	38
06-56-12	1983	TRH	F[3]	5	44	4	23	3	13	12	80
06-56-13	1983	TRH	F[3]	4	37	1	35	5	33	10	105
06-56-15	1983	TRH	Y[3]	1	10	0	0	2	16	3	26
06-56-18	1984	TRH	F[3]	0	0	1	3	2	13	3	16
06-56-21	1984	TRH	Y[3]	0	0	0	0	1	7	1	7
06-56-24	1984	TRH	Y+	0	0	1	3	1	3	2	6
06-59-08	1982	IGH	Y	18	165	4	31	4	20	26	216
06-59-09	1982	IGH	F	4	30	1	3	1	7	6	40
06-59-10	1982	IGH	F[3]	3	29	0	0	0	0	3	29
06-59-11	1982	IGH	Y[3]	3	27	0	0	0	0	3	27
06-59-20	1982	IGH	F[3]	1	10	0	0	0	0	1	10
06-59-23	1983	IGH	F	3	32	0	0	1	6	4	38
06-59-24	1983	IGH	F	6	62	2	14	1	4	9	80
06-59-25	1983	IGH	Y[3]	2	21	0	0	1	4	3	25
06-59-26	1983	IGH	Y	1	11	1	12	2	11	4	34
06-59-32	1983	IGH	Y	1	10	0	0	0	0	1	10
06-61-13	1983	TRH	Y	2	21	0	0	4	41	6	62
06-61-23	1982	TRH	F[3]	0	0	0	0	1	7	1	7
06-61-24[4]	1982	TRH	F	3	23	0	0	1	4	6	51
06-61-25	1982	TRH	F[3]	3	27	0	0	0	0	3	27
06-61-26	1983	TRH	F	7	63	2	7	4	17	13	87
06-61-27	1984	TRH	F	0	0	0	0	1	6	1	6
06-61-29	1982	TRH	Y	4	37	0	0	0	0	4	37
06-63-01	1983	TRH	Y+	0	0	0	0	2	13	2	13
07-26-14	1982	CRH	Y	2	2	1	1	0	0	3	3
B6-08-02	1983	WILD	F	0	0	0	0	1	6	1	6
B6-08-04	1984	WILD	F	0	0	0	0	1	7	1	7
TOTAL TAGS				104	952	25	186	47	276	178	1438
AD - NO TAGS				28	255	7	72	6	35	41	362

1/ IGH - Iron Gate Hatchery
TRH - Trinity River Hatchery
CRH - Cole Rivers Hatchery - Rogue River
WILD - Wild Stock Assessment Program - Bogus Creek Stock

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

3/ Off-site release

4/ Total includes fish harvested in May and June during the spring chinook fishery

TABLE 18. Contribution rate of CWT age 3 and 4 fall chinook to the Indian net fishery on the Klamath River portion of the Hoopa Valley Reservation.

Tag Code	Brood Year	Rearing 1/ Facility	Release 2/ Type	NUMBER HARVESTED 3/ 3	4	Total	Number 4/ Released Tagged	Contribution 5/ Rate
06-59-02	1979	IGH	Y	26	59	85	91,000	.093
06-59-03	1979	IGH	F	81	21	102	189,420	.054
06-61-09	1979	TRH	Y	49	32	81	90,995	.089
06-61-16	1979	TRH	F	14	5	19	188,727	.010
06-61-17	1979	TRH	F 6/	141	49	190	193,897	.098
06-61-20	1979	TRH	Y+	105	39	144	82,982	.174
06-59-05	1980	IGH	F	50	47	97	185,857	.052
06-59-06	1980	IGH	Y	28	254	282	87,450	.322
06-61-18	1980	TRH	F	0	0	0	201,090	0
06-61-21	1980	TRH	Y	25	37	62	104,160	.060
06-52-01	1981	HVBC	F	72	0	72	34,000	.212
06-59-04	1981	IGH	Y	0	39	39	65,385	.060
06-59-07	1981	IGH	F	154	125	279	159,092	.175
06-59-18	1981	IGH	Y	0	32	32	25,586	.125
06-59-19	1981	IGH	Y	0	37	37	30,781	.120
06-61-19	1981	TRH	F	0	15	15	192,795	.008
06-61-22	1981	TRH	Y	18	51	79	94,991	.083
06-50-10	1982	IGH	Y	22	118	140	39,127	.357
06-50-11	1982	IGH	Y	50	147	197	36,997	.243
06-56-07	1982	TRH	Y 6/	0	21	21	88,854	.024
06-56-09	1982	TRH	Y 6/	22	21	43	20,765	.207
06-56-10	1982	TRH	Y 6/	19	13	32	20,902	.153
06-56-11	1982	TRH	Y 6/	70	38	108	21,223	.509
06-59-08	1982	IGH	Y	129	216	345	70,171	.492
06-59-09	1982	IGH	F	23	40	63	158,824	.040
06-59-10	1982	IGH	F 6/	60	29	89	83,023	.107
06-59-11	1982	IGH	Y 6/	56	27	83	13,880	.598
06-59-20	1982	IGH	F 6/	0	10	10	47,040	.021
06-61-23	1982	TRH	F 6/	4	7	11	90,242	.012
06-61-24	1982	TRH	F	9	51	360	138,801	.043
06-61-25	1982	TRH	F 6/	0	27	27	90,694	.030
06-61-29	1982	TRH	Y	86	37	123	96,583	.127
06-56-08	1983	TRH	F 6/	25	-	25	91,153	.027
06-56-12	1983	TRH	F 6/	80	-	80	97,311	.082
06-56-13	1983	TRH	F 6/	105	-	105	100,227	.105
06-56-14	1983	TRH	Y 6/	0	-	0	25,547	0
06-56-15	1983	TRH	Y 6/	26	-	26	25,754	.101
06-56-16	1983	TRH	Y 6/	0	-	0	26,171	0
06-59-23	1983	IGH	F	38	-	38	191,352	.020
06-59-24	1983	IGH	F 6/	80	-	80	97,566	.082
06-59-25	1983	IGH	Y	25	-	25	94,738	.026
06-59-26	1983	IGH	Y	34	-	34	23,725	.143
06-59-31	1983	IGH	Y	0	-	0	22,599	0
06-59-32	1983	IGH	Y	10	-	10	24,830	.040
06-59-33	1983	IGH	Y	0	-	0	23,766	0
06-61-13	1983	TRH	Y	62	-	62	100,520	.062
06-61-26	1983	TRH	F	87	-	87	191,094	.046
06-63-01	1983	TRH	Y+	13	-	13	92,965	.014

1/ IGH - Iron Gate Hatchery
TRH - Trinity River Hatchery
HVBC - Hoopa Valley Business Council Hatchery

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

3/ Estimated number of coded-wire tagged fall chinook

4/ From Pacific Marine Fisheries Commission CWT release data (PMFC 1985)

5/ Contribution rate = estimated number harvested / number released tagged X 100

6/ Off-site release

The age composition of fall CWT chinook harvested in the 1986 Indian net fishery was 2.5% 2-year-olds, 41.1% 3-year-olds and 56.4% 4-year-olds. Age composition in the net harvest shifted from a 3-year-old majority in 1985 to a 4-year-old majority in 1986. The decline in jack percentage most likely is a reflection of a decrease in overall mean jack length. It is of interest to compare age composition data from the two different sampling programs at FAO-Arcata, i.e., the net harvest monitoring program and the beach seining program. Of 96 3- and 4-year-old ad-clipped fish aged by the seining operation, 76 (79.2%) were 3-year-olds. CWT expansion data from the net harvest program indicates that of 1,387 3- and 4-year-old fish, only 585 (42.2%) were 3-year-olds. If the net harvest information is restricted to the estuary, as is that of the beach seine program, only 34.0% of the CWT recoveries are 3-year-old fish.

It should be noted that TRH stocks return later in the season than those of IGH origin. Late season closures, particularly in the estuary, may therefore potentially bias the CWT data. Nevertheless, existing information suggests a need for study on the effects of gill net selectivity in the Klamath River basin.

Mean lengths of coded-wire tag groups harvested in 1986 did not differ significantly ($p>0.05$) from those harvested in 1985 (Table 19). Significantly smaller ($p<0.05$) mean lengths of CWT groups harvested in 1983 and 1984 are thought to be a reflection of the 1982-83 El Niño oceanographic effect (USFWS 1986). Comparisons of 1986 CWT groups and those prior to 1983 showed no significant differences ($p>0.05$) in mean lengths.

Traditionally, fall and spring chinook salmon have distinctive run times. Spring fish are usually caught in April and May, whereas fall chinook in the net fishery are caught from August through October. In 1986, however, several CWT fall chinook were captured in the spring gill net fishery (Table 17). Similarly, several CWT spring fish were captured in the fall fishery. Further development of this trend would have serious management implications. Consequently, this issue will become one of significance when evaluating existing hatchery programs.

Spring Chinook

Coded-wire tag recoveries from spring chinook salmon in the 1986 Indian net harvest totaled 22, all of which were obtained from the net harvest monitoring program (Table 20). These recoveries expanded to an estimated 159 spring fish representing four release groups. Spring fish captured in the fall fishery are included in Table 20.

Contribution rates of CWT spring chinook to the Indian gill net fishery have been declining steadily since 1982. This decline is most likely due to the decline in CWT spring chinook releases from TRH in the last four years.

Information on age contribution is limited to three release groups in 1986. A majority of the CWT spring fish captured in the net fishery can be attributed to the release group 06-61-40. Yearling releases contribute to the spring gill net fishery at higher rates than do fingerling released CWT groups (Table 21). However, contribution rates of yearling release groups and off-site fingerling release groups are not significantly different.

TABLE 19. Mean fork length (cm), standard deviation and number of recoveries for 34 fall chinook CWT groups harvested in the Klamath River portion of the Hoopa Valley Reservation in 1986.

Tag Code	Brood Year	Hatchery[1/] of Origin	Release[2/] Type	RESERVATION MONITORING AREA Estuary	Middle Klamath	Upper Klamath	All Areas
06-50-10	1982	IGH	Y	88.7[3/]	74.5	---	86.6
				7.6[4/]	16.2	---	9.8
				12[5/]	2	0	14
06-50-11	1982	IGH	Y	88.1	86.7	77.0	86.3
				9.2	9.6	5.6	9.2
				10	3	2	15
06-56-07	1982	TRH	F[6/]	74.0	---	---	74.0
				5.6	---	---	5.6
				2	0	0	2
06-56-09	1982	TRH	Y[6/]	83.5	---	---	83.5
				4.9	---	---	4.9
				2	0	0	2
06-56-10	1982	TRH	Y[6/]	75.0	---	85.0	80.0
				---	---	---	7.1
				1	0	1	2
06-56-11	1982	TRH	Y[6/]	79.3	82.0	80.5	80.2
				3.0	---	2.1	2.4
				3	1	2	6
06-59-08	1982	IGH	Y	83.4	84.5	85.3	83.8
				6.4	11.3	11.9	7.8
				18	4	4	26
06-59-09	1982	IGH	F	82.8	81.0	80.0	82.0
				7.3	---	---	5.8
				4	1	1	6
06-59-10	1982	IGH	F[6/]	78.0	---	---	78.0
				1.0	---	---	1.0
				3	0	0	3
06-59-11	1982	IGH	Y[6/]	81.0	---	---	81.0
				10.5	---	---	10.5
				3	0	0	3
06-59-20	1982	IGH	F[6/]	82.0	---	---	82.0
				---	---	---	---
				1	0	0	1
06-61-23	1982	TRH	F[6/]	---	---	68.0	68.0
				---	---	---	---
				-	0	1	1
06-61-24[7/]	1982	TRH	F	79.0	---	80.0	79.0
				6.5	---	---	6.3
				3	0	1	6
06-61-25	1982	TRH	F[6/]	85.7	---	---	85.7
				5.1	---	---	5.1
				3	0	0	3
06-61-29	1982	TRH	Y	78.0	---	---	78.0
				7.6	---	---	7.6
				4	0	0	4
07-26-14	1982	CRH	Y	87.0	84.0	---	86.0
				5.6	---	---	4.4
				2	1	0	3
06-56-08	1983	TRH	F[6/]	75.0	69.0	69.7	70.6
				---	---	5.1	4.4
				1	1	3	5

1/ TRH - Trinity River Hatchery
IGH - Iron Gate Hatchery
CRH - Cole Rivers Hatchery
WILD - Wild Stock Assessment Program

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

3/ Mean fork length (cm)

4/ Standard deviation

5/ Number in sample

6/ Off-site release

7/ Includes fish harvested in May and June during the spring chinook fishery

TABLE 19. (Continued)
Mean fork length (cm), standard deviation and number of recoveries for 34 fall chinook CWT groups harvested in the Klamath River portion of the Hoopa Valley Reservation in 1986.

Tag Code	Brood Year	Hatchery[1/] of Origin	Release[2/] Type	RESERVATION MONITORING AREA Estuary	Middle Klamath	Upper Klamath	All Areas
06-56-12	1983	TRH	F[6/]	71.0[3/]	72.8	74.0	72.3
				4.8[4/]	6.5	4.5	5.1
				5[5/]	4	3	12
06-56-13	1983	TRH	F[6/]	74.0	70.0	73.6	73.4
				5.3	---	5.3	4.9
				4	1	5	10
06-56-15	1983	TRH	Y[6/]	73.0	---	68.5	70.0
				---	---	3.5	3.6
				1	0	2	3
06-59-23	1983	IGH	F	68.7	---	73.0	69.8
				1.5	---	---	2.5
				3	0	1	4
06-59-24	1983	IGH	F[6/]	72.0	68.5	74.0	71.4
				3.3	4.9	---	3.6
				6	2	1	9
06-59-25	1983	IGH	Y	68.5	---	64.0	67.0
				3.5	---	---	3.6
				2	0	1	3
06-59-26	1983	IGH	Y	74.0	72.0	66.5	69.8
				---	---	3.5	4.3
				1	1	2	4
06-59-32	1983	IGH	Y	71.0	---	---	71.0
				---	---	---	---
				1	0	0	1
06-61-13	1983	TRH	Y	75.0	---	68.5	70.7
				2.8	---	4.5	5.0
				2	0	4	6
06-61-26	1983	TRH	F	72.6	67.0	71.5	71.4
				3.4	2.8	4.5	3.9
				7	2	4	13
06-63-01	1983	TRH	Y+	---	---	60.0	60.0
				---	---	1.4	1.4
				0	0	2	2
B6-08-02	1983	WILD	F	---	---	76.0	76.0
				---	---	---	---
				0	0	1	1
06-56-18	1984	TRH	F[6/]	---	49.0	49.5	49.3
				---	---	2.1	1.5
				0	1	2	3
06-56-21	1984	TRH	Y[6/]	---	---	46.0	46.0
				---	---	---	---
				0	0	1	1
06-56-24	1984	TRH	Y+	---	38.0	36.0	37.0
				---	---	---	1.4
				0	1	1	2
06-61-27	1984	TRH	F	---	---	47.0	47.0
				---	---	---	---
				0	0	1	1
B6-08-04	1984	WILD	F	---	---	49.0	49.0
				---	---	---	---
				0	0	1	1

1/ TRH - Trinity River Hatchery
IGH - Iron Gate Hatchery
CRH - Cole Rivers Hatchery
WILD - Wild Stock Assessment Program

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

3/ Mean fork length

4/ Standard deviation

5/ Number in sample

6/ Off-site release

7/ Includes fish harvested in May and June during the spring chinook fishery

TABLE 20. Mean fork length (cm), standard deviation, and actual and expanded (underlined) recoveries for spring chinook CWT groups harvested in the net fishery on the Klamath River portion of the Hoopa Valley Reservation in 1986.

Tag Code	Brood Year	Hatchery[1/] of Origin	Release[2/] Type	CWT Recoveries		Mean Fork Length	Standard Deviation
06-61-38	1982	TRH	Y	6	50	81.0	7.0
06-61-40	1983	TRH	Y	14	96	71.3	6.0
06-61-41	1982	TRH	F	1	12	76.0	---
07-28-53	1982	CRH	Y	1	1	--- [3/]	---
TOTALS				22	159		

1/ TRH - Trinity River Hatchery
CRH - Cole Rivers Hatchery

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

3/ No Length Sample

TABLE 21. Contribution rate of CWT age 3 and 4 spring chinook to the Indian net fishery on the Klamath River portion of the Hoopa Valley Reservation.

Tag Code	Brood Year	Rearing[1/] Facility	Release[2/] Type	NUMBER HARVESTED[3/] 3	4	Total	Number[4/] Released Tagged	Contribution[5/] Rate
06-61-11	1978	TRH	F[6/]	163	47	210	192,800	0.109
06-61-12	1978	TRH	F	69	11	80	170,800	0.047
06-61-30	1978	TRH	Y	126	541	667	191,916	0.348
06-61-31	1978	TRH	Y+	25	351	376	134,948	0.279
06-61-32	1979	TRH	F	0	15	15	187,494	0.008
06-61-33	1979	TRH	F[6/]	40	73	113	181,134	0.062
06-61-34	1979	TRH	Y	44	30	73	86,594	0.084
06-61-36	1979	TRH	Y+	0	10	10	35,666	0.028
06-61-39	1980	TRH	Y	10	39	49	34,601	0.142
06-61-35	1981	TRH	F	0	0	0	182,635	0.000
06-61-37	1981	TRH	Y	9	73	82	98,637	0.083
06-61-38	1982	TRH	Y	76	50	126	96,461	0.131
06-61-41	1982	TRH	F	6	12	18	146,194	0.012
06-61-40	1983	TRH	Y	96	-	96	90,293	0.106

1/ TRH - Trinity River Hatchery

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

3/ Estimated number of coded-wire tagged spring chinook

4/ From Pacific Marine Fisheries Commission CWT release data (PMFC 1985)

5/ Contribution rate = number harvested / number released tagged X 100

6/ Off-site release at Trinity River kilometer 40.0 (Willow Creek)

CHINOOK SALMON HARVEST OVERVIEW

INTRODUCTION

The presentation of fall chinook harvest levels occurring in the Indian gill net fishery of the Hoopa Valley Reservation earlier in this report describes one component of the fisheries impacts incurred by the Klamath River fall chinook stocks. To provide a broader view, data from the other fisheries operating on these stocks are presented here, as published by the Pacific Fishery Management Council (PFMC). In addition, a discussion of noncatch mortality factors affecting these stocks is provided to give a more complete perspective of total fisheries impacts on the stocks.

The following analysis concerns adult fall chinook data only. The reader is advised to employ discretion when making comparisons with analyses presented in previous reports since methodologies have changed.

HARVEST OVERVIEW

The 1986 seasons for the various ocean and inland fisheries were shaped following recommendations by the Klamath River Salmon Management Group (KRSMG) concerning allowable harvest levels for all Klamath River chinook stock fisheries. To continue the protection of the depressed Klamath River fall chinook stocks, the KRSMG recommended and the various user groups agreed to a harvest sharing plan which set preselected harvest rates for the ocean fisheries operating between Point Delgado in Northern California and Cape Blanco in Southern Oregon and the Klamath River inland fisheries. These harvest rates would allow the rebuilding of the stocks while also allowing harvest by the various fisheries to continue. The harvest rates agreed to in 1986 would allow a 35 percent of the age 3 and age 4 Klamath River fish in the ocean to be caught by recreational and commercial troll fisheries and allow 50 percent of the mature fish that returned to the Klamath River as age 3 and age 4 to be harvested by in-river sport and Indian fisheries. This harvest rate combination (.35/.50) would allow 35 percent of the adult Klamath River fish to escape the fisheries and contribute to either the spawning population or to the subsequent year's population size.

The 1986 California ocean troll landings totaled 785,700 chinook which represented an increase of 118% from 1985 (360,300) and was 40% above the 1971-1975 average (562,700). Northern California landings (Fort Bragg, Eureka and Crescent City) of 319,100 chinook increased 107% over 1985 landings (154,300) and were 7% above the 1971-1975 average (298,600). As in 1985, a large component (80%) of the Northern California commercial troll landings was reported from the port of Fort Bragg (254,800) (PFMC 1987). The California ocean recreational fishery in 1986 was regulated through various bag limits, gear restrictions and in-season closures. Landings in the California recreational fishery totaled 133,700 chinook, and represented a decrease of 17% from 1985 (160,600). Northern California landings of 22,400 chinook represented a decrease of 54% from the 1985 landings (49,100). In 1986, landings were 42% above the 1971-1975 average of 15,800 (PFMC 1987).

Landings for the 1986 Oregon ocean commercial troll fishery totaled 401,200 chinook, and was 89% larger than 1985 (212,200) and 92% larger than the 1971-1975 average of 209,200. Troll landings in 1986 south from Coos Bay totalled 292,400 chinook, an increase of 81% from 1985 (161,200). As in 1985, a large component (82%) of the southern Oregon troll chinook harvest was reported from the port of Coos Bay (238,900) (PFMC 1987). The 1986 Oregon ocean recreational landings totaled 22,400 chinook which was 60% below the 1985 total (55,900) and 60% below the 1974-1975 average of 56,200. The 1986 landings south from Coos Bay totaled 17,700 chinook and were 61% below the 1985 landings of (45,600) (PFMC 1987).

Various contribution rate estimates of Klamath River fall chinook to the ocean fisheries operating between Fort Bragg, California and Coos Bay, Oregon have been used to monitor the influence of off shore regulations on the Klamath River stocks. California Department of Fish and Game (CDFG) has used contribution rates of 40% (CDFG 1980) and 21% (CDFG 1983) while PFMC has used a contribution rate of 30% (PFMC 1983). A report by the Technical Advisory Team (KRTT) to the KRSMG (KRTT 1986a) recommended using an estimate of 28% for the contribution rates to the ports of Eureka, Crescent City and Brookings. Estimates of contribution rates are generally derived through analysis of Coded-Wire Tag (CWT) recovery data. This report has used a 30% contribution rate in presenting ocean landings from Coos Bay to Fort Bragg during 1978-1985. Through analysis of CWT return data, CDFG had estimated that an average of 90% of the total ocean harvest of Klamath River fall chinook occurred in the Fort Bragg to Coos Bay area; this analysis assumed the same. Beginning in 1986, this report incorporated the KRTT contribution rate analysis to estimate the total Klamath River harvest of adult fall chinook by the ocean fisheries (unpublished material, KRTT, 1987). Using the contribution values derived by the KRTT from CWT data and applying these to the ocean landings, the 1986 combined ocean fisheries off the coasts of Oregon and California landed 118,300 Klamath River fall chinook.

The Klamath River Indian gill net adult fall chinook harvest, discussed previously in this report, increased 117% from 11,570 in 1985 to 25,130 in 1986. This harvest comprised 13.5% of the 1986 CDFG adult in-river run size estimate. The net fishery has harvested an average 17,180 adult fall chinook during the 1978-1986 period.

The Klamath River 1986 sport fishery harvest of 16,870 adult fall chinook was 340% above the 1984 harvest of 3,830 and 205% above the 1978-1986 average harvest of 5540. The 1986 adult sport harvest comprised 9% of the in-river run size.

The harvests presented here do not perfectly represent the impact of these fisheries on the resource. Such data do not account for noncatch mortality caused by fisheries or the harvest of fish which would otherwise have died from natural causes prior to spawning. While such information is difficult to address and therefore generally not factored into harvest estimates, a brief discussion of these factors appears worthwhile. The reader should consult appropriate references to gain insight on methods used to assess noncatch mortality.

Noncatch mortality of chinook in the ocean troll fishery has been discussed by Ricker (1976), O'Brien et al (1970), Wright (1972) and others and appears to approximate 30-50% of the coastwide ocean harvest. Recently the KRTT adopted a value of 30% to represent the offshore fisheries operating on Klamath River stocks (KRTT 1986b).

Noncatch mortality of chinook in the in-river net fishery occurred primarily through pinniped depredation on the fish trapped in nets prior to removal. Pinniped depredation has been estimated to be 13.2% of the fall chinook gill net harvest in the Klamath River estuary (Herder 1983). This estimate accounts for all pinniped damage; however, a portion of the pinniped damaged chinook were kept for consumption and these were already included in harvest estimates. Data collected by FAO-Arcata indicated that approximately 3% of all salmon impacted by the Reservation-wide net fishery were lost or damaged because of pinniped depredation and were not included in net harvest estimates. Further, FAO-Arcata data indicated that an additional 5% of all salmon impacted by the net fishery were lost due to drop out and were not included in harvest estimates. These fish become enmeshed in gill nets then subsequently escape and finally die as a result of the encounter. These noncatch mortality factors have been adopted by the KRTT for determining gill net fishery impacts on the Klamath River fall chinook stocks (KRTT 1986b). Further information on gill net noncatch mortality may be found in French and Dunn (1973), Jewell (1970) and Parker (1960).

No direct data on noncatch mortality of chinook in the Klamath River sport fishery has been gathered; however it has been assumed to be minimal. A review of available information by the KRTT has led to the adoption of a noncatch rate of 2% of total impact for the in-river sport fishery (KRTT 1986b).

A major difference between the ocean and terminal fisheries with regard to noncatch mortality concerns the existence of size limits in the ocean, while the terminal fisheries have none. Hence, fish captured in the terminal fisheries that were below the legal size limits of the ocean fisheries have generally been kept. To allow data comparability, adult harvest only in the terminal fishery was compared with ocean landings.

Tables 22 and 23 present an overview of the harvest data discussed. These data result in ratios of 0.6:1 ocean landings to river returns, 2.8:1 ocean landings to terminal harvest and 1.1:1 total fishery harvest to spawning escapement (Figure 18).

TABLE 22. Estimated numbers of Klamath River fall chinook in total ocean landings, 1978-1986.

Year	TOTAL CHINOOK LANDINGS[1/]						
	N. Ca. Troll	N. Ca. Sport	S. Or. Troll	S. Or. Sport	N. Ca./S. Or. Area Total	Klamath[2/] Contribution to N.Ca./S.Or.	Klamath Total Contribution
$\bar{X}$ 1971-1975	298,600	15,800	153,000	17,400[3/]	484,800	145,440	161,600
$\bar{X}$ 1978-1985	265,830	15,430	122,800	18,820	422,880	126,900	141,000
1986	319,100	22,400	292,400	17,700	651,600	89,830	118,300
		53,630		53 920			

1/ Landings in N. Ca. include Fort Bragg, Eureka and Crescent City and in S. Or. include Brookings and Coos Bay. All data are from PFMC 1987.

2/ Contribution rates of Klamath stocks prior to 1986 derived using 30% contribution rate. 1986 contribution values are from unpublished material KRTT 1987.

3/ 1974-75 Average only, S. Or. sport.

TABLE 23. Estimated contribution of Klamath River adult fall chinook to the ocean, inland sport and Indian gill net fisheries, 1978-1986[1].

Year	Klamath Ocean Catch	In-River Run Size	In-River Sport Catch	In-River Gill Net Catch	Total Spawning Escapement	Ratio of Ocean Catch to In-River Run Size	Ratio of Ocean Catch to Terminal Catch	Ratio of Total Catch to Spawning Escapement
1978	159,900	91,350	1,690	18,200	71,450	1.8:1	8.0:1	2.5:1
1979	236,700	50,060	2,140	13,650	34,270	4.7:1	15.0:1	7.4:1
1980	151,900	44,500	4,500	12,010	27,990	3.4:1	9.2:1	6.0:1
1981	143,900	77,300	5,980	33,030	38,280	1.9:1	3.7:1	4.8:1
1982	189,000	65,180	8,340	14,480	42,360	2.9:1	8.3:1	5.0:1
1983	62,600	57,920	4,340	7,890	45,680	1.1:1	5.1:1	1.6:1
1984	47,000	43,290	2,140	18,670	22,670	1.1:1	2.3:1	3.0:1
1985	136,900	59,340	3,830	11,570	43,940	2.3:1	8.9:1	3.5:1
$\bar{X}$ 1978-1985	141,000	61,120	4,120	16,190	40,830	2.3:1	7.0:1	4.0:1
1986	118,300	186,260	16,870	25,130	144,270	0.6:1	2.8:1	1.1:1

1/ All data are from the USFWS or from PFMC 1987.

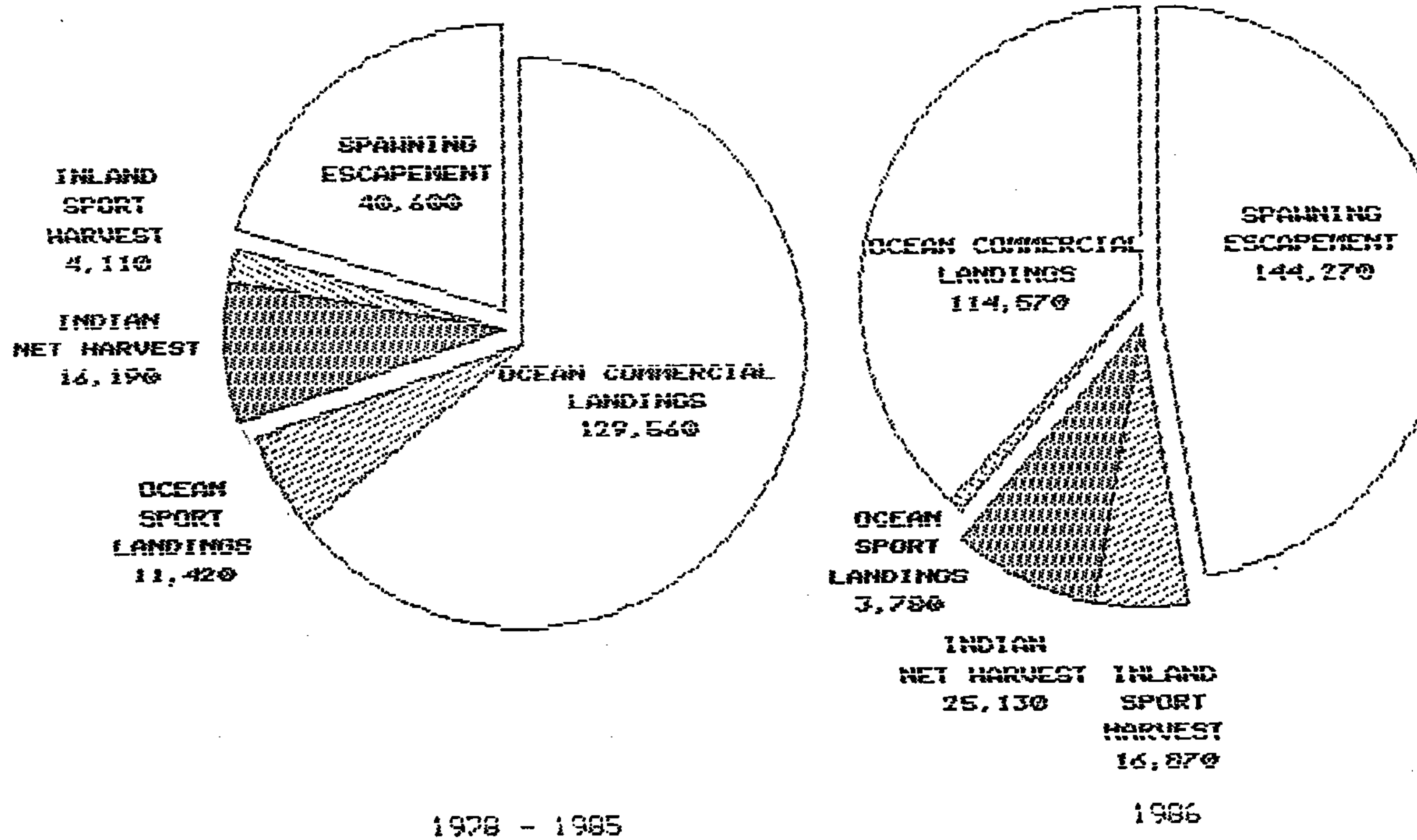

FIGURE 18. Estimated contributions of Klamath River adult fall chinook to the ocean, in-river fisheries, and spawning escapement during 1986 compared to estimated mean annual contributions of Klamath River adult fall chinook to the ocean, in-river fisheries, and spawning escapement during 1978-1985.

COHO SALMON, STEELHEAD TROUT AND STURGEON INVESTIGATIONS

ABSTRACT

A total of 63 coho salmon, including 55 jacks, were captured during 1986 beach seining operations in the Klamath River estuary. Adipose fin-clipped coho comprised 8.6% of the beach seine sample and 8.6% of the total sample was hook scarred. Based on scale samples collected from 56 coho, age composition of returning coho was 87.5% 2-year-olds, 10.7% 3-year-olds and 1.8% 4-year-olds. Jaw tags were placed on 34 coho; none were recovered. An estimated 172 coho salmon, including 9 jacks, were harvested by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation in 1986. Adipose fin-clipped coho comprised 44.0% of the harvest sample. A total of 18 coded-wire tags (CWT) representing three release groups were recovered.

A total of 653 steelhead trout, including 323 half-pounders, were captured during 1986 beach seining operations in the Klamath River estuary. Mean length for adults and half-pounders were 51.1 cm and 36.7 cm, respectively. The estimate for fall steelhead captured in the 1986 Indian gill net fishery on the Klamath River portion of the Hoopa Valley Reservation is 212, including 53 half-pounders. Adults comprised 57 fish in the harvest sample with a mean length of 57.6 cm, while 19 half-pounders sampled showed a mean length of 36.9 cm.

One green sturgeon was observed during the 1986 beach seining operations in the Klamath River estuary. An estimated 421 green sturgeon were harvested in the Indian gill net fishery on the Klamath River portion of the Hoopa Valley Reservation in 1986. Peak net harvest occurred in the April-July period during the annual upstream spawning migration.

COHO SALMON, STEELHEAD TROUT AND STURGEON INVESTIGATIONS

INTRODUCTION

The 1986 coho salmon, steelhead trout and sturgeon runs in the Klamath River were observed through the previously described net harvest monitoring and beach seining programs. Coho and steelhead are not target species for the Indian net fishery and their harvest is generally considered incidental to that of spring and fall chinook salmon and sturgeon. The FAO-Arcata beach seining operation, similarly, does not target on steelhead, coho or sturgeon and data on these species are collected incidentally to that of fall chinook salmon.

METHODS

Methods used in collecting and analyzing beach seine and net harvest data for coho, steelhead and sturgeon are the same as previously described for chinook salmon. Statistical analysis of data was limited to the t-test unless otherwise noted. The data were compared at the 95% confidence level.

RESULTS AND DISCUSSION

Coho Salmon

Beach Seining

A total of 63 coho salmon (55 jacks and 8 adults) were captured during the 1986 beach seining operations. Of 61 coho caught during September, 37 were caught over five consecutive days (9/15-9/19) of sampling.

The mean length of jacks was 41.8 cm and 63.7 cm for adults with the largest jack 52 cm in length. These lengths differed significantly ($p<0.05$) from those of 1985 (jacks, 49.0 cm; adults, 66.6 cm), and 1984 (jacks 45.0 cm; adults, 66.6 cm).

Of 51 jack coho examined, two were adipose fin-clipped and two were left pectoral fin-clipped. Three jacks had hook scars. Seven adults were examined; three were adipose fin-clipped and two were hook-scarred. Jaw tags were applied on 28 jacks and six adults. None of these tags were recovered.

Scales were collected from 56 coho to determine age composition (see "Methods" of Age Composition section). The majority of coho captured were 2-year-olds (87.5%), followed by 3-year-olds (10.7%) and 4-year-olds (1.8%). For comparison, 53 of the 61 coho caught in 1985 were 3-year-olds (86.9%). The dominance of 2-year-old coho and associated mean lengths of jacks and adults may not be representative of the entire Klamath River coho population as the beach seining operation targeted on chinook salmon, and sampling was ended prior to the end of the 1986 coho run.

Net Harvest

An estimated 172 coho, including 9 jacks (<53 cm), were netted on the Klamath River portion of the Hoopa Valley Reservation (HVR) in 1986 (Table 24). Coho caught in the Upper Klamath Area accounted for 83.1% (143) of the total harvest estimate. The peak catch period occurred in mid-October. The 1986 catch was less than the 1985 high of 1,943 coho. A smaller run size and a decline in late season fishing effort may have contributed to the low 1986 catch. Net harvest estimates for all coho salmon netted on the HVR during 1980-1986 are presented in Table 25.

A total of 38 coho were measured in the net harvest monitoring program. Mean length of adults (72.1 cm) did not differ significantly ($p>0.05$) from that of 1985 (Figure 19). Adipose fin-clipped coho comprised 44.0% of the net harvest sample.

Coded-wire tag recoveries from coho in the 1986 net harvest totaled 18 (Table 26). These recoveries expanded to an estimated 115 coho representing three released groups: two from TRH and one from IGH. Three-year-old coho comprised 100% of the CWT harvest sample.

Steelhead Trout

Beach Seining

A total of 653 fall steelhead trout (323 half-pounders, 330 adults) were captured during the 1986 beach seining operation. Of 346 steelhead examined, 94 were half-pounders (<42 cm) and 252 were adults. Mean fork length of half-pounders (36.7 cm) was significantly smaller ($p<0.05$) than those of 1985 (40.0 cm) and 1984 (38.7 cm), but significantly larger ($p<0.05$) than those sampled in 1983 (34.7 cm). The mean length of adults (51.1 cm) was smaller ($p<0.05$) than those of the three prior (1983-1985) seasons (53.8 cm, 53.5 cm, 52.5 cm), respectively.

Length information of beach-seine caught fall steelhead may not be representative of the Klamath River run. The beach seine operation targets on fall chinook and seining was terminated on September 30, 1986, whereas the fall steelhead run lasts through mid-October in most years (J. Hopelain, personal communications, CDFG, 1987). The seining site is selected to favor chinook over other species (see "Methods" of Beach Seine section). Many steelhead are released unmeasured, as they are captured concomitantly with large numbers of chinook salmon in the seine which often physically damage the smaller steelhead. In addition, small steelhead that become gilled in the mesh are also released to minimize mortality. These operational difficulties tend to inflate the mean length of half-pounders.

Net Harvest

An estimated 212 fall steelhead trout, including 53 half pounders (<42 cm), were netted on the Klamath River portion of the Hoopa Valley Reservation (HVR) in 1986. Fall steelhead were observed from early July to the end of October in the gill net fishery (Table 27). Net harvest estimates for all steelhead trout netted on the HVR during 1980-86 are presented in Table 28.

TABLE 24. Net harvest estimates of coho salmon captured on the Klamath River portion of the Hoopa Valley Reservation in 1986.

Time Period		NET HARVEST MONITORING AREA Estuary	Middle Klamath	Upper Klamath	Semi-Monthly Total (All Areas)	Cumulative Seasonal Total
Aug.	1-15	0	0	0	0	0
	16-31	12	0	0	12	12
Sept.	1-15	0	0	0	0	12
	16-30	0	7	27	34	46
Oct.	1-15	0	10	96	106	152
	16-31	0	0	20	20	172
TOTAL		12	17	143	172	

TABLE 25. Final harvest estimates of coho salmon taken in the gill net fishery of the Hoopa Valley Reservation during 1980-1986[1/].

Year	COHO Jacks	Adults	Total
1980	-	-	1,500
1981	163	1,470	1,633
1982	49	951	1,000
1983	4	121	125
1984	261	738	999
1985	119	3,009	3,128
1986	24	248	272

1/ Estimates for 1983-1986 Trinity River net fishery were obtained from the Hoopa Valley Business Council, Fisheries Department. All other harvest estimated by the U. S. Fish & Wildlife Service by methods described in previous annual reports.

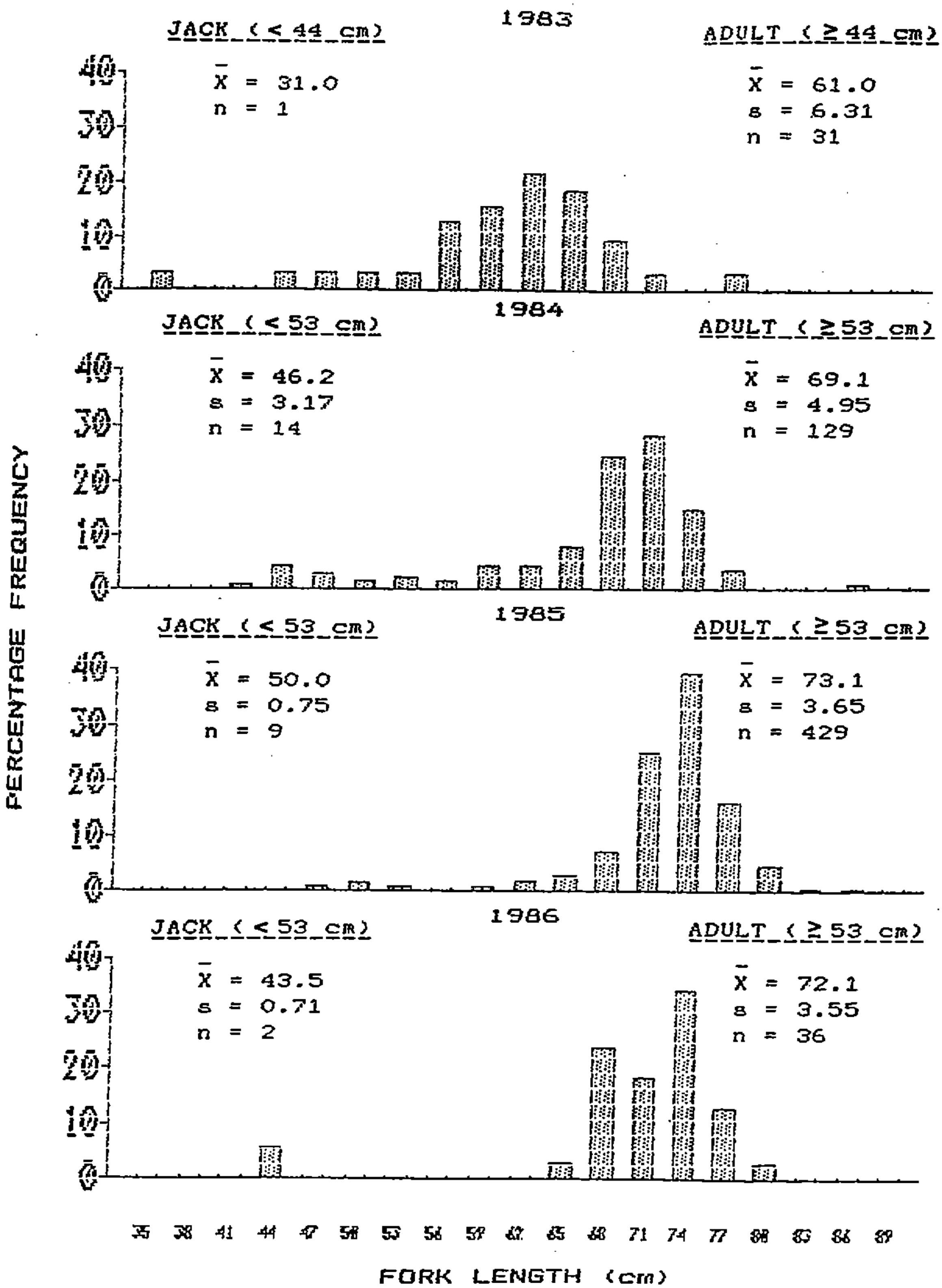

FIGURE 19. Length-frequency distributions of coho salmon caught by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1983-1986 (3 cm groupings with midpoints noted).

TABLE 26. Mean fork length (cm), standard deviation, and actual and expanded (underlined) recoveries for coho salmon CWT groups harvested in the net fishery on the Klamath River portion of the Hoopa Valley Reservation in 1986.

Tag Code	Brood Year	Hatchery[1/] of Origin	Release[2/] Type	CWT Recoveries		Mean Fork Length	Standard Deviation
06-56-50	1983	TRH	Y+	8	51	72.5	4.0
06-56-51	1983	TRH	Y+	2	13	72.0	5.6
06-59-30	1983	IGH	Y+	8	51	71.8	2.9
TOTALS				18	115		

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

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

TABLE 27. Net harvest estimates of steelhead trout captured on the Klamath River portion of the Hoopa Valley Reservation in 1986.

Time Period	NET HARVEST MONITORING AREA			Semi-Monthly Total (All Areas)	Cumulative Seasonal Total
	Estuary	Middle Klamath	Upper Klamath		
Jul. 1-15	3	0	0	3	3
16-31	0	0	0	0	3
Aug. 1-15	8	7	17	32	35
16-31	27	5	24	56	91
Sept. 1-15	8	10	55	73	164
16-30	0	12	23	35	199
Oct. 1-15	0	5	4	9	208
16-31	0	0	4	4	212
TOTAL	46	39	127	212	

TABLE 28. Final harvest estimates of steelhead trout taken in the gill net fishery on the Hoopa Valley Reservation during 1980-1986[1/].

	FALL STEELHEAD TROUT		
Year	H-P	Adults	Total
1980	-	-	300
1981	181	535	716
1982	48	352	400
1983	23	340	363
1984	110	696	806
1985	46	457	503
1986	53	254	307

1/ Estimates for 1983-1985 Trinity River net fishery were obtained from the Hoopa Valley Council, Fisheries Department. All other harvest estimated by the U. S. Fish & Wildlife Service by methods described in previous annual reports.

Mean length of adult steelhead harvested by Indian fishers in 1986 (57.6 cm) did not significantly differ ($p>0.05$) from that of 1985 (56.2 cm) (Figure 20). Likewise, half pounders showed no significant difference ($p>0.05$) in mean length (36.9 cm) when compared with the previous year (36.5 cm).

Sturgeon

Beach Seining

One green sturgeon, 77 cm in total length, was captured on August 15, 1986 during beach seine operations.

Net Harvest

An estimated 421 green sturgeon were harvested in the Indian gill net fishery on the Klamath River portion of the Hoopa Valley Reservation (Table 29). No white sturgeon (*Acipenser transmontanus*) were sampled during the net harvest monitoring activities. Of the estimated 421 green sturgeon, 87.4% (368) were captured in the spring gill net fishery. Green and white sturgeon harvest estimates for the HVR during 1980-1986 are presented in Table 30.

Total lengths of 21 adult green sturgeon (>130 cm) harvested in the Indian gill net fishery ranged in length from 134 cm to 210 cm with a mean of 169.2 cm (Figure 21). Mean total length of three juvenile green sturgeon (<130 cm) was 83.7 cm and ranged from 39 to 107 cm.

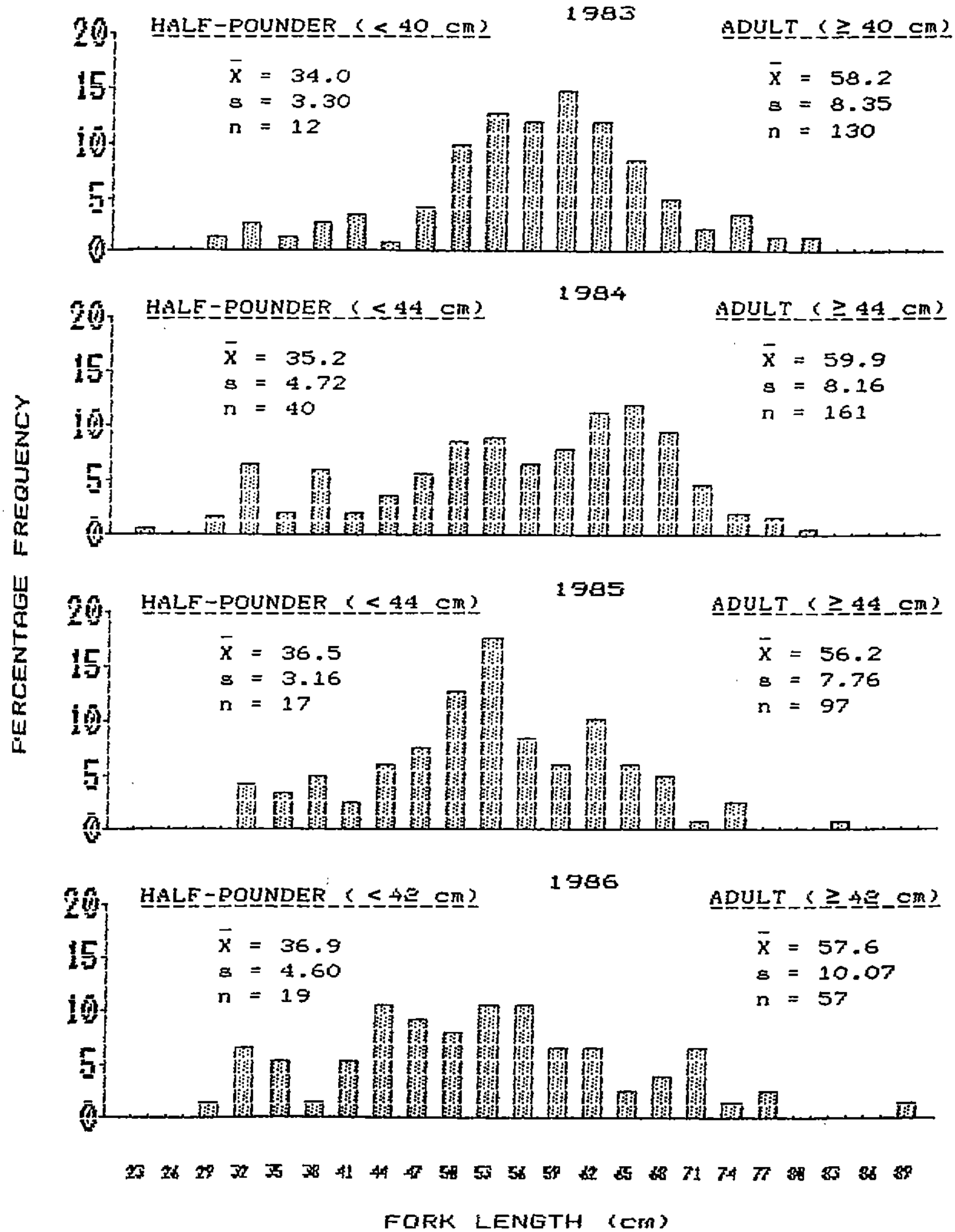

FIGURE 20. Length-frequency distributions of fall steelhead caught by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1983-1986 (3 cm groupings with midpoints noted).

TABLE 29. Net harvest estimates of green sturgeon captured on the Klamath River portion of the Hoopa Valley Reservation in 1986.

Time Period		NET HARVEST MONITORING AREA Estuary	Middle Klamath	Upper Klamath	Semi-Monthly Total (All Areas)	Cumulative Seasonal Total
(Spring Fishery)		-	-	-	368[1/]	368
Jul.	1-15	2	0	0	2	370
	16-31	11	4	0	15	385
Aug.	1-15	5	5	11	21	406
	16-31	4	2	0	6	412
Sept.	1-15	1	0	4	5	417
	16-30	0	0	2	2	419
Oct.	1-15	0	2	0	2	421
	16-31	0	0	0	0	421
TOTAL		23	13	17	421	

1/ Harvest monitoring procedures during the spring vary from the fall. Consequently, only a total sturgeon estimate is presented.

TABLE 30. Final harvest estimates of green and white sturgeon taken in the gill net fishery on the Hoopa Valley Reservation during 1980-1986.[1/]

	WHITE			GREEN		
	JUV	ADULT	TOTAL	JUV	ADULT	TOTAL
1980	10	3	13	30	300	330
1981	10	5	15	25	810	835
1982	10	5	15	53	347	400
1983	10	0	10	89	406	495
1984	2	0	2	21	394	415
1985	2	1	3	31	330	361
1986	0	0	0	53	398	451

1/ Estimates for 1983-1986 Trinity River net fishery were obtained from Hoopa Valley Business Council, Fisheries Department. All other harvest estimated by the U. S. Fish & Wildlife Service by methods described in previous annual reports.

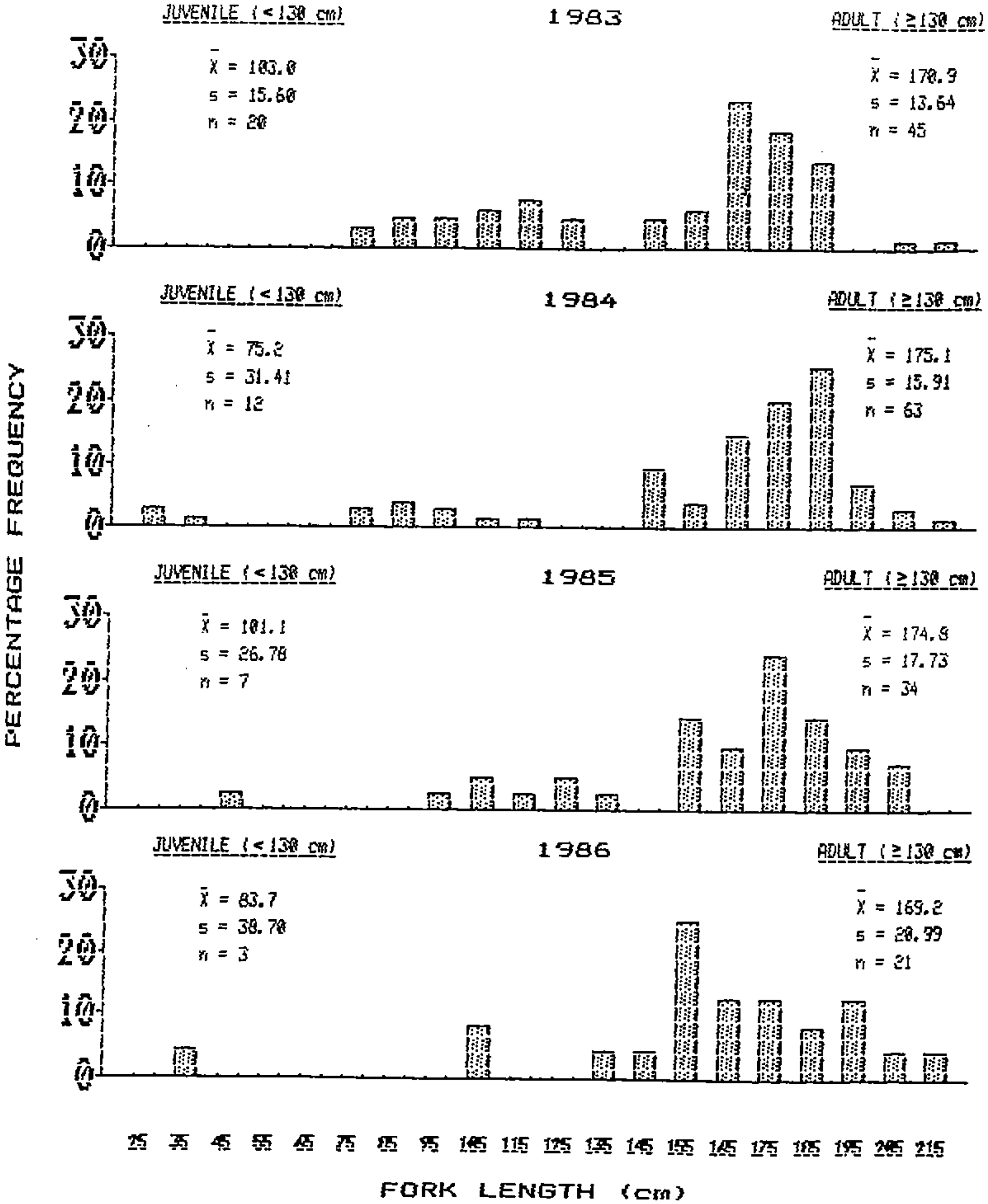

FIGURE 21. Length-frequency distributions of green sturgeon caught by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1983-1986 (10 cm groupings with midpoints noted).

PROGRAM PLANNING

INTRODUCTION

The course of the Klamath River Fisheries Investigation Program (KRFIP), 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 Agreement and the Critical Issues Management System, the USFWS Management By Objectives program, and a variety of other past and present Departmental and external factors. Further direction has been received through the Service Management Plan (USFWS 1982b), through the preparation of a Regional Resource Plan by the USFWS Region One directorate (USFWS 1982c) and through a Statement of Responsibilities and Role (USFWS 1985b) of the Fishery Resources Program. Bureau of Indian Affairs (BIA) planning processes involving fisheries resources of the Hoopa Valley Indian Reservation (HVR), including the Klamath River Basin Fisheries Resource Plan (USDI 1985), will continue to exert a strong influence on program direction. The passage of P.L. 98-541, the Trinity River Basin Fish and Wildlife Management Program, on October 24, 1984 and P.L. 99-552, the Klamath River Fish and Wildlife Restoration Act, on October 27, 1986, will also exert an influence on program direction. Details of other actions with potential relevance to FAO-Arcata programs have been presented in previous Annual Reports.

The goal of FAO-Arcata is to provide assistance by conducting various specialized field programs which address specific problems as they are recognized. This project has neither the funding to support or the authority which would mandate a more comprehensive approach to basin fisheries work. With this in mind, flexibility must be maintained in order to react to changing needs in current fisheries management while at the same time reserving the ability to conduct longer term monitoring programs such as are reported here.

PROGRAM PLANNING

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 1982c). The KRFIP has and will continue to focus on five of these stocks: fall chinook, spring chinook, fall steelhead, coho salmon and green sturgeon, which have been recognized as fitting the criteria of being depressed stocks, largely of natural origin, with high value to fisheries and good restoration potential.

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, (3) monitoring of in-river net harvest levels and (4) analysis and presentation of pertinent information in a timely manner to those agencies responsible for managing this important resource. FAO-Arcata programs will be conducted to the extent possible in cooperation with those of other agencies involved with the Klamath River fishery resource.

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 capacity within the BIA or local Indian groups at that time. At such time as fisheries expertise is developed among local Indians, part or all of existing FAO-Arcata programs will be transferred to these groups. Such transfer of programs began with the establishment in 1981 of the Hoopa Valley Business Council (HVBC), Fisheries Department, and the hiring of two biologists by the Tribe. Former FAO-Arcata programs operating on the Trinity River under MOA with the BIA have been entirely transferred to the HVBC. 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 as long as Department of the Interior or Indian-regulated fisheries are in operation on the Klamath River. With this in mind, a major aspect of FAO-Arcata operations continues 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 need to be continued on a yearly basis. Primary emphasis will remain with fall chinook. FAO-Arcata beach seining operations currently provide the only available estimates of Klamath River fall chinook population age composition. Such data have proven useful in generating annual ocean stock size projections for use in fisheries management. The beach seining and harvest monitoring programs together provide two key interactive components of the Klamath River basin anadromous fisheries database. Both programs need to be viewed as on-going monitoring programs to be continued indefinitely and not as baseline studies which will soon reach a point where necessary input has been supplied.

(2) Harvest Monitoring Operations provide the only presently available estimates of Indian gill net harvest of spring and fall chinook, coho, steelhead and sturgeon within the Klamath River portion of the Hoopa Valley Reservation and collection of this critical information will continue. Research into data on size selectivity will be incorporated into this program in FY87 with the funding of a three year study through BIA. Research into the relationship between net harvest and river flow models to predict net harvest and escapement associated with specific management options and other management-oriented aspects of the fishery should continue. Collection of a variety of baseline biological data from the net harvest should continue. Recoveries of coded-wire tags through monitoring of the net fishery is important to management of the fisheries and of hatchery stocks within the basin and will continue.

(3) Other Programs. In recent years, FAO-Arcata staff have proposed and sought funding for various new field projects. Study proposals have been prepared for investigation into harvest patterns and population characteristics of anadromous species not previously covered by the program, specifically winter run steelhead trout and

Pacific lamprey (*Entosphenus tridentata*). Additional field work for the purpose of involvement in the rapidly expanding stream enhancement and artificial propagation programs now occurring in the basin, including an update of the Inventory of Reservation Waters (USFWS 1979), have also been proposed. Support for juvenile studies has also been solicited. Of particular interest is production generated from Blue Creek, the largest tributary in the lower river area. Unfortunately, funds have not been attracted for any of this work. Such efforts will continue, however, since it is believed that augmentation of current programs would greatly benefit the data base and therefore enhance management capability.

(4) 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 and agencies involved with the Klamath-Trinity fishery resource are recognized as high priorities. Frequent meetings will continue to be held with biologists representing the BIA, CDFG, USFS, HVBC, ODFW, NMFS and other groups. Coordination with the Trinity River program under P.L. 98-541 and the Klamath River Restoration Act under P.L. 99-552 is essential. Such activities are crucial to the effective provision of fisheries assistance.

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