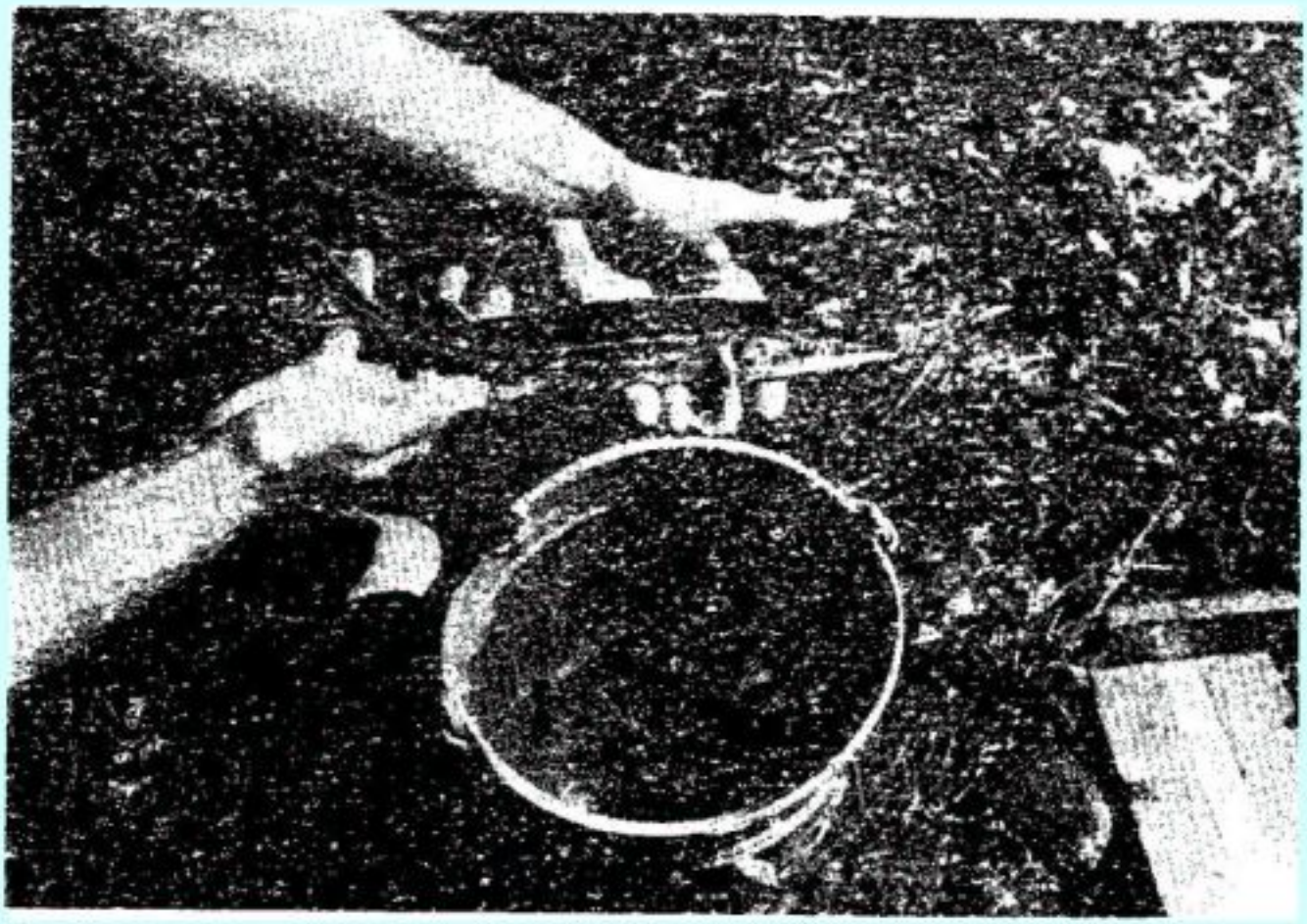
Fisheries Assistance Office
Arcata California
Western Region

July 1988

KLAMATH RIVER FISHERIES ASSESSMENT PROGRAM

Annual Report 1987



ANNUAL REPORT

KLAMATH RIVER FISHERIES ASSESSMENT PROGRAM

1987

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

REPORT NO. FR1/FAO-88-14

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

August 1988

THIS REPORT IS DEDICATED TO THE MEMORY

OF

DANIELLE W. ZUMBRUN

DISCLAIMER

Mention of trade names or commercial products in this report **does not** constitute endorsement by the U.S. Fish and Wildlife Service.

TABLE OF CONTENTS

	Page
LIST OF FIGURES	iii
LIST OF TABLES	vii
LIST OF ACRONYMS, ABREVIATIONS	x
ACKNOWLEDGEMENTS	xi
FORWARD	1
ABSTRACT	5
CHINOOK SALMON INVESTIGATIONS	7
BEACH SEINING PROGRAM	7
INTRODUCTION	7
METHODS	7
Chinook Salmon	7
RESULTS AND DISCUSSION	9
Adipose Fin-Clips	11
Length-weight	11
Gill Net Marking	11
Hook Scarring	15
Mark-Recapture	15
Catch/Effort and Run Timing	23
Migration	23
AGE COMPOSITION	26
INTRODUCTION	26
METHODS	26
RESULTS AND DISCUSSION	26
NET HARVEST MONITORING PROGRAM	34
INTRODUCTION	34
METHODS	34
Fall Fishery	36
Estuary Area	36
Middle Klamath Area	37
Upper Klamath Area	37
Harvest Estimate and Associated Variance Calculations	38
Spring Fishery	39
RESULTS AND DISCUSSION	40
Fall Chinook	40
Spring Chinook	48
CODED-WIRE TAG RECOVERY INVESTIGATIONS	51
INTRODUCTION	51
METHODS	51

TABLE OF CONTENTS (Continued)

	Page
RESULTS AND DISCUSSION	52
Fall Chinook	52
Spring Chinook	56
CHINOOK SALMON HARVEST OVERVIEW	61
INTRODUCTION	61
HARVEST OVERVIEW	61
COHO SALMON, STEELHEAD TROUT, STURGEON AND SHAD INVESTIGATIONS	68
INTRODUCTION	68
METHODS	68
RESULTS AND DISCUSSION	68
Coho Salmon	68
Beach Seining	68
Net Harvest	71
Steelhead Trout	71
Beach Seining	71
Net Harvest	71
Sturgeon	80
Beach Seining	80
Net Harvest	80
Shad	80
Beach Seining	80
BLUE CREEK SALMONID INVESTIGATIONS	84
INTRODUCTION	84
METHODS	84
RESULTS AND DISCUSSION	85
Chinook Salmon	85
Steelhead Trout	88
Other Species	92
KLAMATH RIVER JUVENILE SALMONID MONITORING	93
INTRODUCTION	93
METHODS	93
RESULTS AND DISCUSSION	93
PROGRAM PLANNING	96
INTRODUCTION	96
PROGRAM PLANNING	96
REFERENCES	99

LIST OF FIGURES

Figure		Page
1.	Overview map of the Klamath-Trinity River basin and Hoopa Valley Indian Reservation	2
2.	Depth contours (expressed in meters below mean high tide) of the Klamath River estuary during 1987	8
3.	Length frequency distributions of chinook salmon captured during beach seining operations in the Klamath River estuary during 1984-1987	12
4.	Length-weight relationship of chinook salmon captured during 1987 beach seining operations in the Klamath River estuary	14
5.	Hook scarring rates observed on jack and adult chinook salmon during 1979-1987 beach seining operations in the Klamath River estuary	18
6.	Julian tagging date and number of days at large of recaptured chinook salmon during 1984-1987 beach seining seasons	21
7.	Number of spaghetti tags applied to beach seine captured chinook salmon, and subsequently recovered from various upstream areas during 1987	22
8.	Weekly averages of the number of chinook salmon captured per seine haul in the Klamath River estuary during the 1984-1987 beach seining seasons	24
9.	Relationship between distance traveled at time of recovery and mean migration rate in km/day of 51 chinook salmon recaptures from the Klamath River in 1987	25
10.	Brood year contributions by age of fall chinook salmon to the 1979-1987 Klamath River returns.	31
11.	Net harvest monitoring areas for the Klamath River portion of the Hoopa Valley Reservation in 1987	35
12.	Length frequency distributions of fall chinook salmon harvested by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1984-1987	43
13.	Length frequency distributions of fall chinook salmon harvested by Indian gill net fishers in the Estuary, Middle Klamath and Upper Klamath Areas in 1987	44

Figure

Page

14. Length frequency distributions of fall chinook salmon harvested by Indian gill net fishers in the Estuary Area during 1984-1987 45

15. Length-weight relationship of fall chinook salmon harvested by Indian gill net fishers in the Estuary area in 1987 47

16. Length frequency distributions of spring chinook salmon harvested by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1984-1987 . . . 49

17. Estimated annual contributions of Klamath River basin adult fall chinook to the ocean, in-river fisheries, and spawning escapement during 1986-1987 compared to estimated annual contributions of Klamath River adult fall chinook to the ocean, in-river fisheries, and spawning escapement during 1978-1985 67

18. Length frequency distributions of coho salmon captured during beach seine operations in the Klamath River estuary during 1984-1987 69

19. Length-weight relationship of coho salmon captured during 1987 beach seining operations in Klamath River estuary 70

20. Length frequency distributions of coho salmon harvested by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1984-1987 74

21. Length frequency distributions of steelhead trout captured during beach seine opeations in the Klamath River estuary during 1984-1987 76

22. Length frequency distributions of fall steelhead trout harvested by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1984-1987 79

23. Length frequency distributions of green sturgeon harvested by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1984-1987 83

24. Numbers of juvenile chinook salmon captured in Blue Creek during 1987 sampling 86

25. Mean fork length of juvenile chinook salmon captured in Blue Creek during 1987 sampling 86

26. Length-volume relationship of juvenile chinook salmon captured in Blue Creek during 1987 sampling 89

Figure | Page

27. Numbers of 0+ and 1+ or older steelhead trout captured in Blue Creek during 1987 sampling 90

28. Mean fork length of 0+ and 1+ or older steelhead trout captured in Blue Creek during 1987 sampling 90

LIST OF TABLES

Table		Page
1.	Categorization of hook scars observed during 1987 beach seining operations in the Klamath River estuary	10
2.	Mean length, standard deviation and sample size of fin-clipped chinook captured during the 1987 beach seining operation	13
3.	Percentage occurrence of hook scars observed on 552 Klamath River fall chinook salmon sampled during 1987 beach seining operations	16
4.	Categorical frequencies of hook scars within a total sample of 115 scars observed on 552 Klamath River fall chinook during 1987 beach seining operations	17
5.	Recovery data from 10,332 fall chinook salmon tagged by the Fish and Wildlife Service on the Klamath River during 1979-1987 beach seining operations (no tags were applied in 1981)	19
6.	The ratio of recovered spaghetti tags compared to each respective sample at the weirs and hatcheries on harvest of the fisheries within the Klamath River basin in 1987 returns from gill net fisery, sport fishery and various locations within the Klamath River basin	20
7.	Percentage age composition of Klamath River fall chinook derived from scale analysis and length frequency information during the 1979-1987 return years	27
8.	Age class contribution of fall chinook during four equal time intervals from the 1987 Klamath River beach seine sample determined through scale analysis	29
9.	Estimated number of fall chinook by age entering the Klamath River during the 1979-1987 return years	30
10.	Mean length, standard deviation and sample size of fall chinook returning to the Klamath River basin by age in 1979 and 1981-1987 return years	33
11.	Final semi-monthly estimates of fall chinook salmon harvest by the gill net fishery in the three Klamath River monitoring areas on the Hoopa Valley Reservation under Department of Interior promulgated regulations in 1987	41
12.	The number and percentage of jack and adult fall chinook harvest by the gill net fishery on the Klamath River portion of the Hoopa Valley Indian Reservation under Department of Interior promulgated regulations in 1987	42

Table		Page
13.	Final monthly estimates of spring chinook salmon harvest in the three Klamath River monitoring areas of the Hoopa Valley Reservation in 1987	48
14.	Final estimates of spring and fall chinook salmon harvest by the gill net fishery on the Hoopa Valley Reservation during 1977-1987	50
15.	Actual and expanded CWT groups recovered during mark sampling of spring and fall chinook salmon in the 1987 gill net fishery on the Klamath River portion of the Hoopa Valley Reservation	53
16.	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	55
17.	Mean fork length, standard deviation and number of recoveries for 52 spring and fall chinook CWT groups harvested on the Klamath River portion of the Hoopa Valley Reservation in 1987	57
18.	Contribution rate of CWT age 3 and 4 spring chinook from brood year 1978-1984 to the Indian net fishery on the Klamath River portion of the Hoopa Valley Reservation	60
19.	Estimated contribution of Klamath River fall chinook to total ocean landings, 1978-1987	65
20.	Estimated contribution of Klamath River adult fall chinook to the ocean, in-river sport and Indian gill net fisheries, 1978-1987	66
21.	Final estimates of coho salmon harvest on the Klamath River portion of the Hoopa Valley Reservation in 1987	72
22.	Final estimates of coho salmon harvest by the gill net fishery of the Hoopa Valley Reservation during 1980-1987	73
23.	Mean fork length, standard deviation and actual and expanded recoveries for coho salmon CWT groups harvested by the gill net fishery on the Klamath River portion of the Hoopa Valley Reservation in 1987	75
24.	Final semi-monthly estimates of steelhead trout harvest by the gill net fishery on the Klamath River portion of the Hoopa Valley Reservation in the fall of 1987	77
25.	Final estimates of steelhead trout harvest by the gill net fishery on the Hoopa Valley Reservation during 1980-1987	78

Table

		Page
26.	Final estimates of green sturgeon harvest by the gill net fishery on the Klamath River portion of the Hoopa Valley Reservation in 1987	81
27.	Final estimates of green and white sturgeon harvest by the gill net fishery on the Hoopa Valley Reservation during 1980-1987	82
28.	Date, sample size, mean fork length, standard deviation, minimum size and maximum size of outmigrantion juvenile chinook sampled in Blue Creek in 1987	87
29.	Mean fork length, standard deviation, sample size, minimum size and maximum size by age class of juvenile steelhead trout captured during Blue Creek in 1987	91
30.	Summary of the juvenile beach seining chinook catch and coded wire tag recoveries in the Klamath estuary during 1987	94
31.	Release information and recovery data for juvenile chinook salmon captured during Fish and Wildlife Service juvenile beach seining in the Klamath River estuary during 1987	95

LIST OF ACRONYMNS AND ABBREVIATIONS

ad-clip	- Adipose fin-clip
CDFG	- California Department of Fish and Game
cm	- Centimeters
CWT	- Coded Wire Tag
DOI	- U.S. Department of the Interior
FAO - Arcata	- Fisheries Assistance Office, Arcata, California
FWS	- U.S. Fish and Wildlife Service
HVR	- Hoopa Valley Indian Reservation
IGH	- Iron Gate Hatchery
kg	- Kilograms
km	- Kilometers
KRFMC	- Klamath River Fishery Management Council
KRSMG	- Klamath River Salmon Management Group
mm	- Millimeters
n	- Sample size
PFMC	- Pacific Fishery Management Council
s	- Standard deviation
TRH	- Trinity River Hatchery
USFS	- U.S. Forest Service

ACKNOWLEDGEMENTS

The authors wish to express their appreciation to the following persons whose efforts were invaluable in the completion of 1987 field studies and preparation of this report:

-- Debra A. Becker for administrative support, editorial assistance, patience and diligence in word processing and related matters;

-- David W. Daum for his work as supervisor of the 1987 net harvest monitoring program;

-- Other members of the Arcata-FAO field staff:

David Anderson	Karl Johnson
Richard Burrow	John Logan
Forrest Carlson	Ken Norton
Willard Carlson	Mark Sanderson
TallChief Comet	Gary Stern
Frank Erickson	David Wills
Rudy Ferrara	Stephen Wing
Joel Gordon	Danielle Zumbrun

-- Indian fishers of the Hoopa Valley Reservation for their hospitality and cooperation in data collection efforts.

-- Point St. George Fisheries for their cooperation in allowing us to sample the commercial harvest.

-- Northern California Indian Development Council for assistance and cooperation during 1987.

Acknowledgement is extended to the Youth Conservation Corps for the valuable manpower and support provided during the past season; and personnel of the California Department of Fish and Game for providing data, advice, access to various equipment and invitations to observe and participate in field projects.

Further acknowledgement is extended to members of the Fisheries Department of the Hoopa Valley Business Council for their assistance, coordination and cooperation in fisheries field programs.

Final acknowledgement is extended to the Bureau of Indian Affairs for funding the Fisheries Assessment Program, and to the many Bureau personnel who have cooperated with FAO-Arcata staff during the past season.

ANNUAL REPORT

KLAMATH RIVER FISHERIES INVESTIGATION PROGRAM

1987

FORWARD

The Klamath River watershed drains approximately 14,400 km^2 in Oregon and 26,000 km^2 in California. The majority of the watershed in California is within the boundaries of the Six Rivers, Klamath and Shasta-Trinity National Forests. The Hoopa Valley Indian Reservation, comprising approximately 583 km^2 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 (Figure 1). The most important anadromous salmonid spawning tributaries in the basin include the Trinity River, draining approximately 7,690 km^2, and the Shasta, Scott and Salmon Rivers, each draining approximately 2,070 km^2. Iron Gate Dam on the Klamath River (river km 306) and Lewiston Dam on the Trinity River (river km 249) represent the upper limits of anadromous salmonid migration in the basin. Iron Gate and Trinity River Hatcheries located near the base of each dam, 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. In addition Klamath River stocks account for up to 30% of commercial chinook salmon landings in northern California and southern Oregon and have averaged approximately 450,000 chinook per year over the last decade. The U.S. Forest Service 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 (O. 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.

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 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 the U.S. Fish and Wildlife Service 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," 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 Trinity River Basin Fish and Wildlife Management Program described above.

Since passage of the Magnuson Fishery Conservation Management Act of 1976 (16 U.S.C. 1801-1882) 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. In 1985, the KRSMG was formed to provide recommendations for the management of the combined fisheries operating on Klamath River chinook stocks. 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. This action authorized 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 replaced the KRSMG.

The Assistant Secretaries of Indian Affairs and Fish and Wildlife and Parks, in addressing Departmental resource and Indian Trust responsibilities concerning the Klamath River basin resource and HVR, have entered into annual fiscal Interagency Agreements 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 ninth in a series of annual reports covering the Klamath River Fisheries Assessment Program, conducted through FAO-Arcata under the Fiscal Year 1987 Interagency Agreement.

The program consists of three 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 HVR 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 KRFMC;

(b) the provision of general technical assistance, as requested, to the CDFG, BIA, HVBC Fisheries Department, other branches of the FWS and various other groups and agencies; and

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

Methods utilized and results obtained during 1987 through these program activities are detailed in sections summarizing data collected on chinook salmon, coho salmon, steelhead trout, sturgeon and shad. During 1983 the HVBC 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 1987. 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.

KLAMATH RIVER FISHERIES ASSESSMENT PROGRAM

ABSTRACT

A total of 2,245 chinook salmon (Oncorhynchus tshawytscha) were captured in 369 sets during 1987 seining operations in the Klamath River estuary. Scales were collected from 552 chinook for age analysis. Tags were applied to 1,119 chinook for mark recapture analysis. Ad-clipped chinook comprised 10.1% of the sample, and 22% and 20.1% of the chinook examined exhibited gill net marks or hook scars, respectively. Age analysis from scale samples and CWT recoveries indicates the dominance of 4-year-olds in 1987. The percentage of 2-year-olds returning (10.1%) is the lowest in the 9-year data base. Gill net harvest on the Klamath River portion of the HVR during 1987 is estimated at 48,267 fall and 1,694 spring chinook. A total of 2,144 CWT, representing 46 fall and 7 spring chinook release groups, were recovered during mark sampling of the 1987 net fisheries on the Klamath River portion of the HVR. These recoveries expanded to a total estimated harvest of 3,390 CWT fall and 418 CWT spring chinook in the 1987 net fisheries. An estimated 4.1 Klamath River fall chinook were harvested through the ocean fisheries for each one harvested by the in-river fisheries and an estimated 2.7 Klamath River fall chinook were harvested in the combined ocean and in-river fisheries for each one spawning in the Klamath River basin in 1987.

One hundred fifteen coho salmon (O. kisutch) were captured during seining operations in the Klamath River estuary. Ad-clipped coho comprised 7.9% of the sample. Based on scales collected from 99 coho, age composition of the returning coho was 15.2% 2-year-olds, 82.8% 3-year-olds and 2.0% 4-year-olds. Tags were applied to 111 coho, of which 21 (18.9%) were recovered. An estimated 935 coho salmon (31 jacks and 904 adults) were harvested in the Indian gill net fishery on the Klamath portion of the HVR in 1987. Ad-clipped coho comprised 9.9% of the sampled harvest. A total of 32 CWT's, representing three release groups, were recovered.

Four hundred forty two steelhead trout (Salmo gairdneri) were captured during 1987 seining operations in the Klamath River estuary. The estimated harvest of fall steelhead by the Indian gill net fishery on the Klamath River portion of the HVR was 270, including 30 half pounders.

Fifteen green sturgeon (Acipenser medirostris) and one white sturgeon (A. transmontanus) were captured during the 1987 seining operations in the Klamath River estuary. An estimated 171 green sturgeon were harvested in the Indian gill net fishery on the Klamath River portion of the HVR.

Seven hundred-eighteen American shad (Alosa sapidissima) were captured during the 1987 seining operations in the Klamath River estuary. Peak catches of shad in the seining operation were observed during August when 662 were captured.

Juvenile salmonid trapping was conducted in Blue Creek, a tributary to the lower Klamath River. A total of 11,816 juvenile chinook salmon were captured. The peak catch night was June 15 when 2,814 chinook were captured. Catches appear to be influenced by lunar phase; peak catches coincided with the last

quarter or new moon of each lunar month while lowest catches occurred on the full moon phase of the lunar month. Mean fork length of chinook salmon ranged from 41.7 mm on March 10 to 74.6 mm on July 7. A total of 1,935 juvenile steelhead were captured. Other fish captured during sampling included coho salmon, cutthroat trout (S. Clarki), suckers (Catostomus spp.), sculpins (Cottos spp.), cyprinids (Cyprinidae), stickleback (Gasterosteus aculeatus) and lamprey (Lampetra spp.). Peamouth (Mylocheilus caurinus), endemic to the Columbia River basin, were also captured in Blue Creek.

Juvenile salmonid sampling was conducted in the Klamath River estuary to evaluate releases made from two Trinity River release sites. A total of 3,188 juvenile chinook salmon were captured during seining operations in the upper portion of the Klamath River estuary. Thirty-two coded wire tagged (CWT's) representing five release groups were recovered, including 16 CWT's from the Trinity River release sites.

CHINOOK SALMON INVESTIGATIONS

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 per unit effort (C/E) and mark-recapture techniques, and to collect biological data on Klamath River fall chinook salmon. During the 1980 season, the assumptions of the mark-recapture methodology could not be met, and thus, the mark-recapture population estimation program was discontinued. An in-season run-size prediction model 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.

This program provides estimates of the age composition of the Klamath River fall chinook run. These data have aided the estimation of ocean stock size of 3- and 4-year-old Klamath River fall chinook, and consequently, the management of the ocean and in-river fisheries. The 1987 season is the ninth consecutive year of sampling fall chinook salmon near the mouth of the Klamath River.

METHODS

The beach seining operation was conducted in the Klamath River estuary, on the North Spit near the river mouth (Figure 2). Seining began on July 13, 1987, and ended on October 6, 1987. The seining was done at a fixed site to sample the fall chinook run prior to sustaining impacts of the various size-selective, in-river fisheries. The selection of the North 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 early July 1987 to obtain depth profile transects to locate and define the channel depth contours.

Seining was conducted five days per week, during daylight hours, by a eight-person crew of biologists and technicians. Seining start times were alternated daily (early (1000 hrs); late (1200 hrs)) throughout the entire season. This allowed sampling through a wider range of tidal stages during successive daily intervals. Six sets, spaced 45 minutes apart were made during each sampling day. 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.

Chinook Salmon

Captured fish were transferred into holding cages, and every fourth chinook was sampled for scales, examined for fin clips, hook scars, tags, gill net marks, predator wounds and other distinguishing characteristics. These fish constituted the representative biological sample (bio-sample). Examination of fish for hook scars and gill net marks is a continuing effort

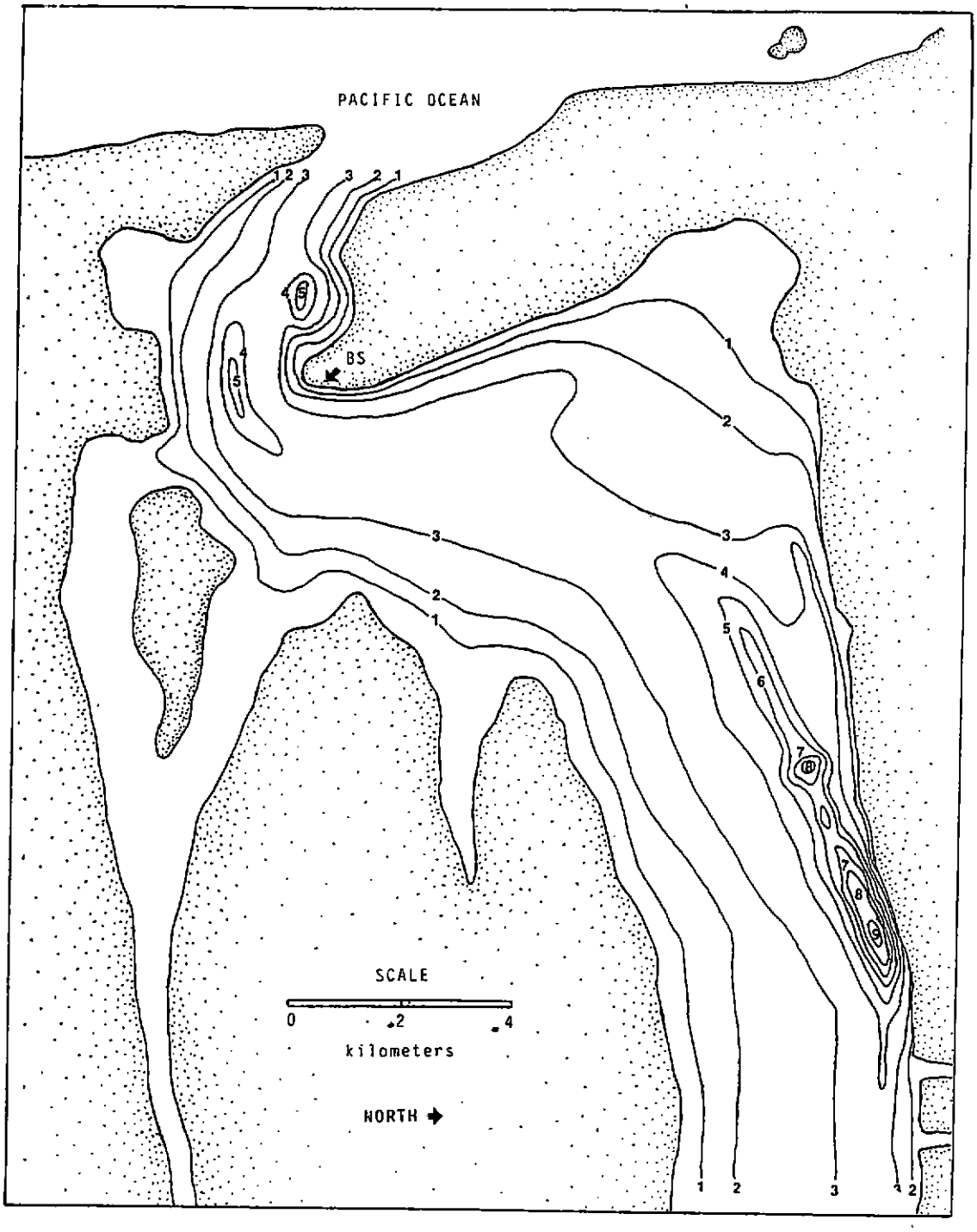


Figure 2. Depth contours (expressed in meters below mean high tide) of the Klamath River estuary during 1987. Beach seine site indicated by arrow.

to document fisheries impacts on Klamath River chinook salmon populations. Physical injuries attributable to hooking incidents were classified according to criteria listed in Table 1. Bio-sample chinook were measured to the nearest centimeter fork length, weighed to the nearest pound and were hole-punched (6.4 mm or 9.5 mm diameter) in the upper caudal lobe for recapture identification. Reward spaghetti tags, provided to FAO-Arcata by CDFG, were applied to each bio-sample chinook. Other chinook (non bio-sample) were measured for fork length, examined only for fin-clips, tags and hole-punched in the upper caudal fin lobe. The non bio-sample chinook were spaghetti-tagged opportunistically as circumstances allowed; efforts focused on tagging as many non bio-sample chinook as possible.

Scales taken from the bio-sample chinook represent a systematic sample collected from every fourth chinook captured throughout the duration of the fall run. However, during sets with large numbers of chinook (>40), the entire catch could not be transferred into the holding cages and then examined in a timely period without risking stress-induced mortality. Thus, in order to maintain the systematic sampling rate, fish were counted and released directly from the seine net, while retaining one chinook for every three chinook released.

The bio-sample fish were weighed with a Chatillion scale (model IN-50), using a tripod and net to facilitate measurement. Readings were made to the nearest pound, then converted to kilograms prior to length-weight data analyses. The post-season jack/adult cutoff (nadir) length was determined by comparison of fork lengths of 2- and 3-year-old chinook, and from length frequency data collected from the seining operation.

All of the 1987 analyses (age-composition, length frequency, hook scar, catch/effort, etc.) were based upon data collected from July 13, 1987 to October 6, 1987, unless otherwise specified. Data analyses were performed on the systematically sampled (bio-sample) chinook. For informative purposes and to allow comparison with results of previous years, certain analyses were also performed utilizing data from all measured and/or captured chinook. These analyses include catch/effort, ad-clips and comparisons of mean fork lengths among prior seasons.

RESULTS AND DISCUSSION

During the 1987 field season, 369 haul sets resulted in the capture of 2,245 chinook salmon (including 12 recaptures). Of this total, 552 chinook were bio-sampled, while 638 chinook were the non bio-sample category. Of the 1,190 chinook measured, 106 were jacks (<55 cm) and 1,084 were adults ($\geq$ 55 cm). The remaining balance (1,043) represent chinook that were released without examination.

Scale samples were collected from 552 of the bio-sampled chinook. Of this total, 58 (10.5%) were jacks and 494 were adults. Four-year-old chinook was the largest age class component (48.2%) of the fall run. Refer to the AGE COMPOSITION section for detailed analysis of the length at age and maturity characteristics.

TABLE 1. Categorization of hook scars observed during 1987 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)	

Mean length of bio-sampled jacks (48.1 cm) and adults (73.0 cm) (Figure 3) did not differ ($p>0.05$) from the means of all measured (combined) jacks (47.5 cm) and adults (72.6 cm) (Table 2). The 1987 jacks were significantly larger ($p<0.05$) than those of 1986, but smaller than the 1985 two-year-olds (Figure 3). The mean length of all measured 1987 adults were significantly ($p<0.05$) larger than the 1986 adults but smaller than those of 1985.

Adipose Fin-Clips

On bio-sampled chinook, ad-clips were observed on 2 (3.5%) of 58 chinook jacks and on 54 (10.9%) of 494 adults. The overall bio-sample ad-clip rate was 10.1%. The mean length of ad-clip jacks (50.0 cm) did not differ significantly ($p>0.05$) from that of non-clipped jacks (48.0 cm). Ad-clip adults were significantly smaller ($p<0.05$) than non-clipped adults (70.2 cm vs. 73.4 cm, respectively). However, by age class, length of ad-clipped 3-year-olds (65.5 cm) did not differ significantly ($p>0.05$) from their non-clipped (67.3 cm) counterparts. No difference ($p>0.05$) in length was found between ad-clipped and non-clipped 4-year-olds (Table 2). One ad-clipped five-year-old was sampled.

For all measured chinook, ad-clips were observed on 116 (10.7%) of 1,084 chinook examined. The mean length of ad-clipped jacks (46.5 cm) did not differ ($p>0.05$) from non-clipped jacks (47.6 cm), whereas ad-clipped adults (70.2 cm) were significantly smaller ($p<0.05$) than non-clipped adults (72.9 cm). Mean lengths of ad-clipped and non-clipped jacks have not differed in the past five seasons. Adult ad-clipped chinook were smaller than non-clipped adults in four of the six previous seasons; no differences were observed in 1986 and 1983.

The cumulative weekly ad-clip rate for all measured chinook varied throughout the seining season. At the end of July, the rate was 12.5%, then decreased to 6.3% by the end of August. From September 7 to 25, the three consecutive weekly adult ad-clip rates were 20.0, 19.2 and 31.3%. These ad-clip rates probably reflect the relative strength of the later-running TRH stock entering the estuary. A similar trend was also observed in 1986.

Length-Weight

Weights were recorded from 540 of the bio-sampled chinook salmon. The mean weight was 5.5 kg, chinook jacks and adults averaged 1.8 kg and 5.9 kg, respectively. The smallest chinook weighed .9 kg; the largest was 14.5 kg. The length-weight relationship was best described by the equation: Log (weight) = -4.553 + 2.848 Log (fork length)(Figure 4). For comparison, the average weight of chinook sampled from the estuary gill net fishery was 7.0 kg, and the mean fork length was 78.9 cm. These data reflect differences in the size selectivity between the beach seine net and the gill net fishery.

Gill Net Marking

Gill net markings were observed on 12 of 552 chinook examined for an incidence rate of 2.2%. All 12 chinook were adults and averaged 72.1 cm in length. The marking rate was slightly higher than the 1986 rate of 1.8%. The

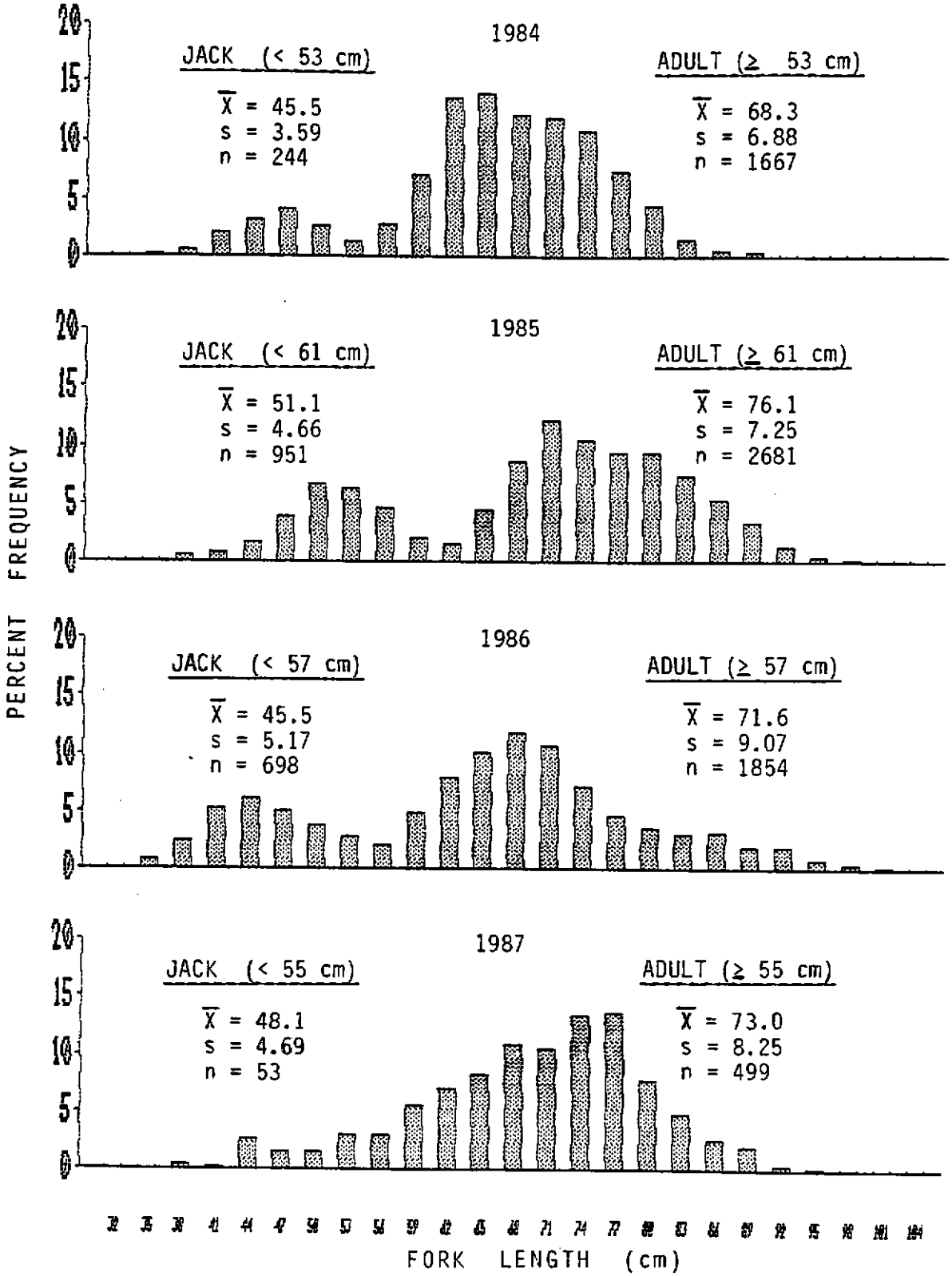


Figure 3. Length frequency distributions of chinook salmon captured during beach seining operations in the Klamath River estuary during 1984-1987 (3 cm groupings with midpoints noted).

TABLE 2. Mean length, standard deviation and sample size of fin-clipped chinook captured during the 1987 beach seining operation. (Percent relative to total jacks and adults sampled per respective categories).

Fin Clips	JACKS (<55cm) $\bar{X}$ (cm)	s	n	%	ADULTS (≥55cm) $\bar{X}$ (cm)	s	n	%
Bio-Sample								
Adipose	50.0	2.8	2	3.5	70.2	8.4	54	10.9
Age III					65.5	5.9	32	
Age IV					76.6	5.9	21	
Age V					89.0	---	1	
Non-Clipped	48.0	4.8	56	96.5	73.4	8.0	440	89.1
Age III					67.3	5.5	180	
Age IV					77.7	5.8	245	
Age V/VI					82.5	5.5	15	
Bio-sample + Non Bio-sample								
Adipose	46.5	3.7	6	5.7	70.2	9.2	110	10.7
Non-Clipped	47.6	4.3	100	94.3	72.9	8.1	974	89.3
Combined	47.5	4.3	106	100.0	72.6	8.3	1,084	100.0

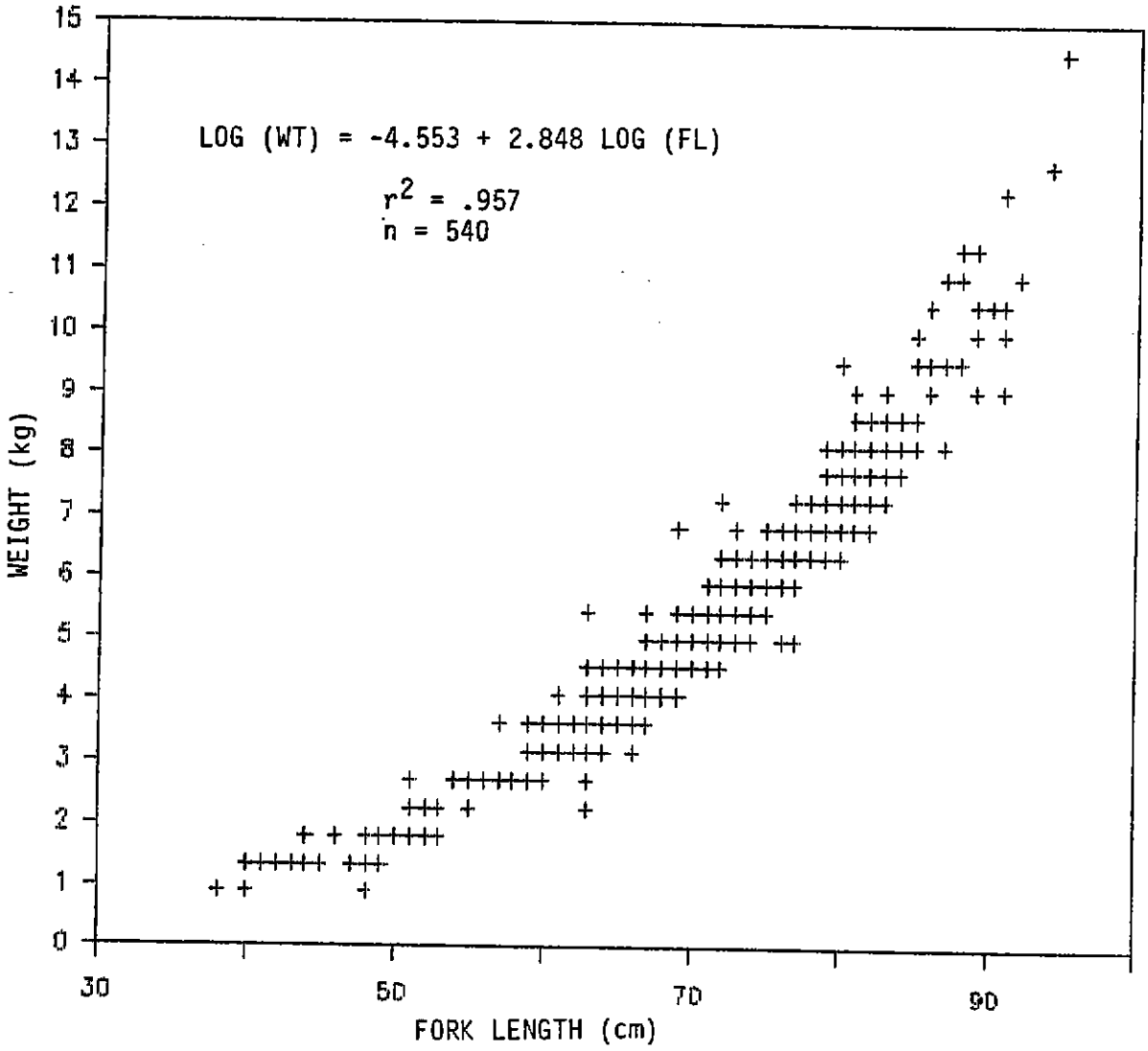


Figure 4. Length-weight relationship of chinook salmon captured during 1987 beach seining operations in the Klamath River estuary.

1985 rate was 0.4%. The higher incidence of gill net markings in 1986 and 1987 is associated with increased harvest levels in the estuary gill net fishery from previous seasons (see NET HARVEST MONITORING PROGRAM).

Hook Scarring

Of 552 chinook examined for hook scarring, 111 (20.1%) had one or more scars attributed to hooking incidents. Ten (18.9%) were jacks and 101 (20.2%) were adults. Five chinook (0.7%) had two hook scars; none were triple-scarred. The 111 hook scarred chinook displayed 115 total hook scars. For this reason, the percentage occurrence of hook scars (Table 3) are not directly comparable to the categorical frequencies presented in Table 4. Chinook with fresh scars (55) were numerically similar to healed scars (56). Minor hook scars (74) were the most common category, followed by moderate (28) and major (9) hook scars. By category, scars were seen most frequently on the lower jaw (41.5%) and upper jaw (37.2%). In the previous six seasons, hook scars were most commonly observed on the upper jaw. The overall incidence of hook scarring (20.1%) decreased slightly from 1986 (21.6%), although the 1987 rate on jacks (18.9%) was the highest since 1983, when 19.2% of the jacks were hook scarred (Figure 5). The hook scar rate seen on jacks may be inflated due to the small sample size (58).

The size of hook scarred jacks (50.0 cm) did not differ significantly ($p<0.05$) from non hook scarred jacks (47.6 cm). In all previous seasons (except 1983), mean length of hook scarred jacks have been larger than those not scarred. Inflated mean lengths of hook scarred jacks resulting from size-dependent mortality attributable to hooking incidences has been suggested to explain their larger lengths. For 1987, the small sample size of hook scarred jacks may be masking any actual significant length difference with non hook scarred jacks.

No difference ($p<0.05$) was noted between hook scarred (73.1 cm) and non hook scarred adults (73.0 cm). Analyses of length by age also did not produce significant differences between hook scarred and non hook scarred chinook. Mean length of hook scarred adults in past years have varied from their non hook scarred counterparts. In the previous eight seasons, hook scarred adults were larger in 1985, smaller in three seasons (1979, 1982 and 1986) and no difference in the other four years (1980-1981, 1983-1984). These findings are difficult to interpret. In certain years, the growth process in adults may be less affected by hooking incidences and/or natural variations in length at age are possibly masking any actual effects from hooking incidents. In 1985, returning 4- and 5-year-olds had higher rates of hook scarring than 3-year-olds and thereby inflating the mean length of all scarred adults (FWS 1986).

Mark-Recapture

During the 1987 season, 12 chinook were recaptured in the beach seine. Nine of these fish were spaghetti-tagged, representing 0.8% of 1,119 chinook tagged. Seven of these nine chinook were recaptured on the same day of tagging. The remaining two chinook were at large for two and ten days. The nine tagged recaptures in the beach seine is the lowest number since 1983 (Table 5). These 1987 beach seine recapture characteristics differed from prior years. The estuary residence time of chinook and tendency of milling was

TABLE 3. Percentage occurrence of hook scars observed on 552 Klamath River fall chinook salmon sampled from the 1987 beach seining operations.

Type of Scar	RUN COMPONENT		
	Jack	Adult	All Chinook
Single Hook Scar[1/]	18.9	20.2	20.1
Two Hook Scars[2/]	0.0	0.8	0.7
Three Hook Scars	0.0	0.0	0.0
Fresh Hook Scar	9.4	10.4	10.3
Healed Hook Scar	9.4	10.6	10.5
Minor Hook Scar	15.1	14.2	14.3
Moderate-Major Hook Scars	3.8	6.8	6.5

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 4. Categorical frequencies of hook scars within a total sample of 115 scars observed on 552 Klamath River fall chinook during 1987 beach seining operations.

Location	Stage	SEVERITY			
		Minor (%)	Moderate (%)	Major (%)	Total (%)
Upper Jaw	Fresh	13.0	5.2	0.0	18.2
	Healed	11.3	6.0	1.7	19.0
	Total	24.3	11.2	1.7	37.2
Lower Jaw	Fresh	17.3	4.2	0.0	21.5
	Healed	16.5	2.6	0.9	20.0
	Total	33.8	6.8	0.9	41.5
Eye and Proximity	Fresh	0.9	0.9	0.0	1.8
	Healed	0.9	0.0	3.5	4.4
	Total	1.8	0.9	3.5	6.2
Opercle	Fresh	0.0	0.9	0.9	1.8
	Healed	2.6	0.0	0.0	2.6
	Total	2.6	0.9	0.9	4.4
Isthmus and Proximity	Fresh	0.9	1.8	0.0	2.7
	Healed	2.6	0.0	0.0	2.6
	Total	3.5	1.8	0.0	5.3
Other Head Areas	Fresh	1.8	1.8	0.0	3.6
	Healed	0.9	0.9	0.0	1.8
	Total	2.7	2.7	0.0	5.4
All Head Areas Combined	Fresh	33.9	14.8	0.9	49.6
	Healed	34.8	9.5	6.1	50.4
	Total	68.7	24.3	7.0	100.0

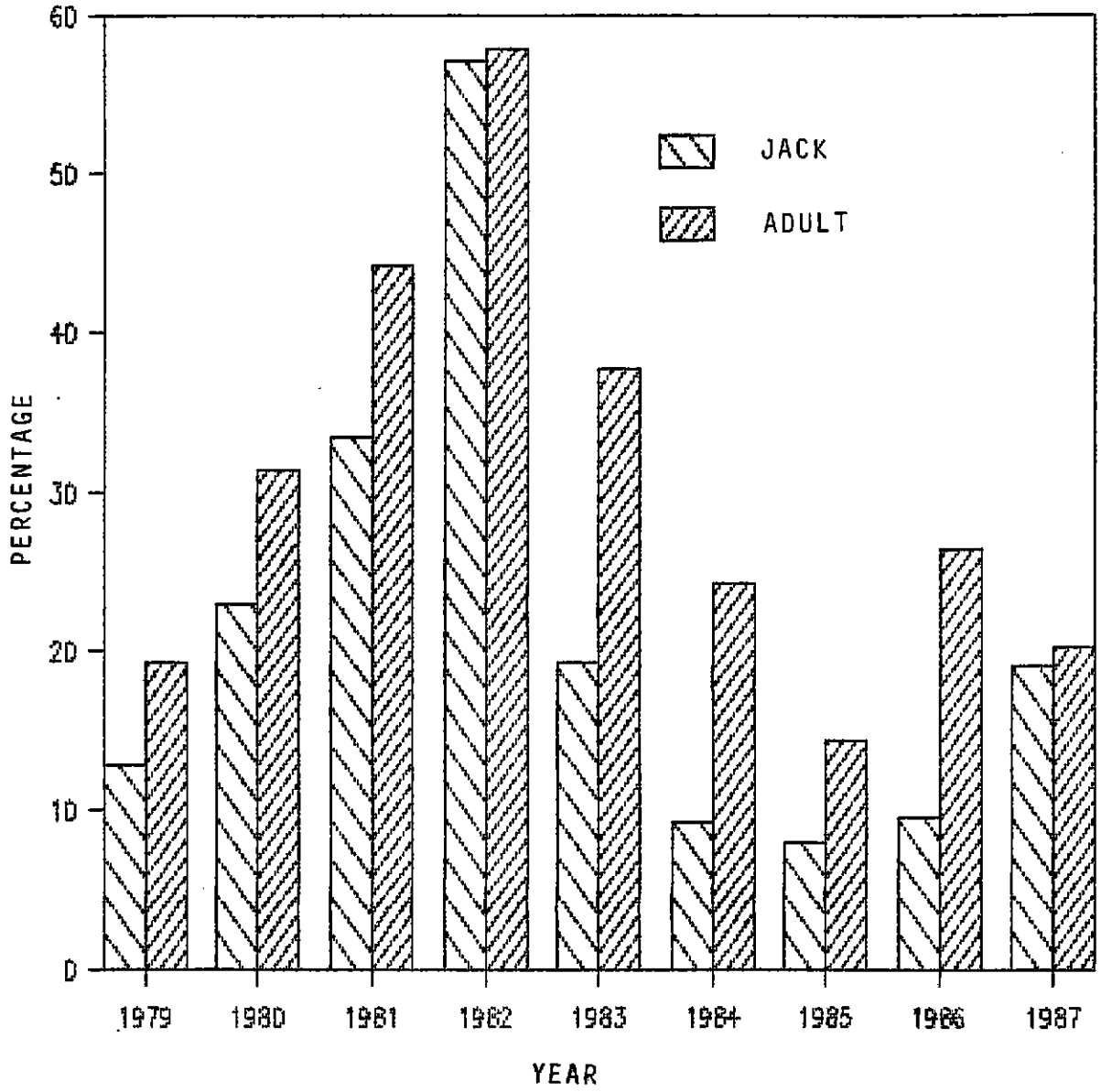


Figure 5. Hook scarring rates observed on jack and adult chinook salmon during 1979-1987 beach seining operations in the Klamath River estuary.

TABLE 5. Recovery data from 10,332 fall chinook salmon tagged by the Fish and Wildlife Service on the Klamath River during 1979-1987 beach seining operations (no tags were applied in 1981).

Source[1/]	NUMBER RECOVERED								
	1979	1980	1982	1983	1984	1985	1986	1987	Total
USFWS Beach Seine	22	67	14	7	20	36	28	9	203
CDFG Beach Seine	4	11	3	-	12	5	7	4	46
Gill Net Fishery	14	111	46	14	31	35	8	45	304
Shasta River Weir	50	21	19	0	3	3	1	7	104
In-River Sport Fishery	14	43	13	11	7	23	13	79	203
Trinity River Hatchery	18	32	16	14	20	72	34	44	250
Iron Gate Hatchery	23	14	20	12	14	85	30	58	256
Bogus Creek Weir	-	-	22	1	8	21	4	48	104
Willow Creek Weir	5	6	8	4	11	22	8	6	70
Scott River Weir	-	-	8	2	2	4	2	6	24
Junction City Weir	0	2	0	-	4	3	2	0	11
South Fork Trinity Weir	-	-	-	-	1	1	0	2	4
North Fork Trinity Weir	-	-	1	0	0	-	-	0	1
Salmon River Weir	-	-	-	-	-	4	0	0	4
Ocean	0	1	0	0	1	0	0	0	2
Spawning Ground Surveys	7	25	1	0	4	5	3	8	53
Other	0	0	8	4	1	13	7	0	33
Totals	157	333	179	69	139	332	147	316	1,672
Number Tagged	1,016	2,363	1,018	588	1,007	1,746	1,475	1,119	10,332
Recovery Rate	0.155	0.141	0.176	0.117	0.138	0.190	0.099	0.282	0.162

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

less than in previous years. Recapture data from past seasons suggests that tagged chinook spend a variable period of time in the estuary (Figure 6). Chinook with longer residence times are presumed to be milling in the estuary and may be more likely to be recaptured in the beach seine.

Of 1,119 spaghetti tags applied to chinook, 316 were recovered, for a recovery rate of 28.2%; the highest since the beach seining program began in 1979 (Table 5). Tag recoveries were generally in proportion to the number of tags applied throughout the seining season; although a higher percentage of the tags were recovered from chinook tagged after August 31 (Figure 7).

The in-river sport fishery returned the largest number of tags (79) from a single source. The combined returns to the IGH and TRH facilities constituted 9.1% of all chinook tagged, and 32.5% of the total recoveries. In contrast to prior seasons, the Bogus Creek weir had a large number (48) of tagged chinook returns. Due to the close proximity of this creek to IGH and the manner of operation of both trapping facilities, many of the tagged fish recovered from Bogus Creek are believed to be of IGH origin (I. Paulson, CDFG, personal communication 1988). With the exception of Bogus Creek, few tags were recovered at the weirs on major tributaries of the Trinity and Klamath Rivers. Gill net fishers returned 43 tags. The ratio of tag recoveries to total catch of this fishery (0.001) was less than the ratios for the estuary (0.011) and upriver sport fishery (0.004), respectively (Table 6).

Table 6. The ratios of recovered spaghetti tags compared to each respective sample at the weirs and hatcheries or the harvest of the fisheries within the Klamath River basin in 1987.

Return Source	Sample or Harvest	Number Tags Recovered	Ratio of Recovered Tags to Sample or Harvest
Gill Net Fishery	53,511	43	.001
Sport Fishery 1/	14,145	52	.004
Sport Fishery 2/	2,374	27	.011
Willow Creek Weir	2,643	6	.002
Trinity River Hatchery	15,397	44	.003
Shasta River Weir	4,697	7	.001
Scott River Weir	8,566	6	.001
Iron Gate Hatchery	17,014	58	.003
Bogus Creek Weir	10,956	48	.004

1/ Estimated sport angler catch above Highway 101 bridge (adults only)
2/ Estimated sport angler catch below Highway 101 bridge (adults only)

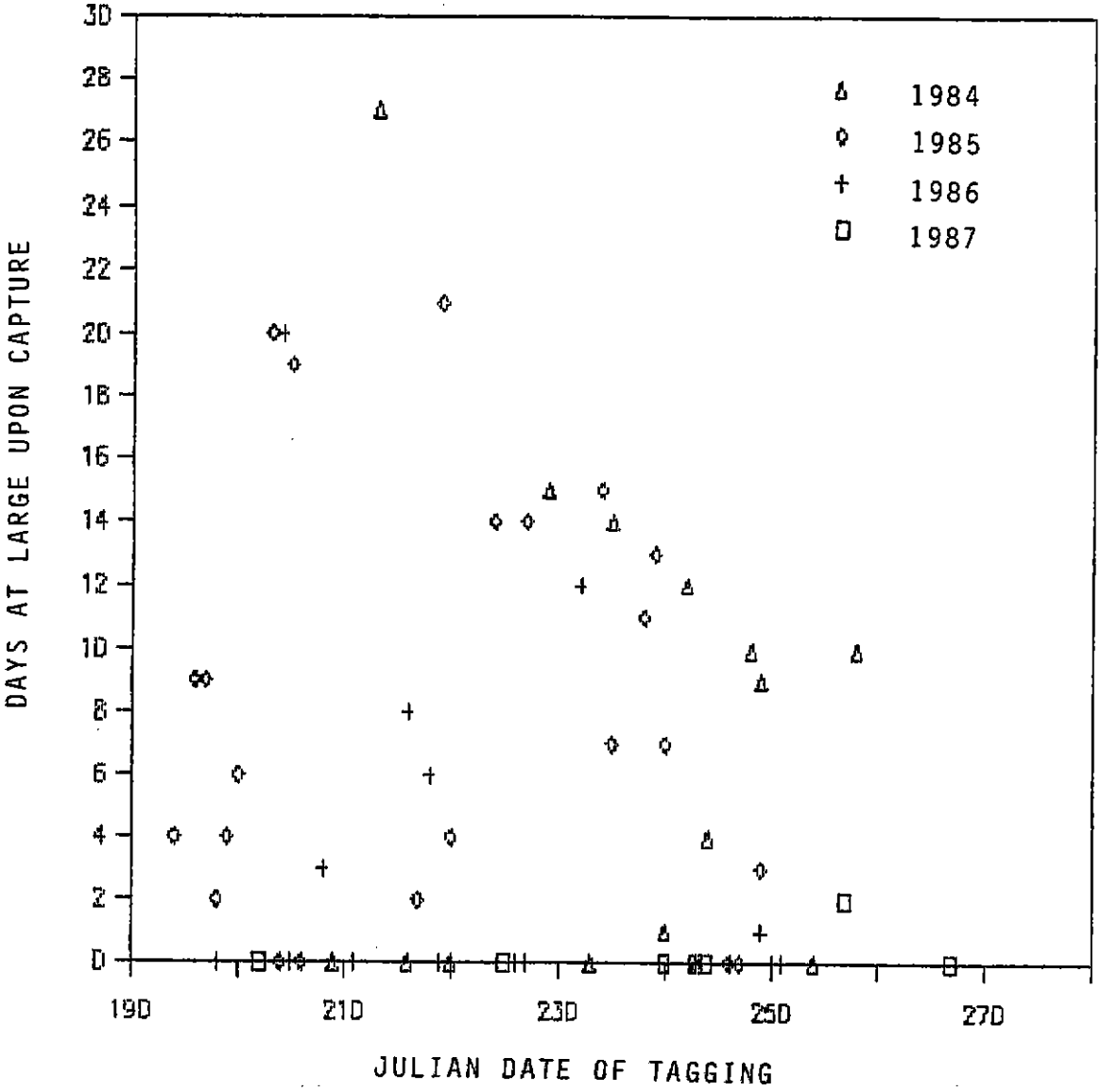


Figure 6. Julian tagging date and number of days at large of recaptured chinook salmon during 1984-1987 beach seining seasons.

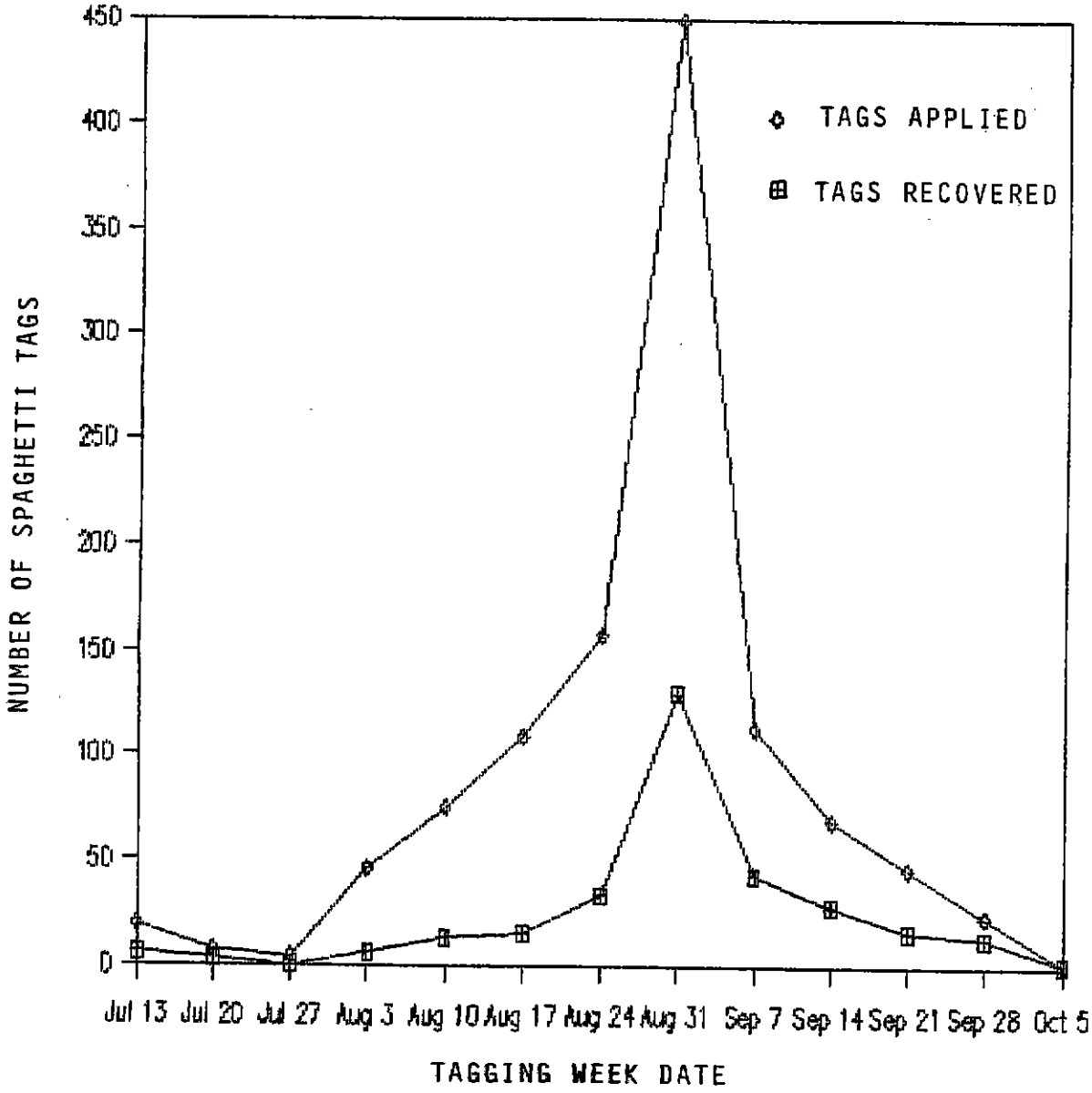


Figure 7. Number of spaghetti tags applied to beach seine caught chinook salmon, and subsequently recovered from various upstream areas during 1987.

Catch/Effort and Run Timing

Catch per unit effort is a standard measure of sampling success and has been used in prior years to show general run timing trends. The catch success is influenced by various factors such as tide, time of day, river mouth and channel morphology, run timing and seining site characteristics. There appears to be no reliable method to standardize the influences of these factors on catch success. These influences complicate and possibly limit the utility of C/E analyses. On a daily basis, it is not possible to uniformly replicate effort to target all tidal stages and times. For these reasons, detailed comparisons of C/E between seasons were omitted.

The highest daily C/E was 83.7 on August 31. This coincides with the highest weekly C/E (41.8) during August 31 to September 4 (Figure 8). Analysis of weekly C/E by tidal stage and time of day failed to show any significant trends. The overall catch success was a function of run timing. Average weekly C/E values from beach seine caught Klamath River chinook during 1984-1987 are presented in Figure 8 to show general run timing trends.

Migration

Of 316 spaghetti-tagged chinook salmon recoveries, 75 had sufficient data to determine post-tagging migration rates to upstream sites within the Klamath and Trinity River basins. For both basins combined, migration rates were highly variable. The up-stream migration rates of early-entry (date of tagging) chinook did not differ from chinook entering the estuary later in the season. Analyses by individual basins also did not reveal any differences in migration rates as a function of run timing. However, chinook from the Klamath River basin appear to migrate faster as they proceed further upstream (Figure 9). Chinook recovered downstream from Weitchpec (Klamath River-Trinity River confluence area) migrated slower ($\bar{X}$=1.92, range 0.18 -4.28 km/day) than those recovered upstream of Weitchpec ($\bar{X}$=6.32, range 1.56-12.92 km/day). The overall mean migration rate was 4.25 km/day. Migration rates of chinook from the Trinity River basin ($\bar{X}$=5.33, range 2.33-8.63 km/day) were variable and did not increase upstream. These results are similar to most previous seasons although faster migration rates were observed in the Klamath River during 1986.

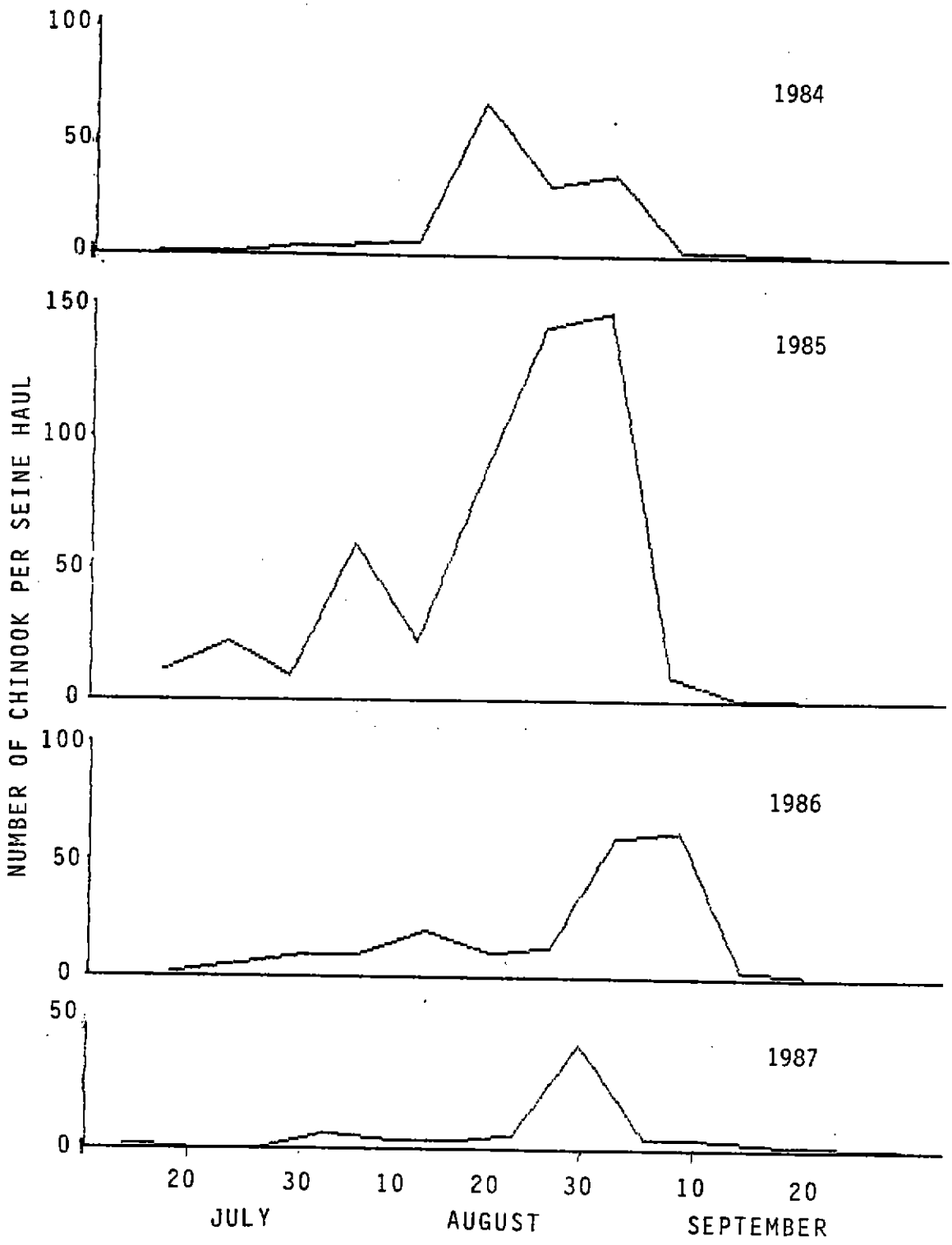


Figure 8. Weekly averages of the number of chinook salmon captured per seine haul in the Klamath River estuary during the 1984-1987 beach seining seasons.

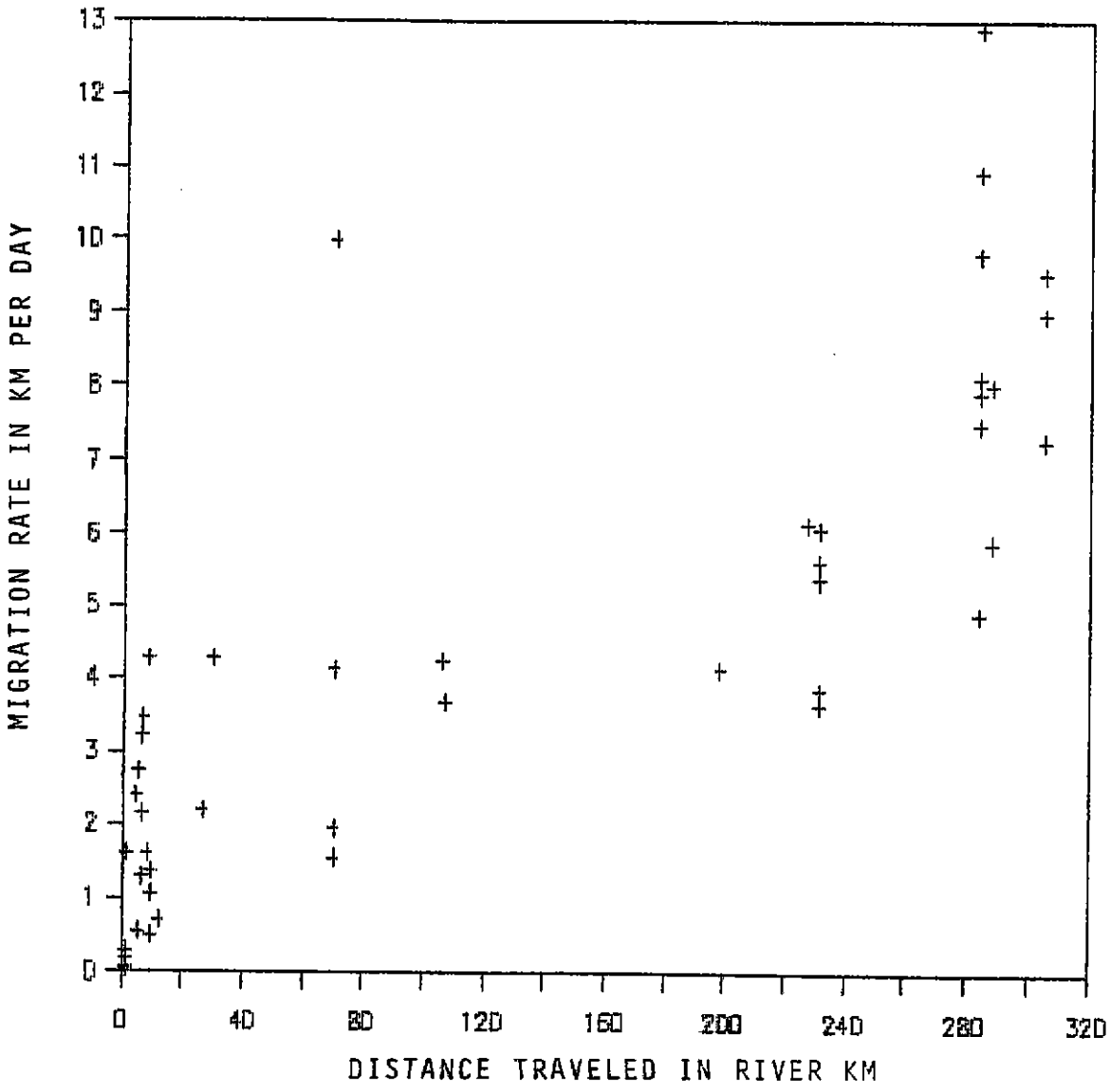


Figure 9. Relationship between distance traveled at time of recovery and mean migration rate in km/day of 51 chinook salmon recaptures from the Klamath River basin.

AGE COMPOSITION

INTRODUCTION

Monitoring the age composition of a fish stock impacted by major fisheries is essential to 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 is useful in setting preseason management goals and regulations. Analysis of these parameters may also be used in judging the results and effectiveness of fishery management practices. In a continuing program to evaluate age composition of fall chinook salmon runs in the Klamath basin, scales were collected through a beach seining program near the mouth of the Klamath River. A summary of age information collected on fall chinook entering the Klamath from past seasons are also presented herein.

METHODS

Age structure of the 1987 fall chinook run was determined through analysis of scales collected in beach seining operations between July 13 and October 6. Scale samples were collected from every fourth chinook captured in the beach seining operation, producing a sample which was proportional to the total catch over time and assumed to be representative of the 1987 fall chinook run. The scale sample size desired was determined through a statistical analysis involving the hypergeometric distribution (Dixon and Massey 1969, Hannah 1982 (unpublished script)). A subsample of 667 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 205,700 (PFMC 1987), assuming the least abundant age-class constitutes 13% of the total cohort run. However, the California Department of Fish and Game post-season estimate of 1987 Klamath River fall chinook in-river run size is 223,207, with the least abundant age-class constituting 11% of the total run. A run of this size would require 806 scales to predict the age composition at the 95% precision level. A total of 552 scales were aged for analysis meeting a 90% level of precision.

Impressions of scales were made on cellulose acetate using a hydraulic press equipped with variable temperature heating elements. Scale impressions were viewed on a microfiche reader. Scale impressions were analyzed independently by two interpreters, with a third reading by 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 (CWT recoveries) were initially used to assist in the age interpretation.

RESULTS AND DISCUSSION

The majority of Klamath River fall chinook returning in 1987 were age 4 (48.2%), followed by age 3 (38.4%), age 2 (10.5%) and age 5 (2.9%) (Table 7). The 1987 run showed an increased proportion of age 4 fish (11.8% to 48.2%), age 5 fish (0.9% to 2.9%) and a decrease in proportion of age 2 fish (22.9% to 10.5%) and age 3 fish (64.4% to 38.4%) compared to the 1986 run. The 1987 3- and 4-year-old classes reflects the relative strengths of the 1983 and 1984 brood years.

TABLE 7. Percentage age composition of Klamath River fall chinook derived from scale analysis and length frequency information during the 1979-1987 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
1987	10.5	38.4	48.2	2.9
1979-1987 Average	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.

The chinook age data collected from the beach seine was stratified into four equal time intervals to identify run timing differences by age class. Significant run timing differences by age were noted ($p<0.05$, Pearson 2-way chi-square). Three-year-olds were the strongest component initially. The age 4 class was dominant in the next two intervals. In the final interval, age three chinook was again the dominant class; the age 2 and age 4 classes were equally represented (Table 8). The increase in these latter two age classes are believed to reflect the entry of Trinity River chinook that typically exhibit late run timing and are also known to mature at an earlier age. Generally, the early entry of age 4 chinook and later entry of age 2 and 3 classes have been observed in prior seasons. The early entry of age 4 chinook was not apparent in 1986; an unusually strong age 3 class may have masked any actual early entry of four-year-olds.

The percentage of 4-year-old chinook in 1987 exceeds that of any return year during 1979-1986 while the percentage of 2-year-old fish was the lowest for the same time period. The age composition of the 1987 Klamath River fall chinook run is similar to the 1979 run when 4-year-old fish dominated the run while the percentages of 2-year-old fish were below average.

Combining FWS age composition data and CDFG run size estimates allow consistent comparison of cohort groups through brood year cycles. Applying FWS age composition data to CDFG run size estimates 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 been used to assist the estimation of ocean stock abundance of 3- and 4-year-old Klamath River fall chinook (PFMC 1985, 1986, 1987, 1988). These estimates are presented for comparative purposes and are not intended to supplant those generated by CDFG.

Estimated returns of 2-year-olds (23,437) is less than the 1979-1986 average of 27,469. The three-year-old chinook return is surpassed only by the 1986 return year (Table 9). The 107,586 4-year-olds exceeds any previous return year since the FWS beach seining program began. Returns of five-year-olds (6,473) by percentage (2.9%) was close to the 1979-1987 average (3.3%).

The strong 3-, 4- and 5-year-old classes are from the 1982-1985 brood years, respectively. The 1983 brood year has produced an estimated 286,746 chinook returns to date, with a larger than average number of five-year-olds returns anticipated in 1988. The 1984 brood year has already contributed 138,102 chinook, with the 4- and 5- year-old age classes still outstanding for the 1988 and 1989 return years. The 1984 brood year should easily surpass the 1978 brood year total of 141,810 estimated chinook (Figure 10).

The number of 2-year-olds returning in certain past years has been a good indicator of the strength of its cohort brood year. This association was observed for the 1977-1980, and 1983-1984 brood years, but did not apply to the 1981-1982 brood years. If this association applies to the 1985 brood year, future returns from this brood may not be promising. The success of the recent (1983 and 1984) brood years may be related to various factors including favorable oceanic conditions and reductions in harvest rates on Klamath River chinook stocks.

TABLE 8. Age class contribution of fall chinook salmon during four equal time intervals from the 1987 Klamath River beach seine sample determined through scale analysis.

	RUN TIMING				
Age	7/13 - 8/3	8/4 - 8/24	8/25 - 9/14	9/13 - 10/6	Total
2	4 (13.3%)	9 (7.6%)	32 (9.4%)	13 (21.0%)	58 (10.5%)
3	15 (50.0%)	36 (30.6%)	126 (36.8%)	35 (56.4%)	212 (38.4%)
4	11 (36.7%)	70 (59.3%)	172 (50.3%)	13 (21.0%)	266 (48.2%)
5	0 (0%)	3 (2.5%)	11 (3.2%)	0 (0%)	14 (2.5%)
6	0 (0%)	0 (0%)	1 (0.3%)	1 (1.6%)	2 (0.4%)
Total	30 (100.0%)	118 (100.0%)	342 (100.0%)	62 (100.0%)	552 (100.0%)

TABLE 9. Estimated number of fall chinook by age entering the Klamath River during the 1979-1987 return years.

Return Year	AGE 2	3	4	5	Total
1979	8,867	20,197	28,695	3,818	61,577
1980	47,021	14,430	15,484	4,135	81,070[1/]
1981	34,567	56,315	12,608	1,576	105,066
1982	30,316	33,338	37,609	2,917	104,180[1/]
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
1979-1987 Average	27,021	50,983	34,285	3,465	115,754

[1/]. Estimated total and associated numbers for 1980 and 1982 differ slightly from those published in previous annual reports due to changes in CDFG run size estimates.

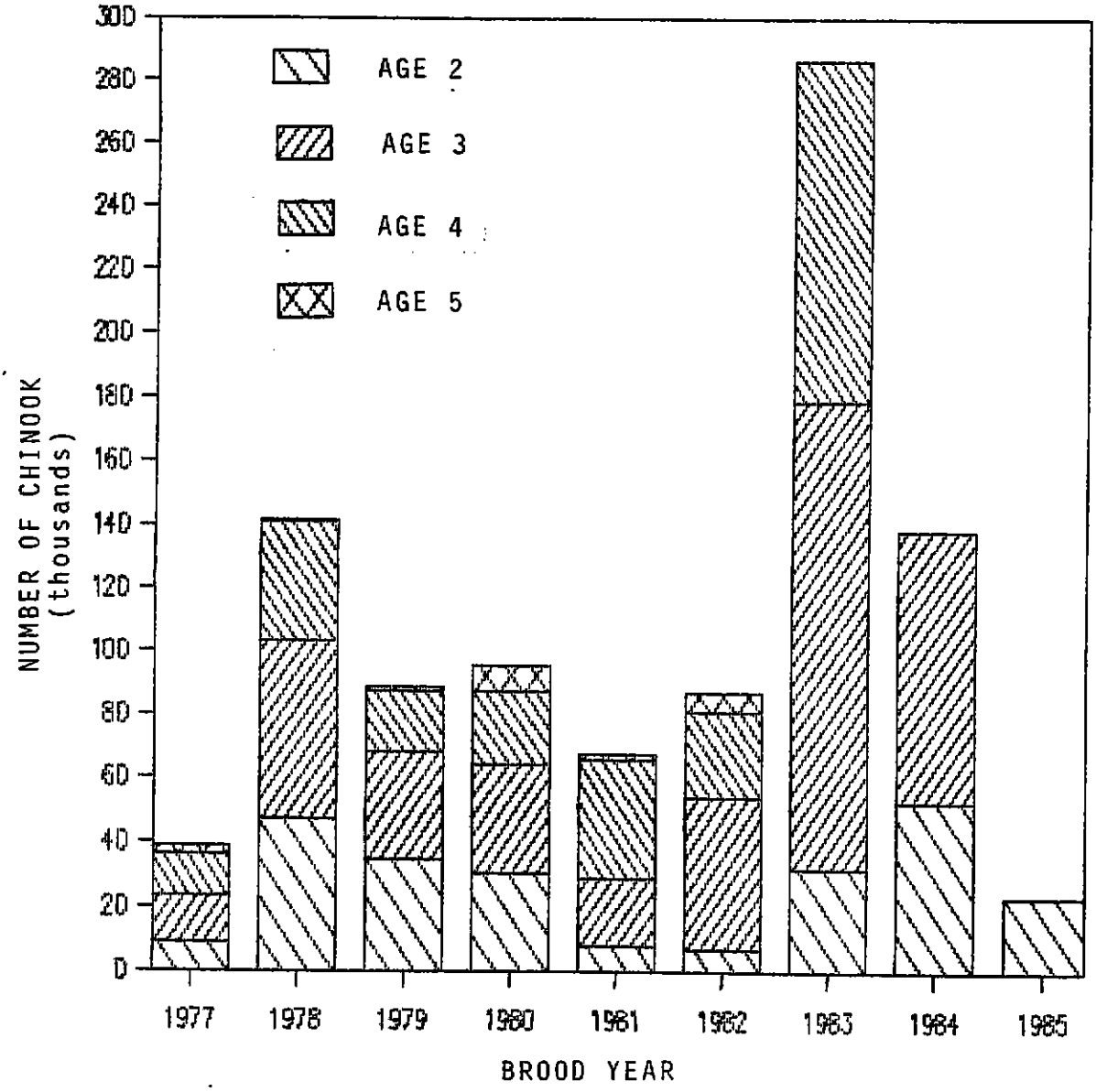


Figure 10. Brood year contributions by age of fall chinook salmon to the 1979-1987 Klamath River returns.

Average age composition of fall chinook returning to the Klamath River for brood years 1979-1982 is 23.5% age 2, 39.8% age 3, 31.4% age 4 and 5.3% age 5 The average age at maturity of chinook from the 1977, 1978, 1979, 1980, 1981, and 1982 brood years are 3.2, 2.9, 2.9, 3.1, 3.5 and 3.4, respectively, with an overall average of 3.1 for the 1977-1982 brood years.

Mean lengths of fall chinooks in 1979-1987 return years are presented in Table 10. Four-year-old chinook were significantly smaller ($p<0.05$) than 4-year-old chinook from all years except those returning in 1983 and 1984 where El Nino ocean conditions depressed the growth rate (see 1983 Annual Report, El Nino). In 1987, two-year-old chinook were significantly larger ($p<0.05$) than those returning in 1983, 1984 and 1986 but were significantly smaller than those returning in 1985. Three-year-old chinook were significantly smaller ($p<0.05$) than those returning from 1979-1982 and 1985 but were significantly larger than those returning in 1983 and 1984. Mean length of age 5 chinook was significantly smaller ($p<0.05$) than 5-year-olds returning in 1979, 1981 and 1986 but did not differ ($p>0.05$) from 1982-1985 mean lengths.

TABLE 10. Mean length, standard deviation and sample size of fall chinook returning to the Klamath River basin by age in 1979 and 1981-1987 return years.

Return Year		AGE AT RETURN 2	3	4	5
	$\bar{X}$ [1/]	**48.8**	**70.1**	**80.3**	**88.7**
1979	s	6.54	5.78	5.69	6.48
	n	97	221	314	42
	$\bar{X}$	**50.2**	**68.1**	**80.5**	**89.0**
1981	s	4.95	6.85	6.09	5.95
	n	176	287	64	8
	$\bar{X}$	**48.3**	**69.3**	**83.2**	**87.2**
1982	s	4.25	6.51	7.02	7.48
	n	161	177	200	13
	$\bar{X}$	**41.9**	**60.3**	**71.5**	**82.2**
1983	s	3.73	4.82	6.07	6.77
	n	80	338	195	9
	$\bar{X}$	**45.4**	**62.9**	**72.6**	**81.1**
1984	s	3.89	3.96	4.78	7.89
	n	123	379	426	19
	$\bar{X}$	**51.0**	**70.5**	**81.0**	**84.7**
1985	s	4.99	4.23	5.60	5.32
	n	126	186	145	32
	$\bar{X}$	**46.6**	**66.9**	**83.9**	**92.7**
1986	s	5.37	5.71	6.87	5.06
	n	**169**	475	87	7
	$\bar{X}$	**49.0**	**66.9**	**77.6**	**82.2**
1987	s	5.38	5.75	5.85	5.63
	n	58	212	266	14

1/ $\bar{X}$ = mean fork length in cm, s = standard deviation, n = sample size

NET HARVEST MONITORING PROGRAM

INTRODUCTION

Hoopa, Karok and Yurok Indian people 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 FWS (1981).

Regulations governing recent Indian fishing on the HVR were first published by the DOI in 1977 and FAO-Arcata biologists began monitoring net harvest levels on the Reservation in 1978 (FWS 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 up river 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 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 user groups of the Klamath River fall chinook resource (ocean commercial, ocean sport, river sport and Indian gill net) was agreed upon in 1986. This allocation allowed harvest of the chinook resource and yet provided for the rebuilding of the chinook population. Toward this goal, the 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 1987 (Figure 11). The Estuary Area was defined as the lower 6 km of the river from the mouth to the crossing of the U.S. 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 mouth. The Upper Klamath Area included the next 37 km stretch of river from Surpur Creek to Weitchpec. During the 1987 fall chinook fishery, DOI regulations divided

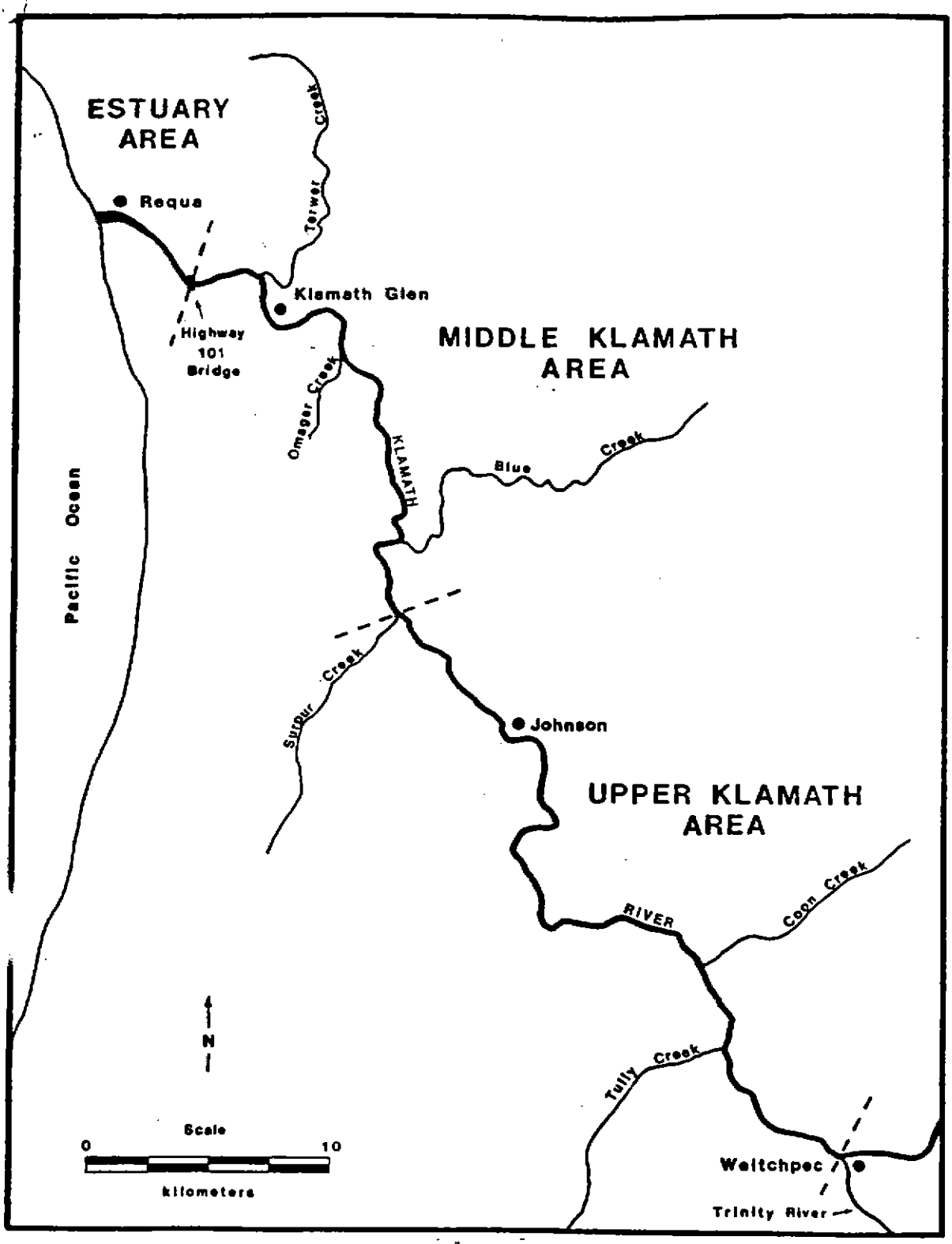


Figure 11. Net harvest monitoring areas for the Klamath River portion of the Hoopa Valley Reservation in 1987.

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 the U.S. Highway 101 bridge (River km 6). Area II began at the crossing of the U.S. Highway 101 bridge 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 1987 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 1987 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 and 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

Under pre-season DOI regulations, the Estuary (DOI Management Area I) was open to gill net fishing Monday through Saturday from 1900 hours to 0700 hours from July 15 to September 30. However, the Estuary Area was closed on September 5 upon the attainment of its harvest quota. One field crew, consisting of one biologist and one Indian technician, monitored the Estuary Area fishery from July 15 to September 5. The crew monitored the estuary fishery every day the fishery was open. In order to improve 1987 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.

Section 1 was a high effort area where nets were fished for varied lengths of time throughout the 12 hour period open to gill netting. 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 interviewed later at their residences or camps. From this information, harvest and variance estimates were generated.

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 ad-clip fish for subsequent CWT recovery and identification. A subsample of chinook in the Estuary Area were weighed to the nearest pound and these weights were then converted to kilograms.

The commercial fishery buying station located at Requa was monitored from July 29 to August 26. All commercially sold salmon were examined for ad-clips. Each ad-clipped chinook was measured to the nearest centimeter fork length, a scale sample taken and snout was removed for CWT recovery and identification. Commercially sold chinook were systematically sampled for fork length data.

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. Under pre-season DOI regulations the Middle Klamath Area is part of Management Area II and was open for fishing under pre-season DOI regulations six days per week, beginning Tuesday at 1700 and continuing until Monday at 0900 from August 15 to September 30. The fishery was monitored 4 to 5 days per week from August 1 to October 29. 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 2000 hours and 0100 hours 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. 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. The crew monitored the fishery 4 to 5 days per week from August 1 to October 29. The sampling methodologies for set and drift net fisheries were the same as in the Middle Klamath Area.

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.

$\bar{C}$ = Daily mean catch per net or net hour.

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

$\hat{Y}$ = Estimated daily total number of net hours fished.

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

$V(\bar{C}_i)$ = Variance of the mean catch per net or net hour.

$\hat{V}(\hat{C}_p)$ = 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 net hours fished.

Estuary (section 1) estimates ($\hat{C}_i$) of catch by species were calculated by multiplying mean catch per net hour values by the total number of net hours fished:

$$(1a) \quad \hat{C}_i = (\hat{Y}_i)(\bar{C}_i)$$

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:

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

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

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

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

Estimated harvest of the subsistance fishery in the Estuary Area (Section 1 and 2) was calculated by subtracting the commercial harvest from the total daily harvest estimate.

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

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

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):

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

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

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

Spring Fishery

FAO-Arcata personnel monitored the fishery from the mouth to Surpur Creek (Estuary and Middle Klamath Areas) and from Johnsons to Weitchpec (Upper Klamath Area), on a periodic basis from April 7 to July 29.

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 1987 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

Indian fishers harvested an estimated 48,267 ± 2,603 chinook salmon from the Klamath River portion of the HVR in 1987 (Table 11). Adult chinook salmon (≥55 cm) accounted for 99.7% of the harvest while jacks (<55 cm) accounted for the remaining 0.3% (Table 12). The majority of the adult harvest occurred in the Estuary Area (83.1%), followed by the Middle Klamath (10.6%) and Upper Klamath (6.4%) areas. Jacks accounted for 0.3% of the Estuary Area subsistance harvest, 0.6% of the Middle Klamath Area harvest and 2.8% of the Upper Klamath Area harvest. The jack harvest in 1987 was the lowest since 1983 when 133 jacks were caught. The low number of jacks harvested by Indian fishers in 1987 appears to support the beach seine age composition data which shows a weakness of the two-year-old component of the run. Estuary Area adult harvest was partitioned into commercial harvest, 29,040 (72.6%), and subsistance harvest, 10,938 (27.4%). Chinook salmon harvest estimates corresponding to Department of the Interior management areas were 39,978 adults and 36 jacks in Management Area I and 8,136 adults and 117 jacks in Management Area II.

In the Estuary Area, most of the salmon were harvested between August 10 and August 29, with the peak weekly harvest of 13,527 occurring between August 24 and August 29. Daily catch estimates for fall chinook ranged from 2 on July 18 to 5,719 on August 24 compared to an estimated peak daily catch of 1,753 on September 6 in 1986. The Estuary Area (Management Area I) commercial quota was reached on August 27 and the subsistance quota was reached on September 5 and was subsequently closed to gill net fishing.

The majority of the chinook salmon harvest (86.9%) in the Middle Klamath Area occurred between August 30 and October 3 with the peak weekly harvest of 1,945 chinook occurring between September 6 and September 12. Most of the chinook salmon harvest (77.0%) in the Upper Klamath Area occurred between September 6 and October 3 with the peak of 832 salmon harvested between September 6 and September 12. Weekly catches in both the Middle and Upper Klamath Areas substantially increased after the Estuary Area was closed to gill net fishing. This can be partially attributed to an effort shift from the Middle and Upper Klamath Areas to the Estuary Area while the commercial fishery was open and then an increase in effort in the Middle and Upper Klamath Areas after the closure of the Estuary Area.

Mean fork length of adult chinook harvested on the Klamath River portion of the HVR was significantly greater ($p<0.05$) than mean lengths of adults harvested in 1984, 1985 and 1986 (Figure 12). Mean fork length of jacks returning in 1987 was significaty greater ($p<0.05$) than 1984 jacks, significantly smaller ($p<0.05$) than 1985 jacks and not significantly different ($p>0.05$) than 1986 jacks. Values for mean fork lengths of jacks and adults harvested during 1984-1986 on the Klamath River portion of the HVR are different than those presented in previous reports due to weighting of these values by area harvest.

TABLE 11. Final semi-monthly estimates of fall chinook salmon harvest by the gill net fishery in the three Klamath River monitoring areas on the Hoopa Valley Reservation under Department of Interior promulgated regulations in 1987.

Time Period	NET HARVEST MONITORING AREA			Semi-Monthly Totals (All Areas)	Cumulative Seasonal Total
	Estuary 1/	Middle Klamath	Upper Klamath		
July 1 - 15	**349** 2/ 38 3/ 10.9% 4/ 110 5/	**0** - - -	**0** - - -	**349**	**349**
July 16 - 31	**1,440** 193 13.4% 712	**0** - - -	**0** - - -	**1,440**	**1,789**
August 1 - 15	**11,834** 385 3.3% 7,017	**72** 8 11.1% 33	**121** 16 13.2% 55	**12,027**	**13,816**
August 16 - 31	**23,820** 800 3.4% 8,768	**362** 48 13.3% 172	**281** 46 16.4% 134	**24,463**	**38,279**
September 1 - 15	**2,571** 377 14.7% 1,324	**2,395** 213 8.9% 806	**1,053** 105 10.0% 475	**6,019**	**44,298**
September 16 - 30	**0** - - -	**1,717** 185 10.8% 679	**1,228** 81 6.6% 616	**2,945**	**47,243**
October 1 - 15	**0** - - -	**468** 47 10.0% 255	**346** 28 8.1% 205	**814**	**48,057**
October 16 - 31	**0** - - -	**95** 16 16.8% 54	**115** 17 14.8% 52	**210**	
Area Season Total	**40,014** 1,793 4.5% 17,931	**5,169** 517 10.1% 1,999	**3,144** 293 9.3% 1,537		**48,267** 2,603 5.4% 21,467

1/ Includes commercial and subsistence fishery.
2/ Harvest estimate.
3/ 95% Confidence interval.
4/ Confidence interval percentage.
5/ Accounted number of fall chinook.

Comparison of mean fork length by area indicates that the Middle Klamath Area harvested significantly larger ($p<0.05$) adult chinook than both the Estuary and Upper Klamath Areas, while adult chinook harvested in the Estuary Area were significantly larger ($p<0.05$) than those harvested in the Upper Klamath Area (Figure 13). Mean fork length of jacks did not differ significantly ($p>0.05$) among any of the areas.

TABLE 12. The number and percentage of jack and adult fall chinook harvested in the net fishery on the Klamath River portion of the Hoopa Valley Reservation Department of Interior promulgated regulations in 1987.

Area	Jack	(%)	Adult	(%)	Total	(%)
Estuary Commercial	0	(0.0%)	29,040	(100.0%)	29,040	(60.2%)
Estuary Subsistence	36	(0.3%)	10,938	(99.7%)	10,974	(22.7%)
Middle Klamath	30	(0.6%)	5,079	(99.4%)	5,109	(10.6%)
Upper Klamath	87	(2.8%)	3,057	(97.2%)	3,144	(6.5%)
Total All Areas	153	(0.3%)	48,114	(99.7%)	48,267	(100.0%)

Mean fork length comparisons of adults harvested in the Estuary Area show that adults harvested in 1987 had the same mean fork length as those returning in 1985 and 1986 (Figure 14). Mean fork length of adults returning in 1987 was significantly greater ($p<0.05$) than that of 1984 adults. Mean fork length of jacks returning in 1987 did not differ significantly ($p>0.05$) from those returning in 1984, 1985, and 1986.

Ad-clipped chinook, representing various CWT groups, comprised 7.7% of all mark sampled chinook. Ad-clips were observed on 7.5%, 6.0% and 14.2% of all chinook sampled in the Estuary, Middle Klamath and Upper Klamath Areas, respectively. No right or left ventral (RV or LV) fin clips were observed in the 1987 fishery. This not unexpected since LV and RV fin clipped chinook were part of the constant fractional amrking program which ended with the marking of the 1982 brood year. These fish would return as 5- and 6-year old fish. One left pectoral (LP) clipped chinook (73 cm) was observed in the Upper Klamath Area.

Mean fork length of ad-clipped jacks was 45.5 cm ($s=0.71$, $n=2$) and mean length of adult chinook was 75.5 cm ($s=8.04$, $n=263$). In the 1985 Annual Report (FWS 1986) it was suggested that differences between ad-clipped and non-fin-clipped chinook may be due to the effects of the fin clipping process or

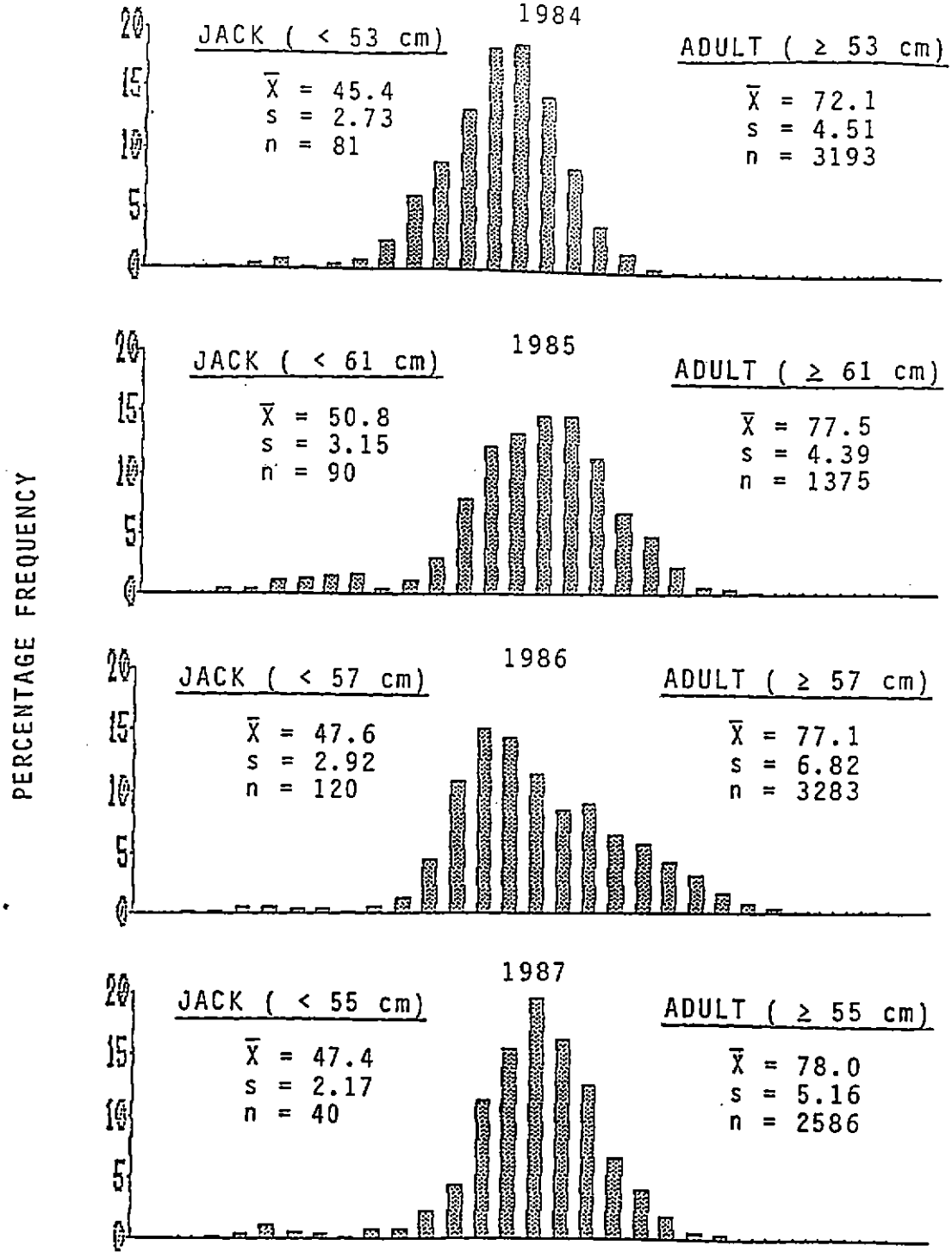


Figure 12. Length frequency distributions of fall chinook salmon harvested by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1984-1987.

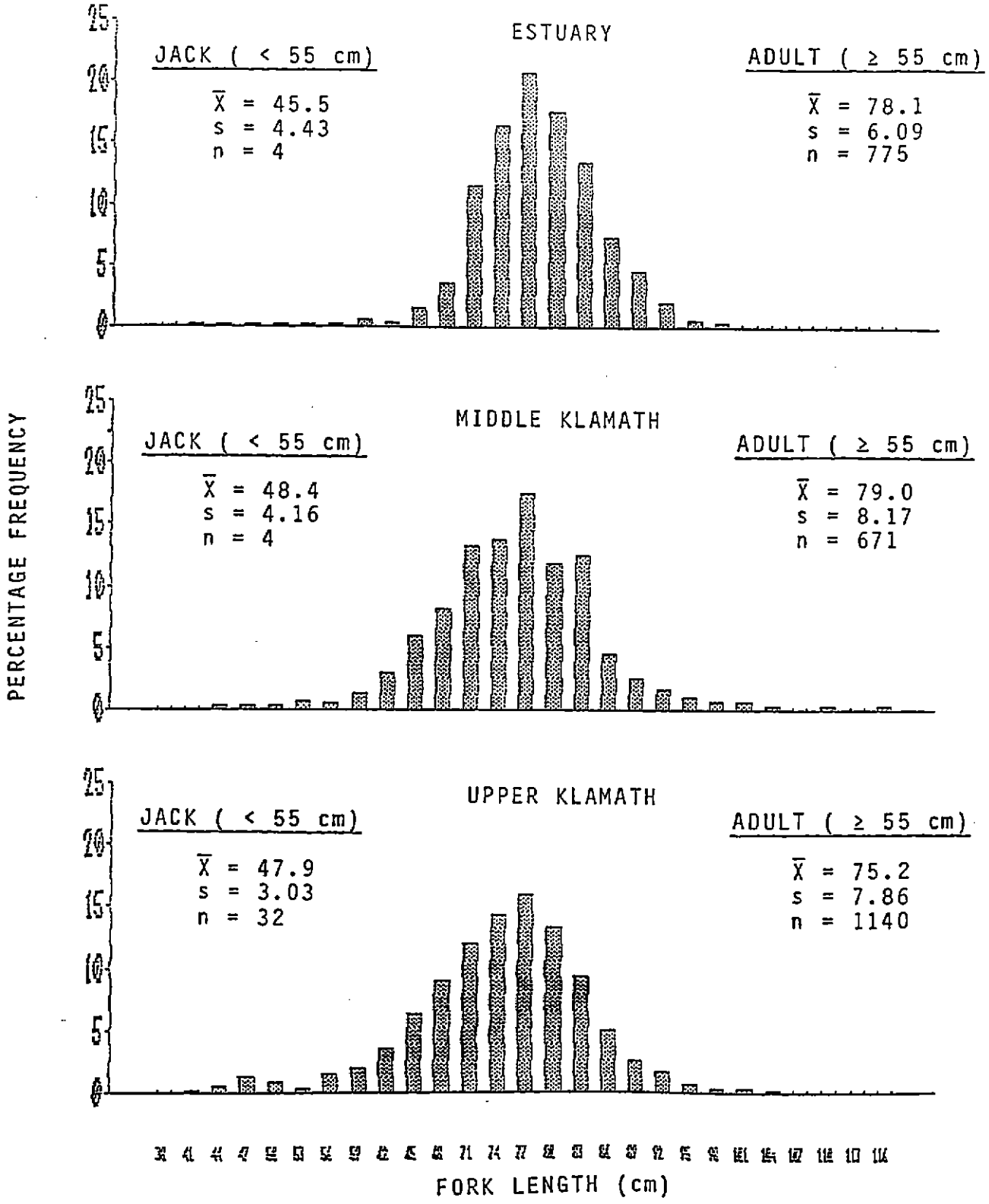


Figure 13. Length frequency distributions of fall chinook salmon harvested by Indian gill net fishers in the Estuary, Middle Klamath and Upper Klamath Areas in 1987.

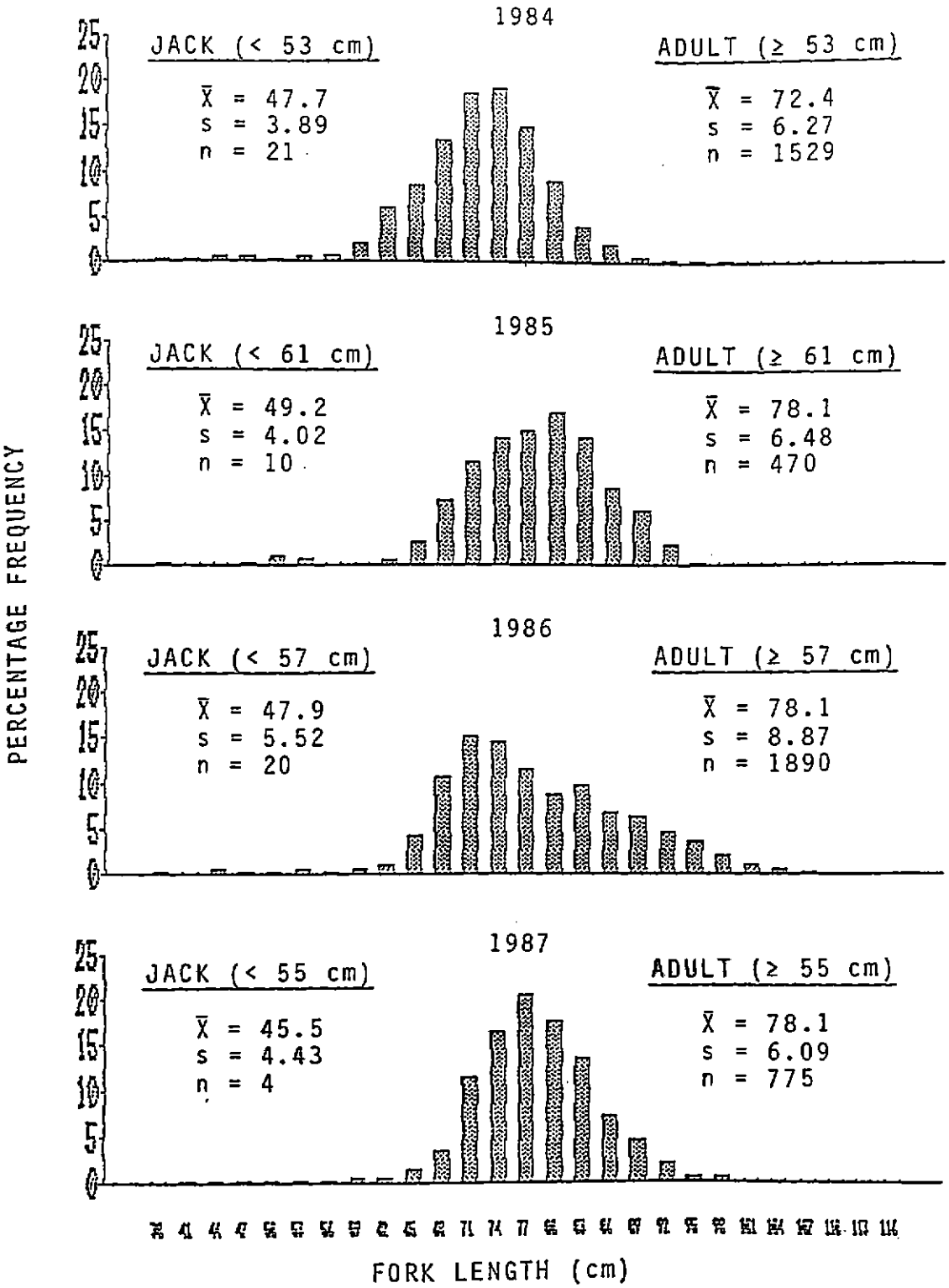


Figure 14. Length frequency distributions of fall chinook salmon harvested by Indian gill net fishers in the Estuary Area during 1984-1987.

differences in maturity rates between hatchery and wild fish. The validity of this comparison in evaluating hatchery versus wild chinook is questionable due to the large percentage of unmarked hatchery reared fish (up to 90%) which would be classified as "wild" fish and wild adipose fin-clipped chinook marked by California Department of Fish and Game's Natural Stock Assessment Program which would be classified as "hatchery" fish.

A total of 28,755 (99.1%) of the 29,040 commercially sold chinook salmon were sampled for ad-clips and 1,388 (4.8%) were systematically selected to obtain fork length data. Ad-clips were observed on 2,126 (7.4%) adult chinook which had a mean fork length of 77.9 cm (s=5.87, n=2,126). Mean length of commercially sold ad-clipped chinook was not significantly different ($p>0.05$) from ad-clipped chinook sampled in the Estuary Area. Mean fork length of chinook salmon that were systematically sampled from the commercial harvest, 78.4 cm (s=5.38, n=1,388), was not significantly different ($p>0.05$) from the mean fork length of adult chinook salmon sampled in the Estuary Area.

Fork lengths and weights from 110 chinook were used to calculate a length-weight regression equation (Figure 15). Sampled fish ranged in fork length from 41 cm to 104 cm and in weight from 1.4 kg to 17.7 kg. Mean fork length and weight were 78.9 cm and 7.0 kg respectively. Using the derived length-weight regression: [Log (weight) = -4.489 + 2.801 Log (fork length); r^2 = 0.92], chinook jacks harvested in 1987 (mean FL = 47.7 cm) would have averaged 1.6 kg and adults (mean FL = 77.1 cm) 6.3 kg. Comparing weights using annual length-weight regressions, a 75 cm chinook returning in 1987 would have weighed 5.8 kg. A 75 cm chinook would have weighed 5.5 kg in 1986, 6.3 kg in 1985 and 6.9 kg in 1984.

Depredation of chinook salmon captured in gill nets by seals (Phoca vitulina) or sea lions (Zalophus californianus and Eumetopias jubatus) appears to have decreased as evidenced by the percentage of harvested salmon with "seal" bites. During 1987 1.8% of the sampled chinook harvested in the Estuary Area had seal bites. This is the lowest percentage in the six years comparable data has been collected. This low percentage is probably due to the occurrence of a commercial chinook salmon fishery in the Estuary Area during which Indian fishers were required to tend their nets closely and thus limiting the opportunities for depredation. Seal bites were also observed in the Middle Klamath (1.0%) and Upper Klamath (1.6%) areas, but probably occurred while the salmon were migrating through the estuary. Percentages of seal bitten fish represent minimum values of seal depredation since they do not account for fish completely removed from the net or for severely damaged fish that are discarded and not reported as being caught.

Bite marks, attributed to the river otter (Lutra canadensis), were observed on 7.0% of chinook examined in the Middle Klamath Area and 2.5% in the Upper Klamath Area. The percentage of otter bites in the Middle Klamath Area is the highest observed in the past four years while that of the Upper Klamath Area is the lowest of the same time period.

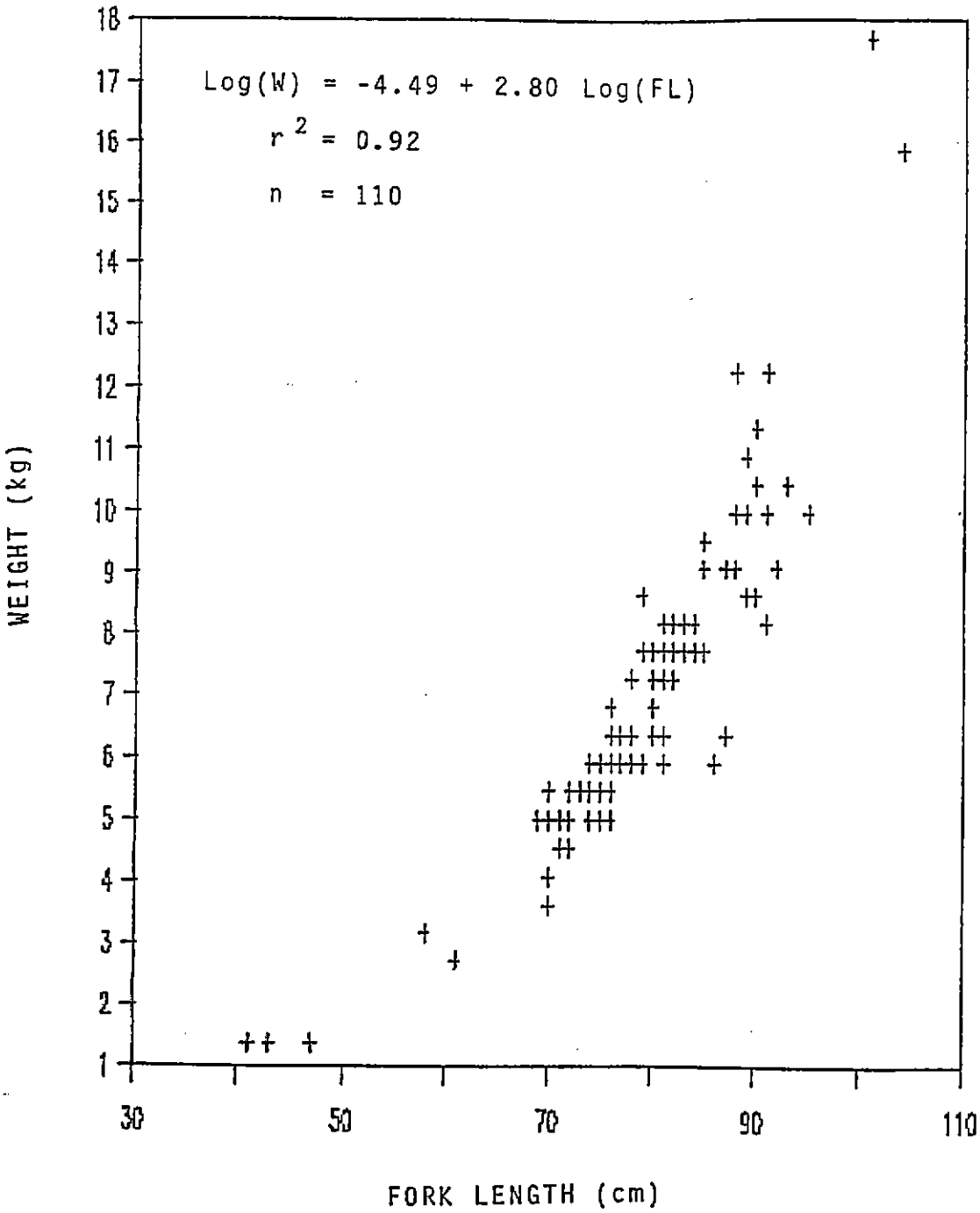


Figure 15. Length-weight relationship of fall chinook salmon harvested by Indian gill net fishers in the Estuary Area in 1987.

Spring Chinook

A total of 1,694 spring chinook salmon were harvested on the Klamath River portion of the HVR in 1987 (Table 13). The harvest of spring chinook consisted of 1,646 (97.2%) adults (≥52 cm) and 48 (2.8%) jacks (<52 cm). The majority of adult spring chinook harvest occurred in the Estuary Area (47.8%), followed by the Upper Klamath (41.8%) and Middle Klamath (10.4%) Areas.

Mean fork length of adult spring chinook, 72.0 cm, was not significantly different ($p>0.05$) than those of chinook returning in 1984 and 1986, but was significantly smaller ($p<0.05$) than mean fork length of 1985 adult spring chinook (Figure 16).

Ad-clipped salmon represented 18.8% of the 152 spring chinook salmon sampled during spring net harvest monitoring. A large proportion of ad-clipped spring chinook were harvested during the fall fishery (See CODED WIRE TAG INVESTIGATIONS SECTION).

Spring and fall chinook harvest estimates for 1977 to 1987 are summarized in Table 14.

TABLE 13. Final monthly estimates of spring chinook salmon harvest in the three Klamath River monitoring areas of the Hoopa Valley Reservation in 1987.

	NET HARVEST MONITORING AREA				
Time Period	Estuary	Middle Klamath	Upper Klamath	Monthly Totals (All Areas)	Cumulative Seasonal Total
April	10	51	18	79	79
May	11	115	120	246	325
June	250	10	169	429	754
July	538	0	402	940	1,694
TOTAL	809	176	709	1,694	
PERCENTAGE	47.8%	10.4%	41.8%		

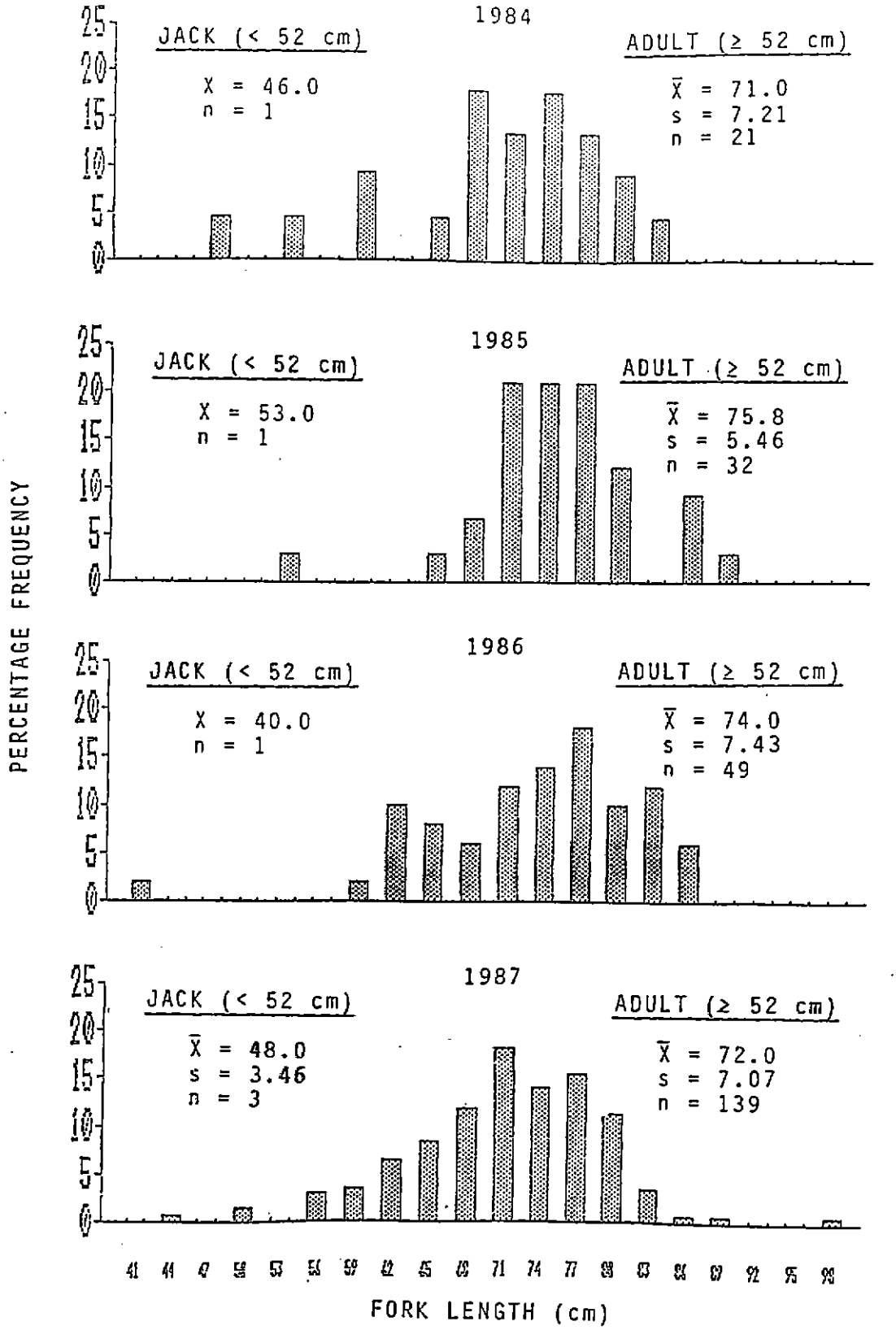


Figure 16. Length frequency distributions of spring chinook salmon harvested by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1984-1987 (3 cm groupings with midpoints noted).

TABLE 14. Final estimates of spring and fall chinook salmon harvest by the gill net fishery on the Hoopa Valley Reservation during 1977-1987[1/].

Year	SPRING CHINOOK			FALL CHINOOK		
	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
1987	176	5,792	5,968	415	53,096	53,511

1/ Estimates for 1983-1987 Trinity River net fishery were obtained from the Hoopa Valley Business Council, Fisheries Department. All other harvest estimated by the Fish and Wildlife Service by methods described in previous annual reports.

CODED-WIRE TAG RECOVERY INVESTIGATIONS

INTRODUCTION

Two hatcheries operated by the CDFG are located in the Klamath River basin. Trinity River Hatchery, 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, IGH lies 306 river kilometers from the mouth (Figure 1). Three release strategies are represented by groups of 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.

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-Arcata biologists conducted CWT recovery efforts in conjunction with 1987 net harvest monitoring activities on the Klamath River portion of the HVR.

METHODS

Methods of acquiring CWT samples during net harvest monitoring 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 a Reichert 580 dissecting scope, Hitachi CCTV camera and Koyo video monitor. If no tag was detected, the head was dissolved in a potassium hydroxide solution. 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) $$\text{Lost Tag Ratio} = \frac{\text{Number of Heads with Tags}}{\text{Number of Tags Decoded}}$$

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 was 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:

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

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

Recoveries of CWT's from fall chinook harvested during the 1987 Indian subsistance and commercial net fishery totaled 1,968 (Table 15). After expansion for fish not sampled, an estimated 3,390 tagged fall chinook were harvested. Two hundred seventy nine (11.5%) of the heads recovered from ad-clipped chinook harvested in both the spring and fall gill net fishery did not contain CWT's and could not be assigned to a race or rearing origin. Coded-wire tag recoveries represented 46 different release groups: 22 from TRH, 13 from IGH, 5 from natural stocks assessment program, 3 from Cole Rivers Hatchery on the Rogue River; 2 from the HVBC hatchery and 1 from Rocky Reach Hatchery on the Columbia River.

Contribution rates of CWT groups vary with type and site of release and among brood years (Table 16). Yearling releases from both IGH and TRH tend to contribute to the gill net fishery at higher rates than fingerling releases. Basin-wide comparisons are not statistically valid due to unquantified differences in CWT shedding rates at the two hatcheries.

In general, releases from IGH contribute to the gill net fishery at higher rates than those from TRH. It appears that this difference can be attributed to gear selectivity, maturity rates and run timing of the two stocks. IGH stocks tend to mature at an older age (see following paragraph on CWT age composition) than TRH stocks and are, therefore, more vulnerable to gill nets. Trinity River Hatchery stocks tend to enter the river later than IGH stocks and are less impacted by the Estuary Area fishery which, because of quota management on the Klamath River portion of the HVR, has typically been closed to fishing by early September.

TABLE 15. Actual and expanded (underlined) CWT groups recovered during mark sampling of spring and fall chinook salmon in the 1987 gill net fishery on the Klamath River portion of the Hoopa Valley Reservation.

Tag Code	Brood Year	Race	Hatchery[1/] of Origin	Release[2/] Type	RESERVATION MONITORING AREA							
					Estuary		Middle Klamath		Upper Klamath		All Areas	
06-50-11	1982	Fall	IGH	Y	1	1	0	0	0	0	1	1
06-52-02	1984	Fall	HVBC	Y	1	2	0	0	0	0	1	2
06-52-04	1985	Fall	HVBC	Y	0	0	0	0	1	2	1	2
06-56-08	1983	Fall	TRH	F[3/]	17	25	0	0	0	0	17	25
06-56-09	1982	Fall	TRH	Y[3/]	0	0	0	0	1	2	1	2
06-56-12	1983	Fall	TRH	F[3/]	12	18	0	0	0	0	12	18
06-56-13	1983	Fall	TRH	F[3/]	16	26	0	0	0	0	16	26
06-56-14	1983	Fall	TRH	Y[3/]	9	14	0	0	1	4	10	18
06-56-15	1983	Fall	TRH	Y[3/]	4	7	0	0	3	8	7	15
06-56-16	1983	Fall	TRH	Y[3/]	4	6	1	11	0	0	5	17
06-56-17	1984	Fall	TRH	F[3/]	29	37	0	0	0	0	29	37
06-56-18	1984	Fall	TRH	F[3/]	16	28	1	3	4	8	21	39
06-56-19	1984	Fall	TRH	F[3/]	26	43	1	18	1	2	28	63
06-56-20	1984	Fall	TRH	Y[3/]	1	2	2	40	0	0	3	42
06-56-21	1984	Fall	TRH	Y[3/]	2	3	1	6	3	6	6	15
06-56-22	1984	Fall	TRH	Y[3/]	1	2	0	0	3	7	4	9
06-56-23	1985	Fall	TRH	Y	0	0	0	0	1	2	1	2
06-56-24	1984	Fall	TRH	Y+	5	9	1	18	23	59	29	86
06-56-25	1985	Fall	TRH	Y	0	0	0	0	1	4	1	4
06-59-08	1982	Fall	IGH	Y	1	1	0	0	0	0	1	1
06-59-22	1984	Fall	IGH	Y	28	41	0	0	5	12	33	53
06-59-23	1983	Fall	IGH	F	96	129	1	20	2	9	99	158
06-59-24	1983	Fall	IGH	F[3/]	61	81	3	9	1	2	65	92
06-59-25	1983	Fall	IGH	Y	653	871	2	18	6	14	661	903
06-59-26	1983	Fall	IGH	Y[3/]	139	200	6	54	12	37	157	291
06-59-27	1984	Fall	IGH	F	25	37	0	0	0	0	25	37
06-59-28	1984	Fall	IGH	F[3/]	67	106	0	0	11	24	78	130
06-59-31	1983	Fall	IGH	Y	79	115	2	40	5	18	86	173
06-59-32	1983	Fall	IGH	Y	100	143	1	20	7	22	108	185
06-59-33	1983	Fall	IGH	Y	161	226	3	21	3	10	167	257

1/ BCWILD - Wild Stock Assessment Program - Bogus Creek Stock
CRH - Cole Rivers Hatchery - Rogue River
HVBC - Hoopa Valley Business Council Hatchery
IGH - Iron Gate Hatchery
LGH - Lookingglass Hatchery - Imnaha River
RRH - Rocky Reach Hatchery - Columbia River
SRWILD - Wild Stock Assessment Program - Shasta River Stock
TRH - Trinity River Hatchery

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

3/ Off-site release

TABLE 15. (Continued)
Actual and expanded (underlined) CWT groups recovered during mark sampling of spring and fall chinook salmon in the 1987 gill net fishery on the Klamath River portion of the Hoopa Valley Reservation.

Tag Code	Brood Year	Race	Hatchery[1] of Origin	Release[2] Type	RESERVATION MONITORING AREA: Estuary		Middle Klamath		Upper Klamath		All Areas	
06-59-35	1984	Fall	IGH	Y[3]	1	1	1	4	0	0	2	5
06-61-13	1983	Fall	TRH	Y	32	50	4	60	12	33	48	143
06-61-26	1983	Fall	TRH	F	20	35	0	0	0	0	20	35
06-61-27	1984	Fall	TRH	F[3]	62	99	2	29	1	7	65	135
06-61-28	1984	Fall	TRH	Y	3	3	0	0	12	31	15	36
06-61-29	1982	Fall	TRH	Y	1	1	0	0	0	0	1	1
06-61-40	1983	Sprg	TRH	Y	60	127	2	11	10	75	72	213
06-61-42	1985	Sprg	TRH	F	0	0	0	0	1	7	1	7
06-61-43	1984	Sprg	TRH	Y	92	151	0	0	7	39	99	190
06-61-44	1985	Sprg	TRH	Y	1	5	0	0	0	0	1	5
06-63-01	1983	Fall	TRH	Y+	62	97	6	76	48	125	116	298
07-26-14	1982	Fall	CRH	Y	1	1	0	0	0	0	1	1
07-30-12	1983	Sprg	LGH	Y	1	1	0	0	0	0	1	1
07-30-20	1983	Fall	CRH	Y	3	3	0	0	0	0	3	3
07-30-39	1984	Fall	CRH	Y	1	1	0	0	0	0	1	1
07-31-15	1983	Sprg	CRH	Y	0	0	0	0	1	1	1	1
07-31-18	1983	Sprg	CRH	Y	0	0	1	1	0	0	1	1
63-28-57	1983	Fall	RRH	Y+	1	1	0	0	0	0	1	1
86-08-01	1983	Fall	SRWILD	F	2	3	0	0	0	0	2	3
86-08-02	1983	Fall	BCWILD	F	4	4	0	0	0	0	4	4
86-08-03	1984	Fall	SRWILD	F	7	11	0	0	0	0	7	11
86-08-04	1984	Fall	BCWILD	F	3	3	0	0	0	0	3	3
86-09-02	1984	Fall	BCWILD	F	6	7	0	0	0	0	6	7
TOTAL TAGS					1917	2779	41	459	186	570	2144	3808
AD - NO TAGS					262	364	2	29	15	42	279	435
TOTAL					2179	3143	43	488	201	612	2423	4243

1/ BCWILD - Wild Stock Assessment Program - Bogus Creek Stock
CRH - Cole Rivers Hatchery - Rogue River
HVBC - Hoopa Valley Business Council Hatchery
IGH - Iron Gate Hatchery
LGH - Lookingglass Hatchery - Imnaha River
RRH - Rocky Reach Hatchery - Columbia River
SRWILD - Wild Stock Assessment Program - Shasta River Stock
TRH - Trinity River Hatchery

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

3/ Off-site release

TABLE 16. 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
06-50-10	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	F[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	60	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	50	91,153	.055
06-56-12	1983	TRH	F[6]	80	18	98	97,311	.101
06-56-13	1983	TRH	F[6]	105	26	131	100,227	.131
06-56-14	1983	TRH	Y[6]	0	18	18	25,547	.071
06-56-15	1983	TRH	Y[6]	26	15	41	25,754	.159
06-56-16	1983	TRH	Y[6]	0	17	17	26,171	.065
06-59-23	1983	IGH	F	38	158	196	191,352	.102
06-59-24	1983	IGH	F[6]	80	92	172	97,566	.176
06-59-25	1983	IGH	Y	25	903	928	94,738	.980
06-59-26	1983	IGH	Y	34	291	325	23,725	1.370
06-59-31	1983	IGH	Y	0	173	173	22,599	.765
06-59-32	1983	IGH	Y	10	185	195	24,830	.785
06-59-33	1983	IGH	Y	0	257	257	23,766	1.081
06-61-13	1983	TRH	Y	62	143	205	100,520	.204
06-61-26	1983	TRH	F	87	35	122	191,094	.064
06-63-01	1983	TRH	Y+	13	298	311	92,965	.335
06-52-02	1984	HVBC	Y	2	-	2	1,909	.105
06-56-17	1984	TRH	F[6]	37	-	37	98,906	.037
06-56-18	1984	TRH	F[6]	39	-	39	98,989	.039
06-56-19	1984	TRH	F[6]	63	-	63	94,100	.067
06-56-20	1984	TRH	Y[6]	42	-	42	30,459	.138
06-56-21	1984	TRH	Y[6]	15	-	15	24,541	.061
06-56-22	1984	TRH	Y[6]	9	-	9	25,450	.035
06-56-24	1984	TRH	Y+	86	-	86	102,512	.084
06-59-22	1984	IGH	Y	53	-	53	98,500	.054
06-59-27	1984	IGH	F	37	-	37	187,500	.020
06-59-28	1984	IGH	F	130	-	130	93,710	.139
06-59-35	1984	IGH	Y[6]	5	-	5	24,275	.021
06-61-27	1984	TRH	F	135	-	135	189,708	.071
06-61-28	1984	TRH	Y	36	-	36	97,070	.037

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) - February 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

Age composition of CWT fall chinook harvested in 1987 was 0.2% age 2, 21.0% age 3, 78.6% age 4 and 0.2% age 5. Age composition of the net harvest CWT chinook from the Estuary Area was 0% age 2, 17.4% age 3, 82.4% age 4 and 0.2% age 5 while the age composition of the entire run estimated from beach seine data was 10.5% age 2, 38.4% age 3, 48.2% age 4 and 2.9% age 5. The large difference in observed percentages of age 3 and age 4 chinook in these two samples can be attributed to the large representation of IGH stock (78.3%) in the net harvest sample which had an age composition of 0% age 2, 9.5% age 3, 90.4% age 4 and 0.1% age 5. Age composition of CWT fall chinook from TRH harvested in the Estuary Area was 0% age 2, 44.8% age 3, 55.0% age 4 and 0.2% age 5.

Mean fork lengths of 1987 CWT groups did not differ ($p>0.05$) from mean length of comparable groups returning in 1986 (Table 17).

In the 1985 Annual Report (FWS 1986) an inverse relationship between size at release and mean length at harvest of CWT groups was noted. Comparisons of mean fork lengths of CWT production groups harvested in 1987 do not fully support this relationship. For 3- and 4-year old chinook from IGH and 4-year old chinook from TRH some yearling releases were significantly smaller than comparable fingerling releases while others were not. Three-year-old chinook from TRH did follow the inverse relationship between size at release and mean length at harvest.

Spring Chinook

A total of 176 spring chinook CWT's were recovered during net harvest monitoring operations (Table 15). After expansion for fish not sampled, an estimated 418 CWT spring chinook were harvested representing 7 release groups: 4 from TRH, 2 from the Cole Rivers Hatchery on the Rogue River and 1 from Lookingglass Hatchery on the Imnaha River.

Contribution rates of CWT spring chinook to the Indian gill net fishery have increased in the past two years (Table 18). This increase can be contributed to two release groups; tag codes 06-61-40 and 06-61-43. Both of these groups were yearling releases which tend to contribute to the gill net fishery at higher rates than fingerling releases.

In 1987, 158 (90.3%) of the CWT's representing spring chinook were recovered during the fall fishery. This trend, also observed in 1986 and noted in the 1986 Annual Report (FWS 1987), poses a problem for the independent management of these two stocks.

TABLE 17. Mean fork length, standard deviation and number of recoveries for 52 spring and fall chinook CWT groups harvested on the Klamath River portion of the Hoopa Valley Reservation in 1987. Footnotes appear on 3rd page of table.

Tag Code	Brood Year	Race	Hatchery[1] of Origin	Release[2] Type	RESERVATION MONITORING AREA			
					Estuary	Middle Klamath	Upper Klamath	All Areas
06-50-11	1982	Fall	IGH	Y	78.0[3] ---[4] 1[5]	--- --- 0	--- --- 0	78.0 --- 1
06-56-09	1982	Fall	TRH	Y[6]	--- --- 0	--- --- 0	81.0 --- 1	81.0 --- 1
06-59-08	1982	Fall	IGH	Y	78.0 --- 1	--- --- 0	--- --- 0	78.0 --- 1
06-61-29	1982	Fall	TRH	Y	79.0 --- 1	--- --- 0	--- --- 0	79.0 --- 1
07-26-14	1982	Fall	CRH	Y	88.0 --- 1	--- --- 0	--- --- 0	88.0 --- 1
06-56-08	1983	Fall	TRH	F[6]	76.1 3.9 17	--- --- 0	--- --- 0	76.1 3.9 17
06-56-12	1983	Fall	TRH	F[6]	76.8 5.5 12	--- --- 0	--- --- 0	76.8 5.5 12
06-56-13	1983	Fall	TRH	F[6]	75.6 3.5 16	--- --- 0	--- --- 0	75.6 3.5 16
06-56-14	1983	Fall	TRH	Y[6]	77.9 3.1 9	--- --- 0	80.0 --- 1	78.1 3.0 10
06-56-15	1983	Fall	TRH	Y[6]	78.5 3.0 4	--- --- 0	76.7 6.4 3	77.7 4.3 7
06-56-16	1983	Fall	TRH	Y[6]	77.0 2.1 4	90.0 --- 1	--- --- 0	79.6 6.1 5
06-59-23	1983	Fall	IGH	F	79.1 4.8 96	75.0 --- 1	81.5 4.9 2	79.1 4.8 99
06-59-24	1983	Fall	IGH	F[6]	79.0 4.8 61	81.0 1.0 3	80.0 --- 1	79.1 4.7 65
06-59-25	1983	Fall	IGH	Y	80.1 5.1 653	83.5 0.7 2	79.5 3.6 6	80.1 5.1 660
06-59-26	1983	Fall	IGH	Y	79.5 5.3 139	84.2 7.7 6	81.2 8.4 12	79.8 5.7 157
06-59-31	1983	Fall	IGH	Y	78.7 4.8 79	79.5 3.5 2	74.6 4.1 5	78.5 4.8 86
06-59-32	1983	Fall	IGH	Y	80.4 5.0 100	77.0 --- 1	82.0 7.5 7	80.5 5.1 108
06-59-33	1983	Fall	IGH	Y	79.6 4.4 161	78.3 7.7 3	84.3 4.0 3	79.6 4.5 167
06-61-13	1983	Fall	TRH	Y	78.9 5.5 32	79.8 2.5 4	79.2 3.6 12	79.1 4.8 48

TABLE 17. (Continued)
Mean fork length, standard deviation and number of recoveries for 52 spring and fall chinook CWT groups harvested on the Klamath River portion of the Hoopa Valley Reservation in 1987. Footnotes appear on 3rd page of table.

Tag Code	Brood Year	Race	Hatchery[1/] of Origin	Release[2/] Type	RESERVATION MONITORING AREA			
					Estuary	Middle Klamath	Upper Klamath	All Areas
06-61-26	1983	Fall	TRH	F	78.1 3.2 20	--- --- 0	--- --- 0	78.1 3.2 20
06-61-40	1983	Spring	TRH	Y	77.5 4.9 60	80.5 2.1 2	75.9 5.2 10	77.4 4.9 72
06-63-01	1983	Fall	TRH	Y+	77.0 5.0 62	78.0 5.8 6	77.1 4.0 48	77.5 4.6 116
07-30-12	1983	Spring	LGH	Y	83.0 --- 1	--- --- 0	--- --- 0	83.0 --- 1
07-30-20	1983	Fall	CRH	Y	84.3 3.7 3	--- --- 0	--- --- 0	84.3 3.7 3
07-31-15	1983	Spring	CRH	Y	--- --- 0	--- --- 0	79.0 --- 1	79.0 --- 1
07-31-18	1983	Spring	CRH	Y	--- --- 0	74.0 --- 1	--- --- 0	74.0 --- 1
63-28-57	1983	Fall	RRH	Y+	76.0 --- 1	--- --- 0	--- --- 0	76.0 --- 1
B6-08-01	1983	Fall	SRWILD	F	72.0 7.0 2	--- --- 0	--- --- 0	72.0 7.0 2
B6-08-02	1983	Fall	BCWILD	F	80.8 2.2 4	--- --- 0	--- --- 0	80.8 2.2 4
06-52-02	1984	Fall	HVBC	Y	72.0 --- 1	--- --- 0	--- --- 0	72.0 --- 1
06-56-17	1984	Fall	TRH	F[6/]	72.5 4.4 29	--- --- 0	--- --- 0	72.5 4.4 29
06-56-18	1984	Fall	TRH	F[6/]	70.7 4.7 16	70.0 --- 1	72.3 3.2 4	71.0 4.2 20
06-56-19	1984	Fall	TRH	F[6/]	72.7 3.5 26	67.0 --- 1	71.0 --- 1	72.4 3.6 28
06-56-20	1984	Fall	TRH	Y[6/]	61.0 --- 1	67.5 0.7 2	--- --- 0	65.3 3.7 3
06-56-21	1984	Fall	TRH	Y[6/]	66.5 4.9 2	66.0 --- 1	69.7 5.7 3	68.0 4.6 6
06-56-22	1984	Fall	TRH	Y[6/]	70.0 --- 1	--- --- 0	66.3 5.5 3	67.3 4.8 4
06-56-24	1984	Fall	TRH	Y+	62.8 2.5 5	68.0 --- 1	61.5 3.5 23	61.9 3.5 29
06-59-22	1984	Fall	IGH	Y	71.0 4.2 28	--- --- 0	67.6 5.4 5	70.5 4.5 33

TABLE 17. (Continued)
Mean fork length, standard deviation and number of recoveries for 52 spring and fall chinook CWT groups harvested on the Klamath River portion of the Hoopa Valley Reservation in 1987.

Tag Code	Brood Year	Race	Hatchery[1/] of Origin	Release[2/] Type	RESERVATION MONITORING AREA			
					Estuary	Middle Klamath	Upper Klamath	All Areas
06-59-27	1984	Fall	IGH	F	71.0	---	---	71.0
					3.0	---	---	3.0
					25	0	0	25
06-59-28	1984	Fall	IGH	F	72.8	---	74.7	73.1
					3.9	---	5.7	4.2
					67	0	11	78
06-59-35	1984	Fall	IGH	Y[6/]	66.0	60.0	---	63.0
					---	---	---	4.2
					1	1	0	2
06-61-27	1984	Fall	TRH	F	71.6	72.0	66.0	71.5
					4.9	4.2	---	4.8
					62	2	1	65
06-61-28	1984	Fall	TRH	Y	63.3	---	66.1	65.5
					1.1	---	4.8	4.4
					3	0	12	15
06-61-43	1984	Spring	TRH	Y	68.9	---	69.9	69.0
					4.7	---	6.7	4.8
					92	0	7	99
07-30-39	1984	Fall	CRH	Y	71.0	---	---	71.0
					---	---	---	---
					1	0	0	1
B6-08-03	1984	Fall	SRWILD	F	75.6	---	---	75.6
					4.9	---	---	4.9
					7	0	0	7
B6-08-04	1984	Fall	BCWILD	F	75.7	---	---	75.7
					1.5	---	---	1.5
					3	0	0	3
B6-09-02	1984	Fall	BCWILD	F	76.2	---	---	76.2
					4.1	---	---	4.1
					6	0	0	6
06-52-04	1985	Fall	HVBC	Y	---	---	46.0	46.0
					---	---	---	---
					0	0	1	1
06-56-23	1985	Fall	TRH	F	---	---	56.0	56.0
					---	---	---	---
					0	0	1	1
06-56-25	1985	Fall	TRH	F	---	---	45.0	45.0
					---	---	---	---
					0	0	1	1
06-61-42	1985	Spring	TRH	F	---	---	53.0	53.0
					---	---	---	---
					0	0	1	1
06-61-44	1985	Spring	TRH	Y	40.0	---	---	40.0
					---	---	---	---
					1	0	0	1

1/ BCWILD - Wild Stock Assessment Program - Bogus Creek
CRH - Cole Rivers Hatchery
HVBC - Hoopa Valley Business Council Hatchery
IGH - Iron Gate Hatchery
LGH - Lookingglass Hatchery - Imnaha River
RRH - Rocky Reach Hatchery - Columbia River
SRWILD - Wild Stock Assessment Program - Shasta River
TRH - Trinity River Hatchery

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

3/ Mean fork length (cm)

4/ Standard deviation

5/ Number in sample

6/ Off-site release

TABLE 18. Contribution rate of CWT age 3 and 4 spring chinook for brood years 1978-1984 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	224	320	90,293	0.354
06-61-43	1984	TRH	Y	207	-	207	98,568	0.210

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 HVR 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 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 1987 seasons for the various ocean and inland fisheries were shaped following recommendations by the KRFMC concerning allowable harvest levels for all Klamath River chinook stock fisheries. To continue the protection of the depressed Klamath River fall chinook stocks, the KRFMC recommended and the various user groups agreed to a 5-year 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 1987 would allow 32.5 percent of the fully vulnerable age 4 and age 5 Klamath River fish in the ocean to be caught by recreational and commercial troll fisheries (due to size limit restrictions and recruitment into the ocean fishery age 3 fish would be harvested at a rate below 32.5) and allow 52.5 percent of the mature fish that returned to the Klamath River as age 4 and age 5 to be harvested by in-river sport and Indian fisheries. This harvest rate combination (.325/.525) 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 1987 ocean troll fishery was regulated through various gear restrictions, time and area closures and area quotas. 1987 California ocean troll landings totaled 878,900 chinook which represented an increase of 11% from 1986 (785,700) and was 56% above the 1971-1975 average (562,700). Northern California landings (Fort Bragg, Eureka and Crescent City) of 413,600 chinook increased 30% over 1986 landings (319,100) and were 38% above the 1971-1975 average (298,600). As in 1986, a large component (74%) of the Northern California commercial troll landings was reported from the port of Fort Bragg (305,500) (PFMC 1988). The ocean recreational fishery in 1987 was regulated through various bag limits, gear restrictions and in-season closures. Landings

in the California recreational fishery totaled 191,000 chinook, and represented an increase of 43% from 1986 (133,700). Northern California landings of 38,900 chinook represented an increase of 74% from the 1986 landings (22,400). In 1987, landings were 146% above the 1971-1975 average of 15,800 (PFMC 1988).

The Oregon landings for the 1987 Oregon ocean commercial troll fishery totaled 519,000 chinook and was 29% larger than 1986 (401,200) and 148% larger than the 1971-1975 average of 209,200. Troll landings in 1987 south from Coos Bay totalled 390,100 chinook, an increase of 33% from 1986 (292,400). As in 1986, a large component (90%) of the southern Oregon troll chinook harvest was reported from the port of Coos Bay (350,300) (PFMC 1988). The 1987 Oregon ocean recreational landings totaled 58,600 chinook which was 99% above the 1986 total (22,400) and 4% above the 1974-1975 average of 56,200. The 1987 landings south from Coos Bay totaled 44,700 chinook and were 152% above the 1986 landings of (17,700) (PFMC 1988).

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 offshore 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 KRFMC (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 1988). Using the contribution values derived by the KRTT from CWT data and applying these to the ocean landings, the 1987 combined ocean fisheries off the coasts of Oregon and California landed 285,200 Klamath River fall chinook.

The harvest of Klamath River fall chinook by the Indian gill net fishery on the HVR, discussed previously in this report, increased 111% from 25,130 in 1986 to 53,100 in 1987. This harvest comprised 26.7% of the 1987 CDFG adult in-river run size estimate. The net fishery has harvested an average 20,770 adult fall chinook during the 1978-1987 period.

The 1987 Klamath River sport harvest of 16,520 adult fall chinook was 2.1% below the 1986 harvest of 16,870 and 149% above the 1978-1987 average harvest of 6,640 The 1987 adult sport harvest comprised 8.3% of the in-river run size.

The harvest levels presented here do not represent the total 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. 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 the fishes removal by the Indian fisher. 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 19 and 20 present an overview of the harvest data. These data show that the ocean commercial troll and recreational fisheries harvested 1.4 Klamath River chinook for every chinook that returned to the Klamath River mouth. These data also show the ocean commercial and recreational fisheries harvested 4.1 Klamath River chinook for every chinook harvested in-river. Total harvests of ocean and in-river fisheries show 2.7 chinook were harvested for every chinook that escaped to spawn in the Klamath River basin. This translates to a 73.0% harvest of Klamath River fall chinook.

The recent increase in the in-river run size (325% of the 1978-1985 average) cannot be used to indicate the strength of all basin stocks. The 1987 escapement is a result of increased hatchery returns, primarily from TRH. Natural stocks have not shown this large increase in adult returns. Returns to the Shasta River were only 75% of the 1978-1985 average Shasta River escapement. This indicates the present harvest rates continue to exceed the level necessary to sustain the natural stocks.

TABLE 19. Estimated contribution of Klamath River fall chinook to total ocean landings, 1978-1987.

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
1987	413,600	38,900	390,100	44,700	887,300	230,760	285,200

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 1988.

2/ Contribution rates of Klamath stocks prior to 1986 derived using 30% contribution rate. 1986 contribution values are from unpublished material KRTT 1987. 1987 contribution values are from unpublished material KRTT 1988.

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

TABLE 20. Estimated contribution of Klamath River adult fall chinook to the ocean, in-river sport and Indian gill net fisheries, 1978-1987[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
1987	285,200	198,950	16,520	53,100	129,330	1.4:1	4.1:1	2.7:1

1/ All data are from the FWS or from PFMC 1988.

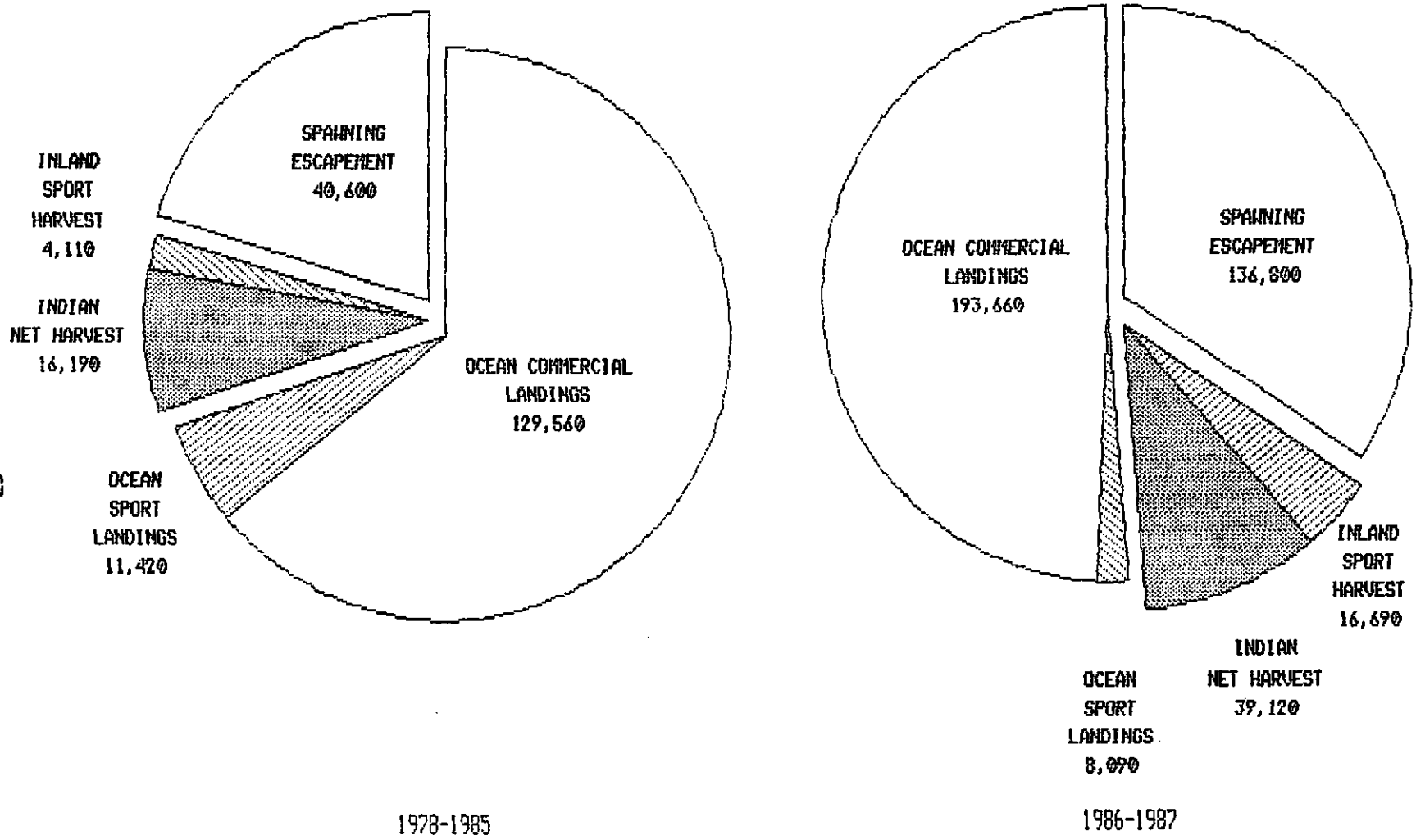


Figure 17. Estimated annual contributions of Klamath River basin adult fall chinook to the ocean, in-river fisheries and spawning escapement during 1986-1987 compared to estimated annual contributions of Klamath River basin adult chinook to the ocean, in-river fisheries and spawning escapement during 1978-1985.

COHO SALMON, STEELHEAD TROUT, STURGEON AND SHAD INVESTIGATIONS

INTRODUCTION

The 1987 coho salmon, steelhead trout, sturgeon and American shad (Alosa sapidissima) runs in the Klamath River were sampled through the previously described beach seining and net harvest monitoring programs. The seining operation targets fall chinook salmon during their migration period. However, incidental species such as coho salmon, steelhead trout, sturgeon and American shad occurred in the catch; often in significant numbers. 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 data collected from these species may not be representative of their various life histories. Descriptive statistics are presented for informative purposes only.

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

During the 1987 beach seining season, 115 coho salmon were captured in 369 seine hauls. The first coho was captured on September 9, 1987. The largest daily catch total was 27, on September 28, 1987. The majority (69) of the coho were captured during the week of September 28 to October 2, 1987. Fork lengths were recorded from 101 coho; ranging from 36 to 75 cm. The jack/adult cutoff length (largest jack) as determined by CDFG was 54 cm. The mean length of jacks and adults were 45.7 and 65.5 cm, respectively (Figure 18). Eight coho were ad-clipped, for an occurrence rate of 7.9%. Thirteen coho had hook-scars (12.9%). Spaghetti tags were applied to 111 coho, of which 21 (18.9%) were recovered. Nineteen of the coho recoveries were from TRH.

Of 94 coho weighed, the mean was 3.2 kg, the range was 0.5 kg to 5.9 kg. The length-weight relationship was Log (weight) = -5.765 + 3.499 Log (fork length) (Figure 19).

Scales were collected from 99 coho salmon of which 15 (15.2%) were two-year-olds, 82 (82.8%) were three-year-olds and 2 (2.0%) coho were four-year-olds. The largest two-year-old was 58 cm, and the smallest three-year-old was 46 cm. Mean length of two-year-olds was 44.6 cm, three-year-olds were 64.7 cm and 68.5 cm for four-year-olds. The average length of adults was 64.8 cm. During 1986, two-year-olds constituted 87.5% of the coho caught in the beach

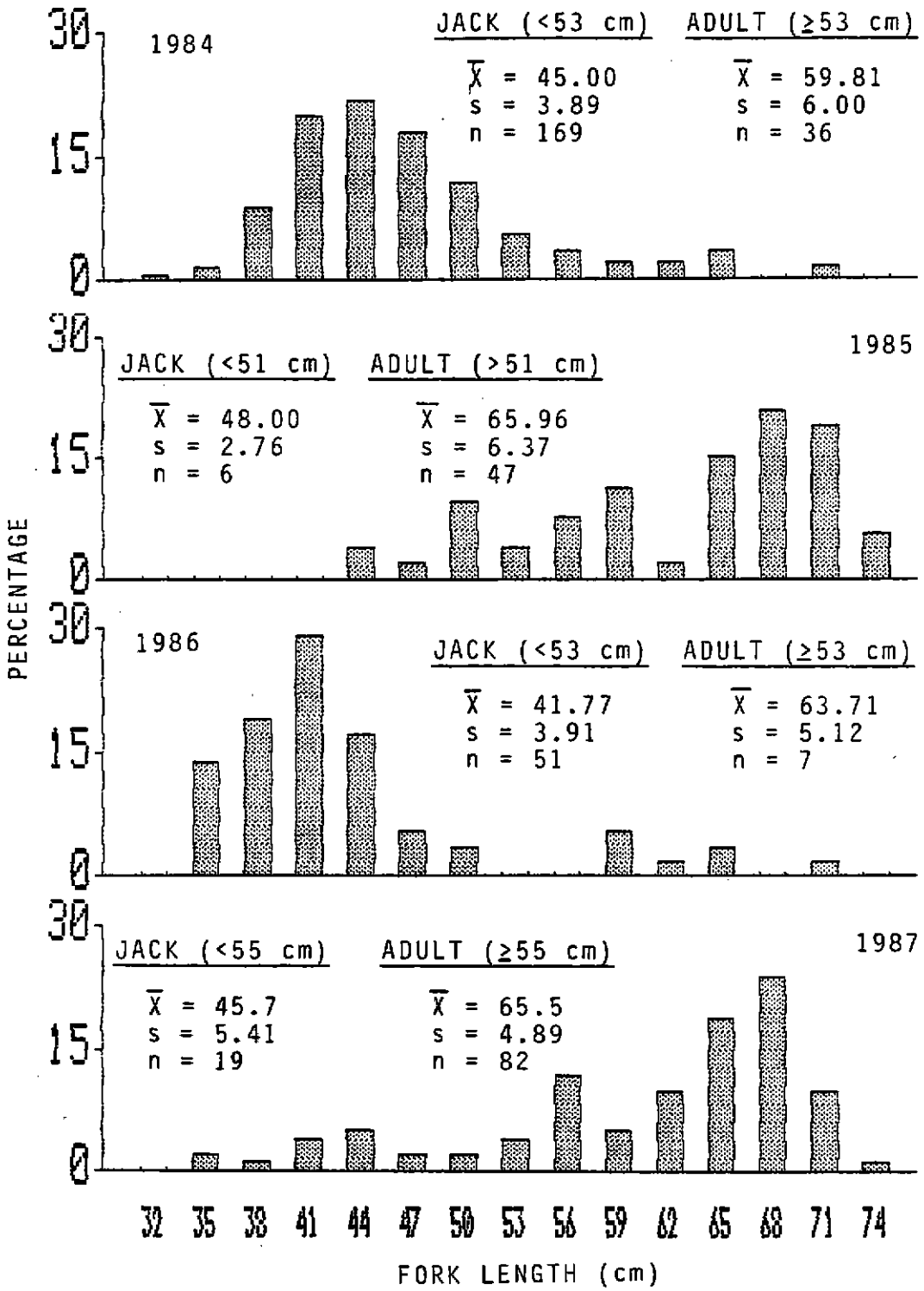


Figure 18. Length frequency distributions of coho salmon captured during beach seine operations in the Klamath River estuary during 1984-1987 (3 cm groupings with midpoints noted).

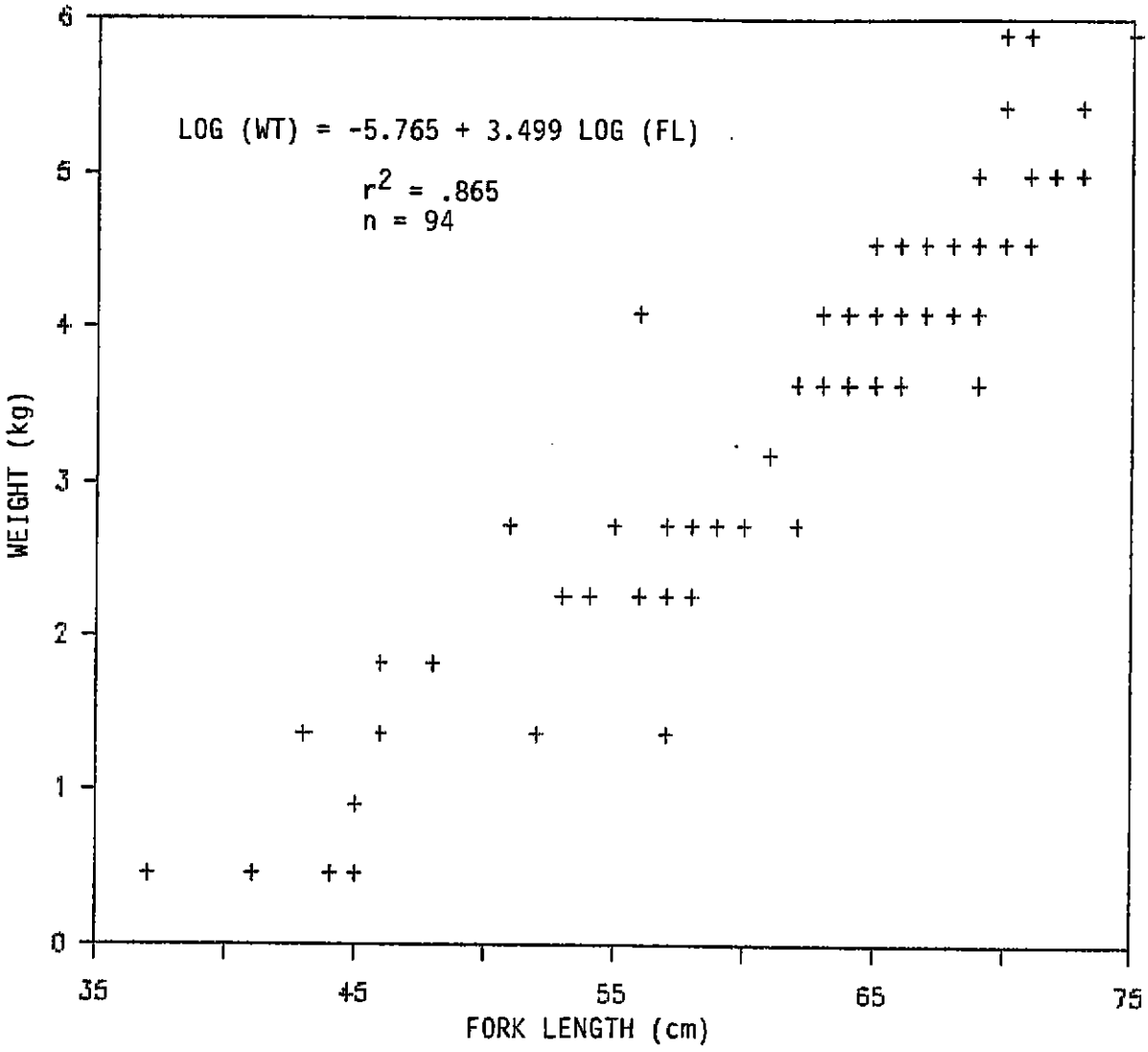


Figure 19. Length-weight relationship of coho salmon captured during 1987 beach seining operations in the Klamath River estuary.

seine. Age composition results from 1987 and the previous season suggests a strong 1984 coho brood. The seining ended prior to completion of the 1987 coho run.

Net Harvest

An estimated 935 coho salmon (31 jacks (<55 cm) and 904 adults), were harvested by Indian gill net fishers on the Klamath River portion of the HVR in 1987 (Table 21). The majority of the coho salmon harvest (83.1%) occurred in the Upper Klamath Area between September 16 and October 31. The 1987 harvest of coho on the HVR is the third largest in the eight years that harvest has been estimated (Table 22).

Mean length of adult coho, 68.2 cm, was significantly smaller ($p<0.05$) than those of adult coho salmon harvested in 1985 and 1986 and was not significantly different ($p>0.05$) than the mean length of coho harvested in 1984 (Figure 20).

Of the 355 coho salmon sampled, 38 (10.7%) were ad-clipped. From these fish, 32 CWT's representing three release groups were recovered; 2 from TRH and 1 from IGH. (Table 23). Three ad-clipped coho did not contain CWT's. After expansion for fish not sampled, an estimated 145 CWT coho were harvested in 1987. An estimated 10 ad-clipped coho did not contain CWT's. All CWT coho were 3-year-olds.

Steelhead Trout

Beach Seining

Steelhead trout were the second most abundant salmonid captured in the beach seine. Four hundred and forty two steelhead were captured in 369 seine hauls; 237 were measured and 205 were released unmeasured. Mean fork length for half-pounders (<42 cm) was 35.6 cm, while adults (>42 cm) was 52.2 cm (Figure 21). One ad-clipped steelhead was captured. The largest weekly catch (103 steelhead) occurred during the week of September 7-11, while the daily peak catch of 77 occurred on September 17, 1987.

Net Harvest

Indian gill net fishers harvested an estimated 270 fall steelhead trout on the Klamath River portion of the HVR from July 1-October 31, 1987 (Table 24). Steelhead harvest consisted of 240 adults ($\geq$ 42 cm) and 30 half-pounders. Estimates of steelhead harvest on the HVR from 1980 to 1987 are presented in Table 25.

Mean length of adult steelhead (60.4 cm) harvested in 1987, was significantly smaller ($p<0.05$) than those harvested in 1985 and did not differ ($p>0.05$) from those harvested in 1984 and 1986 (Figure 22). Mean length of half-pounders 34.7 cm) harvested in 1987, was not significantly different ($p>0.05$) from those harvested in 1984-1986.

TABLE 21. Final estimates of coho salmon harvest on the Klamath River portion of the Hoopa Valley Reservation in 1987.

Time Period	NET HARVEST MONITORING AREA			Semi-Monthly Total (All Areas)	Cumulative Seasonal Total
	Estuary	Middle Klamath	Upper Klamath		
Aug. 1-15	0	0	0	0	0
16-31	0	2	0	2	2
Sept. 1-15	0	6	2	8	10
16-30	0	101	63	164	174
Oct. 1-15	0	216	232	448	622
16-31	0	80	233	313	935
TOTAL	0	405	530	935	

TABLE 22. Final estimates of coho salmon harvest by the gill net fishery on the Hoopa Valley Reservation during 1980-1987[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
1987	31	1,517	1,548

1/ Estimates for 1983-1987 Trinity River net fishery were obtained from the Hoopa Valley Business Council, Fisheries Department. All other harvest estimated by the Fish and Wildlife Service by methods described in previous annual reports.

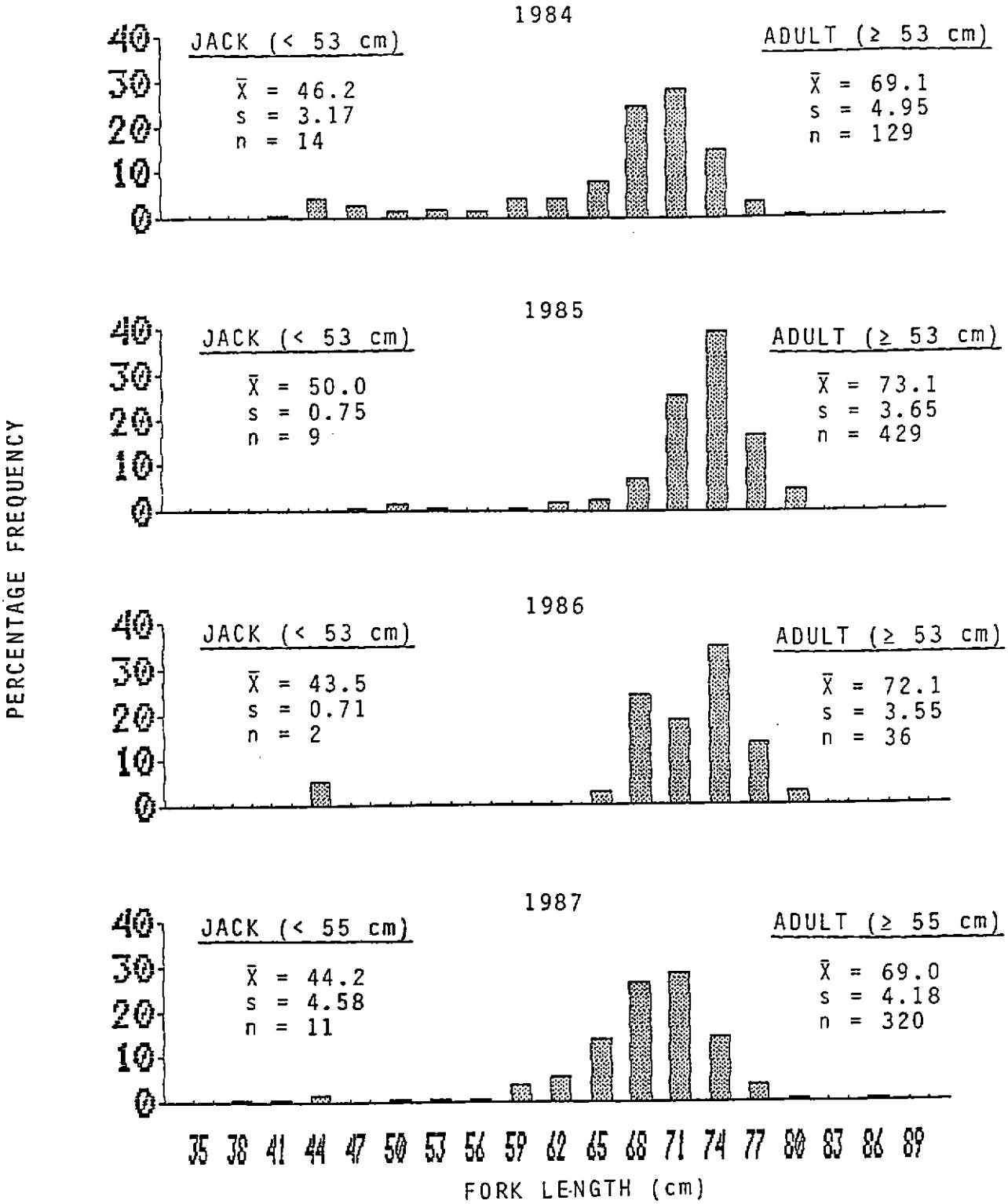


Figure 20. Length frequency distributions of coho salmon harvested by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1984-1987.

TABLE 23. Mean fork length, standard deviation and actual and expanded (underlined) recoveries for coho salmon CWT groups harvested by the gill net fishery on the Klamath River portion of the Hoopa Valley Reservation in 1987.

Tag Code	Brood Year	Hatchery[1/] of Origin	Release[2/] Type	CWT Recoveries		Mean Fork Length (cm)	Standard Deviation
06-56-53	1984	TRH	Y+	18	93	67.7	3.77
06-56-55	1984	TRH	Y	2	6	69.5	2.12
06-59-43	1984	IGH	Y+	12	46	71.7	2.84
TOTALS				32	145		

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

2/ Y (Yearling) - - - Late September to early December release
Y+ (Yearling-Plus) - March release

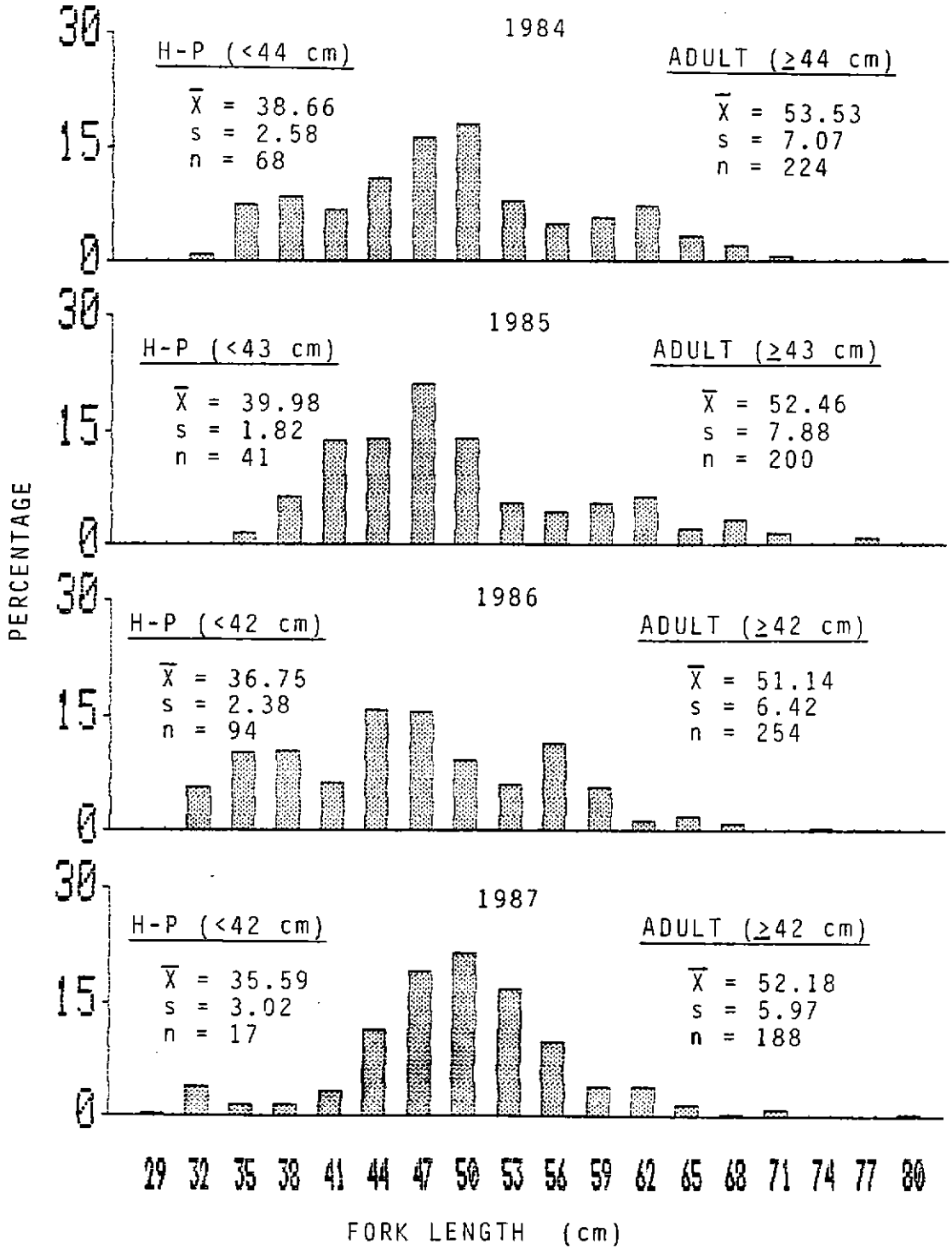


Figure 21. Length frequency distributions of steelhead trout captured during beach seining operations in the Klamath River estuary during 1984-1987 (3 cm groupings with midpoints noted).

TABLE 24. Final semi-monthly estimates of steelhead trout harvest by the gill net fishery on the Klamath River portion of the Hoopa Valley Reservation in the fall of 1987.

Time Period	NET HARVEST MONITORING AREA			Semi-Monthly Total (All Areas)	Cumulative Seasonal Total
	Estuary	Middle Klamath	Upper Klamath		
Jul. 1-15	0	0	0	0	0
16-31	15	0	0	15	15
Aug. 1-15	36	10	12	58	73
16-31	26	2	9	37	110
Sept. 1-15	4	14	9	27	137
16-30	0	33	24	57	194
Oct. 1-15	0	23	28	51	245
16-31	0	4	21	25	270
TOTAL	81	86	103	270	

TABLE 25. Final estimates of steelhead trout harvest by the gill net fishery on the Hoopa Valley Reservation during 1980-1987[1/].

Year	STEELHEAD TROUT		
	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
1987	30	347	377

1/ Estimates for 1983-1987 Trinity River net fishery were obtained from the Hoopa Valley Council, Fisheries Department. All other harvest estimated by the Fish and Wildlife Service by methods described in previous annual reports.

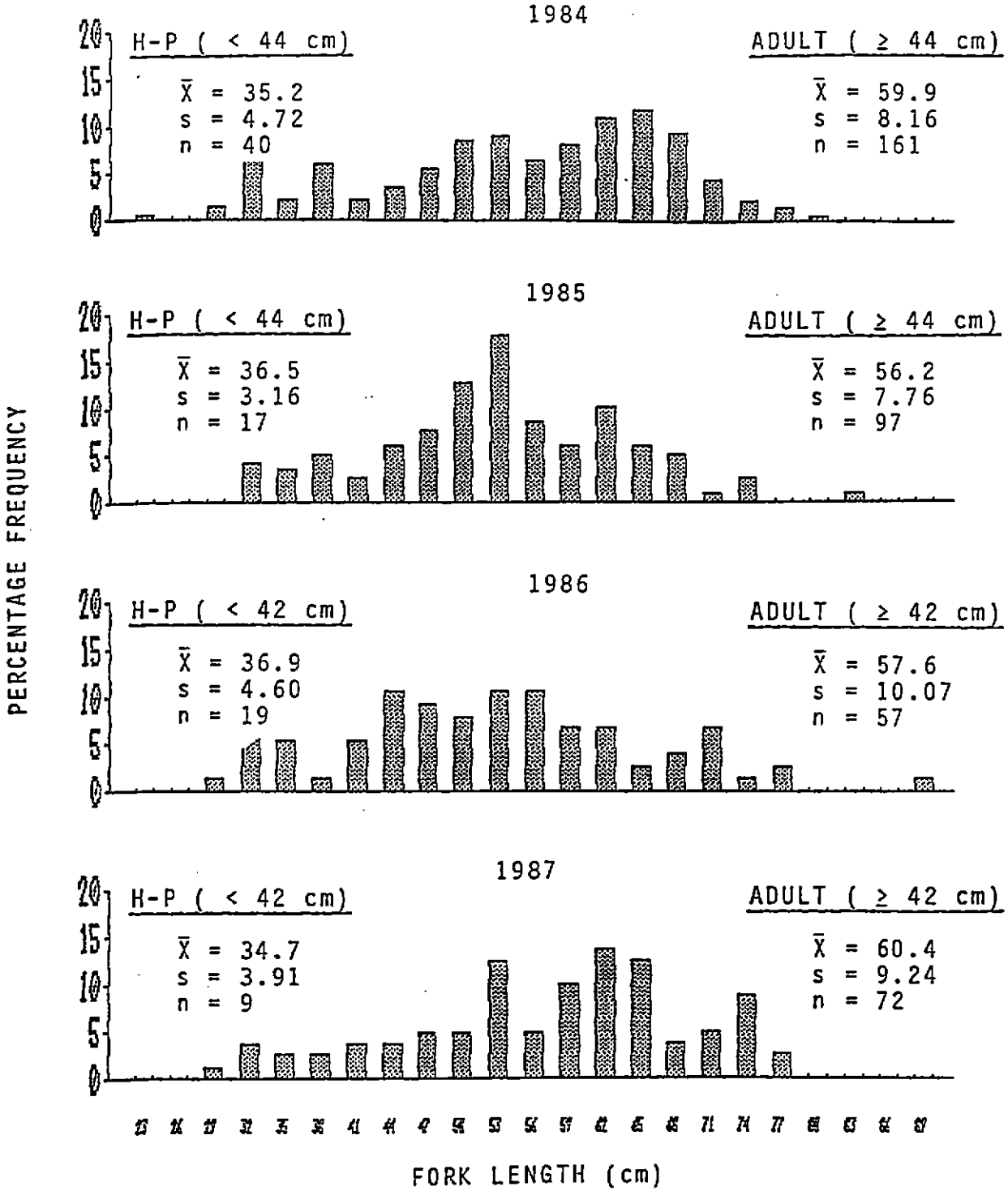


Figure 22. Length frequency distributions of fall steelhead trout harvested by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1984-1987.

Sturgeon

Beach Seining

Fifteen green sturgeon and one white sturgeon were captured during beach seining. The green sturgeon lengths ranged from 32 to 225 cm total length (TL); the mean was 79.0 cm. Only two were adults (>130 cm TL). Peterson-type disc tags were applied to nine sturgeon; four juvenile green sturgeon were recaptured. The recaptures occurred between July 13 and August 11, 1987. The white sturgeon (244 cm TL) was captured on October 5, 1987. Prior to this season, two white sturgeon (Acipenser transmontanus) were captured in the beach seine in 1983.

Net Harvest

An estimated 171 green sturgeon were harvested by Indian gill net fishers on the Klamath River portion of the HVR in 1987 (Table 26). Green sturgeon harvest consisted of 138 adults (>130 cm total length) and 33 juveniles. The majority of the green sturgeon harvest (83.0%) occurred during the spring gill net fishery (April to June). No white sturgeon were sampled during net harvest monitoring operations. Total harvest estimates for green and white sturgeon on the HVR from 1980 to 1987 are presented in Table 27.

Total length of the 21 adult green sturgeon sampled ranged from 143 to 260 cm with a mean length of 176.9 cm (Figure 23). Mean length of the 5 juvenile green sturgeon sampled was 95.2 cm with lengths ranging from 77 to 106 cm.

American Shad

Beach Seining

A total of 718 American shad were caught during the beach seining operations. The largest weekly catch (518) was on August 3-7, 1987. The largest daily total (400) occurred on August 5, 1987. Shad catches were the highest during August (662), while only 35 and 11 were caught in July and September, respectively.

TABLE 26. Final estimates of green sturgeon harvest by the gill net fishery on the Klamath River portion of the Hoopa Valley Reservation in 1987.

Time Period	NET HARVEST MONITORING AREA			Semi-Monthly Total (All Areas)	Cumulative Seasonal Total
	Estuary	Middle Klamath	Upper Klamath		
(Spring Fishery)	-	-	-	142	142
Jul. 1-15	0	0	0	0	142
16-31	11	0	0	11	153
Aug. 1-15	5	0	3	8	161
16-31	0	0	4	4	165
Sept. 1-15	0	2	0	2	167
16-30	0	2	0	2	169
Oct. 1-15	0	0	0	0	169
16-31	0	2	0	2	171
TOTAL	16	6	7	171	

TABLE 27. Final estimates of green and white sturgeon harvest by the gill net fishery on the Hoopa Valley Reservation during 1980-1987.1/

	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
1987	0	0	0	33	158	191

1/ Estimates for 1983-1987 Trinity River net fishery were obtained from Hoopa Valley Business Council, Fisheries Department. All other harvest estimated by the Fish and Wildlife Service by methods described in previous annual reports.

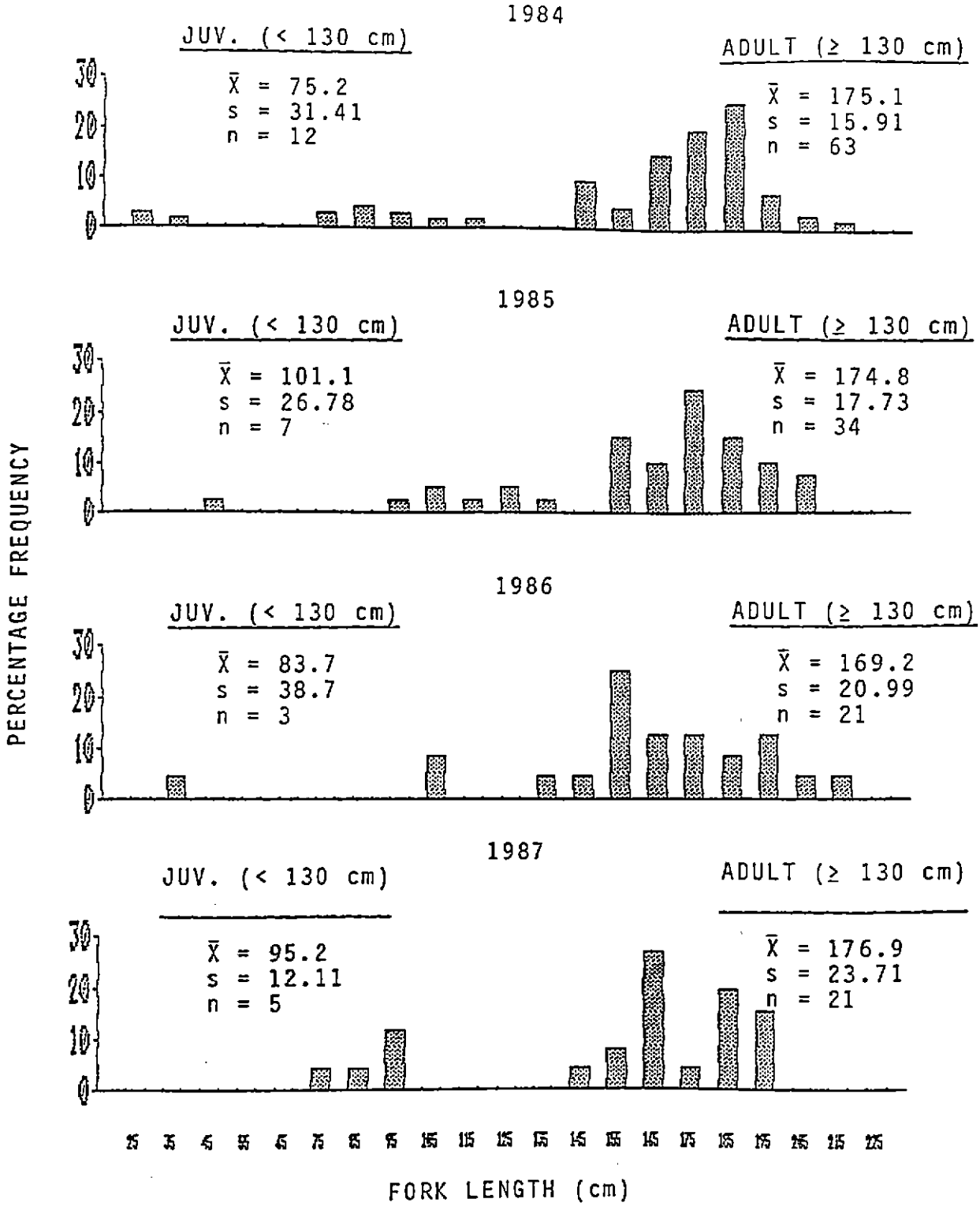


Figure 23. Length frequency distributions of green sturgeon harvested by Indian gill net fishers on the Klamath River portion of the Hoopa Valley Reservation during 1984-1987.

BLUE CREEK SALMONID INVESTIGATIONS

INTRODUCTION

Blue Creek is the largest tributary to the lower Klamath River below the confluence of the Trinity River, draining 312 square km and providing an estimated 11.7 hectares of anadromous spawning habitat (FWS 1979). Chinook salmon, coho salmon, steelhead trout and cutthroat trout (Salmo Clarki) utilize the available habitat in Blue Creek for spawning and rearing. DeWitt (1951) in a letter to the California Department of Fish and Game dated August 25, 1951, estimated chinook salmon spawner abundance to be 5,000 to 10,000 fish. Due to degradation of salmonid spawning and rearing habitat and the overharvest of chinook stocks, a general decline in spawning escapement has occurred throughout the Klamath River basin. It is assumed that abundance of fall chinook in Blue Creek has also declined but no information is available to support this assumption.

Owing to the uniqueness of this stock (possibly the largest late fall run in the Klamath River basin) and the lack of knowledge on the Blue Creek stock of chinook salmon, FAO-Arcata initiated investigations concerning chinook salmon in Blue Creek.

Cursory spawning ground surveys have been conducted intermittently since 1977 with most of these surveys limited to the lower 13 km. Due to the low numbers of fish observed and poor visibility during high flows, these surveys were discontinued in December. Because of the difficulty in accessing the Blue Creek watershed, comprehensive spawning ground surveys that would yield reliable spawning escapement estimates are virtually impossible to conduct without a major commitment of manpower and time. An alternate method for assessing chinook salmon abundance in Blue Creek was to trap juvenile salmonids during their spring outmigration. While this methodology would not yield a reliable adult spawning escapement for the brood year, it would provide a juvenile production index, approximate timing of spawning and other miscellaneous biological information. Toward this end, sampling of outmigrant juvenile chinook salmon in Blue Creek was initiated in the spring of 1987 to collect biological data, time of out migration and to indirectly access the timing of spawning activity. In addition, information on other salmonids utilizing Blue Creek was collected.

METHODS

Outmigrant juvenile chinook were sampled in Blue Creek using a 1.07 m x 1.52 m fyke net (0.48 cm delta mesh netting) with a live box attached to the cod end of the fyke net. Weir panels constructed of 0.64 cm hardware cloth mounted on wooden frames were used to block off the entire width of the creek when possible. The fyke net and weir panels were installed at the tailout of a pool approximately 1.6 km above the creek mouth. The trap was fished during the night from 1800 to 0700 with the live box periodically checked. Trapping was conducted during the night based on the observations by Hoar (1953) and Reimers (1973) that the majority of juvenile chinook migrate under the cover of darkness. Sampling was conducted on March 10 and weekly from March 30 to July 7. Due to water depth only two weir panels could be deployed in conjunction

with the fyke net on March 10 and March 30, which resulted in only a portion of the creek being "sampled." To estimate the relative number of juvenile chinook trapped the first two sampling nights, the trap was set up on April 8 in the same configuration as on March 10 and March 30. The remainder the creek was "sampled" using an identical fyke net and weir panels. The percentage of chinook captured in the first net was used to estimate the relative capture efficiency of the previous two sampling nights, which yielded an estimated number of migrants passing the sampling site during the period when only a portion of the creek was sampled. Trapping efficiency of the weir and fyke net was not determined due to time constraints, but it was assumed that nightly catches were comparable throughout the sampling period.

During a sample night, fishes were removed from the live box and all salmonids were classified to species and enumerated. A subsample of each salmonid species was anesthetized with MS-222 and forklength was measured to the nearest millimeter. The volume, in milliliters, was determined for each measured juvenile chinook from May 19 to July 7. Other species of fish captured were noted and released.

On March 30 six minnow traps baited with salmon roe were placed in various locations in the creek and were allowed to "soak" overnight. Due to the fishes captured (numerous sculpins (Cottus spp.), several juvenile steelhead and no juvenile chinook) the use of these sampling devices was discontinued.

RESULTS AND DICUSSION

Chinook Salmon

A total of 11,816 juvenile chinook salmon were captured during the 16 nights sampled. Based on a 33% relative trapping efficiency applied to the March 10 and March 30 samples, an estimated 11,930 chinook emigrated from Blue Creek during the nights sampled. Nightly catches ranged from 9 chinook (corrected number) on March 10 to 2,814 chinook on June 15 (Figure 24). Numbers of chinook salmon captured on April 8 and April 29 are minimum values due to some equipment failures that caused trapping inefficiency. Lunar phase appeared to influence the magnitude of juvenile chinook emigration. Three peak migration pulses occurred during the sampling period (April 21, May 26, June 15), generally coinciding with the last quarter or the new moon of the lunar month. Lowest nightly catches occurred on the full moon phase of the lunar month. Creek discharge generally decreased throughout the sampling period but there were no drastic increases or decreases in flow that would be expected to affect emmigration and possibly mask the influences of the lunar cycle.

Mean fork length of juvenile chinook ranged from 41.7 mm on March 10 to 74.6 mm on July 7 (Table 28). Many of the chinook captured before the April 29 sampling night were button-up fry and some fish had not yet absorbed their yolk sac. Three large increases in mean fork length occurred, May 11, June 10, and July 7 (Figure 25). These increases may also be related to the lunar cycle, all coinciding with a full moon. The increases on May 11 and June 10 were followed by a plateau of mean fork length for the following three sampling nights (weeks). This may possibly be due to either the fish reaching a particular size

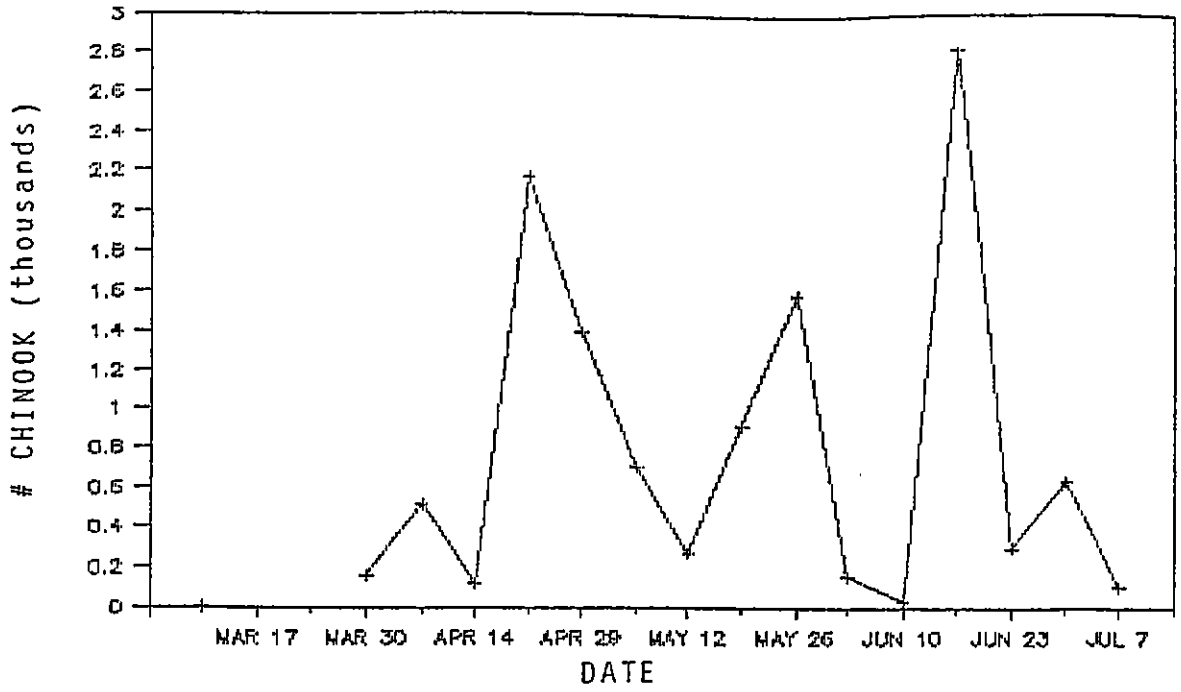


Figure 24. Numbers of juvenile chinook salmon captured in Blue Creek during 1987 sampling.

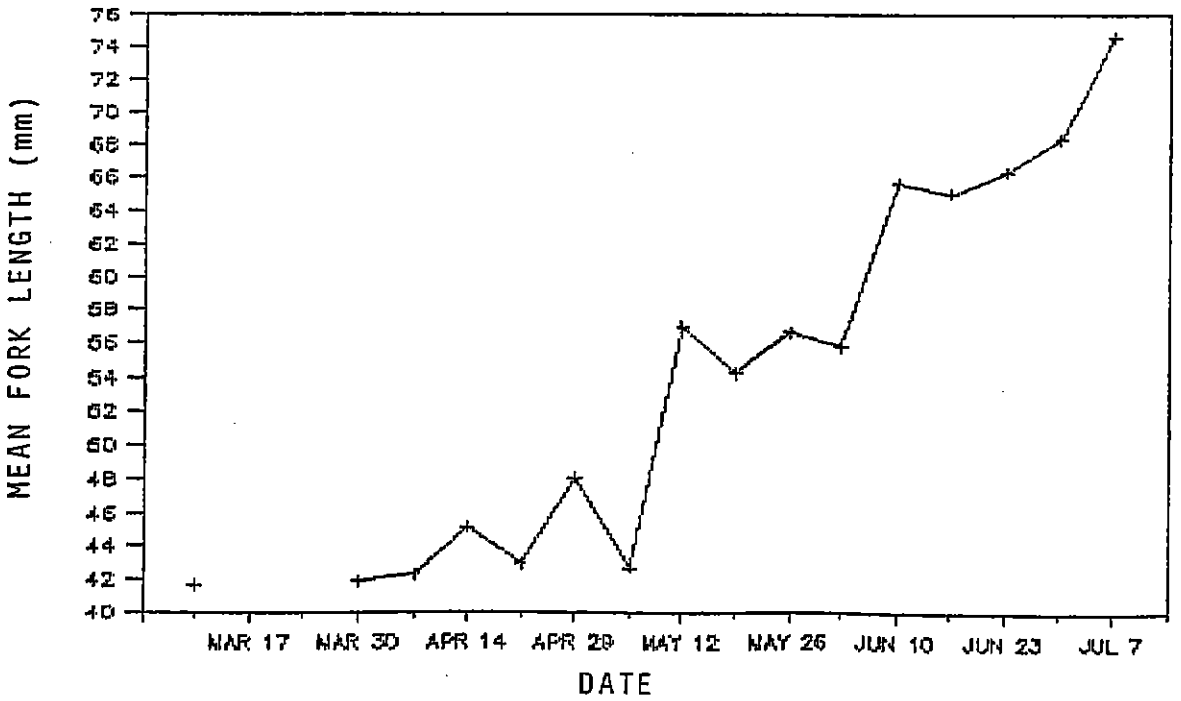


Figure 25. Mean fork length of juvenile chinook salmon captured in Blue Creek during 1987 sampling.

TABLE 28. Date, sample size, mean forklength, standard deviation, minimum size and maximum size of outmigrant juvenile chinook sampled juvenile chinook sampled in Blue Creek during 1987.

Date	n	$\bar{X}$ (mm)	s	MIN (mm)	MAX (mm)
March 10	3	41.7	1.25	40	43
March 30	44	41.9	2.10	34	44
April 8	102	42.3	2.90	38	66
April 14	89	45.2	6.22	36	64
April 21	104	43.0	3.83	36	57
April 29	103	48.1	7.02	38	81
May 5	93	42.7	5.15	38	60
May 11	104	57.0	6.69	42	75
May 19	105	54.3	6.20	40	70
May 26	97	56.7	7.43	40	77
June 2	100	55.9	6.61	45	76
June 10	31	65.7	8.85	49	82
June 15	114	65.1	8.52	47	86
June 23	158	66.4	8.16	48	85
June 30	101	68.4	10.16	47	89
July 7	104	74.6	8.41	55	99

(size of smoltification) that triggered their migration or pulses of fish migrating from different Blue Creek tributaries. Due to the discontinuation of sampling after July 7 this trend was not defined.

Length-volume relationship of juvenile chinook emigrating from Blue Creek was determined from 596 length and volume samples collected from May 19 to July 7 (Figure 26).

Mean lengths and abundance of juvenile chinook emigrants indicate that the peak spawning of fall chinook in Blue Creek occurred in late December to February. With this data, it is obvious that the spawning ground surveys conducted in previous years missed the majority of the chinook spawning in Blue Creek. Due to low sampling intensity of this study making estimates of the approximate magnitude of spawning is not warranted. It does appear that spawner escapement is relatively low when compared to previous estimates (Dewitt 1951). Data collection has become more important because of proposals to utilize Blue Creek chinook salmon as an egg source for pond rearing projects. With the apparent low number of adult chinook entering Blue Creek, uncontrolled broodstock collection may have adverse effects on the spawning population and future production.

Steelhead Trout

Steelhead trout were the second most numerous salmonid captured during the juvenile sampling of Blue Creek. A total of 1,935 juvenile steelhead were captured with nightly catches ranging from 6 on March 10 and March 30 to 866 on May 26. Juvenile steelhead were partitioned into two age classes; young-of-the-year (0^+) and yearling plus or greater (1^+ or greater). From length frequency data collected, it was obvious that multiple age classes and possibly different races (summer and winter) were present in Blue Creek. Since scales were not collected to verify ages, the older age classes (1^+ and greater) were combined so as to not present data that might be misleading. The magnitude of juvenile steelhead migration tended to follow the same trend of juvenile chinook with the lowest number of migrants occurring during full moons and peaks occurring during the last quarter and new moon phase. Yearling and older steelhead were captured throughout the sampling period with peak migration occurring on April 29 (Figure 27). Age 0^+ steelhead were first captured on April 29 with peak migration occurring on May 26. It appears that the peak spawning of winter steelhead in Blue Creek occurs in late January and February.

Mean fork length of age 0^+ steelhead remained relatively constant (30-40 mm) until the end of June when it began to increase (Table 29 and Figure 28). Mean fork length of age 1^+ and older steelhead was greatest on April 21 and coincided with the migration of many large (>170 mm) individuals. It then decreased and after May 19 began to gradually increase until June 10 when a second peak occurred. These peaks and subsequent increases are probably the result of larger steelhead smolting and migrating from Blue Creek. Shapovalov and Taft (1954) found that there was a gradual decrease in average size of migrants of each age class because larger individuals tend to migrate earlier. Data collected during the spring of 1987 in Blue Creek does not clearly exhibit this trend due to the lumping of age 1^+ and older steelhead. It was obvious that older steelhead (2^+ and possibly 3^+) migrated earlier in the spring with the largest being 310 mm on April 21. After May 12 the largest migrant steelhead captured was a 162 mm individual on June 30.

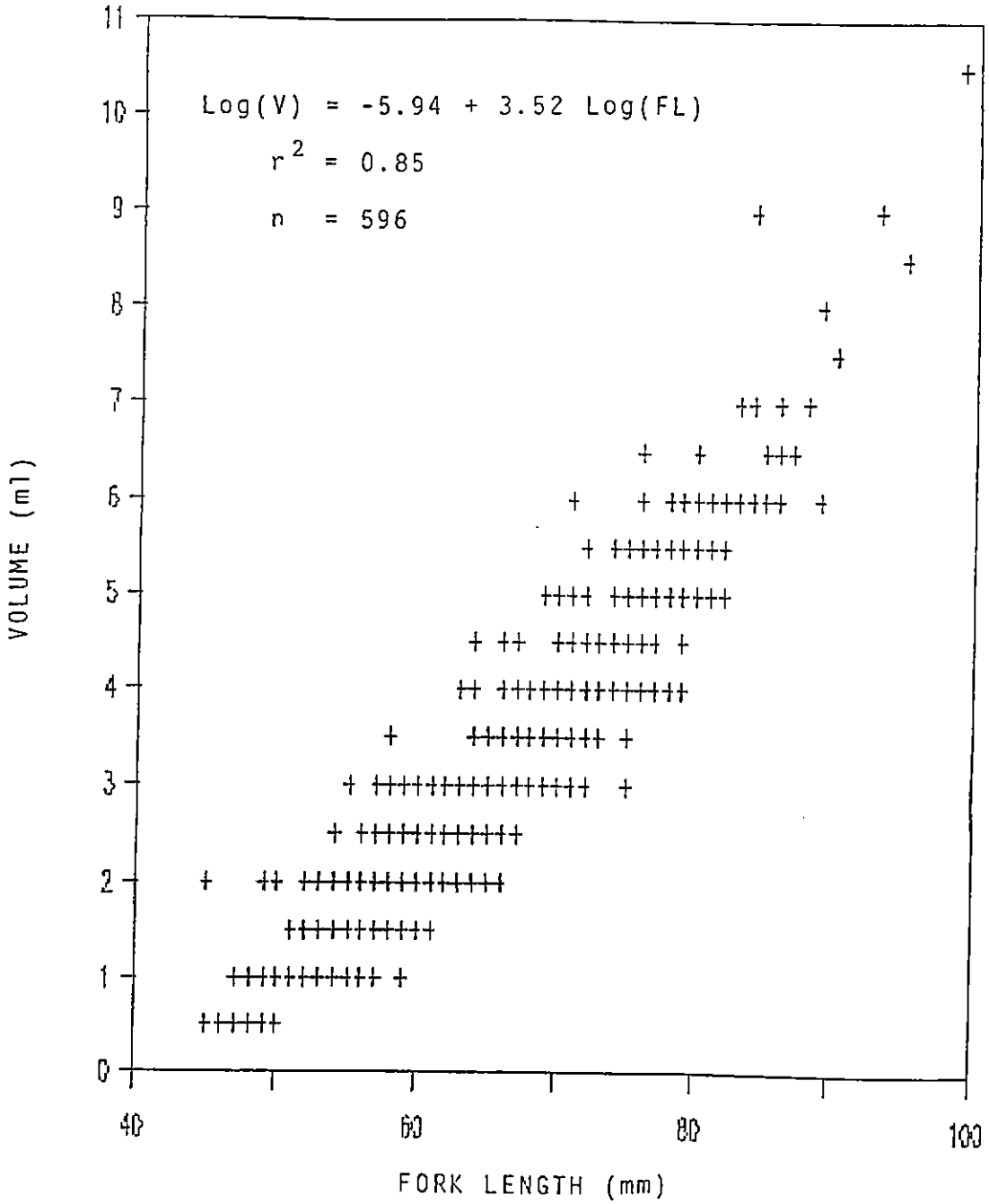


Figure 26. Length-volume relationship of juvenile chinook salmon captured in Blue Creek during 1987 sampling.

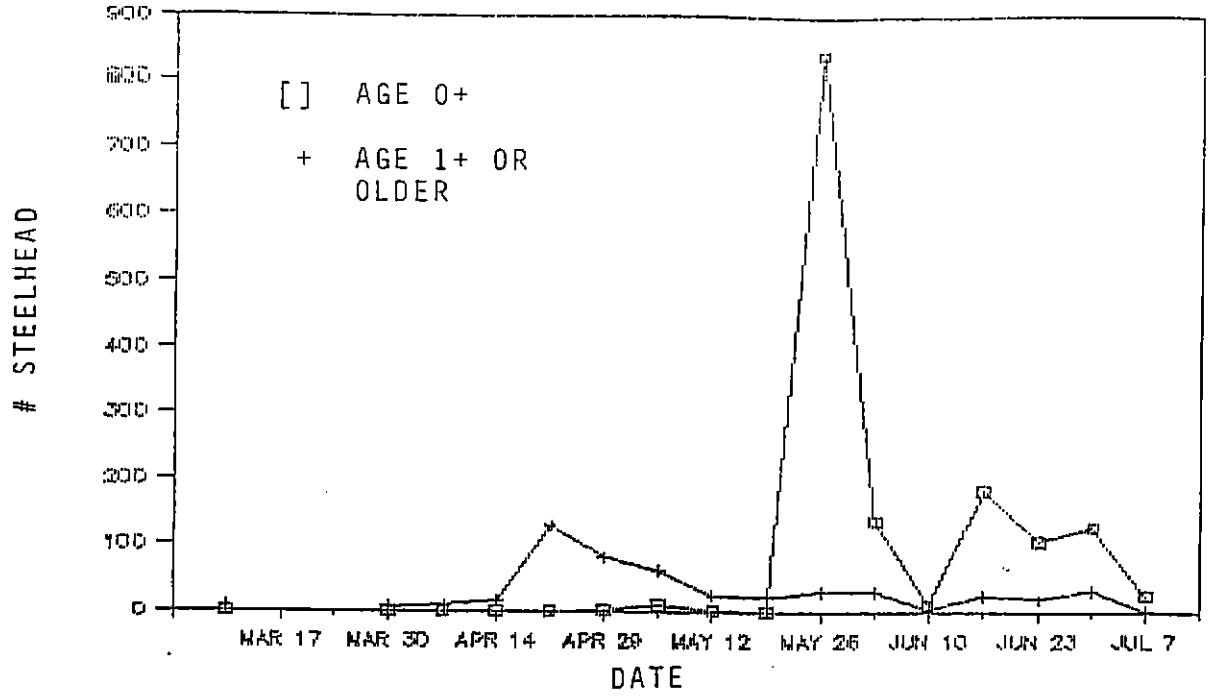


Figure 27. Numbers of 0+ and 1+ or older steelhead trout captured in Blue Creek during 1987 sampling.

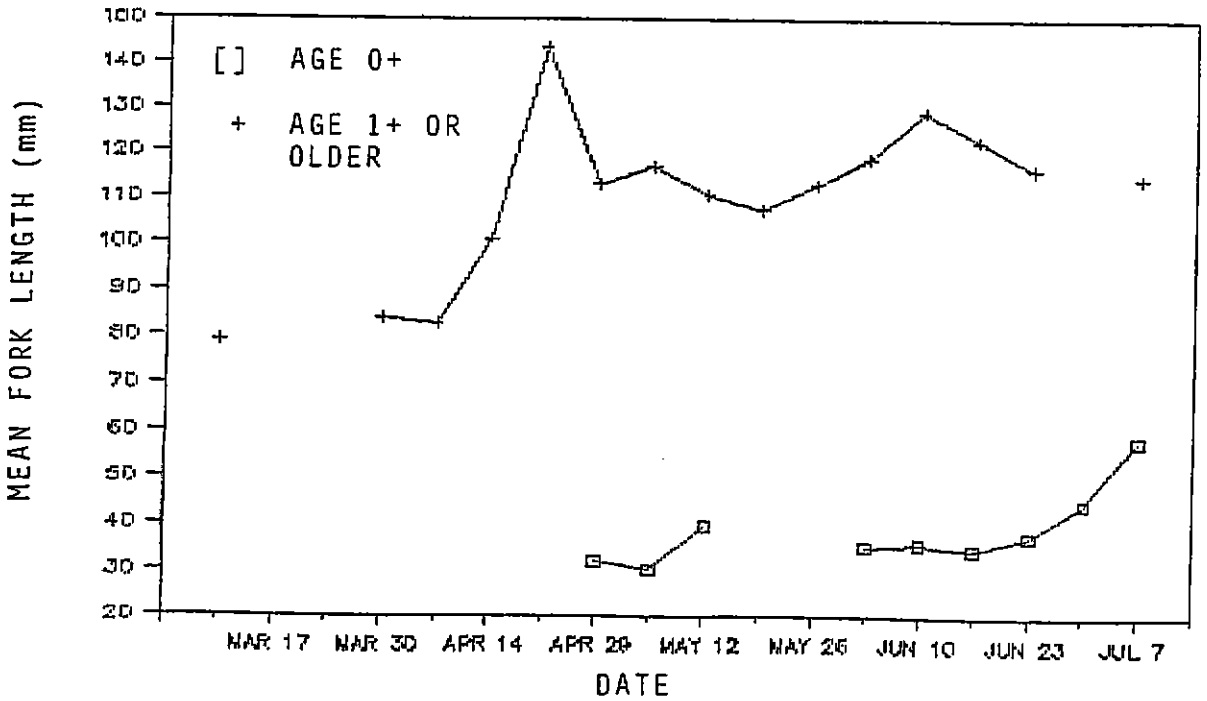


Figure 28. Mean fork length of 0+ and 1+ or older steelhead trout captured in Blue Creek during 1987 sampling.

Table 29. Mean fork length, standard deviation, sample size, minimum size and maximum size by age class of juvenile steelhead trout captured in Blue Creek during 1987.1/

Date	AGE 0^+ $\bar{X}$(mm)	s	n	MIN	MAX	AGE 1^+ and GREATER $\bar{X}$(mm)	s	n	MIN	MAX
March 10	---	---	0	---	---	79.0	22.63	2	63	95
March 30 2/	---	---	0	---	---	84.0	1.41	2	83	85
April 08	---	---	0	---	---	82.7	10.57	9	65	101
April 14	---	---	0	---	---	101.0	34.26	16	66	181
April 21	---	---	0	---	---	143.6	46.54	95	76	310
April 29	32.0	0	2	32	32	112.9	30.05	80	75	204
May 5	30.1	0.78	9	29	31	116.9	30.21	59	75	187
May 12	39.5	0.71	2	39	40	110.5	27.79	25	80	182
May 19	---	---	0	---	---	107.3	18.81	19	79	147
May 26 3/	---	---	0	---	---	112.8	16.16	30	80	143
June 2	35.3	7.27	61	28	59	118.7	22.72	13	78	157
June 10	35.8	9.83	10	27	58	129.3	22.35	4	102	149
June 15	34.5	5.21	13	29	44	122.9	20.28	13	78	157
June 23	37.6	10.89	86	26	66	116.4	17.08	12	90	146
June 30	44.6	13.63	25	28	77	162.0	---	1	---	---
July 7	58.0	12.62	25	34	80	114.5	19.09	2	101	128

1/ Designations of age class groupings were based on fork length histograms, not scale analyses.

Age Class	March 10 - June 15	June 23 - July 7
0^+	< 61 mm	< 85 mm
1^+ and GREATER	≥ 61 mm	≥ 85 mm

2/ Juvenile steelhead captured in minnow traps are not included.
3/ Age 0^+ steelhead were captured on this sampling date but were not measured.

Other Species

Anadromous salmonids captured, other than chinook salmon and steelhead trout, were coho salmon and cutthroat trout. A total of 29 coho salmon where captured from April 21 to June 2, with the peak catch of 9 occurring on June 2. Fork length of captured coho ranged from 46 mm to 127 mm. One cutthroat trout, fork length 116 mm, was captured on May 19.

Fish, other than anadromous salmonids, captured during sampling were suckers (Catostomus spp.), sculpins, cyprinids (Cyprinidae), threespine stickleback (Gasterosteus aculeatus), adult Pacific lamprey (Lampetra tridentata) and lamprey ammocoetes (Lampetra spp.).

Peamouths, Mylocheilus caurinus, which are endemic to the Columbia River basin (Dr. Peter Moyle, personal communication June 1988), were found in Blue Creek. Positive identification was provided by Dr. Ronald Fritzsche of Humboldt State University (personal communication, March 1988).

KLAMATH RIVER JUVENILE SALMONID MONITORING

INTRODUCTION

In 1986, adult fall-run chinook salmon returned to TRH in record numbers, exceeding the facility's egg-rearing capacity by five million eggs. Through the cooperative efforts of local citizens, county, state and Federal agencies, the Ambrose and Sawmill ponds facilities were utilized to hatch and rear these surplus chinook eggs. Personnel from the Bureau of Reclamation and Fish and Wildlife Service Trinity River Field Office in Weaverville coordinated the rearing and release of chinook. Prior to release, 98,245 and 103,141 chinook from the Ambrose and Sawmill ponds, respectively, were implanted with CWT. On June 11, 1987, 1,924,119 Sawmill pond chinook were released into the Trinity River (river km 177.5). A total of 2,179,623 Ambrose pond chinook were released into the Trinity River (river km 173.1) on June 27, 1987. The Trinity River Field Office requested that FAO-Arcata monitor the downstream migration of the two release groups.

METHODS

The Klamath River, in the vicinity of the Highway 101 bridge crossing, was chosen as the main sampling area, because of access and suitability for beach seining. These areas were sampled one night per week by a three person crew, beginning June 25 and ending on September 22, 1987. Seining began at 1900 hours and ended by 2230 hours. A 30.5 m x 2.5 m x 7.9 mm delta mesh (3.2 mm bag mesh) beach seine net was deployed from a Valco 4.9 m river jet boat or by hand. At least ten sets were made each night. The first 100 chinook salmon captured were anethesized with MS-222, measured to the nearest mm, examined for ad-clips and released. All additional chinook were examined for ad-clips and released. All ad-clipped fish were sacrificed and retained for recovery of CWT's. Steelhead trout juveniles were caught incidentally and were counted and measured prior to release. Other species were identified and released.

RESULTS AND DISCUSSION

A total of 3,188 juvenile chinook salmon were captured during the survey. Thirty-two CWT's representing five code groups were recovered from 36 chinook bearing ad-clips (Table 30). Five CWT's were from to the Ambrose pond (06-56-30) and eleven were from the Sawmill pond (06-56-29).

CWT chinook from both ponds were captured throughout the sampling period. During the first week of sampling (June 25-31), two chinook from the Sawmill and one from the Ambrose pond were captured. The Sawmill pond fish had been released fourteen days earlier. The chinook from the Ambrose pond represents an individual that had escaped prior to the actual release date of June 27, 1987.

Half of the 32 recovered CWT were released from the Ambrose and Sawmill ponds (Table 31). The percentage (relative to total CWT tagged) of Ambrose and Sawmill fish recovered were appreciably higher than the three hatchery release

TABLE 30. Summary of the juvenile beach seining (chinook and coded-wire tag recoveries) catch statistics in the Klamath River estuary during 1987.

Date	Tidal Stage[1/]	Total Chinook	AD-Clip	Fish Measured	$\bar{X}$ (mm)	Tags Recovered	Tag Codes Recovered (Number)			
06-25-87	In	454	9	9	83.4	8	06-56-29 (2)	06-56-26 (3)	06-61-45 (2)	06-56-30 (1)
07-01-87	Out-LS	542	8	109	79.0	7	06-56-29 (4)	06-56-26 (1)	06-61-45 (2)	
07-07-87	In-HS	274	2	106	83.0	2	06-56-29 (1)	06-56-26 (1)		
07-16-87	Out	537	2	100	81.5	2	06-56-30 (1)	06-59-60 (1)		
07-23-87	In-HS	21	0	9	80.6	-				
07-29-87	Out-LS	302	1	122	88.2	1	06-56-30 (1)			
08-06-87	In-HS	25	1	25	88.7	1	06-56-29 (1)			
08-13-87	Out-LS	369	4	134	89.5	3	06-59-60 (3)			
08-20-87	In-HS	207	1	107	90.3	1	06-56-29 (1)			
08-27-87	LS-In	324	6	190	92.0	5	06-56-26 (1)	06-56-29 (2)	06-56-30 (1)	06-61-45 (1)
09-02-87	HS-Out	22	0	21	92.4	-				
09-16-87	HS-Out	33	1	33	99.1	1	06-56-30 (1)			
09-22-87	In	78	1	78	104.3	1	06-56-26 (1)			
		3,188	36	1,043		32				

[1/] In=Incoming, Out=Outgoing, LS=Low Slack, HS=High Slack. Vicinity Highway 101 Bridge.

groups recovered. Differences in recovery rate may be attributed to a number of factors including survival, differing migration rates, size at recovery or variable tag shedding rates.

Monthly catches were highest in July (1,676), and declined through August and September (Table 30). CDFG sampled the estuary with beach seining and trawling gear during this same time period, and also observed a similar trend (Mark Pisano, CDFG, personal communication 1987). However, this decline in catch may not be related entirely to changes in actual chinook abundance or to movement out of the sampling areas. During September 1986, Joe Krakker (CDFG, personal communication, 1987) observed higher catches using boat-electrofishing when seining and trawling methods yielded lower catches. As the chinook attained a larger size, their distribution shifted to deeper, open-water areas. Smaller chinook were captured in near-shore areas by seining, whereas larger fish were captured more frequently in deeper water by trawling. The larger chinook may be more successful in avoiding the seine and trawl nets. During the 14-week sampling period, an increase in the mean fork length of chinook was observed. The mean fork length of the samples was 79.0 mm on July 1, 1987, and 104.3 mm on September 22, 1987 the final sampling night (Table 30).

Table 31. CWT release information and recovery data for juvenile chinook salmon capturing during Fish and Wildlife Service juvenile beach seining in the Klamath River estuary during 1987.

Code Group	Release Site[1/]	Release Date(s)	# CWT Tagged	# CWT Recovered	Recovery Rate of CWT
6-56-29	Sawmill	6/11/87	103,141	11	.011 %
6-56-30	Ambrose	6/27/87	98,245	5	.005 %
6-59-60	IGH	6/26/87	200,000	4	.002 %
6-61-45	TRH	5/26-6/1/87	197,113	5	.003 %
6-56-26	TRH	6/11, 6/17/87	202,480	7	.003 %

1/ IGH=Iron Gate Hatchery, TRH=Trinity River Hatchery

PROGRAM PLANNING

INTRODUCTION

The goal of FAO-Arcata is to provide technical assistance and fishery expertise by conducting various specialized field programs which address specific problems as they are recognized; while at the same time reserving the ability to conduct longer term monitoring programs such as are reported here.

The course of the Klamath River Fisheries Assessment Program, and the role of FAO-Arcata in addressing resource-related issues involving the Klamath River basin, evolved in response to Departmental direction through Memoranda of Agreement, the Critical Issues Management System, and the FWS Management By Objectives program. Further direction has been received through a Statement of Responsibilities and Role (FWS 1985b) of the Fishery Resources Program. The BIA planning processes involving fisheries resources of the HVR, continues to greatly influence program direction. Recently 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, is also exerting an influence on program direction with proposed fishery work scheduled to be initiated in FY 88. Details of other actions with potential relevance to FAO-Arcata programs have been presented in previous Annual Reports.

PROGRAM PLANNING

Anadromous fishes of the Klamath-Trinity basin were identified as high priority and have been listed in order of preference for investment in restoration (FWS 1982c). The Klamath River Fisheries Assessment Program 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 information in a timely manner to those agencies responsible for managing this 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 Klamath River Fisheries Assessment Program was initiated through the FWS 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 FWS 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 HVBC, Fisheries Department. Former FAO-Arcata programs operating on the Trinity River under Memorandum of Agreement with the BIA have been entirely transferred to the HVBC. 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. This database is used by the PFMC to assist in the management of the ocean fisheries and provides insight assessing the spawning escapement annually. 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 HVR. This estimate is provided to the CDFG to assist in estimating the annual Klamath River run size. This estimate provides a view of the contiribution made by the Klamath stocks to the various fisheries and the spawning escapement. Collection of this critical information will continue. Research into data on size selectivity was 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 will 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) Juvenile Chinook Salmon Production Monitoring will be initiated in the spring of 1988 to provide abundance indices of juvenile chinook salmon from the two major subbasins (upper Klamath and Trinity Rivers above Weitchpec). Such data will provide key information on production of hatchery and natural stocks in the basin; assist the management agencies in predicting year class strength at the juvenile stage; and assist in evaluating the restorations efforts under P.L 98-541 and 99-552.

(4) 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 (FWS 1979) and evaluation of New River, a tributary to the Trinity River, have also been proposed. Of particular interest is production generated from Blue Creek, the largest tributary in the lower river area. Program planning, direction and coordination will remain essential and on-going parts of FAO-Arcata activities. Program coordination and information dissemination to other groups and agencies involved with the Klamath-Trinity basin fishery resource are recognized as high priorities. Frequent meetings will continue to be held with biologists representing the Bureau of Indian Affairs, Califoria Department of Fish and Game, U.S. Forest Service, Hoopa Valley Business Council, Oregon Department of Fish and Wildlife, National Marine Fisheries Service 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.

REFERENCES

Bearss, E. C. 1981. Historical resource study - Hoopa-Yurok fisheries suit, Hoopa Valley Indian Reservation - Del Norte and Humboldt Counties, California. Denver Service Center. Denver, Colorado. 443 pp.

CDFG (California Department of Fish & Game). 1980. Rationale used in determining contribution of Klamath River system fish to Northern California and Southern Oregon coastal fisheries. Anadromous Fisheries Branch. 3 pp.

_____. 1983. Klamath River fishery biological considerations. Anadromous Fisheries Branch. 12 pp.

Cochran, W. G. 1977. Sampling techniques. Wiley. New York, New York. 428 pp.

DeWitt, John W. 1951. Personal letter from Head, Fisheries Department, Humboldt State University, Arcata, California, to California Division of Fish and Game, August 25, 1951. 1 pp.

Dixon, W. J. and Massey, F. J., Jr. 1969. Introduction to statistical analysis. Third Edition. McGraw-Hill Book Company. U.S.A. 638 pp.

French, R. R. and J. R. Dunn. 1973. Loss of salmon from high seas gill netting with reference to the Japanese salmon mothership fishery. U.S. Natl. Marine Fish. Serv. Fish. Bull. 71:845-875.

Goodman, L. A. 1960. On the exact variance of products. J. Amer. Stat. Assoc. 55:708-713.

Hannah, R.W. 1982. Recommended bio-sampling rates for fall chinook at state and Federal hatcheries in the Columbia basin. Unpublished memorandum, U.S. Fish and Wildlife Service, Vancouver, Washington. 5 pp.

Herder, M. J. 1983. Pinniped fishery interactions in the Klamath River system, July 1979 - October 1980. NMFS Admin. Rep. LJ-83-12C. Natl. Marine Fish. Ser., SW Fisheries Ctr. LaJolla, California.

Hoar, W.S. 1953. Control and timing of fish migration. Biological Reviews of the Cambridge Philosophical Society. 28(4):437-452

Hoptowit, D. R. 1980. Klamath-Trinity salmon restoration project - final report. California Resources Agency. Sacramento, California. 92 pp.

Jewell, E. 1970. Gill net dropout study. Wash. Dept. Fish., Prog. Rep. AFC-14.

KRTT (Klamath River Technical Advisory Team). 1986a. Recommended methods of allocation harvest of Klamath River fall-run chinook in 1986 including allowable harvest levels under harvest rate management.

_____. 1986b. Recommended spawning escapement policy for Klamath River fall-run chinook. 96 pp.

PFMC (Pacific Fishery Management Council). 1987. Review of 1986 ocean salmon fisheries. Portland, Oregon.

Parker, R. R. 1960. Critical size and maximum yield for chinook salmon (Oncorhynchus tshawytscha). J. Fish. Res. Bd. Can. 17:105-112.

O'Brien, P., S. Taylor, and P. Jensen. 1970. A review of chinook and coho shaker catches in the Pacific coast troll fishery. Calif. Dept. Fish and Game. Sacramento, California.

Reimers, P.E. 1973. The length of residence of juvenile fall chinook salmon in Sixes River, Oregon. Research Reports of the Fish Commission of Oregon. 4(2):1-43.

Ricker, W. E. 1976. Review of the rate of growth and mortality of Pacific salmon in salt water, and noncatch mortality caused by fishing. J. Fish. Res. Bd. Can. 33:1483-1524.

Shapovalov, L., and A.C. Taft. 1954. The life histories of steelhead rainbow trout (Salmo gairdneri gairdneri) and silver salmon (Oncorhynchus kisutch) with special reference to Waddell Creek, California, and recommendations regarding their management. California Department of Fish and Game Bulletin 98. 375 pp.

DOI (U.S. Department of the Interior). 1985. Klamath River basin fisheries resource plan. Redding, California.

FWS (Fish and Wildlife Service). 1979. Inventory of reservation waters, fish rearing feasibility study, and a review of the history and status of anadromous fishery resources of the Klamath River basin. Fisheries Assistance Office. Arcata, California. 134 pp.

_____. 1981. Annual Report: Klamath River fisheries investigation program, 1980. Fisheries Assistance Office. Arcata, California. 107 pp.

_____. 1982a. Annual Report: Klamath River fisheries investigation program , 1981. Fisheries Assistance Office. Arcata, California. 131 pp.

_____. 1982b. Regional resource plan, Region 1. Portland, Oregon. 519 pp.

_____. 1983. Annual Report: Klamath River fisheries investigation program, 1982. Fisheries Assistance Office. Arcata, California. 153 pp.

_____. 1985a. Annual Report: Klamath River fisheries investigation program, 1984. Fisheries Assistance Office. Arcata, California. 142 pp.

_____. 1985b. Statement of responsibilities and role. U.S. Fish and Wildlife Service, Fishery Resources Program. Washington, D.C. 39 pp.

_____. 1986. Annual Report: Klamath River fisheries investigations program, 1985. Fisheries Assistance Office. Arcata, California.

_____. 1987. Annual Report: Klamath River fisheries investigations program, 1986. Fisheries Assistance Office. Arcata, California.

USFS (U.S. Forest Service). 1977. An economic evaluation of the salmon and steelhead fisheries attributable to Klamath National Forest. Klamath National Forest. Yreka, California. 17 pp.

_____. 1978. The economic value of anadromous fisheries for Six Rivers National Forest. Six Rivers National Forest. Eureka, California 47 pp.

Wright, S. 1972. A review of the subject of hooking mortalities in Pacific salmon (Oncorhynchus). 23rd Ann. Rpt. Pac. Mar. Fish. Comm. pp. 47-56.

PERSONAL COMMUNICATION

Fritzsche, R. 1988. Professor of Fisheries, Humboldt State University. Arcata, California.

Krakker, J. 1988. Fishery Biologist, California Department of Fish and Game. Weaverville, California.

Moyle, P. 1988. Professor of Wildlife and Fisheries Biology, University of California, Davis. Davis, California.

Paulson, I. 1988. Fishery Biologist, California Department of Fish and Game. Yreka, California.

Pisano, M. 1988. Fishery Biologist, California Department of Fish and Game. Arcata, California.