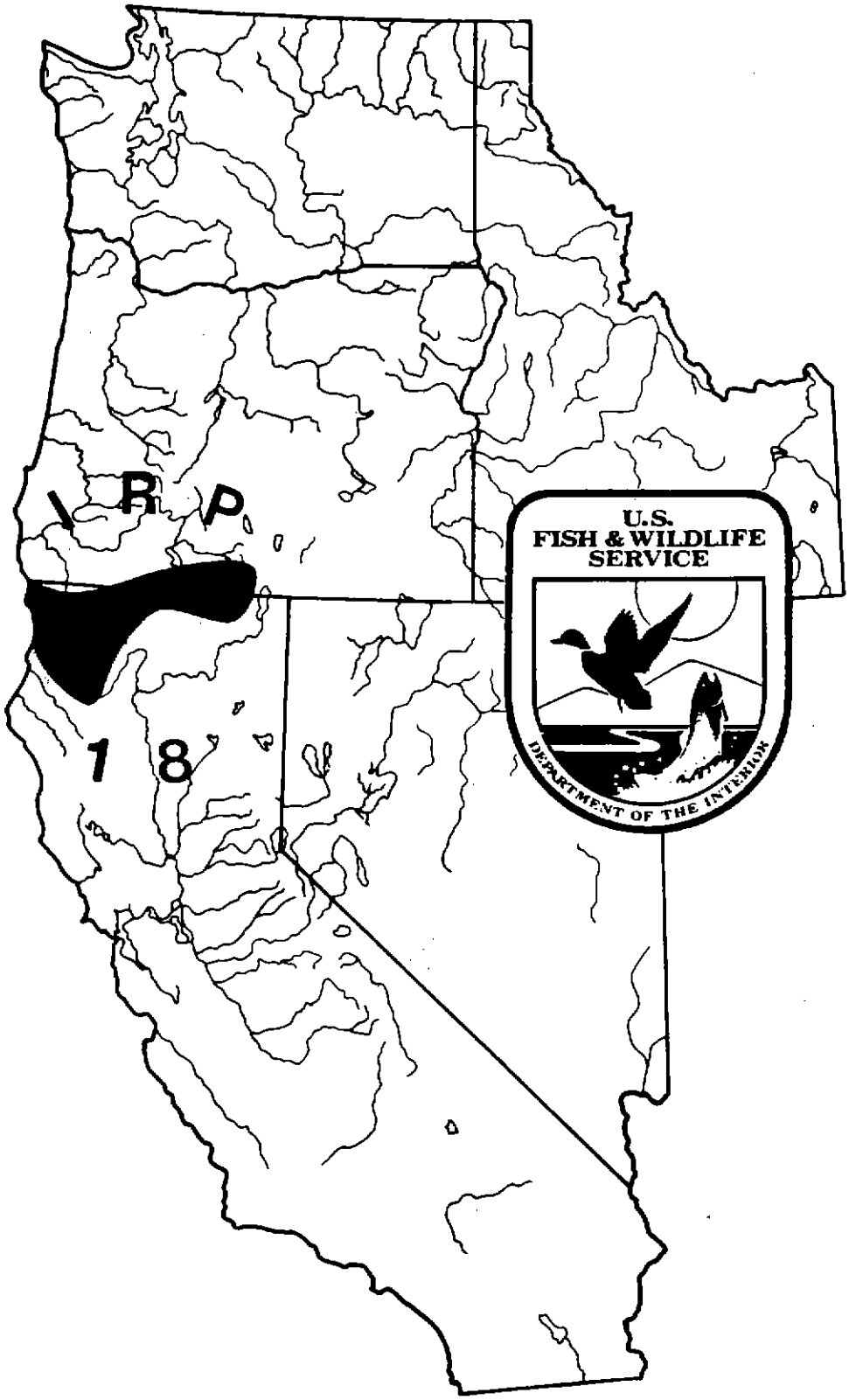
J. Craig

KLAMATH RIVER FISHERIES INVESTIGATION PROGRAM



ANNUAL REPORT - 1983

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KLAMATH RIVER FISHERIES INVESTIGATION PROGRAM

1983

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

Robert Adair, Wayne Harper, Richard Edwards,
James Larson, Keith Lutz and Craig Tuss
Fishery Biologists

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TABLE OF CONTENTS

	Page
LIST OF FIGURES	iii
LIST OF TABLES	vii
LIST OF PLATES	x
ACKNOWLEDGEMENTS	xi
FORWARD	1
CHINOOK SALMON INVESTIGATIONS	6
ABSTRACT	6
BEACH SEINING PROGRAM	7
INTRODUCTION	7
METHODS	7
RESULTS AND DISCUSSION	10
Hook Scarring and Gill Net Marking Investigations	14
Gill Net Markings	14
Hook Scars	14
Mark-Recapture Analysis	17
Run Timing and Catch/Effort Analysis	25
Sport Fishery - Klamath Estuary	30
Indian Gill Net Fishery - Klamath Estuary	30
NET HARVEST MONITORING PROGRAM	36
INTRODUCTION	36
METHODS	36
Estuary Area	36
Middle Klamath Area	36
Upper Klamath Area	40
RESULTS AND DISCUSSION	43
Fall Chinook Salmon	43
Spring Chinook Salmon	59
AGE COMPOSITION	65
INTRODUCTION	65
METHODS	65
RESULTS AND DISCUSSION	65
Fall Chinook Salmon	65
RUN SIZE ESTIMATION PROGRAM	71
INTRODUCTION	71
METHODS	71
RESULTS AND DISCUSSION	71
CODED-WIRE TAG RECOVERY INVESTIGATIONS	79
INTRODUCTION	79
METHODS	79
RESULTS AND DISCUSSION	80
Fall Chinook Salmon	80
Spring Chinook Salmon	87
In-River Versus Ocean Fisheries	87

Page

CHINOOK SALMON HARVEST OVERVIEW 96

EL NINO 101
INTRODUCTION 101
METHODS 101
RESULTS AND DISCUSSION 101

COHO SALMON INVESTIGATIONS 107
ABSTRACT 107

COHO SALMON 108
INTRODUCTION 108
METHODS 108
RESULTS AND DISCUSSION 108
Beach Seining 108
Net Harvest 108

STEELHEAD TROUT INVESTIGATIONS 114
ABSTRACT 114

STEELHEAD TROUT 115
INTRODUCTION 115
METHODS 115
RESULTS AND DISCUSSION 115
Beach Seining 115
Net Harvest 116

STURGEON INVESTIGATIONS 121
ABSTRACT 121

STURGEON INVESTIGATIONS 122
INTRODUCTION 122
METHODS 122
RESULTS AND DISCUSSION 122
Harvest 122
Population Characteristics 123

PROGRAM PLANNING, DIRECTION AND COORDINATION 130
INTRODUCTION 130
LONG-TERM PLANNING 130

REFERENCES 133

LIST OF FIGURES

Figure		Page
1.	The Klamath River basin and Hoopa Valley Indian Reservation	2
2.	Depth contours (expressed in meters below mean high tide) of the Klamath River estuary during July 1983. Arrow depicts beach seining site	8
3.	Length frequency distributions of chinook salmon captured during beach seining operations in the Klamath River estuary in 1981, 1982 and 1983 (3 cm groupings, with midpoints noted)	11
4.	Length frequency distributions of adipose and non-adipose fin-clipped chinook salmon captured during 1983 beach seining operations (3 cm groupings, with medians noted)	12
5.	Percentage occurrence of LV- and RV-clipped chinook by day during 1983 beach seining operations	13
6.	Least squares linear regressions of hook scarring frequencies by Julian week for chinook salmon captured during 1979-1983 beach seine operations	18
7.	Ocean commercial troll salmon landings at northern California ports (Crescent City, Eureka, Fort Bragg), 1979-1983. Numbers at the top of each figure represent the percentage of that season's catch occurring before and after June 30	19
8.	Length frequency distributions of hook-scarred and non-hook-scarred chinook in the 1983 beach seine sample	20
9.	Grilse and adult chinook salmon hook scarring rates observed during 1979, 1980, 1981, 1982 and 1983 beach seining operations in the Klamath River	21
10.	Overview map of the Klamath-Trinity basin delineating recovery areas for chinook tagged during 1979-1983 mark-recapture studies	22
11.	Three-day moving average of numbers of adult chinook salmon captured per beach seine haul (all sets) in the Klamath River estuary during 1980-1983	26
12.	Daily numbers of adult chinook salmon captured per beach seine haul (all sets and peak 3 sets) in the Klamath River estuary in 1983	31
13.	Cumulative daily adult chinook salmon catch/efforts values (all sets and peak 3 sets) in 1983 beach seining operations in the Klamath River estuary	32
14.	Three-day moving averages of number of adult chinook salmon captured per seine haul and peak number of sport fishing boats per day in the Klamath River estuary in 1983	34

Figure

Page

15. Three-day moving averages of number of adult chinook salmon captured per seine haul and number of gill nets per night in the Klamath River estuary in 1983 34

16. Net harvest monitoring areas for the Klamath River portion of the Hoopa Valley Indian Reservation in 1983 38

17. Typical net placement pattern in the Klamath River estuary during the peak of the 1983 fall chinook salmon run. 39

18. Typical net placement pattern in the Middle Klamath Area during the peak of the 1983 fall chinook salmon run. 41

19. Typical net placement pattern in the Upper Klamath Area during the peak of the 1983 fall chinook salmon run. 42

20. Three-day moving average of the estimated number of fall chinook caught by Indian fishers in the Estuary, Middle Klamath and Upper Klamath Areas of the Hoopa Valley Reservation in 1983 44

21. Regression of the index of adult chinook harvest (catch/effort/run size) on the mean July, August and September flows in the Klamath River 48

22. Three-day moving average of the estimated number of fall chinook caught by Indian fishers in the Estuary Area of the Klamath River in 1980-1983. 49

23. Three-day moving average of the estimated number of fall chinook salmon caught by Indian fishers in the Middle Klamath "A" section of the Klamath River in 1980-1983 50

24. Three-day moving average of the estimated number of fall chinook salmon caught by Indian fishers in the combined region of the Middle Klamath "B" section and the Upper Klamath Area of the Klamath River in 1980-1983. 52

25. Length-weight relationship of chinook salmon caught by Indian gill netters on the lower Klamath River in 1983. 53

26. Length frequency distributions of adipose-clipped (AD-CLIP), left ventral clipped (LV-CLIP), right ventral clipped (RV-CLIP) and non-clipped (NON-CLIP) chinook salmon caught by Indian gill netters in the Klamath River portion of the Hoopa Valley Reservation in 1983 54

27. Number of LV- and RV-clipped fall chinook salmon observed in the Upper Klamath Area gill net fishery in 1983. 55

Figure | Page

28. Length frequency distributions of fall chinook salmon caught by Indian gill netters in the Estuary, Middle Klamath and Upper Klamath Areas of the Hoopa Valley Reservation in 1983 57

29. Length frequency distributions of fall chinook salmon caught in drift and set gill nets of the Upper Klamath Area fishery in 1983 58

30. Length frequency distributions of fall chinook salmon caught by Indian gill netters in the Klamath River from 1981-1983 60

31. Estimated monthly Indian gill net harvests of spring chinook salmon in the Klamath River monitoring areas of the Hoopa Valley Reservation in 1983. 62

32. Length frequency distributions of adipose-clipped and non-clipped spring chinook salmon caught by Indian gill netters on the Klamath River portion of the Hoopa Valley Reservation in 1983 63

33. Length frequency distributions of spring chinook salmon caught by Indian gill netters in the Klamath River portion of the Hoopa Valley Reservation from 1980-1983 64

34. Percentage age composition of fall chinook salmon returning to the Klamath River from 1979-1983. Dotted line represents the average return percentage of each age group 66

35. Brood year contribution by age of fall chinook salmon to the 1979-1983 Klamath River returns 69

36. Linear relationships between beach seine C/E indices and run size estimates of chinook returning as grilse in 1980-1983 74

37. Linear relationships between beach seine C/E indices and run size estimates of chinook returning as adults in 1980-1983 75

38. Cumulative daily adult chinook salmon catch/effort (C/E) values during peak three sets of run peak periods in 1980-1983 beach seining operations, relative to final season C/E values 77

39. Age composition of Trinity River and Iron Gate Hatchery groups harvested in the three monitoring areas of the Klamath River portion of the Hoopa Valley Reservation in 1983 (percentages corrected for unequal size of CWT release groups in their respective brood years) 85

40. Percentage contribution of Iron Gate Hatchery CWT groups (lined) and Trinity River Hatchery CWT groups (plain) to the estimated Upper Klamath fall chinook CWT net harvest in 1983 85

41. Relative contribution indices of CWT Klamath River fall chinook to 1983 ocean landings by California, Oregon and Washington ports. (Calculated from preliminary data provided by CDFG, ODFW and WDF.) . . . 94

Figure

Page

42. Estimated mean annual contributions of Klamath River chinook salmon (adult and grilse combined) to the ocean, in-river sport and Indian gill net fisheries compared with spawning escapement during 1979-1983 100

43. Length frequency distributions of fall chinook salmon measured at the Shasta River weir in 1982 and 1983 (3 cm groupings) 104

44. Growth between age 2 to 3 and 3 to 4 CWT fall chinook captured by Indian fishers on the Klamath River portion of the Hoopa Valley Reservation from 1980 to 1983 105

45. Linear relationship between the inverse of years in ocean and percent change in mean lengths of 2-, 3- and 4-year-old fall chinook returning in 1983 106

46. Length frequency distribution of coho salmon captured during beach seining operations in the Klamath River estuary during 1983 (3 cm groupings) 109

47. Length frequency distributions of coho salmon caught by Indian gill netters on the Klamath River portion of the Hoopa Valley Reservation from 1980-1983 111

48. Length frequency distributions of fall steelhead trout captured during beach seining operations in the Klamath River estuary from 1980-1983 (3 cm groupings) 117

49. Three-day moving average of the numbers of fall steelhead trout captured per beach sine haul in the Klamath River estuary from 1980-1983 118

50. Length frequency distributions of fall steelhead trout harvested in the Indian gill net fishery on the Klamath River portion of the Hoopa Valley Reservation from 1980-1983 120

51. Length frequency distributions of Klamath River adult green sturgeon captured by beach seine, gill net, and hook and line during 1980-1983 (5 cm groupings) 126

52. Combined length frequency distribution of Klamath River adult green sturgeon captured by beach seine, gill net, and hook and line during 1980-1983 (3 cm groupings) 127

53. Combined length frequency distribution of Klamath River adult male and female green sturgeon captured during 1980-1982 by beach seine, gill net, and hook and line (3 cm groupings) 128

54. Length frequency distributions of coastal migrant marine resident immature green sturgeon captured by beach seine and gill net in the Klamath River estuary during 1979-1983 (2 cm groupings) 129

LIST OF TABLES

Table		Page
1.	Categorization of hook scars observed during 1983 beach seining operations in the Klamath River estuary	15
2.	Percentage occurrence of hook scars observed on 916 Klamath River chinook salmon sampled through 1983 beach seining operations	15
3.	Categorical frequencies of hook scars within a total sample of 378 scars observed during 1983 beach seine activities	16
4.	Recovery data from 4,985 chinook salmon tagged by the U.S. Fish and Wildlife Service on the Klamath River during 1979-1983	23
5.	Migration data from 60 recoveries of tagged fall chinook salmon within the Klamath-Trinity basin during 1983	24
6.	Adult chinook salmon catch per seine haul by time of day and tidal stage during 1980, 1981, 1982 and 1983 beach seining operations in the Klamath River estuary (all sets included)	27
7.	Percent effort (from number of sets) by time of day and tidal stage during 1980, 1981, 1982 and 1983 beach seining operations in the Klamath River estuary	28
8.	Effort (number of sets) by time of day and tidal stage during 1980, 1981, 1982 and 1983 beach seining operations in the Klamath River estuary	29
9.	Summary of catch/effort data for chinook salmon captured in 1980, 1981, 1982 and 1983 beach seining operations in the Klamath River estuary	33
10.	Semi-monthly net harvest estimates of fall chinook salmon captured in the three Klamath monitoring areas of the Hoopa Valley Reservation in 1983	45
11.	Catch per net-night indices of fall chinook salmon harvested in the Estuary and Resighinni (1981-1983) areas of the Klamath River	47
12.	Numbers of fin-clipped fall chinook salmon observed in the 1983 Indian gill net fishery on the Klamath River portion of the Hoopa Valley Reservation	56
13.	Incidences of seal depredation on netted fall chinook salmon in the 1983 gill net fisheries of the lower Klamath River	61
14.	Monthly net harvest estimates of spring chinook salmon captured in the Klamath River monitoring areas of the Hoopa Valley Reservation	61

Table		Page
15.	Percentage age composition of Klamath River fall chinook as derived from scale analysis and length-frequency information during 1979-1983 return years	67
16.	Estimated number of fall chinook by age entering the Klamath River during the 1979-1983 return years	68
17.	Mean length of fall chinook returning at each age in 1979, 1981, 1982 and 1983 return years	70
18.	Post-season run size estimates for Klamath River fall chinook during 1980-1983	73
19.	Actual and expanded (underlined) CWT groups recovered during mark-sampling of fall chinook salmon in the 1983 gill net fishery in the Klamath River portion of the Hoopa Valley Reservation	81
20.	Contribution rates of age 3 and 4 adult fall chinook to the Indian net fishery on the Klamath River portion of the Hoopa Valley Reservation for fingerling and yearling juveniles released from Trinity River Hatchery	82
21.	Contribution rates of age 3 and 4 adult fall chinook to the Indian net fishery on the Klamath River portion of the Hoopa Valley Reservation for fingerling and yearling juveniles released from Iron Gate Hatchery	83
22.	Mean fork length, standard deviation and number of recoveries for 16 fall chinook CWT groups harvested in the Klamath River portion of the Hoopa Valley Reservation in 1983	86
23.	Mean fork length, standard deviation, and actual and expanded (underlined) CWT recoveries for eight spring chinook CWT groups harvested in the Klamath River portion of the Hoopa Valley Reservation in 1983	88
24.	Spring chinook contribution rates to the Indian net fishery on the Klamath River portion of the Hoopa Valley Reservation for age 3 and 4 adults of the four release types from the Trinity River Hatchery	89
25.	Estimated contributions of Iron Gate Hatchery fall chinook CWT groups to the 1981-1983 ocean and Indian gill net fisheries	91
26.	Estimated contributions of Trinity River Hatchery fall chinook CWT groups to the 1980-1983 ocean and Indian gill net fisheries	92
27.	Estimated contributions of age 3 and 4 adult fall chinook CWT groups to the 1980-1983 ocean and Klamath River gill net fisheries	93
28.	Estimated contributions of Trinity River Hatchery spring chinook CWT groups to the 1980-1983 ocean and Indian gill net fisheries	95

Table		Page
29.	Estimated numbers of Klamath River chinook salmon lost through ocean fisheries in 1979-1983	98
30.	Contribution estimates of Klamath River chinook salmon (adults and grilse) to the ocean, inland sport and Indian gill net fisheries in 1979-1983	99
31.	Mean lengths of 2-, 3- and 4-year-old fall chinook returning in 1979, 1981, 1982 and 1983, and the percent change in mean lengths of 1983 fall chinook from those of fall chinook returning in 1979-1982 by age group	106
32.	Semi-monthly net harvest estimates of coho salmon captured in the 1983 Indian gill net fishery on the Klamath River portion of the Hoopa Valley Reservation	110
33.	Actual and expanded (underlined) CWT groups recovered during mark-sampling of coho salmon in the 1983 gill net fishery on the Klamath River portion of the Hoopa Valley Reservation	112
34.	Tag code contribution rates and fork lengths of five coho salmon release groups harvested by the 1983 Indian gill net fishery on the Klamath River portion of the Hoopa Valley Reservation	113
35.	Numbers of steelhead captured during beach seining operations from 1979 to 1983 (catch per seine haul in parenthesis)	116
36.	Semi-monthly harvest estimates of fall steelhead captured in the 1983 Indian gill net fishery in the Klamath River portion of the Hoopa Valley Reservation	119
37.	Harvest estimates for green and white sturgeon on Hoopa Valley Reservation in 1983	124
38.	Harvest estimates for green and white sturgeon on the Hoopa Valley Reservation, 1981-1983	124

LIST OF PLATES

Plate		Page
1.	The mouth of the Klamath River during summer of 1983	3
2. and 3.	The crowding (above) and examination (below) of fish captured through 1983 beach seining operations in the Klamath River estuary	9
4.	Sport fishermen at the mouth of the Klamath River, summer 1983	35
5.	U.S. Fish and Wildlife Service personnel collecting biological data on net-harvested salmon during 1983 net harvest monitoring operations on the Klamath River	37
6.	An Indian fisher removing a salmon from an upriver eddy net in the Klamath River	46

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ANNUAL REPORT

KLAMATH RIVER FISHERIES INVESTIGATION PROGRAM

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FORWARD

The Klamath River watershed drains approximately 40,400 sq km in Oregon and California, including about 26,000 sq km in California, most included within the boundaries of the Six Rivers, Klamath, Shasta, and Trinity National Forests (Figure 1). The Hoopa Valley Indian Reservation (HVR), comprising approximately 583 sq km in Humboldt and Del Norte counties, borders the lower 68 km of the Klamath River and lower 26 km of the Trinity River, the largest tributary in the drainage. The most important anadromous salmonid spawning tributaries in the basin include the Trinity River, draining approximately 7,690 sq km, and the Shasta, Scott, and Salmon Rivers, each draining approximately 2,070 sq km. Iron Gate Dam on the Klamath River (km 306) and Lewiston Dam on the Trinity River (km 249) represent the upper limits of anadromous salmonid migration in the basin, and hatcheries located near the base of each dam (Iron Gate and Trinity River Hatcheries) were constructed in mitigation for natural fish production losses resulting from each project.

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

Concern about the depletion of anadromous salmonid resources and associated habitat in the basin emerged around the turn of the century, and has accelerated in recent decades coincident with expanded logging and fishing operations, dam building activity, road construction, and other development. As in other river systems of the Pacific Northwest, chinook salmon of the Klamath River basin have experienced the continued effects of habitat degradation and over-exploitation, as reflected by declining runs in recent decades. Since passage of the Fishery Conservation and Management Act of 1976 and the promulgation of the first set of Federal fishing regulations governing Indian fishing on the HVR in 1977, considerable attention has focused on the depressed chinook salmon runs and associated

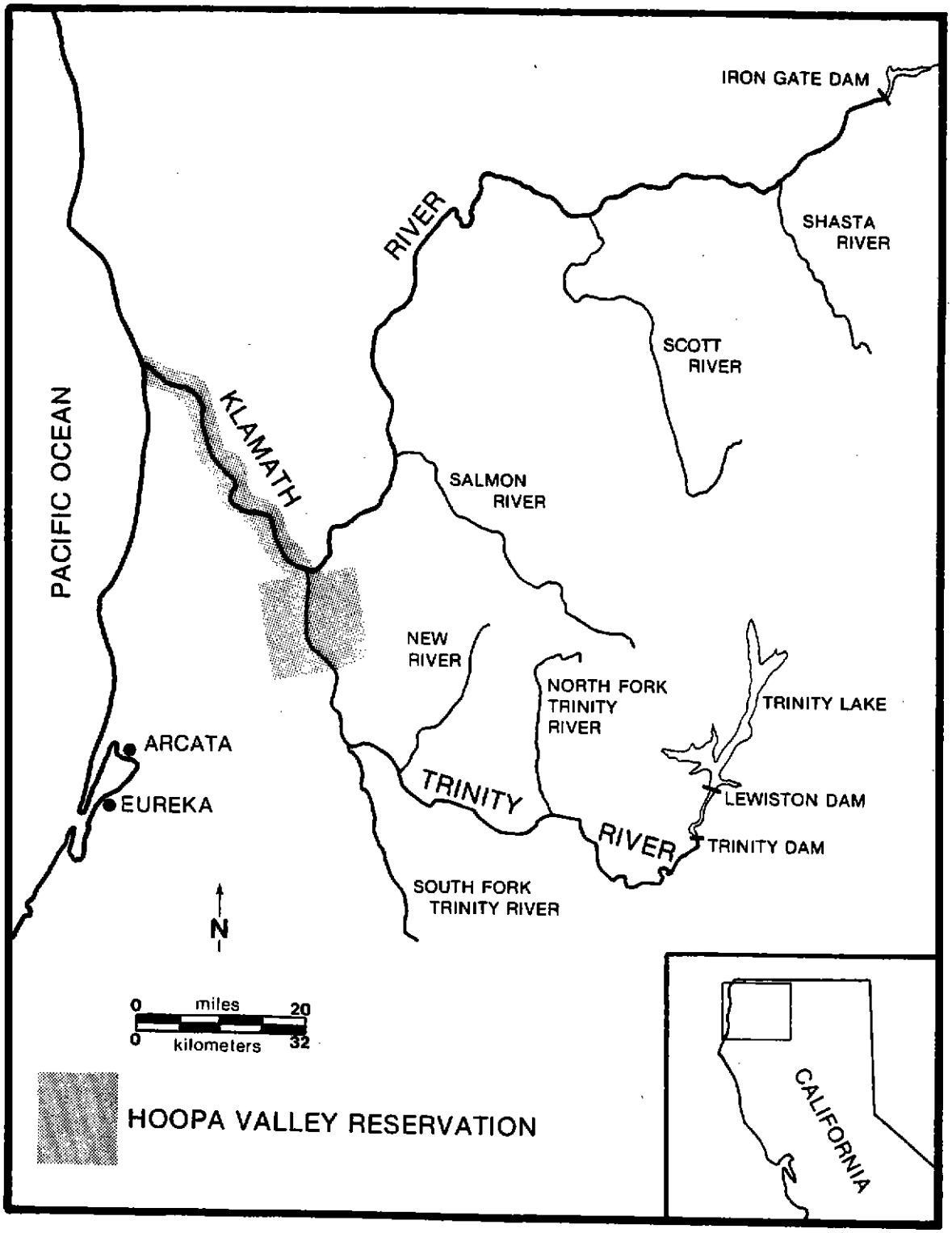


FIGURE 1. The Klamath River basin and Hoopa Valley Indian Reservation.

PLATE 1. The mouth of the Klamath River during summer of 1983.

fisheries, notably the ocean troll fisheries and the Indian gill net fishery on the Klamath and Trinity Rivers.

The U.S. Fish and Wildlife Service (USFWS) has ranked anadromous salmonid problems of the Klamath River basin number 18 of 78 "Important Resource Problems" (IRP's) in the United States (USFWS 1980). The Assistant Secretaries of Indian Affairs and Fish, Wildlife, and Parks, in addressing Departmental resource and Indian Trust responsibilities concerning the Klamath River basin resource and Hoopa Valley Reservation, have entered into annual fiscal memoranda of agreement (MOA) 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 fifth in a series of annual reports covering the Klamath River Fisheries Investigation Program, conducted through the Fisheries Assistance Office, Arcata, California (FAO-Arcata) under the Fiscal Year 1983 MOA.

The program consists of six major groupings of related activities:

(1) Beach Seining Operations focus on:

(a) development of a model for annual estimation of fall chinook run size on an in-season basis, and;

(b) the annual monitoring of fall chinook runs to evaluate natural/hatchery composition, to assess hook scarring and gill net marking incidences, to collect age-growth, length-frequency and length-weight data, and to provide data on run timing and migration patterns by external tag application.

(2) Harvest Monitoring and Evaluation Efforts focus on:

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

(b) development of a model for annual estimation of fall chinook run size on an in-season basis in conjunction with data collected through the beach seining operations, and;

(c) the annual monitoring of chinook and coho salmon, steelhead trout, and green sturgeon runs to evaluate natural/hatchery composition, to assess length-frequency, age-growth, and length-weight reltationships within the harvest and to collect run-timing and migration pattern data by recovery of tags placed during beach seining operations.

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

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

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

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

Methods utilized and results obtained during 1983 through these program activities are detailed in sections summarizing data collected on chinook salmon, coho salmon, steelhead trout, and sturgeon. Abstracts covering the primary points precede each of the major sections of this report. While previous annual reports through 1981 have included sections detailing information on juvenile salmonid investigations within the basin, no such data is available for 1983 since budget constraints precluded field activities involving juvenile salmon and steelhead. During 1983 the Hoopa Valley Business Council Fisheries Department assumed responsibility for harvest monitoring programs covering the Trinity River portion of the HVR, formerly a part of FAO-Arcata responsibilities. It should, therefore, be realized that harvest data presented in this report, unless otherwise noted, are not strictly comparable with harvest data presented in previous reports since the area of coverage has changed as described.

CHINOOK SALMON INVESTIGATIONS

ABSTRACT

A total of 999 chinook salmon, including 142 grilse, were captured during 1983 seining operations in the Klamath River estuary. Adipose fin-clipped chinook comprised 8.4% of the sample, and a respective 0.0 and 35.3% of the chinook exhibited gill net markings and hook scars. Tags were applied to 588 chinook for mark-recapture analysis. Scales were collected from 891 chinook for age analysis.

Gill net harvest on the Klamath River portion of the Hoopa Valley Reservation during 1983 is estimated at 6,633 fall and 515 spring chinook. The 1983 harvest represents a 54% reduction in the fall chinook fishery and a 79% decrease in the spring chinook fishery over respective 1982 levels. Catch per net-night indices in 1983 for the lower river fisheries are the lowest among the 4-year data base. River flow appears to have exerted a major influence on the success of the lower river fisheries.

Age analysis from scale samples and coded-wire tag recoveries indicates the dominance of 3-year-olds and the lack of 2-year-old fall chinook in the 1983 returns. The percentage of age 2 fish returning in 1983 is the lowest in the 5-year database.

Catch-effort data collected through beach seine operations during 1980-1983 are analyzed regarding the possibility of predicting run size on an in-season basis. Problems encountered in attempting to estimate in-season abundance during a year when timing of entry varies from normal are discussed.

A total of 133 coded-wire tags (CWT), representing 16 fall and 8 spring chinook release groups, were recovered in the 1983 net fisheries on the Klamath River portion of the Hoopa Valley Reservation. These recoveries expand to a total estimated harvest of 468 CWT fall and 256 CWT spring chinook in the 1983 Klamath River fisheries. In-river net and preliminary ocean CWT return data suggest an overall ratio of ocean to Klamath in-river net landings of CWT Klamath River basin fall chinook of 7.0:1 in 1983.

An estimated 4.2 Klamath River chinook were lost through ocean and river fisheries for each one spawning in the basin since 1979. The ratio between ocean fishing losses and river returns during the 1979-1983 period is esimated at 2.5:1.

The "El Nino" phenomenon, an atmospheric and oceanographic event which occurred off the Pacific coasts of North and South America in 1982-1983, and its effect on chinook abundance and growth, is discussed.

BEACH SEINING PROGRAM

INTRODUCTION

A beach seining program was initiated by FAO-Arcata biologists in 1979 with the intent of evaluating potential for developing in-season and post-season run size estimates utilizing catch/effort and mark-recapture techniques and to collect biological data on fall chinook salmon. Problems encountered during the 1980 season in satisfying the requirements of mark-recapture methodology resulted in a decision to discontinue the mark-recapture post-season population program and focus efforts on developing the catch/effort in-season and biological data portions of the program. The 1983 season marks the fifth consecutive year of beach seine sampling of fall chinook salmon near the mouth of the Klamath River.

METHODS

Beach seining operations were conducted on the south spit of the Klamath River estuary from July 15 to October 5, 1983 (Figure 2). An estuarine site was again chosen in an attempt to sample the fall chinook run prior to impacts of the various size-selective, in-river fisheries and to provide data comparability with the 1979-1982 seasons. Site selection within the estuary was based on previous experience which indicated that fall chinook tend to migrate through the deep channel of cool, highly saline water adjacent to the south spit, and on depth profile data collected in order to locate this channel during a July 1983 hydro-acoustic survey (Figure 2).

Methods utilized in 1983 were similar to those of previous years. Seining was conducted 5 days per week during daylight hours by a 5 to 12 person crew of biologists and technicians. A 150 m long by 6 m deep seine of 8.9 cm stretch mesh was set from a Valco river boat and retrieved utilizing gas powered winches.

Once crowded, fish were transferred into holding cages and then individually examined in a padded cradle for tags, fin-clips, hook scars, gill net marks and other distinguishing characteristics. Close examination of fish for hook scars and gill net markings is part of a continuing effort, initiated in 1979, to collect information on fisheries impacts on the Klamath River chinook salmon populations. Identified wounds, scars, and marks were classified as described in Table 1. Detailed observations were recorded in conjunction with length frequency information on specially prepared data forms. All salmonids were measured to the nearest centimeter fork length and each chinook salmon received a 9.5 mm (3/8 inch) or 6.4 mm (1/4 inch) hole punch placed in the upper caudal lobe for recapture identification. In addition, a numbered aluminum or monel-metal band was applied to the right mandible of every other adult chinook (>48 cm) during the first 6 weeks of the season and to every adult chinook during the balance of the sampling. Jaw tags were applied for evaluation of migration patterns. Grilse (<49 cm) were not tagged as their jaws were too small for the available band sizes. Scale samples were taken as in previous years for age analysis.

Large numbers of fish (>25) in two sets necessitated subsampling to minimize handling time and reduce stress to fish sampled. Fish not examined were identified as to species and size class (i.e., grilse, adult) prior to release, for inclusion in

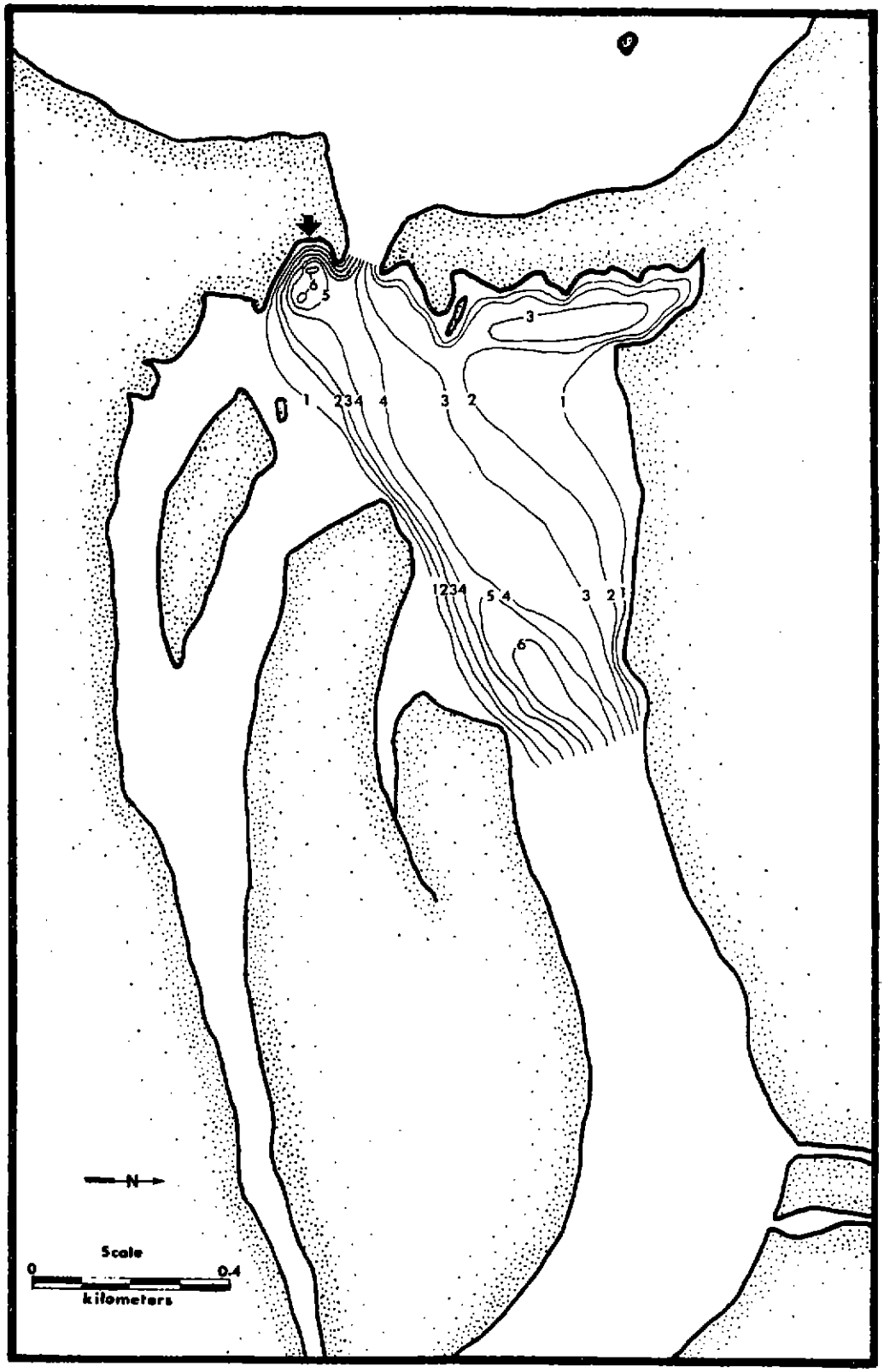
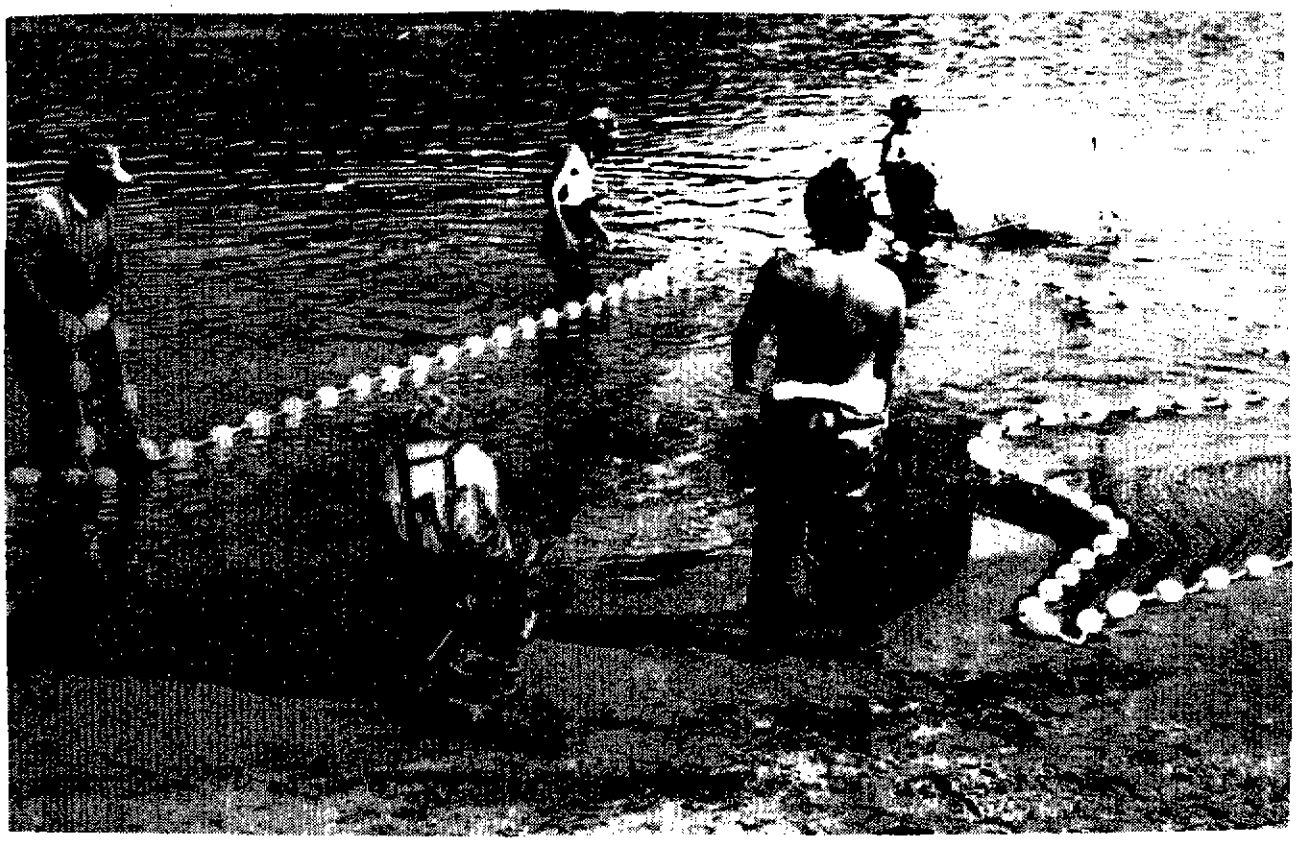
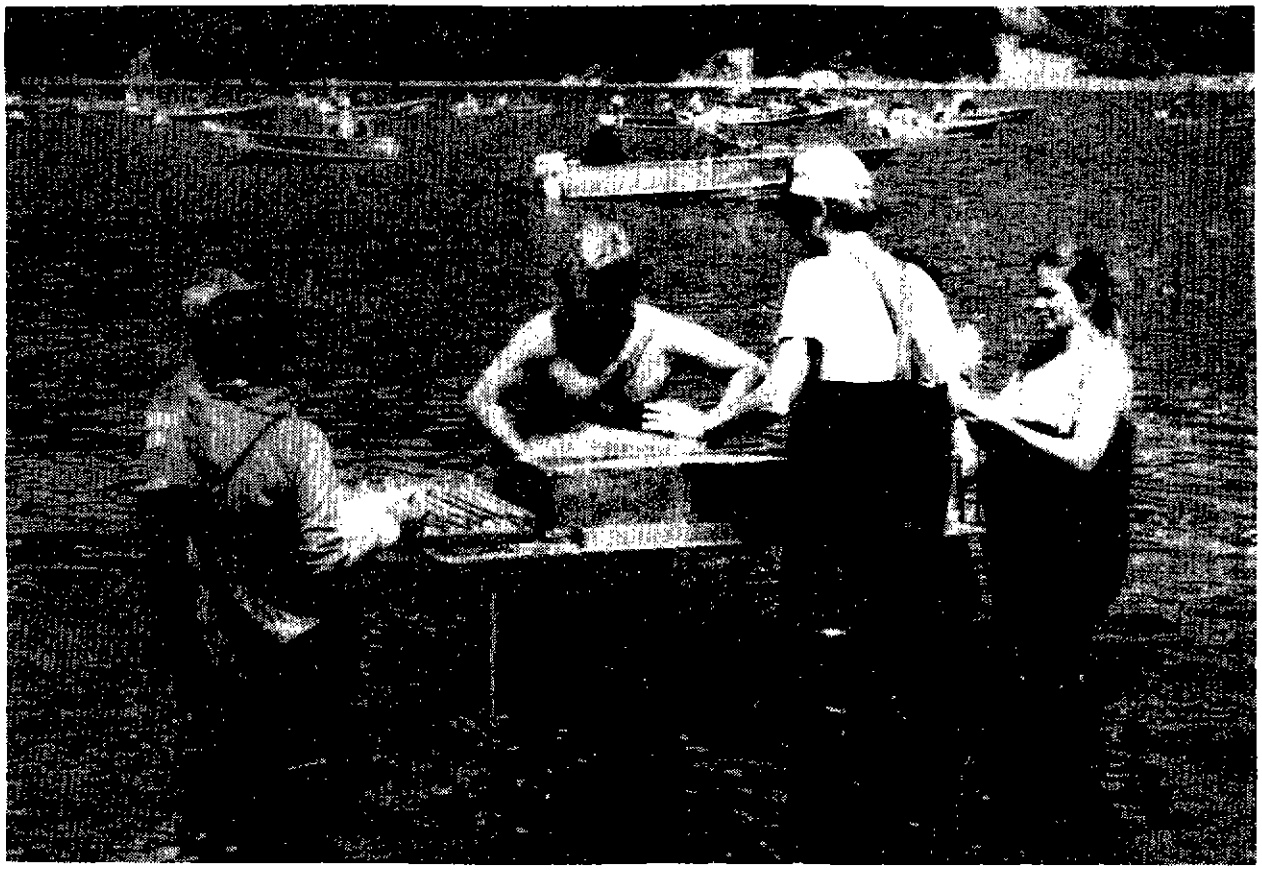


FIGURE 2. Depth contours (expressed in meters below mean high tide) of the Klamath River estuary during July 1983. Arrow depicts beach seining site.





PLATES 2. and 3. The crowding (above) and examination (below) of fish captured through 1983 beach seining operations in the Klamath River estuary.

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

RESULTS AND DISCUSSION

A total of 999 chinook salmon were captured in 304 seine hauls during 1983 operations, of which 916 (91.7%) were examined. Grilse (<49 cm) accounted for 14.2% of all chinook captured. One subsampled set (50 of 99 chinook) was discarded from length-frequency analysis due to significantly disproportionate grilse-adult ratio of chinook sampled versus chinook captured (chi-square analysis, $p < 0.05$). Data from an additional subsampled set was included as no bias was apparent. All fish from the remaining 302 sets were examined. A shift in the length-frequency distribution of adults from 1982 to 1983 appears to be the result of two main factors (Figure 3). First, mean lengths of grilse and adults in 1983, 41.1 cm and 64.9 cm respectively, were significantly less than those in 1982, 48.5 cm and 77.3 cm (t-test; $p < 0.05$). Poor ocean growth conditions resulting from a strong 1982-1983 El Nino phenomenon almost certainly had an impact on mean lengths of all age groups returning in 1983. Secondly, 3-year-old fish dominated the 1983 run (54.3%), while 4-year-olds comprised the greatest proportion of the 1982 run (36.1%). For a more detailed analysis of age class length frequencies, refer to the Age Composition section.

Adipose fin-clips representing various hatchery coded-wire tag (CWT) release groups occurred on 6 of 125 grilse (4.8%) and 71 of 791 adults (9.0%) examined. Mean length of adipose fin-clipped adults, 64.7 cm, did not differ significantly from non-adiposed clipped adults, 64.9 cm (t-test; $p > 0.05$). Mean lengths of adipose clipped grilse, 42.2 cm, did not differ significantly from non-adipose clipped grilse, 41.1 cm ($p > 0.05$, Figure 4.). Of other fin-clips observed, 4 (3.2%) grilse and 33 (4.2%) adults exhibited right ventral (RV) clips, while no grilse and 41 (5.2%) adults exhibited left ventral (LV) clips.

RV and LV fin-clipped chinook represent a constant fractional marking program which was intiated in 1979 to assist in estimation of the proportional contribution of hatchery fish to production within the basin, and ultimately to assist in escapement estimation. Complete marking, however, did not occur until 1980. Therefore, only data from 1980 brood and subsequent releases is useable for generating estimates. As a result, 2- and 3-, but not 4-year-old chinook returns during the 1983 spawning run provide complete data. Fully comparable data on 2-, 3- and 4-year-old age components will not be available for use in the fractional marking program until the 1984 spawning run. For this reason, only data from 2- and 3-year-old ventral clipped chinook in 1983 will be discussed. Although attempts were made to estimate the proportional contribution of hatchery fish to the 1983 2- and 3-year-old run components, sample size was insufficient to lend significant results (Hankin 1982). Potential bias due to size overlap between 3- and 4-year-old chinook would render such an estimate of questionable validity. Straying of hatchery fish, which violates an important assumption of the fractional marking estimation model, may also render this estimate invalid.

The constant fractional marking program also allows differentiation of fish by hatchery origin, LV representing Iron Gate Hatchery (IGH) and RV representing Trinity River Hatchery (TRH). In 1983, as in 1982, an apparent behavior difference was noted between RV and LV fish with respect to timing of river entry. A greater percentage of sampled LV fish (70.7%) entered on or before September 14 while the

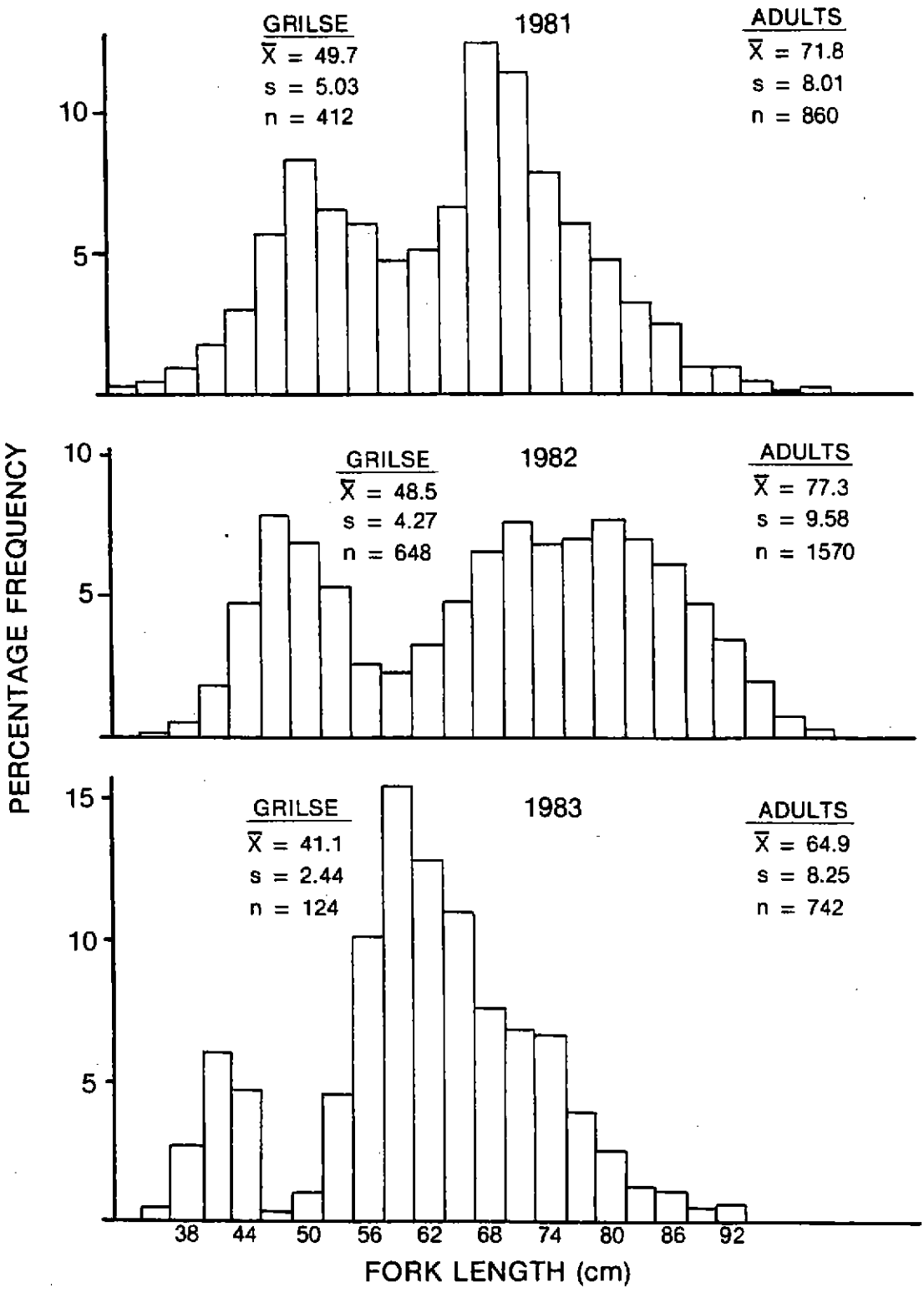


FIGURE 3. Length frequency distributions of chinook salmon captured during beach seining operations in the Klamath River estuary in 1981, 1982 and 1983 (3 cm groupings, with midpoints noted).

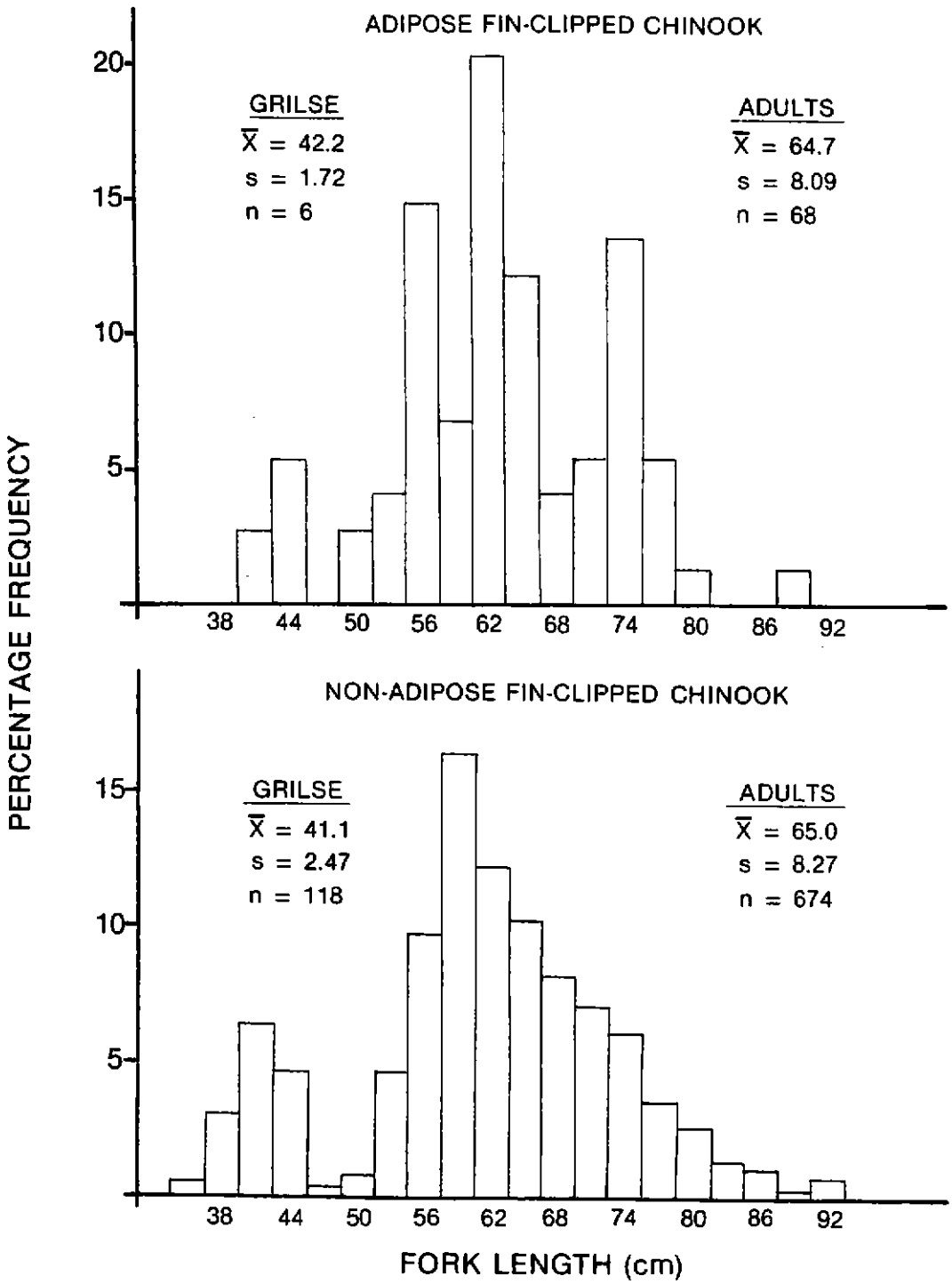


FIGURE 4. Length frequency distributions of adipose and non-adipose fin-clipped chinook salmon captured during 1983 beach seining operations (3 cm groupings, with medians noted).

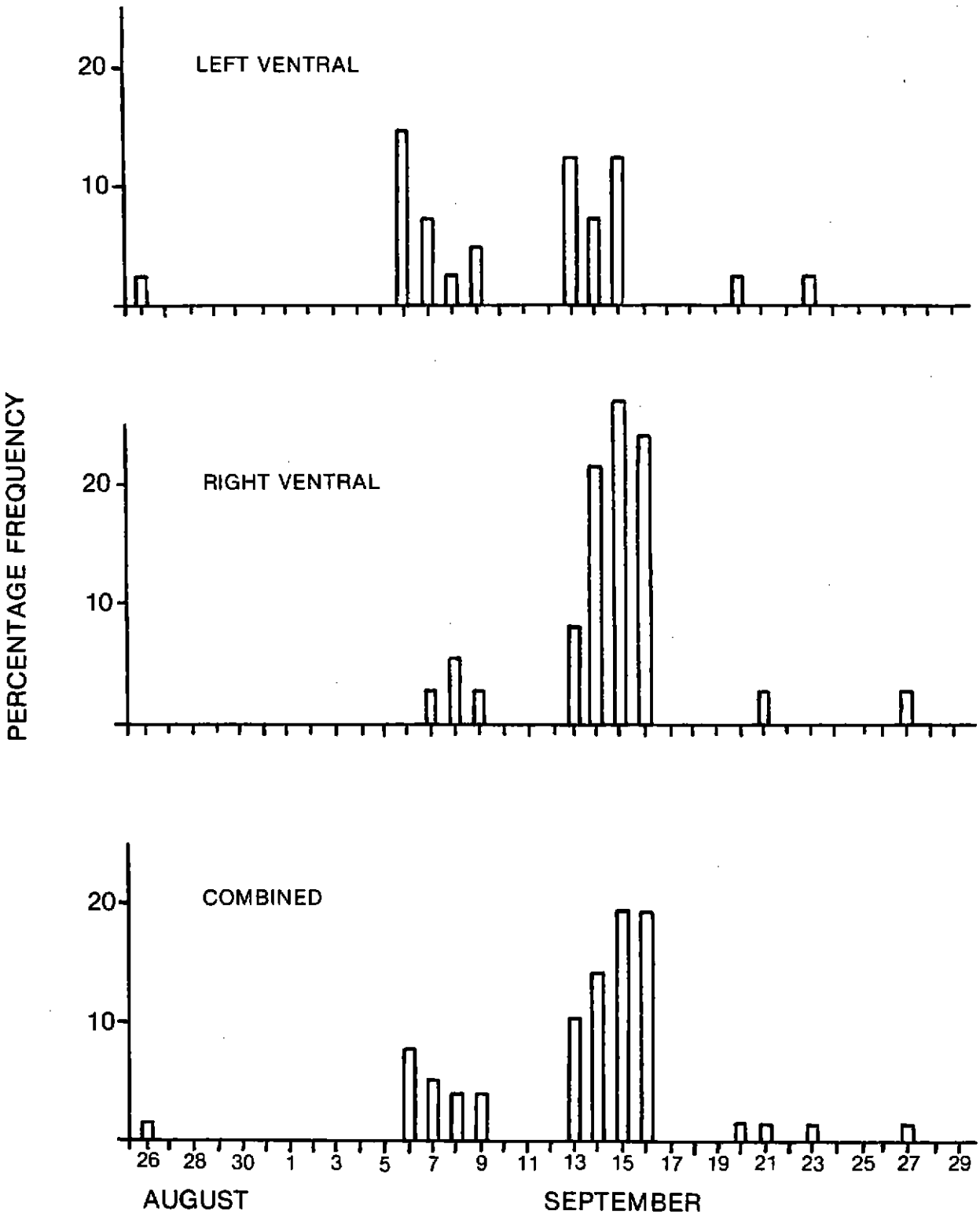


FIGURE 5. Percentage occurrence of LV and RV clipped chinook by day during 1983 beach seining operations.

majority of sampled RV fish (59.5%) entered after this date (Figure 5.). The statistical significance of this comparison is unknown as it is an a posteriori or unplanned comparison.

A significant run timing difference between grilse and adults, as observed in 1982, was not noted in 1983. Grilse apparently entered the run uniformly over the same period as adults. Prior to September 5, 149 adults were measured with a mean length of 69.4 cm while after September 5, 592 adults were measured with a mean length of 63.8 cm. These data may indicate a dominance of 4- and 5-year-olds earlier and 3-year-olds later in the run.

Hook Scarring and Gill Net Marking Investigations

Gill Net Markings

Markings directly attributed to previous contact with gill nets were not observed on any of 916 grilse and adult chinook salmon examined during 1983 beach seining activities in the Klamath River estuary. The observed marking frequency (0%) decreased 100% from the 0.44% observed in the 1982 beach seining program. The fact that gill net harvest of chinook in the estuary dropped 83% from 4,837 in 1982 to 812 in 1983 seems to indicate a relationship between rate of harvest in this area and the observed marking rate.

To provide a means of comparison, chinook were examined for gill net marks at IGH after beach seining operations were completed in October. Gill net marks were observed on 1 of 391 adults (0.26%) and on none of the 33 grilse examined. No sampling for gill net marks was carried out at TRH or the Shasta River weir during 1983.

Reservations concerning the collection and potential use of gill net marking data on Klamath River chinook were stated in a previous Annual Report (USFWS 1982a). Actual frequencies observed in recent years have varied sharply between sampling sites, agencies and personnel involved. Meaningful gill net marking data can probably be collected under carefully controlled conditions; however, the utility of such information beyond provision of a very general index of net harvest rate in the basin may be questioned. The potential application of such data in addressing noncatch mortality in the net fisheries due to gill net dropout and fallout is being pursued.

Hook Scars

Scars or wounds directly attributable to hooks were observed on 24 of 125 grilse (19.2%) and 299 of 791 adult (37.8%) chinook salmon examined during 1983 beach seining activities in the Klamath River estuary for an overall frequency of 35.0% (Tables 1 and 2). Healed hook scars were more common than fresh (22.9% versus 14.6%) and moderate-major scars were more common than minor (22.4% versus 14.9%). Two or more scars attributed to separate hooking incidents were observed on 5.6% of all chinook examined. Hooks were found imbedded in 7 of 916 (0.8%) chinook examined. Two of 916 chinook (0.2%) had been blinded in one eye from a hooking incident.

Within the 1983 total sample of 378 scars, 49.2% were found on the upper jaw and 22.2% were found on the lower jaw, which compares closely with frequencies observed in both the 1981 and 1982 samples. Within the 1982 sample of 1,510 scars,

TABLE 1. Categorization of hook scars observed during 1983 beach seining operations in the Klamath River estuary.

Chacteristic	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	

TABLE 2. Percentage occurrence of hook scars observed on 916 Klamath River chinook salmon sampled through 1983 beach seining operations.

Type of Scar	RUN COMPONENT		
	Grilse	Adults	All Chinook
Fresh Hook Scar	14.4	14.7	14.6
Healed Hook Scar	6.4	25.7	22.9
Minor Hook Scar	7.2	16.1	14.9
Moderate-Major Hook Scars	13.6	23.6	22.4
Single Hook Scar[1/]	19.2	37.8	35.3
Two Hook Scars[2/]	4.0	5.8	5.6
Three Hook Scars	0.5	0.5	0.4
Hook Imbedded	0.8	0.8	0.8
Blind In One Eye	0.0	0.3	0.2

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 3. Categorical frequencies of hook scars within a total sample of 378 scars observed during 1983 beach seine activities.

Location	Healing Stage	SEVERITY			
		Minor	Moderate	Major	Total
Upper Jaw	Fresh	10.8	4.2	4.7	19.7
	Healed	10.3	11.4	7.7	29.4
	Total	21.1	15.6	12.4	49.1
Lower Jaw	Fresh	3.4	3.2	2.6	9.2
	Healed	5.8	4.8	2.4	13.0
	Total	9.2	8.0	5.0	22.2
Eye and Proximity	Fresh	0.3	0.5	0.5	1.3
	Healed	0.0	1.1	1.1	2.2
	Total	0.3	1.6	1.6	3.5
Opercle	Fresh	0.3	1.6	0.5	2.4
	Healed	1.3	1.9	0.5	3.7
	Total	1.6	3.5	1.0	6.1
Isthmus and Proximity	Fresh	1.9	2.1	2.1	6.1
	Healed	3.4	4.8	0.8	9.0
	Total	5.3	6.9	2.9	15.1
Other Head Areas	Fresh	1.3	0.0	0.5	1.8
	Healed	0.3	1.1	0.8	2.2
	Total	1.6	1.1	1.3	4.0
All Head Areas Combined	Fresh	18.0	11.6	11.1	40.7
	Healed	21.2	24.9	13.2	59.3
	Total	39.2	36.5	24.3	100.0

48.8% occurred on the upper jaw and 24.2% occurred on the lower jaw, while the 1981 sample of 583 scars consisted of 49.6% and 24.2% on upper and lower jaw structures, respectively. Table 3 represents recorded occurrence frequencies for respective categories within the total 1983 sample of 378 scars. These frequencies do not directly convert to occurrence frequencies of scarring within the total sample of 916 chinook as 51 multiple hook scarred fish are represented by 106 individual scars. The incidence of hook scarred fish in the 1983 beach seine sample period decreased at a rate of 0.014% per week, the slope of the regression being significant (F-test; $p < 0.05$, Figure 6).

The observed decrease in hook scarring rate within the 1983 season contrasts with trends observed in previous seasons (1981-1982) (Figure 6). It has been noted that ocean scarring is responsible for the great majority of observed scars (USFWS 1983). Commercial chinook salmon landings in northern California ports apparently decreased earlier during the 1983 season than in 1979-1982 (Figure 7). This drop in effort is reflected by lower landings in July and August as compared to May and June, even though these latter months each contained a 2-week closure period in 1983. Small fish, low catches, and a depressed market all contributed to the apparent drop in effort. This decrease in effort may have had a significant impact on the hook scarring pattern observed this season. As the season progressed fewer fish were contacted in the troll fishery and the hook scarring rate observed in the beach seine decreased.

No significant difference was found in mean lengths between hook scarred and non-scarred chinook captured during 1983 beach seining activities (t-test; $p > 0.05$, Figure 8). This departure from the 1980-1982 trend, where significant length differences in both adult and grilse chinook were thought to be a reflection of growth interruptions caused by hooking incidents, may be partially a result of the smaller 1983 sample size. The barbless hooks used in the 1983 troll fishery may also have had less impact than the barbed hooks used in previous seasons. The adverse effects of ocean conditions may have overshadowed differences in length due to hook-scarring induced growth interruptions.

For the first time since beach seining operations began in 1979, seasonal hook scarring incidences for adult and grilse chinook dropped substantially in 1983. Just as the steady rise from 1979-1982 has been largely attributed to harvest patterns in the commercial fisheries (USFWS 1983), the decreases in grilse and adult hook scarring incidences in 1983 may be a reflection of the decrease in effort and harvest by the commercial troll fleet this year as compared with past years (Figure 9). The sharp drop in hook scarred grilse further substantiates the lesser impact of the troll fishery in 1983, as these fish have only been available to the fishery in the present season, while the percentage of hook scarred adults, which decreased less markedly than the grilse, consists of fish scarred in the past two seasons as well as in 1983.

Mark-Recapture Analysis

Totals of 1,016, 2,363, 1,018 and 588 fall chinook salmon were tagged and released during beach seining operations in the Klamath River estuary in 1979, 1980, 1982 and 1983 respectively. Recovery areas in the Klamath-Trinity basin for chinook tagged in 1979-1983 are shown in Figure 10. A total of 738 tags were recovered during the four seasons, for an overall recovery rate of 0.148 (Table 4). The recovery rate in 1983, 0.117, was slightly lower than rates observed in 1979, 1980, and 1982 (0.155, 0.141, and 0.175 respectively). The lower recovery rate may

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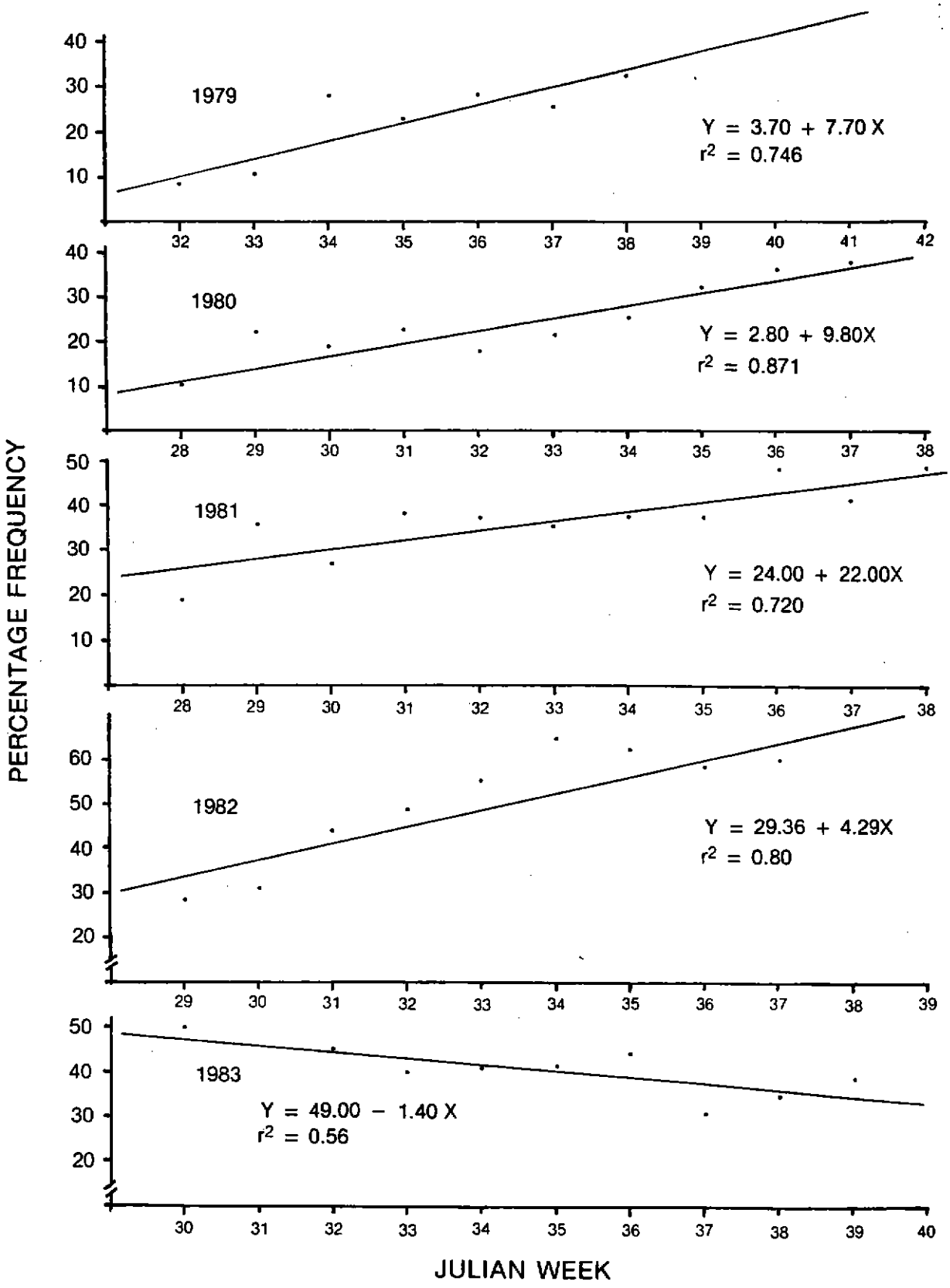


FIGURE 6. Least squares linear regressions of hook scarring frequencies by Julian week for chinook salmon captured during 1979-1983 beach seine operations.

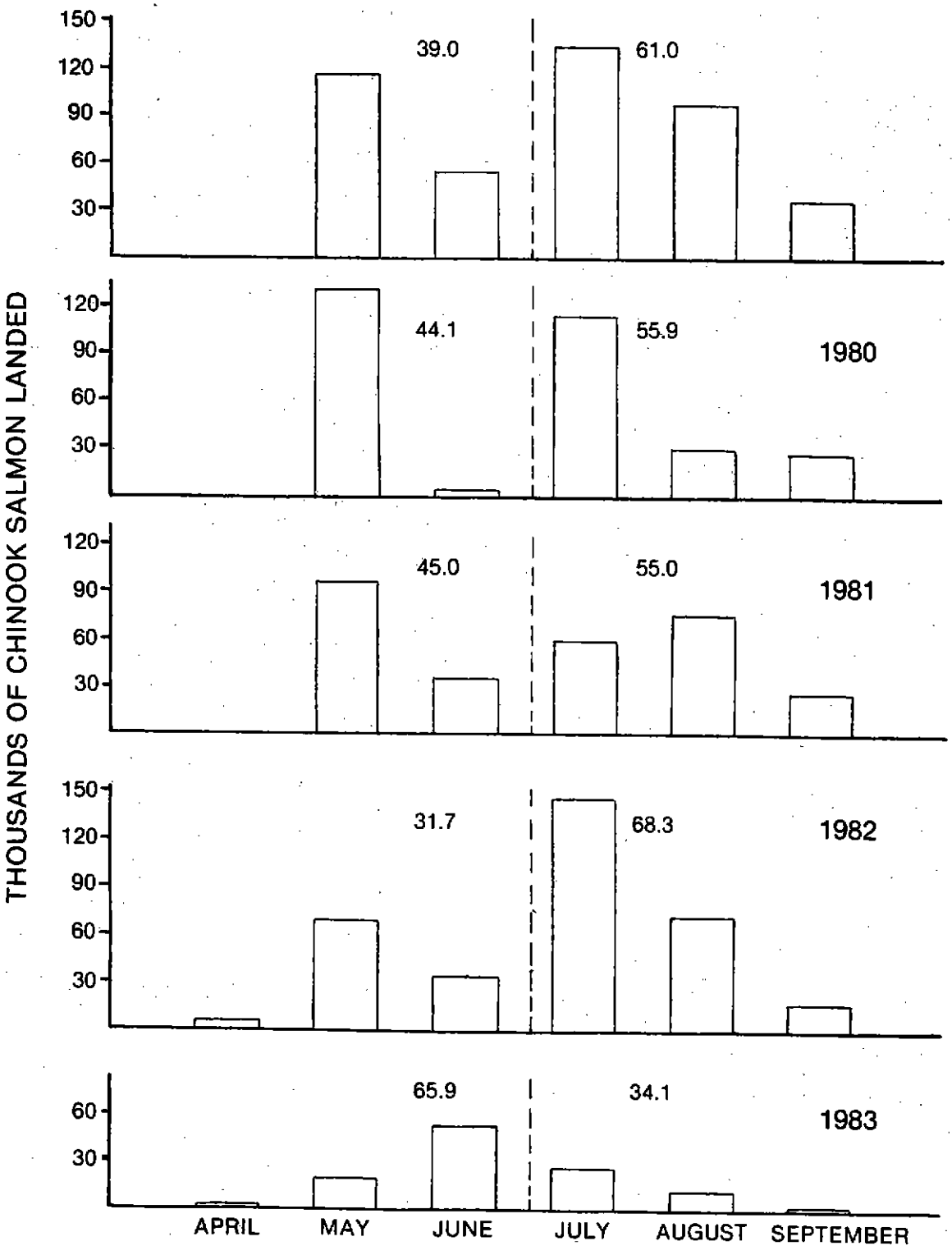


FIGURE 7. Ocean commercial troll salmon landings at northern California ports (Crescent City, Eureka, Fort Bragg), 1979-1983. Numbers at the top of each figure represent the percentage of that season's catch occurring before and after June 30.

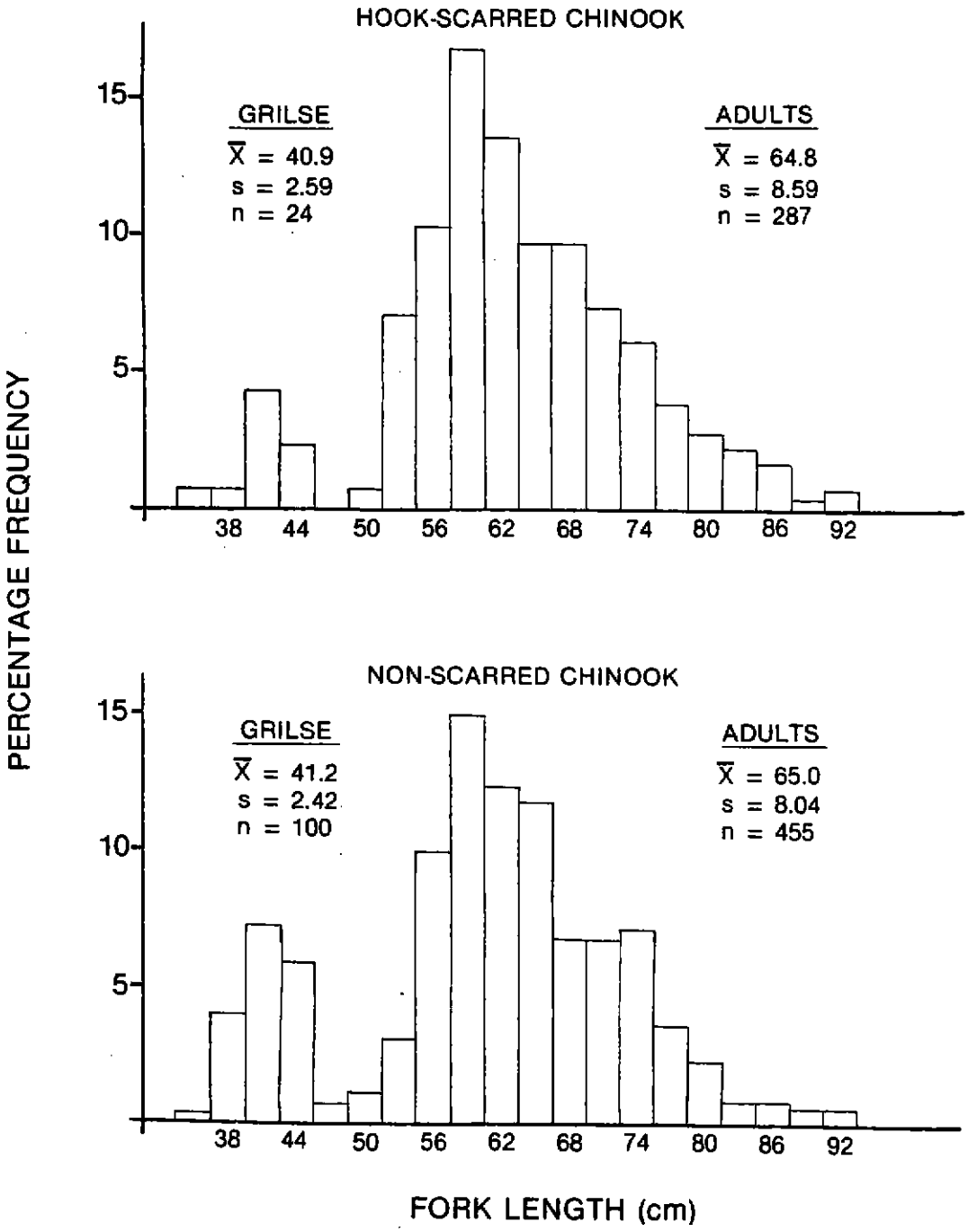


FIGURE 8. Length frequency distributions of hook-scarred and non-hook-scarred chinook in the 1983 beach seine sample.

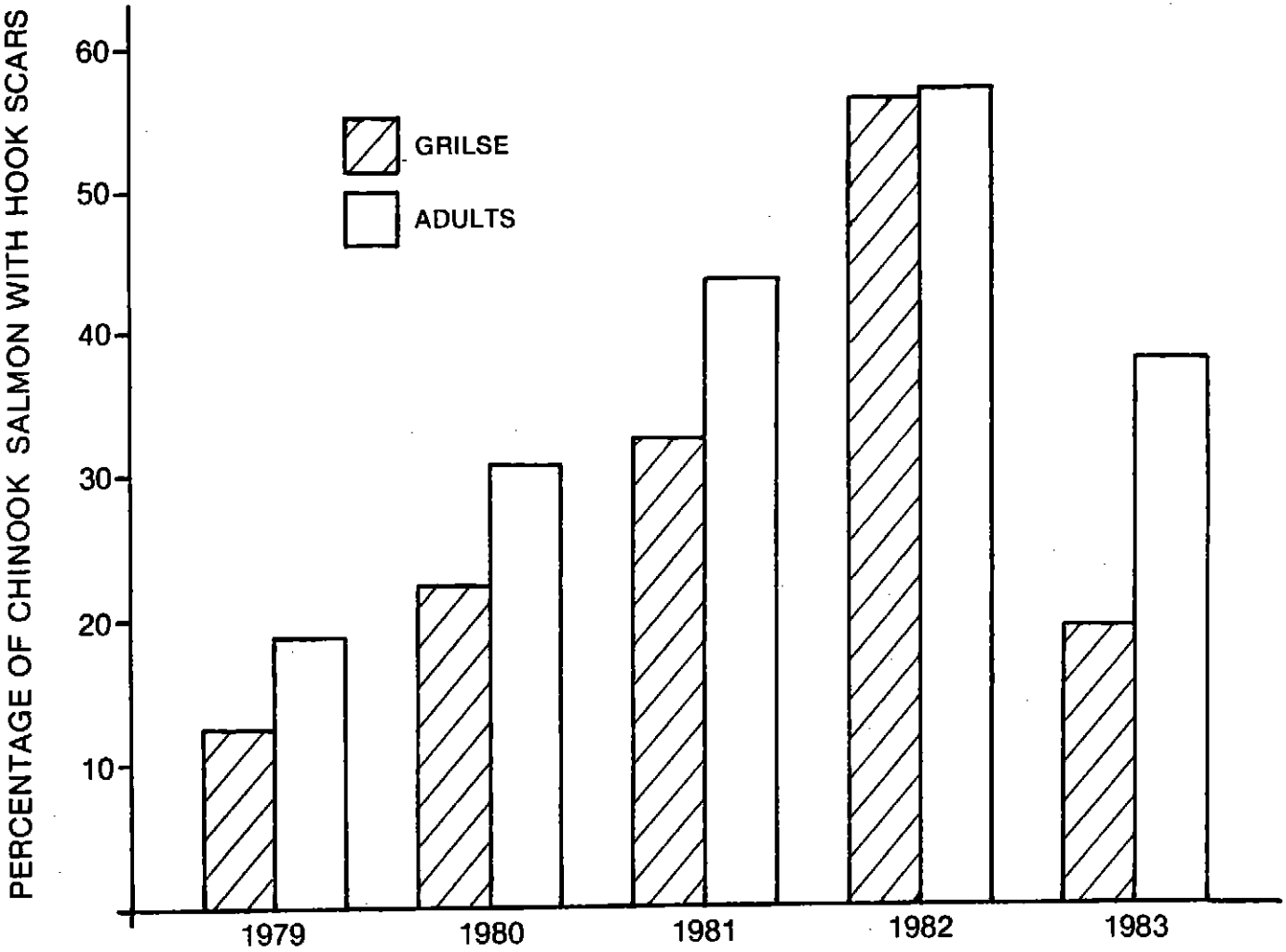
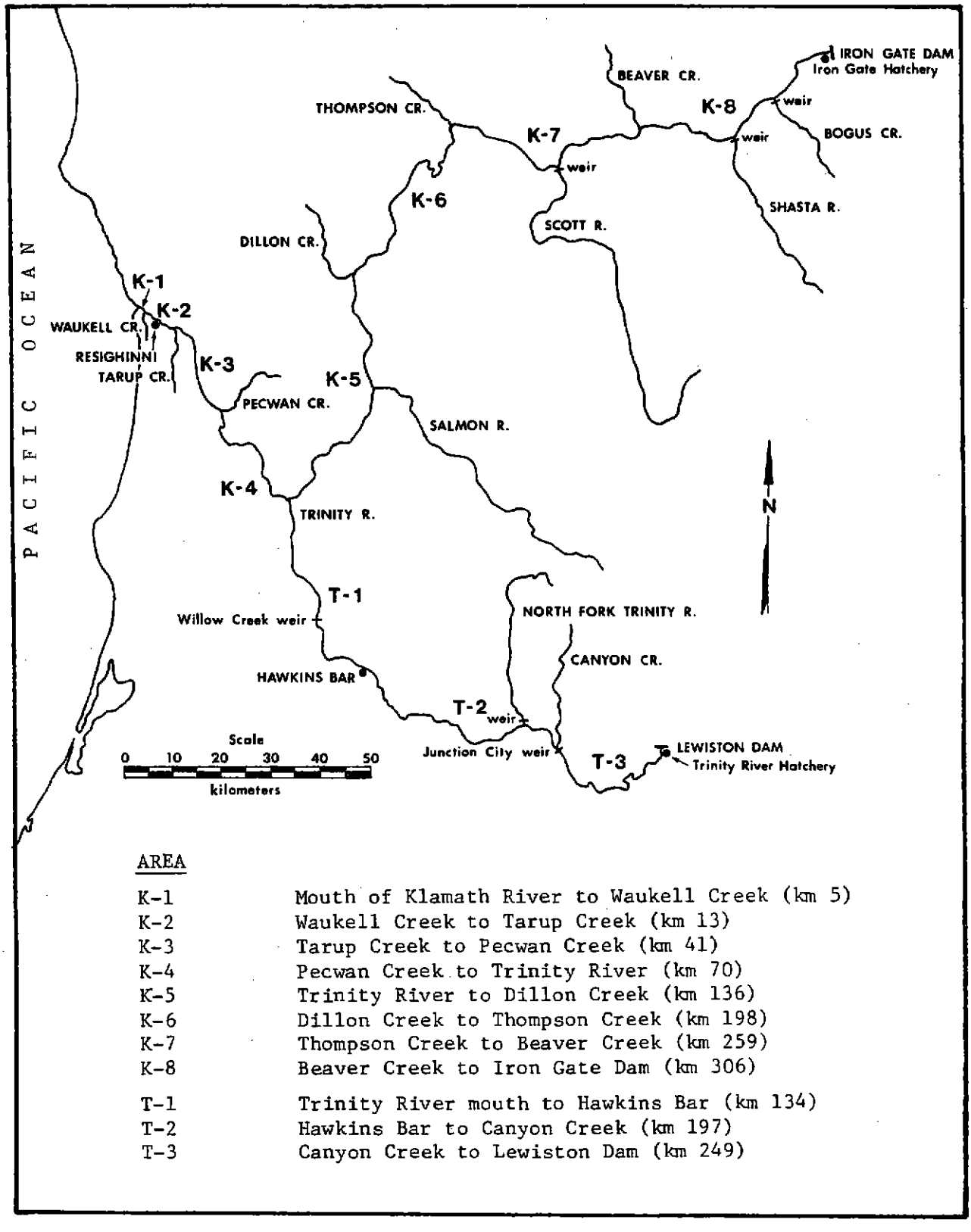


FIGURE 9. Grilse and adult chinook salmon hook scarring rates observed during 1979, 1980, 1981, 1982 and 1983 beach seining operations in the Klamath River.



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

FIGURE 10. Overview map of the Klamath-Trinity basin delineating recovery areas for chinook tagged during 1979-1983 mark-recapture studies.

TABLE 4. Recovery data from 4,985 chinook salmon tagged by the U.S. Fish and Wildlife Service on the Klamath River during 1979-1983.

Source	NUMBER RECOVERED				Total
	1979	1980	1982	1983	
Gill Net Fishery	14	111	46	14	185
USFWS Beach Seine	22	67	14	7	110
Shasta River Weir	50	21	19	0	90
Sport Fishery	14	43	13	11	81
Trinity River Hatchery	18	32	16	14	80
Iron Gate Hatchery	23	14	20	12	69
CDFG Spawning Ground Surveys	7	25	1	0	33
Bogus Creek Weir	-	-	22	1	23
Willow Creek Weir	5	6	8	4	23
CDFG Beach Seine	4	11	3	-	18
Scott River Weir	-	-	8	2	10
Junction City Weir	0	2	0	-	2
North Fork Trinity Weir	-	-	1	0	1
Other (Found Dead)	0	1	8	4	13
TOTALS	157	333	179	69	738

TABLE 5. Migration data from 60 recoveries of tagged fall chinook salmon within the Klamath-Trinity basin during 1983.

Area	Kilometers From River Mouth	Tag Recoveries	MIGRATION TIME (Days)		MIGRATION RATE (km/day)	
			Range	Mean	Range	Mean
K-1	0 - 5	9	1- 3[1/]	2.33[1/]	NA	NA
K-2	5 - 13	3	9-15	12	0.61-0.81	0.71
K-3	13 - 41	5	6-34	16.2	0.81-3.95	2.64
K-4	41 - 70	5	10-12	10.8	3.39-4.82	4.32
K-5	70 - 136	2	47-67	57.0	1.59-2.48	2.03
K-6	136 - 198	0	-	-	-	-
K-7	198 - 259	2[2/]	40	40	5.8	5.8
K-8	259 - 306	4	33-34	33.5	5.50-5.60	5.55
IGH	306	12	32-48	38.3	6.40-9.6	8.13
T-1	70 - 134	6	17-34	21.4	2.8 -6.3	5.14
T-2	134 - 197	5	25-35	28.80	4.14-5.80	5.11
T-3	197 - 249	2	26-37	31.50	5.98-7.65	6.81
TRH		14	35-62	47.00	4.0 -7.10	5.46

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

2/ Only one chinook had sufficient information for calculating migration data.

be the result of several factors. Sample size may have influenced recovery rate since fewer chinook were tagged in 1983 than in previous years. The poor condition of fish entering the river, which is documented elsewhere in this report, may have had an effect on in-river mortality rate and therefore on the number of chinook reaching up-river areas such as the Shasta River and Bogus Creek weirs. In addition, the lower 1983 gill net harvest had an obvious effect in lowering the observed recovery rate since this had been the primary means of recovery in previous seasons.

A general picture of upstream migration behavior of fall chinook within the Klamath River system during 1979-1982 was presented in the 1982 Annual Report (USFWS 1983). In 1983, 60 of 69 tags recovered were accompanied with sufficient information to be used in migration time and rate calculations. Table 5 illustrates general migration patterns of fall chinook in the basin in 1983. As in previous years (USFWS 1983) mean migration rate (km/day) appears to increase gradually with distance from the mouth. Migration rates were generally similar in 1983 to those of 1979-1982 with the apparent exception of increased rates to IGH (8.13km/day in 1983 vs an average of 6.1 km/day during 1979-1982).

Run Timing and Catch/Effort Analysis

Numbers of fall chinook captured per seine haul in 1983 were 0.47 for grilse and 2.82 for adults. Comparative grilse and adult catch/effort values were 3.04 and 8.24 in 1982, 1.90 and 3.92 in 1981 and 2.40 and 1.65 in 1980 respectively. For reasons discussed herein, direct comparison of these figures would not be valid in addressing differences in magnitude between 1980, 1981, 1982 and 1983 fall chinook runs. Comparisons of total adult chinook catch/effort data depicting general run magnitude and timing trends during 1980-1983 are given in Figure 11.

Treatments similar to those used in previous years (USFWS 1982a and 1983) were necessary in order to compare catch/effort data between years. Changes in physical and environmental conditions in the estuary, differences in run timing between age classes, gear selectivity, migration patterns of fish through the estuary, holding of fish in the estuary and inconsistent sampling effort all provide potential sources of bias in these data. Variations in physical and environmental conditions in the estuary appear to have exerted minimal influence on catch/effort values as the seining site location has again remained relatively uniform in relationship to the river mouth and the main channel within the estuary in 1983.

Recaptures were eliminated from the data to treat any tendency of chinook to linger in the lower estuary. Recapture rates, 1.2% in 1983 and averaging 1.6% from 1979 to 1983, indicate that this bias is minor.

Catch/effort statistics indicate that most movement of chinook into the estuary occurs over a 1- to 2-hour period between the latter stage of outgoing and the beginning of incoming tide (Table 6). No bias related treatment appears necessary in this case as beach seining efforts from 1980-1983 have remained somewhat proportional particularly with regard to tide (Table 7).

To compensate for bias in comparison of total season catch/effort between a high effort year and a low effort year (e.g. 1980 and 1983) seasonal catch/effort data were compared from the three highest consecutive daily seine hauls (peak three sets) only (Table 8). This treatment appears effective considering that 73%,

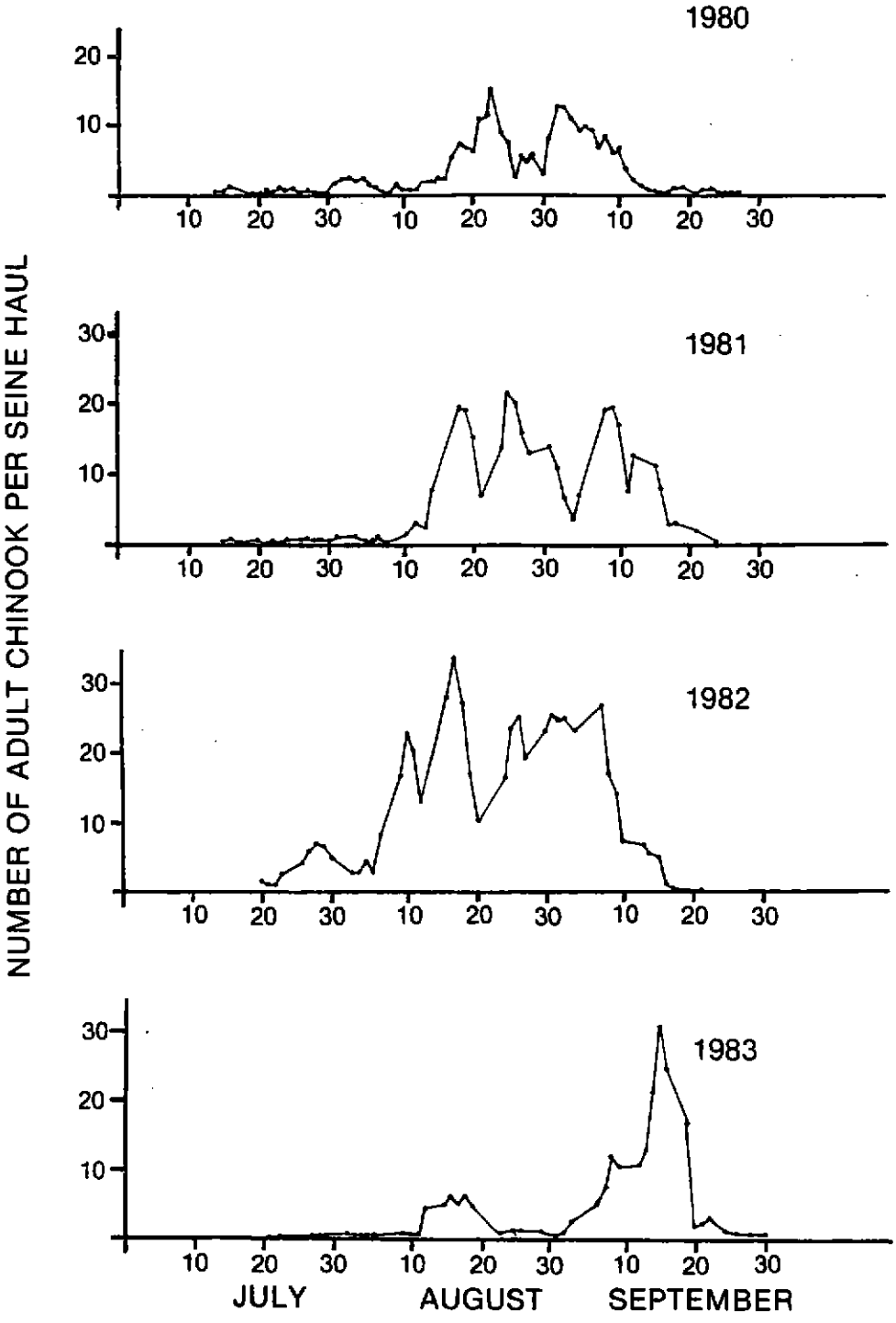


FIGURE 11. Three-day moving average of numbers of adult chinook salmon captured per beach seine haul (all sets) in the Klamath River estuary during 1980-1983.

TABLE 6. Adult chinook salmon catch per seine haul by time of day and tidal stage during 1980, 1981, 1982 and 1983 beach seining operations in the Klamath River estuary (all sets included).

Year	Tidal Stage	HOURS OF DAY 0800-1100	1100-1400	1400-1700	All Hours
1983	Outgoing	8.08	3.92	3.56	4.16
	Low Slack	0.00	7.44	0.33	5.67
	Incoming	1.50	1.23	2.60	1.67
	High Slack	0.00	0.50	0.67	0.50
	ALL TIDES	4.60	2.47	2.96	2.82
1982	Outgoing	24.87	6.27	14.46	11.70
	Low Slack	11.66	10.88	17.50	12.00
	Incoming	5.08	6.54	4.60	5.86
	High Slack	0.00	1.10	0.00	0.93
	ALL TIDES	12.29	6.24	10.44	8.24
1981	Outgoing	1.00	4.54	5.38	4.29
	Low Slack	0.50	1.90	11.00	3.91
	Incoming	0.55	5.26	3.41	3.85
	High Slack	0.00	2.94	7.40	3.35
	ALL TIDES	0.58	4.25	5.29	3.92
1980	Outgoing	0.67	0.75	1.27	0.90
	Low Slack	0.22	1.24	2.79	1.15
	Incoming	1.19	1.42	4.32	2.27
	High Slack	0.00	1.09	1.00	0.92
	ALL TIDES	0.81	1.21	3.01	1.65

TABLE 7. Percent effort (from number of sets) by time of day and tidal stage during 1980, 1981, 1982 and 1983 beach seining operations in the Klamath River estuary.

Year	Tidal Stage	HOURS OF DAY 0800-1100	1100-1400	1400-1700	All Hours
1983	Outgoing	4.0	19.4	17.8	41.1
	Low Slack	0.0	3.0	1.0	4.0
	Incoming	4.0	32.6	15.8	52.3
	High Slack	0.3	1.3	1.0	2.6
	ALL TIDES	8.2	56.3	35.5	100.0
1982	Outgoing	3.1	17.1	19.5	39.7
	Low Slack	1.2	3.5	0.8	5.5
	Incoming	4.7	30.7	13.6	49.0
	High Slack	0.4	5.0	0.4	5.8
	ALL TIDES	9.4	56.4	34.2	100.0
1981	Outgoing	3.3	12.8	6.9	23.0
	Low Slack	3.9	9.5	4.6	18.0
	Incoming	8.8	25.6	16.0	50.5
	High Slack	1.3	5.6	1.6	8.5
	ALL TIDES	17.3	53.5	29.2	100.0
1980	Outgoing	8.5	9.2	9.4	27.1
	Low Slack	5.6	3.3	3.0	12.0
	Incoming	13.9	21.9	16.5	52.4
	High Slack	1.1	5.0	2.3	8.5
	ALL TIDES	29.2	39.6	31.2	100.0

TABLE 8. Effort (number of sets) by time of day and tidal stage during 1980, 1981, 1982 and 1983 beach seining operations in the Klamath River estuary.

Year	Tidal Stage	HOURS OF DAY 0800-1100	1100-1400	1400-1700	All Hours
1983	Outgoing	12	59	54	125
	Low Slack	0	9	3	12
	Incoming	12	99	48	159
	High Slack	1	4	3	8
	ALL TIDES	25	171	108	304
1982	Outgoing	8	44	50	102
	Low Slack	3	9	2	14
	Incoming	12	79	35	126
	High Slack	1	13	1	15
	ALL TIDES	24	145	88	257
1981	Outgoing	10	39	21	70
	Low Slack	12	29	14	55
	Incoming	27	78	49	154
	High Slack	4	17	5	26
	ALL TIDES	53	163	89	305
1980	Outgoing	54	59	60	173
	Low Slack	36	21	19	76
	Incoming	89	140	105	334
	High Slack	7	32	15	54
	ALL TIDES	186	252	199	637

80%, 80% and 77% of the total chinook catches during 1980, 1981, 1982 and 1983 respectively were captured in the peak three daily sets.

Bias due to season-to-season variation in the proportion of total effort occurring outside of a defined seasonal run peak can be treated by comparing only catch/effort data collected during the peak of each annual run. Seasonal differences in duration of run peak periods may then be considered by comparing the number of days each peak lasted.

To assist in identifying the 1983 fall chinook run peak, daily chinook catch/effort values were plotted for all sets and peak three sets (Figure 12). Daily cumulative adult chinook catch/effort values were also plotted for all sets and daily peak three sets (Figure 13). The run peak in 1983 was defined as that period during which adult catch/effort values in the peak three sets consistently exceeded 3.0. Justification for choosing this value was that it eliminated as many points as possible that the peak run period and outlying periods had in common. In 1983 only 1 of the outlying values was above 3.0 and 12 of the peak period values were below 3.0. A summary of 1980-1983 run peak periods and associated catch/effort values resulting from various data treatments is included in Table 9. Use of beach seine catch and effort data in addressing fall chinook run size within the basin is explored in a subsequent section.

Sport Fishery - Klamath Estuary

A major sport fishery for chinook salmon occurs annually near the mouth of the Klamath River. This fishery consists of both shore and boat anglers. The California Department of Fish and Game (CDFG) has monitored this fishery in the past, but for various reasons was unable to do so in 1983. FAO-Arcata biologists have routinely counted the peak number of sport fishing boats near the mouth of the river on a daily basis throughout the duration of beach seining activities. These data have been collected in attempt to identify any impact this fishery may exert on catch/effort, hook scarring frequency and other information collected in the project. These data may be useful in providing some information on the size and possible impacts of this fishery in 1983. The boat count and beach seine catch/effort data are presented as 3-day moving averages to provide a comparison of the fluctuations in sport effort and chinook abundance in 1983 (Figure 14). Angler effort (number of boats) appears to parallel catch/effort in the beach seine throughout most of the study period. The data also give an indication of the range of sport fishing effort during the 1983 peak run period, 33 to 109 boats. During 1982 beach seining activities, a peak count of 287 sport boats was recorded.

Indian Gill Net Fishery - Klamath Estuary

Observed numbers of Indian gill nets set near the mouth of the Klamath River in 1983 were also compared with beach seine catch/effort data (Figure 15). The effort of Indian gill net fishers near the mouth of the river remained relatively constant throughout the early part of the season and dropped off markedly in September. The gill net fishery near the mouth did not shadow the run entering the river as did the sport fishery. The decrease in number of gill nets during the peak of the beach seine catch/effort may reflect a shift in effort away from the mouth to more upriver fishing sites, as net fishing success in the estuary during 1983 was low.

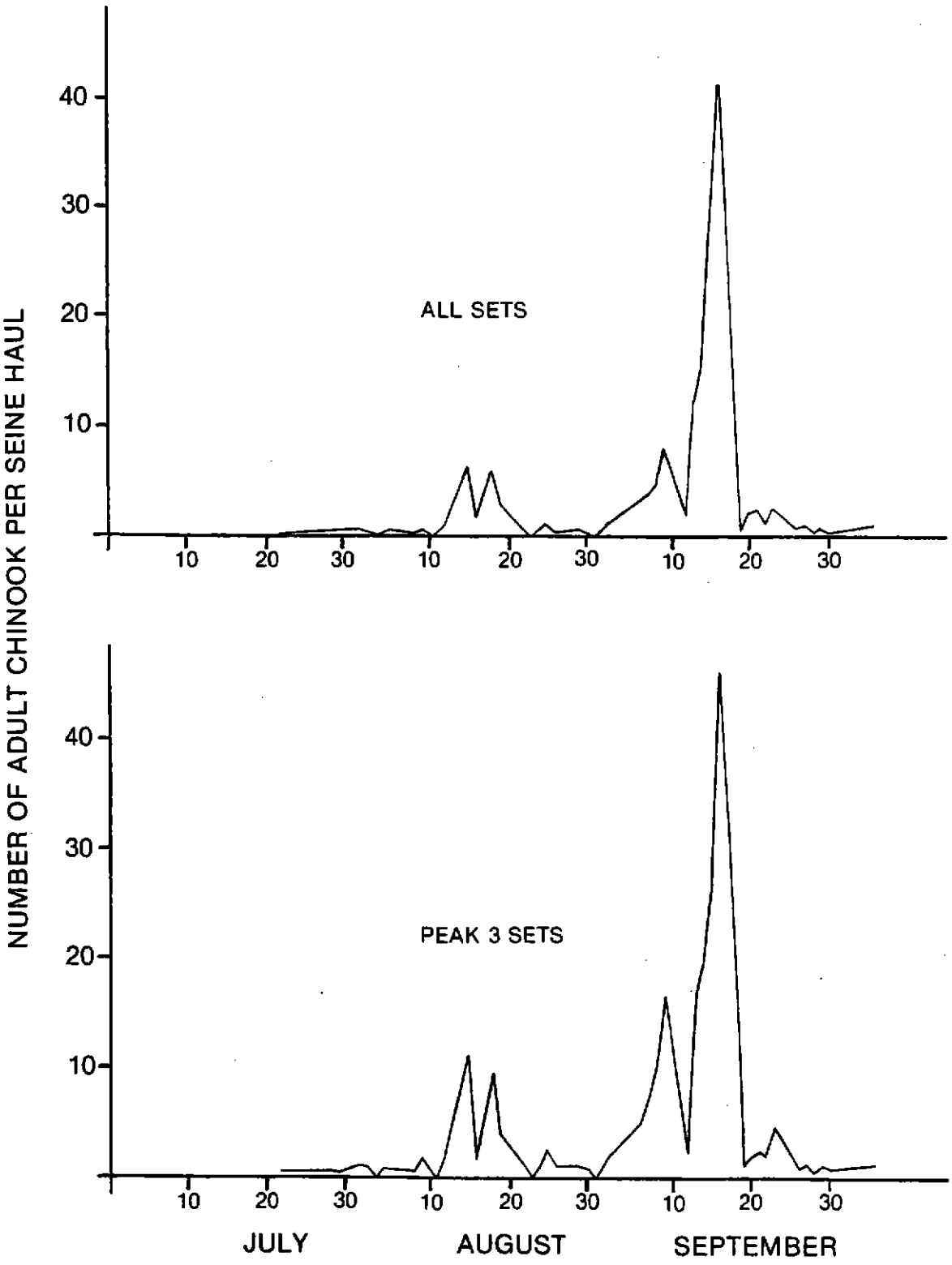


FIGURE 12. Daily numbers of adult chinook salmon captured per beach seine haul (all sets and peak 3 sets) in the Klamath River estuary in 1983.

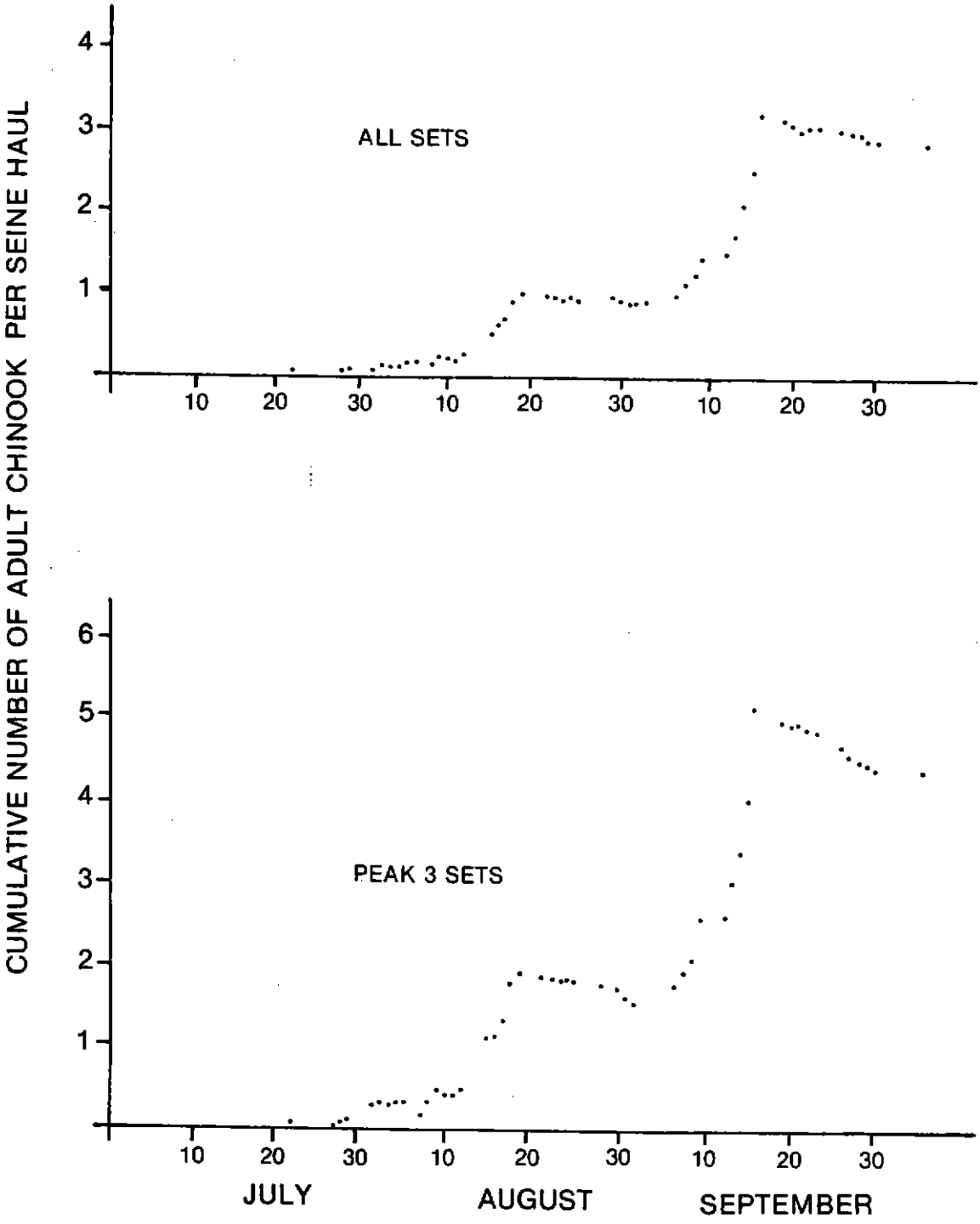


FIGURE 13. Cumulative daily adult chinook salmon catch/effort values (all sets and peak 3 sets) in 1983 beach seining operations in the Klamath River estuary.

TABLE 9. Summary of catch/effort data for chinook salmon captured in 1980, 1981, 1982 and 1983 beach seining operations in the Klamath River estuary.

Timing	Chinook Run Component	YEAR 1980	1981	1982	1983
Total Season		7/13-9/28	7/13-9/25	7/19-9/22	7/15-10/05
All Sets	Grilse	2.40	1.90	3.04	0.47
	Adults	1.65	3.92	8.24	2.82
	All Chinook	4.06	5.82	11.28	3.29
Peak Three Sets	Grilse	4.73	2.97	4.49	0.76
	Adults	3.41	6.55	12.19	4.46
	All Chinook	8.14	9.51	16.68	5.22
Run Peak Period		8/18-9/10	8/18-9/15	8/9-9/9	8/13-9/18
All Sets	Grilse	5.13	4.21	5.41	0.91
	Adults	4.11	9.18	14.42	5.48
	All Chinook	9.24	13.39	19.83	6.39
Peak Three Sets	Grilse	9.90	6.28	8.14	1.32
	Adults	8.57	14.38	21.80	8.95
	All Chinook	18.47	20.67	29.94	9.77

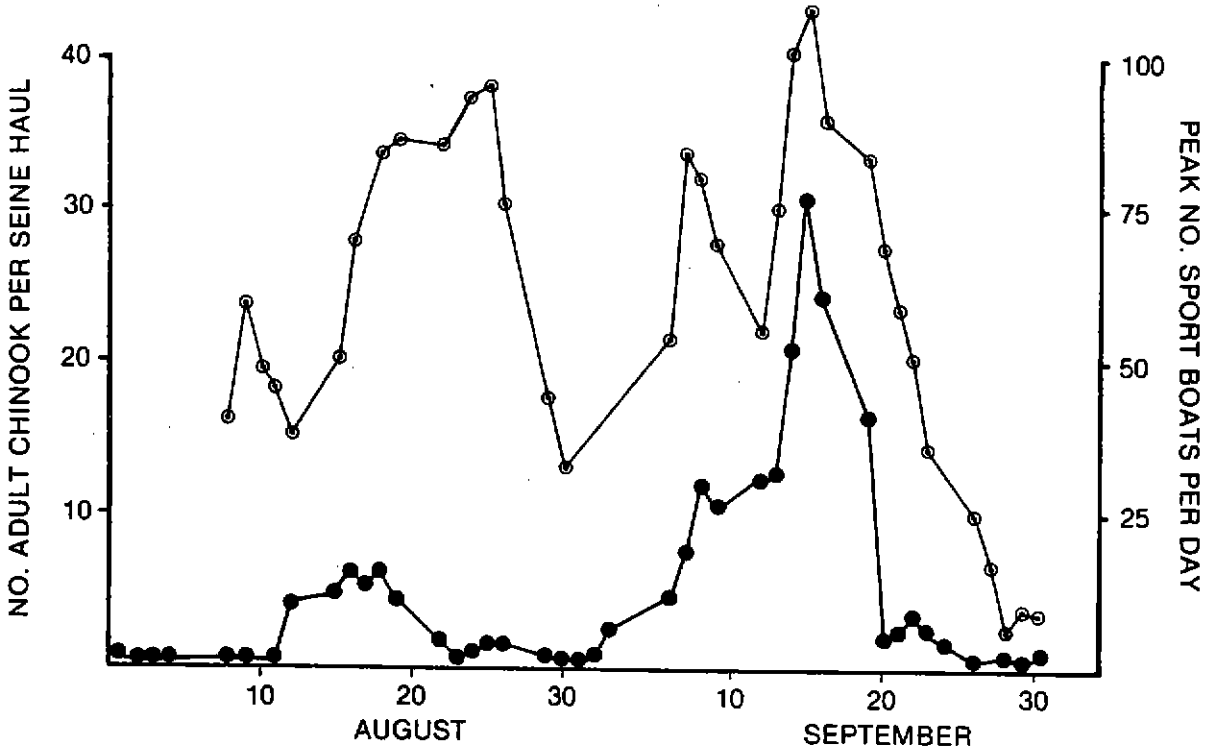


FIGURE 14. Three-day moving averages of number of adult chinook salmon captured per seine haul (●—●) and peak number of sport fishing boats per day (o—o) in the Klamath River estuary in 1983.

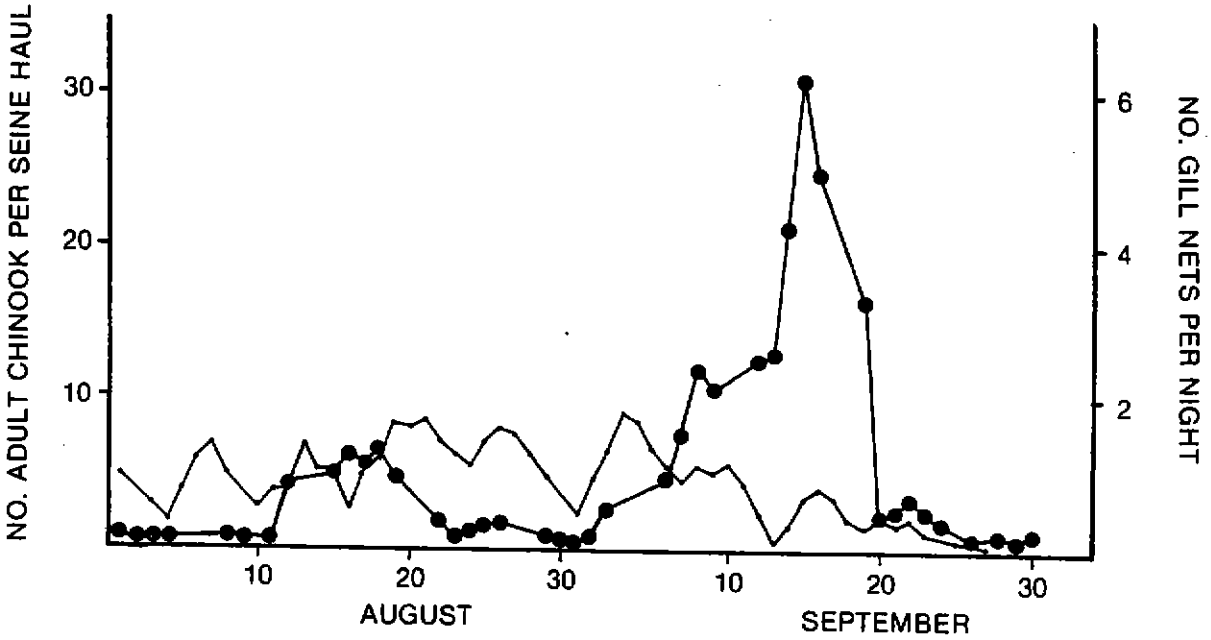


FIGURE 15. Three-day moving averages of number of adult chinook salmon captured per seine haul (●—●) and number of gill nets per night (·——) in the Klamath River estuary in 1983.

PLATE 4. Sport fishermen at the mouth of the Klamath River, summer 1983.

NET HARVEST MONITORING PROGRAM

INTRODUCTION

Regulations governing Indian fishing on the Hoopa Valley Reservation were first promulgated by the Department of the Interior in 1977, and FAO-Arcata biologists began monitoring gill net harvest levels on the reservation in 1978 (USFWS 1981), focusing efforts on fall chinook salmon. Considerable progress was made in ascertaining net harvest levels with the establishment in 1980 of a net harvest monitoring station in the lower Klamath River. Starting in 1981, net harvest monitoring operations were expanded upriver for reservation-wide coverage of the net fishery. Beginning in 1983, FAO-Arcata biologists focused censusing efforts solely on the Klamath River portion of the reservation, operating three monitoring stations based near Requa, Omagar Creek and Johnson. Net harvest levels on the Trinity River portion of the Hoopa Valley Reservation in 1983 were monitored by the Hoopa Valley Tribal Fisheries Department.

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 Hoopa Valley Reservation in 1983 (Figure 16). The Estuary Area was defined as the lower 6 km of the river from the mouth to the crossing of the Highway 101 bridge. The Middle Klamath, encompassing the next 27 km upriver, was divided into two census sections: an "A" section (previously designated as the Resighinni Area) from the Highway 101 crossing to the mouth of Terwer Creek, 8.5 km above the river mouth, and a "B" section from Terwer Creek to Surpur Creek, 33 km upstream from the mouth. The Upper Klamath Area included the 37 km stretch of river from Surpur Creek to Weitchpec. Following is a description of monitoring procedures employed for each area.

Estuary Area

FAO-Arcata personnel, operating from a base camp at Welk-Wau Village located near the river mouth at the southern edge of the estuary, monitored the Estuary Area on a periodic basis during the spring chinook run and daily from July 15 to September 29 to assess fall chinook harvest levels. Indian fishers were contacted while in their boats, at their riverside camps, or at several boat landings in the area. Monitoring activities were generally concentrated in the lower 2 km of the estuary, as Indian fishers typically set their nets in the deep channel off the south spit or just off the north bank of the river near Requa (Figure 17). Daily surveys, scheduled to coincide with hours of peak netting activity, typically occurred from 5:00 p.m. to 2:00 a.m. and 7:00 a.m. to 9:00 a.m., with occasional spot surveys conducted between 9:00 a.m. and 5:00 p.m. Daily net counts typically made just prior to dark were adjusted to include additional nets that subsequently entered the fishery.

Middle Klamath Area

The Middle Klamath Area was monitored periodically during the spring chinook run and on a 5-day-a-week basis from August 1 to October 22 during the fall run. Spring surveys were made by FAO-Arcata personnel stationed at Welk-

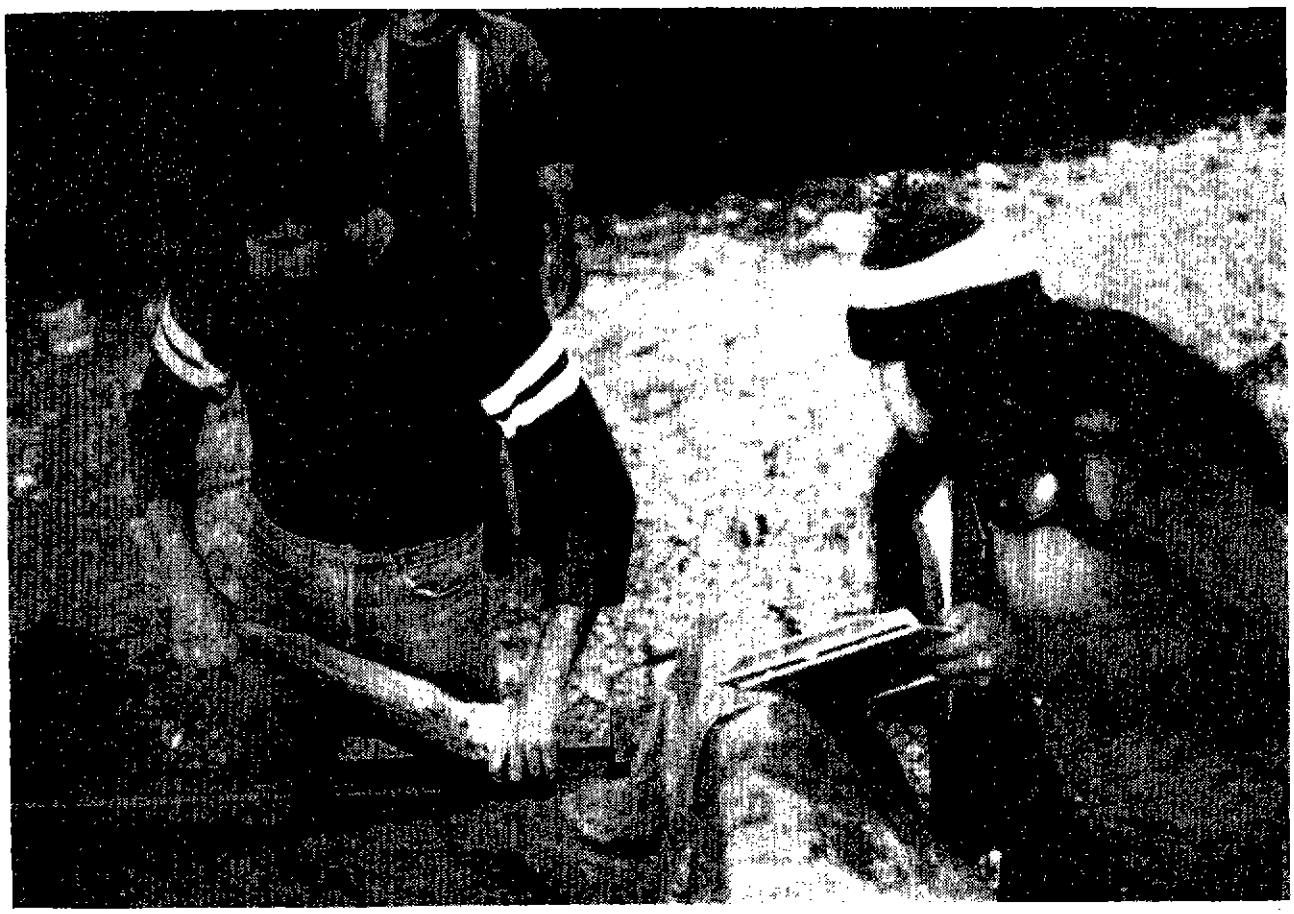


PLATE 5. U.S. Fish and Wildlife Service personnel collecting biological data on net-harvested salmon during 1983 net harvest monitoring operations on the Klamath River.

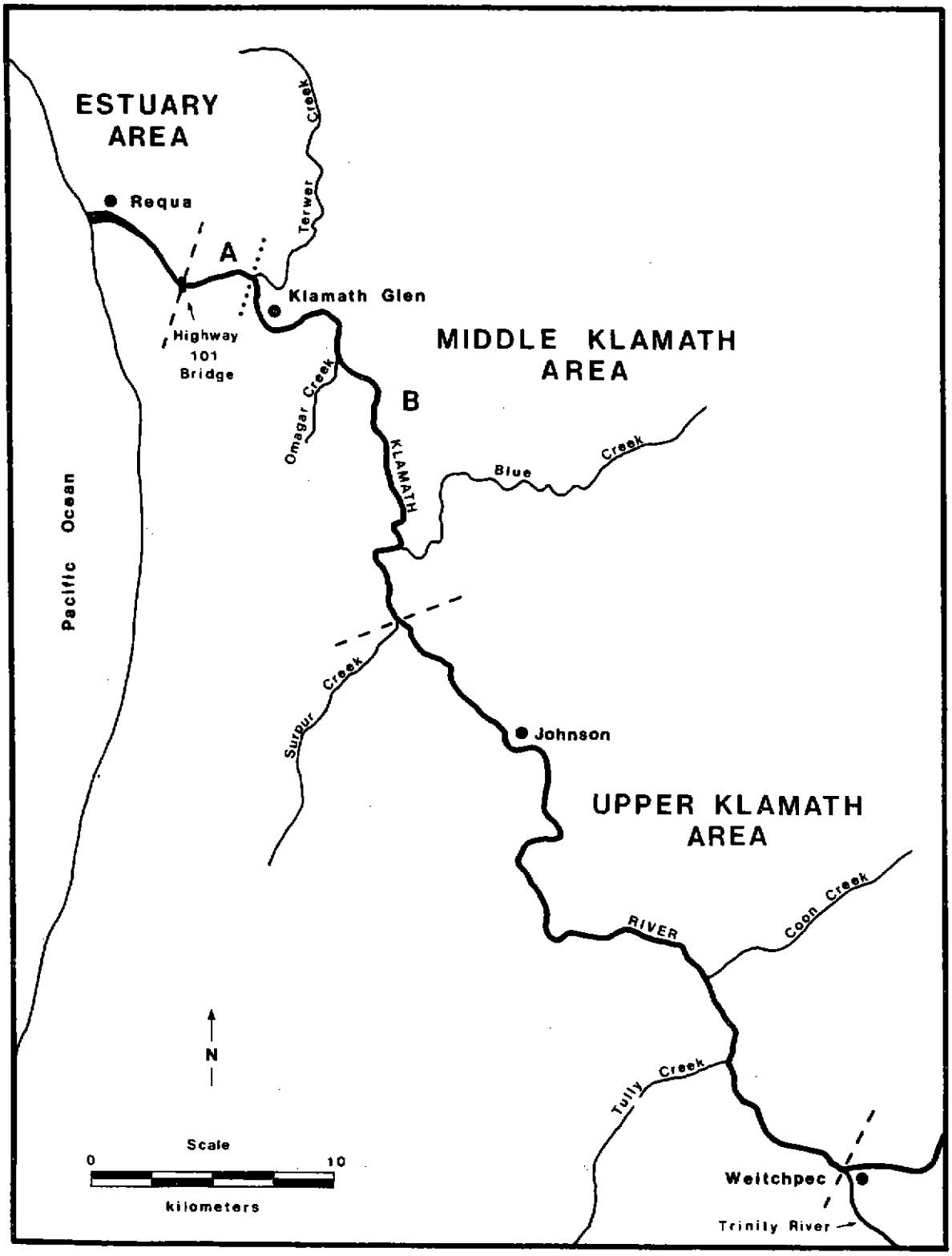


FIGURE 16. Net harvest monitoring areas for the Klamath River portion of the Hoopa Valley Indian Reservation in 1983.

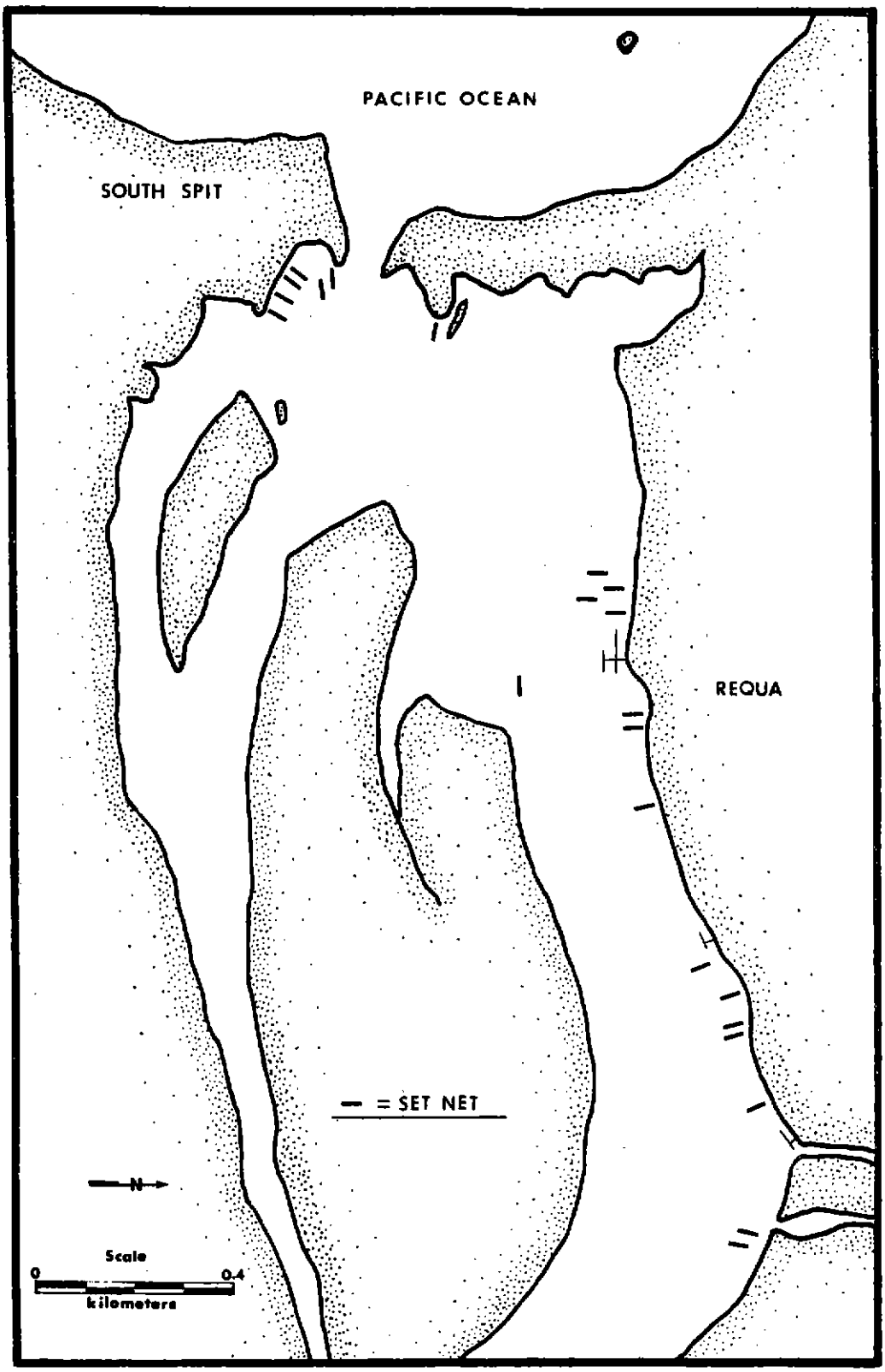


FIGURE 17. Typical net placement pattern in the Klamath River estuary during the peak of the 1983 fall chinook salmon run.

Wau Village; fall run operations were conducted by personnel operating from a base camp near Omagar Creek, 17 km upstream. Boat surveys were made during the morning hours when fishers typically checked their nets. Later in the day, Indian fishers not contacted earlier were interviewed at their residences. Monitoring activities were also occasionally conducted during afternoon and evening hours. Net counts were made daily, either in the early morning or late evening hours. A typical net placement pattern in the Middle Klamath Area during the peak of the 1983 fall chinook salmon run is given in Figure 18.

Upper Klamath Area

Net harvest monitoring in the Upper Klamath Area was conducted periodically during the spring chinook run and on a 5-day-a-week basis from August 1 to October 23 during the fall run. Spring surveys were made by personnel stationed at Welk-Wau Village. Fall run surveys were conducted by FAO-Arcata personnel residing in Hoopa and operating at Johnson, a small community located 39 km upstream from the mouth. Netting activity from Surpur Creek to Coon Creek was monitored by boat during the morning and evening hours. Because of the difficulty of negotiating a boat over Coon Creek Falls, Indian fishers in the Coon Creek to Weitchpec section were surveyed by motor vehicle. Indian fishers not contacted on the river were subsequently interviewed at their residences. Net counts were made from the boat surveys, with estimates of net effort being used for the portion of river above Coon Creek falls. A typical net placement pattern in the Upper Klamath Area during the peak of the 1983 fall chinook run is given in Figure 19.

Methods utilized in estimating net harvest levels for the three Klamath monitoring areas in 1983 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 estimated percentages of net harvest these sums were judged to represent, based on net count information, on intimate knowledge of the net fisheries and a network of contacts on the reservation. Fall chinook harvest estimates were derived daily and spring chinook harvest estimates were determined monthly for each of the three areas. The close association between FAO-Arcata biologists and the Indian fishing communities afforded opportunities to formulate reasonably dependable, albeit subjective, judgements regarding the reliability of unseen harvest data supplied. Questionable harvest data obtained was routinely evaluated by field biologists and subjected to possible adjustment taking into account a variety of factors including: (1) fishing location, (2) average catch/effort values of nets in close proximity to the fishing location, (3) netting proficiency of individual fishers as gleaned over a period of time, and (4) the reliability of past reporting by individual fishers.

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

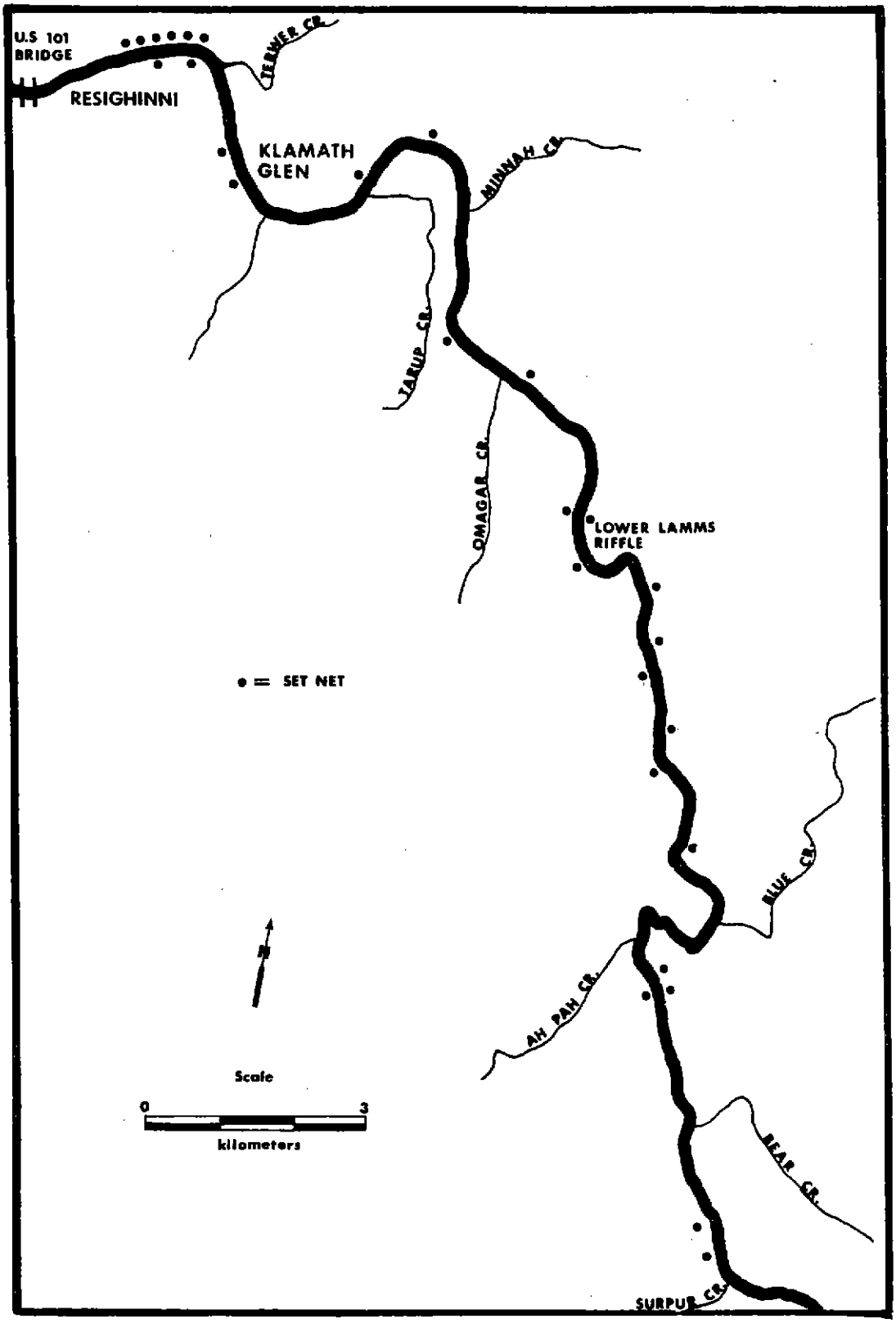


FIGURE 18. Typical net placement pattern in the Middle Klamath Area during the peak of the 1983 fall chinook salmon run.

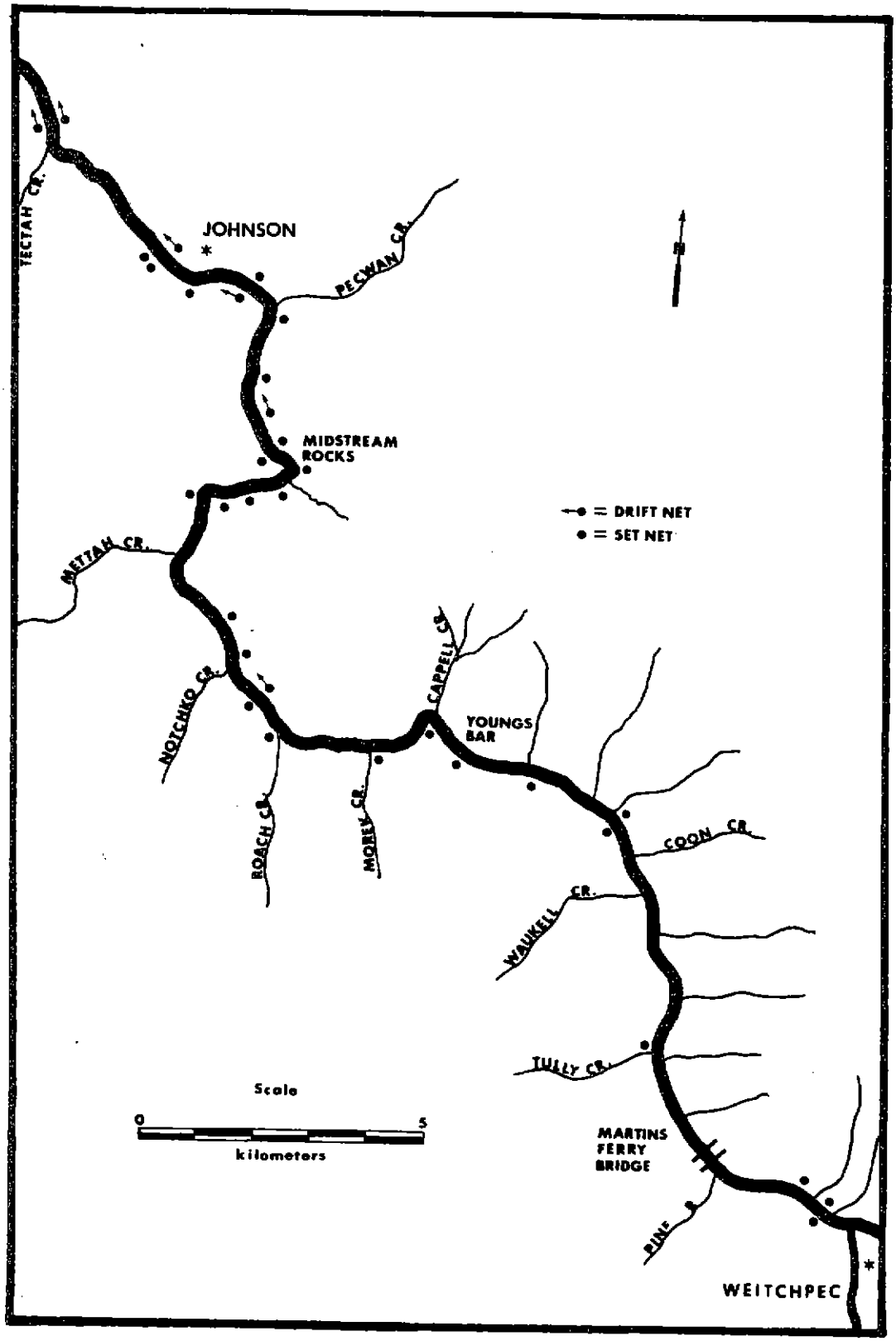


FIGURE 19. Typical net placement pattern in the Upper Klamath Area during the peak of the 1983 fall chinook salmon run.

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

Catch per net-night indices for fall chinook salmon were developed to compare yearly variations in catch/effort data within an area fishery over a fixed time period during which much of the catch had occurred. The time period from August 10 to September 15 was used for the Estuary Area index. In the last 4 years, at least 75% of the yearly harvest of fall chinook was taken during this time. The Middle Klamath "A" index period selected was August 20 to September 25, when in the last 3 years, at least 85% of the yearly fall chinook catch had occurred.

Chinook sampled in the net fishery were measured to the nearest centimeter fork length, examined for tags and fin-clips, and inspected for seal or otter-bite damage. A subsample of chinook in the lower Klamath were weighed to the nearest pound and these weights were then converted to kilograms. Snouts were removed from adipose fin-clipped fish for subsequent coded-wire tag identification.

Coded-wire tag recoveries in the Estuary, Middle Klamath and Upper Klamath Areas revealed relatively distinct timing of entry patterns of spring and fall chinook into these fisheries; consequently, cutoff dates of July 10 for the Estuary Area, and July 31 for the Middle and Upper Klamath Areas were established to separate the harvest of spring and fall chinook.

RESULTS AND DISCUSSION

Fall Chinook Salmon

FAO-Arcata biologists observed over 3,000 fall chinook salmon harvested by Indian fishers on the Klamath River portion of the Hoopa Valley Indian Reservation in 1983. Of these, 2,656 were mark-sampled for tags and fin-clips and 2,616 were measured to fork length. Based on over 2,400 contacts with Indian fishers during the fall season, net harvest in the Klamath River portion of the reservation was estimated at 6,633 fall chinook salmon, including 6,500 adults (98%) and 133 grilse (<49 cm).

Among the three Klamath monitoring areas, nearly half (47.7%) of the catch occurred in the Upper Klamath fishery with an estimated harvest of 3,163 salmon (Table 10). Grilse comprised 2.8% of the Upper Klamath catch, representing approximately 89 salmon. The Middle Klamath and Estuary Area fisheries comprised 40.1% and 12.2% of the harvest, representing 2,658 and 812 salmon, respectively. Grilse accounted for a respective 1.2% and 1.5% of the Middle Klamath and Estuary Area catches, representing approximately 44 fish.

Most of the salmon harvested in the Estuary Area were taken from August 26 to September 20, with peak harvest occurring on September 7 and 8 (Figure 20). During this time period, daily catch estimates for fall chinook ranged from 0 to

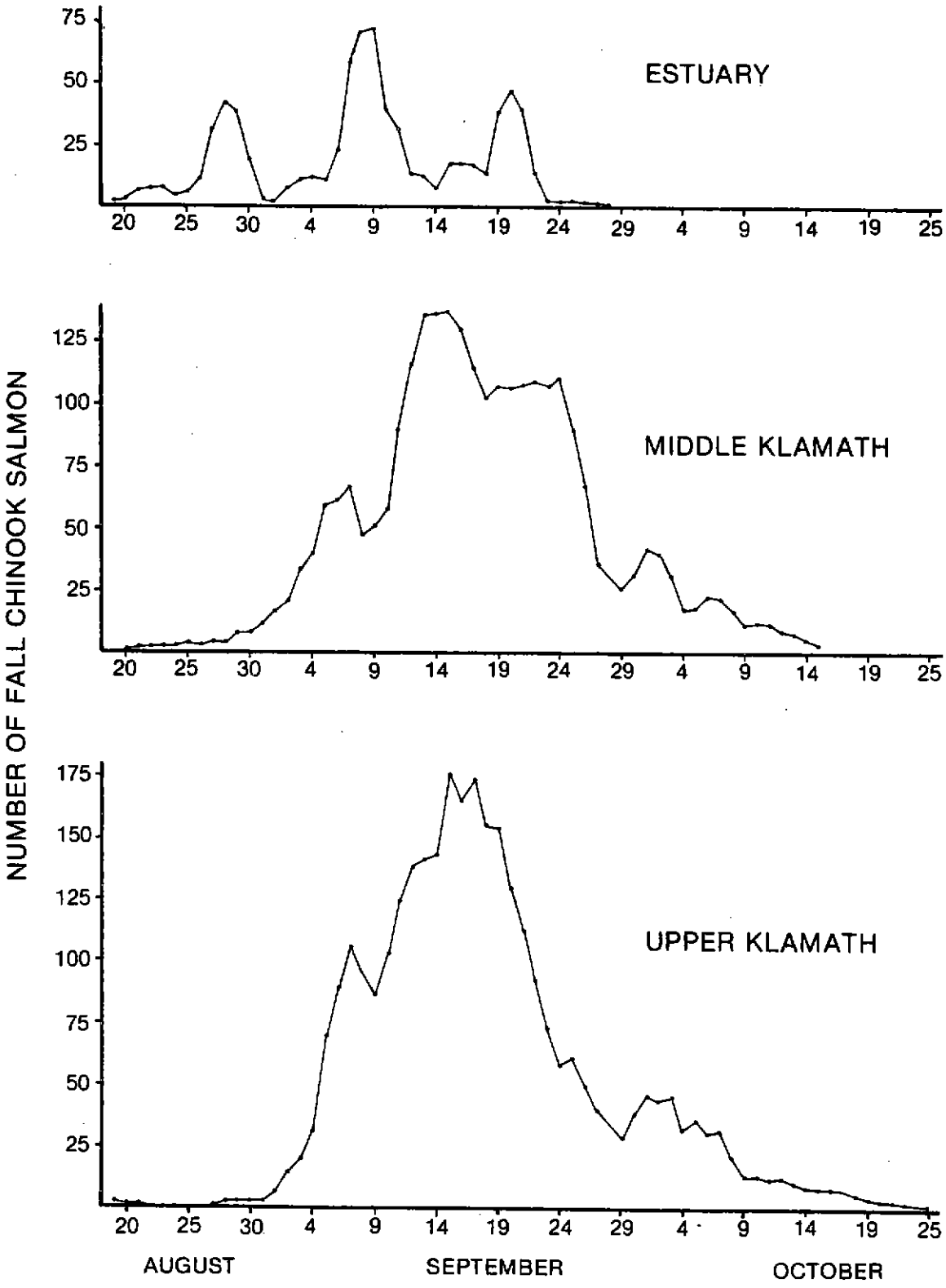


FIGURE 20. Three-day moving average of the estimated number of fall chinook caught by Indian fishers in the Estuary, Middle Klamath and Upper Klamath areas of the Hoopa Valley Reservation in 1983.

105, with an average catch of 28 chinook. Effort ranged from 3 to 30 nets, averaging 16 nets per night. Daily catch per net-night values ranged from 0.00 to 3.50 chinook with a weighted average of 1.69 chinook/net night.

TABLE 10. Semi-monthly net harvest estimates of fall chinook salmon captured in the three Klamath monitoring areas of the Hoopa Valley Reservation in 1983.

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	2	0	0	2	2
Aug.	1-15	8	2	27	37	39
	16-31	192	66	29	287	326
Sept.	1-15	420	1,189	1,536	3,145	3,471
	16-30	180	1,154	1,189	2,523	5,994
Oct.	1-15	10	235	331	576	6,570
	16-31	0	12	45	57	6,627
Nov.	1-15	0	0	6	6	6,633
TOTAL		812	2,658	3,163		
PERCENTAGE		12.2	40.1	47.7		

The Estuary Area fishery has exhibited a dramatic decline in harvest of fall chinook over the past three seasons. Estuary Area catches, typically the most abundant on the reservation, dropped from 24,009 chinook in 1981, to 4,837 chinook in 1982, to a low in 1983 of 812 chinook. Catch per net-night indices show the Estuary Area harvest rate for 1983 at 1.21, the lowest among the 4-year database (Table 11). The 1983 figure represents a harvest rate value 3 times lower than 1982, the previously lowest index, and nearly 13 times lower than the 1981 value.

River flow appeared to be the primary factor in the success of the Estuary Area net fishery. Annual harvest index levels by Indian netters in the Estuary Area was negatively correlated to mean Klamath River summer flows (Figure 21). Higher flows impact the net fishery by creating more turbulent tidewater currents which reduce the amount of time a fisher can properly set his net without it being pulled off the bottom of the river or out of the vertical fishing position. Higher flows also increase the volume of water in the estuary and presumably make it less likely for fish to encounter nets.

PLATE 6. An Indian fisher removing a salmon from an upriver eddy net in the Klamath River.

Fall chinook salmon entered the Estuary Area fishery in 1983 much later in the season than was observed in previous years (Figure 22). The 1983 peak harvest period occurred 12, 5 and 2 days later than in the 1980, 1981 and 1982 seasons, respectively.

TABLE 11. Catch per net-night indices of fall chinook salmon harvested in the Estuary (1980-1983) and Resighinni (1981-1983) areas of the Klamath River.

(Time Period)	Year	Catch/Net Night Index	Percent of Area Harvest
ESTUARY			
(Aug. 10 - Sept. 15)	1980	7.47	90
	1981	15.49	82
	1982	3.74	83
	1983	1.21	76
MIDDLE KLAMATH "A"			
(Aug. 20 - Sept. 25)	1981	13.47	86
	1982	12.03	89
	1983	1.02	86

Most of the fall chinook salmon harvest in the Middle Klamath Area took place from September 3 to October 6, with peak harvesting occurring during the 4 days from September 12 to 15 (Figure 20). During this 5-week period, catch per net-night values ranged from 0.80 to 6.50 chinook and averaged 3.00. Daily catches ranged from 12 to 142 chinook, averaging 74.

For the Middle Klamath "A" section, representing the lower tidewater portion of the Middle Klamath Area, an estimated 325 fall chinook were harvested in 1983, compared to 3,919 salmon taken in 1982. Catch per net-night indices showed the harvest rate for 1983 nearly 12 times lower than the 1982 value. Effort for the Middle Klamath "A" section during the fall season was estimated at 425 net-nights, down 9% from 1982. The 1983 Middle Klamath "A" harvest pattern showed a later than normal peak catch period compared with the 1980-1982 return years (Figure 23). For the Middle Klamath "B" section, representing the upriver eddy portion of the Middle Klamath Area, an estimated 2,333 fall chinook were harvested in 1983.

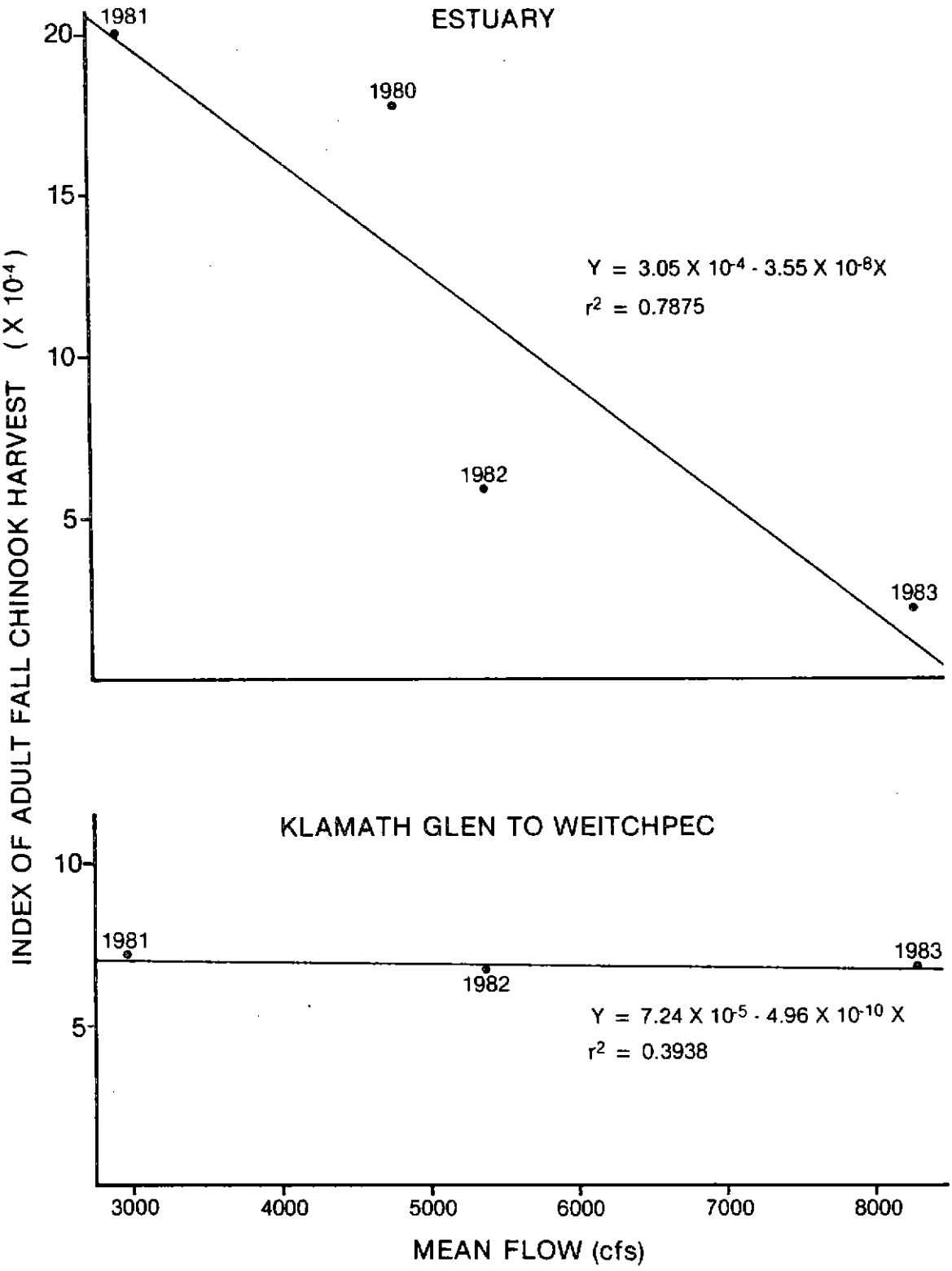


FIGURE 21. Regression of the index of adult chinook harvest (catch/effort/run size) on the mean July, August and September flows in the Klamath River.

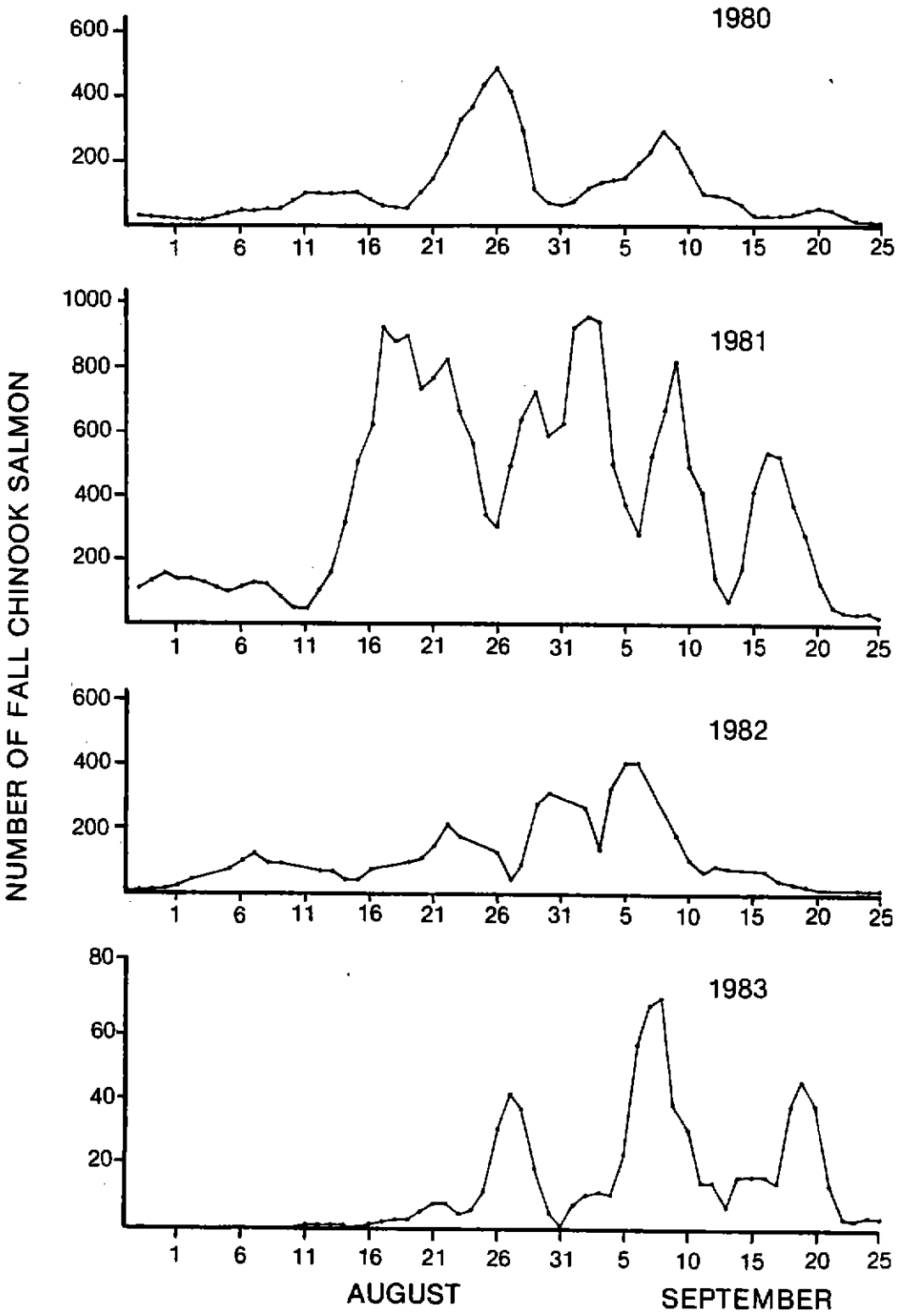


FIGURE 22. Three-day moving average of the estimated number of fall chinook caught by Indian fishers in the Estuary Area of the Klamath River in 1980-1983.

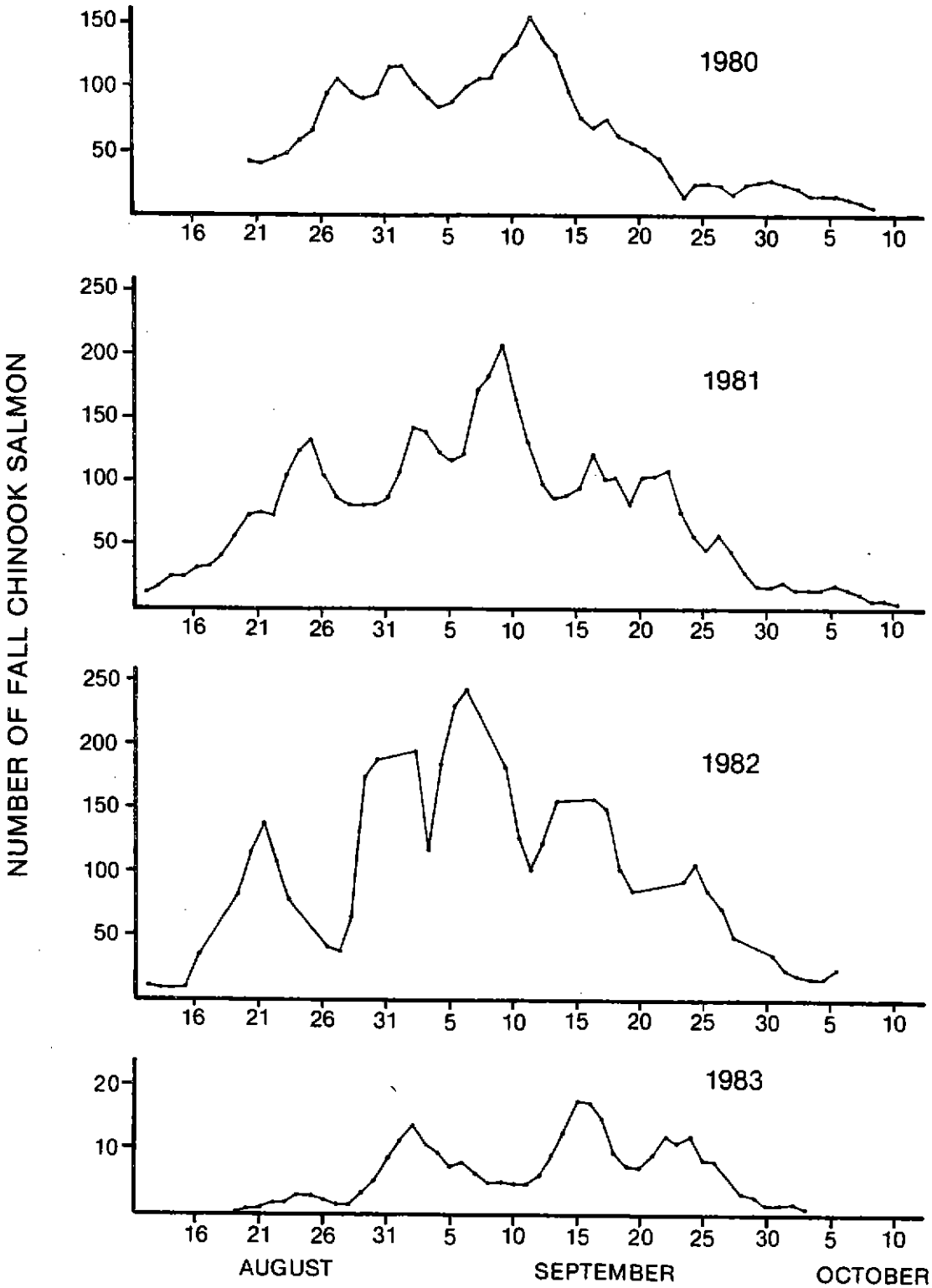


FIGURE 23. Three-day moving average of the estimated number of fall chinook salmon caught by Indian fishers in the Middle Klamath "A" section of the Klamath River in 1980-1983.

The majority of fall chinook harvest in the Upper Klamath Area took place from September 3 to October 6, with peak catches occurring during the 3-day period from September 14 to 16. For the 5-week period, daily harvest ranged from 10 to 210 chinook, averaging 88. Daily catch per net-night values ranged from 0.91 to 7.06 chinook, and averaged 3.88.

As depicted in Figure 24, the Middle Klamath "B" section and the Upper Klamath Area harvest pattern data were combined for comparisons between 1982 and 1983 data. The 1983 harvest pattern showed a lower, more protracted high catch period with harvesting occurring later in the season than was evident in 1982.

River flow does not appear to have a major influence on the success of the upriver eddy fisheries (Figure 21). Annual harvest index levels for Indian fishers from Klamath Glen to Weitchpec show little correlation with mean Klamath summer flows, with a slope value near zero.

The length-weight relationship Log W = -5.681 +3.435 (Log L) was determined for chinook salmon captured in the lower Klamath River, based on a sample of 24 fish ranging in fork length from 63 cm to 93 cm and in weight from 3.2 kg to 12.7 kg (Figure 25). Chinook grilse taken in the Klamath net fishery averaged 42.4 cm fork length and 0.8 kg in weight, and adults averaged 70.8 cm and 4.6 kg. Combining grilse and adult samples, the average fall chinook salmon captured in the Klamath net fishery in 1983 measured 70.3 cm and weighed 4.5 kg.

Based on the respective length-weight regressions, fall chinook of a given length have been returning to the Klamath River progressively smaller in weight for the last 3 return years. For example, chinook measuring 75 cm in length would have respective estimated weights of 6.6 kg, 6.1 kg and 5.6 kg in the 1981, 1982 and 1983 return years.

Chinook exhibiting adipose fin-clips, representing various hatchery CWT release groups, comprised 7.3% of the total 1983 fall chinook net harvest in the Klamath River portion of the reservation, including 5.6%, 5.8% and 8.5% of the harvest in the Estuary, Middle Klamath, and Upper Klamath Areas, respectively (Table 12). Adipose-clipped adult chinook averaged 69.5 cm in length and were significantly smaller (t-test; $p < 0.05$) than non-clipped adults, 71.0 cm (Figure 26).

Ventral (RV and LV) fin-clipped fall chinook, representing a constant fractional marking program for Iron Gate (IGH) and Trinity River (TRH) hatcheries, entered the net fishery as 2-, 3-, and 4-year-olds in 1983. A total of 96 LV (IGH) and 43 RV (TRH) clipped chinook were sampled in the 1983 Klamath River net harvest, with 70.5% of the ventral-clipped fish observed in the Upper Klamath fishery. LV-clipped chinook tended to enter the net fishery earlier than RV-clipped salmon (Figure 27). In the Upper Klamath Area, where most of the fin-clipped fish were observed, LV-clipped salmon were sampled from September 4 to September 30, while RV-clipped chinook were seen from September 11 to October 21. RV-clipped adult chinook sampled in the net fishery were significantly smaller ($p < 0.05$) than LV-clipped and non-clipped adults (Figure 26). LV-clipped adult chinook exhibited no significance size difference ($p > 0.05$) with non-clipped salmon. Because of the incomplete marking of 1983 4-year-old returns, no attempt was made to estimate the proportional contribution of hatchery fish to the 1983 net harvest.

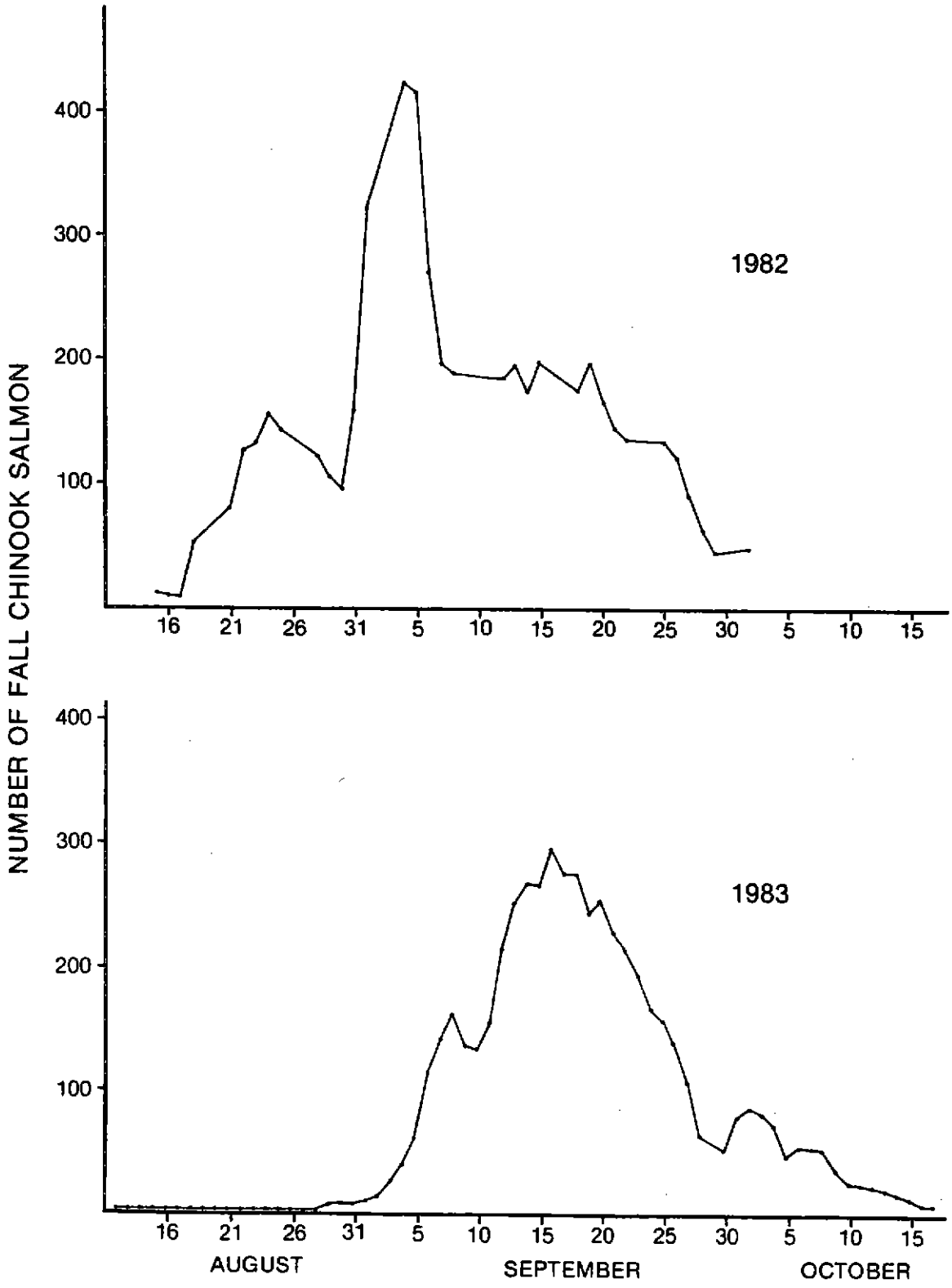


FIGURE 24. Three-day moving average of the estimated number of fall chinook salmon caught by Indian fishers in the combined region of the Middle Klamath "B" section and the Upper Klamath Area of the Klamath River in 1980-1983.

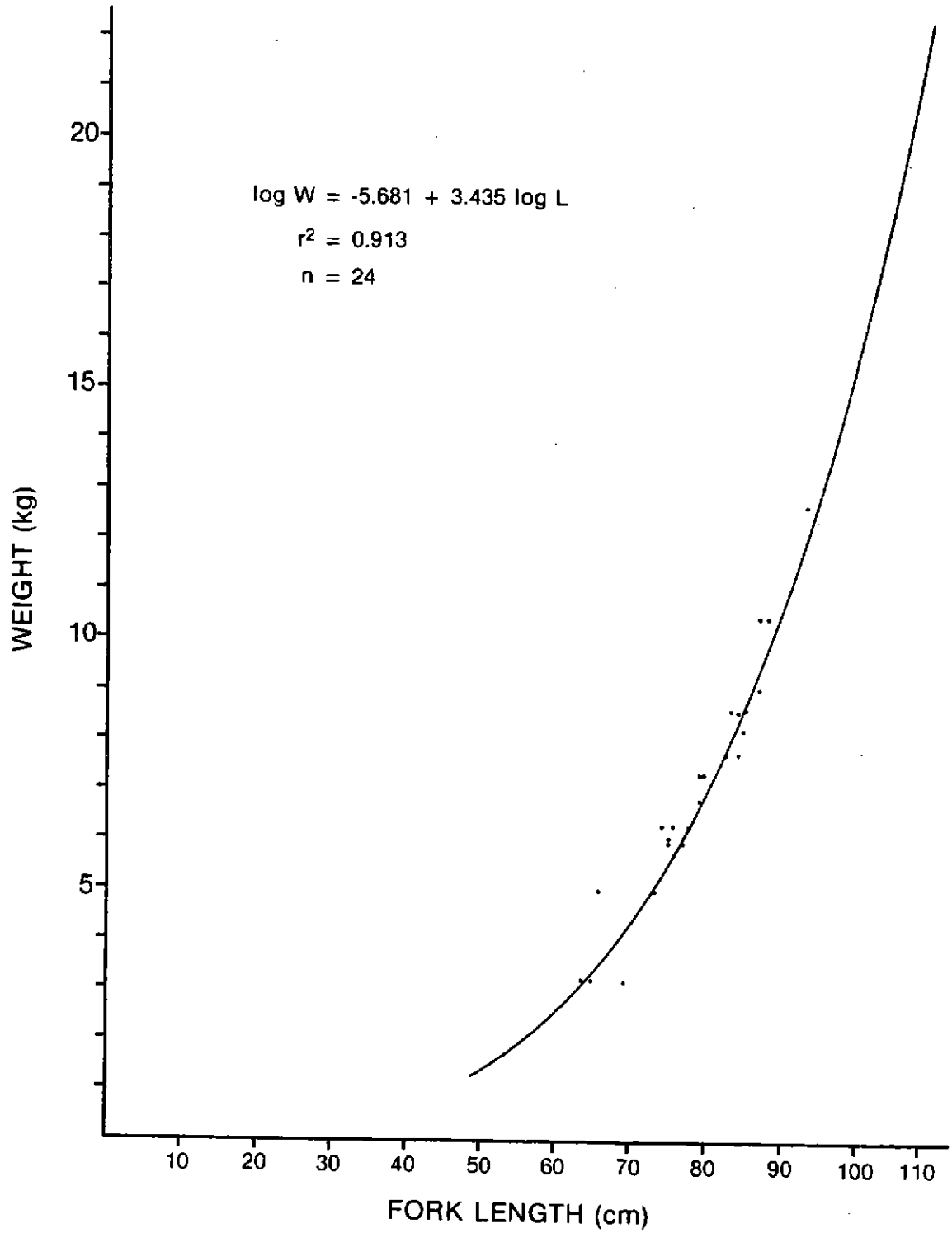


FIGURE 25. Length-weight relationship of chinook salmon caught by Indian gill netters on the lower Klamath River in 1983.

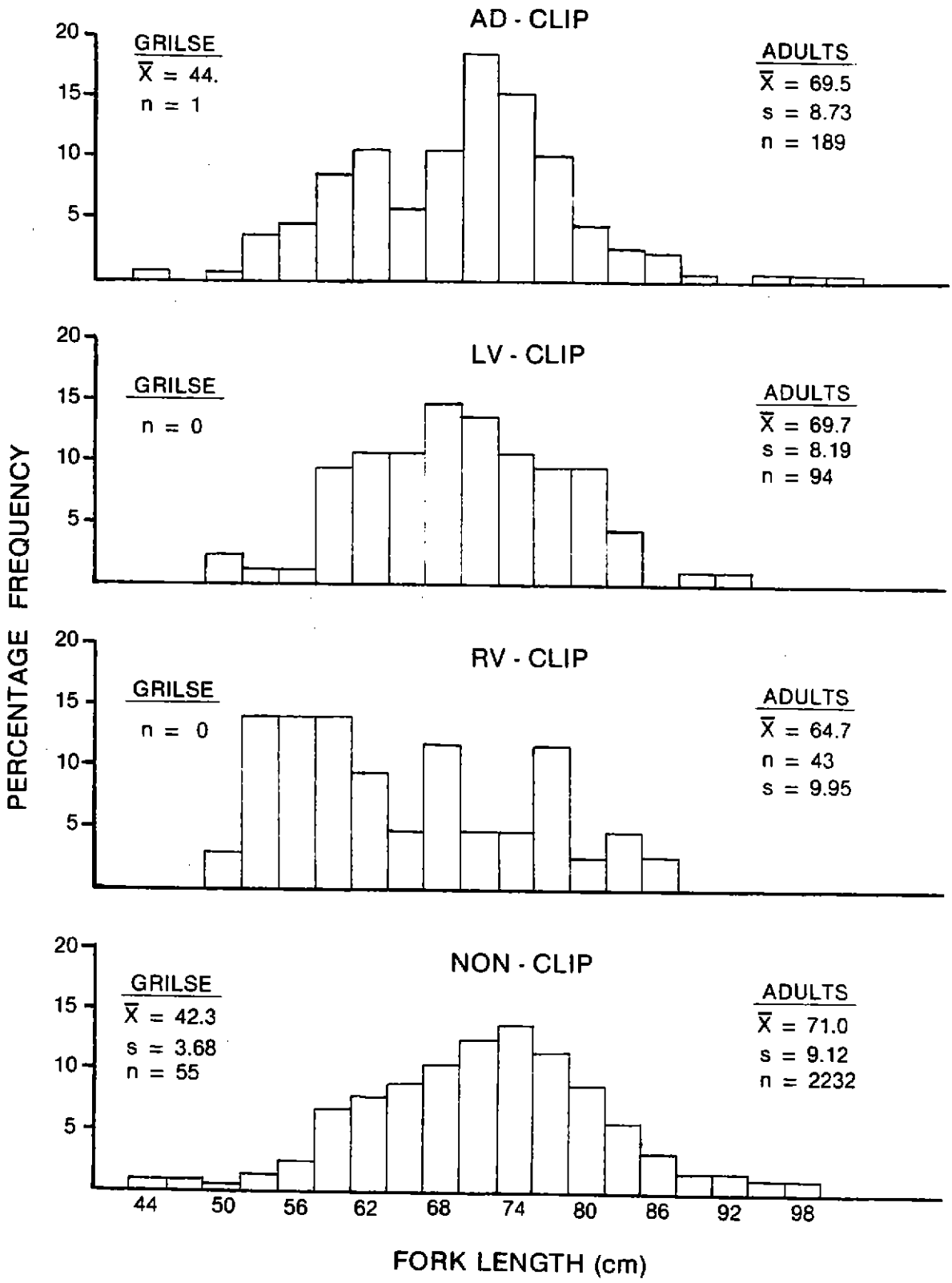


FIGURE 26. Length frequency distributions of adipose-clipped (AD-CLIP), left ventral clipped (LV-CLIP), right ventral clipped (RV-CLIP) and non-clipped (NON-CLIP) chinook salmon caught by Indian gill netters in the Klamath River portion of the Hoopa Valley Reservation in 1983. (Note: The number below the bars represents the median of a 3 cm grouping.)

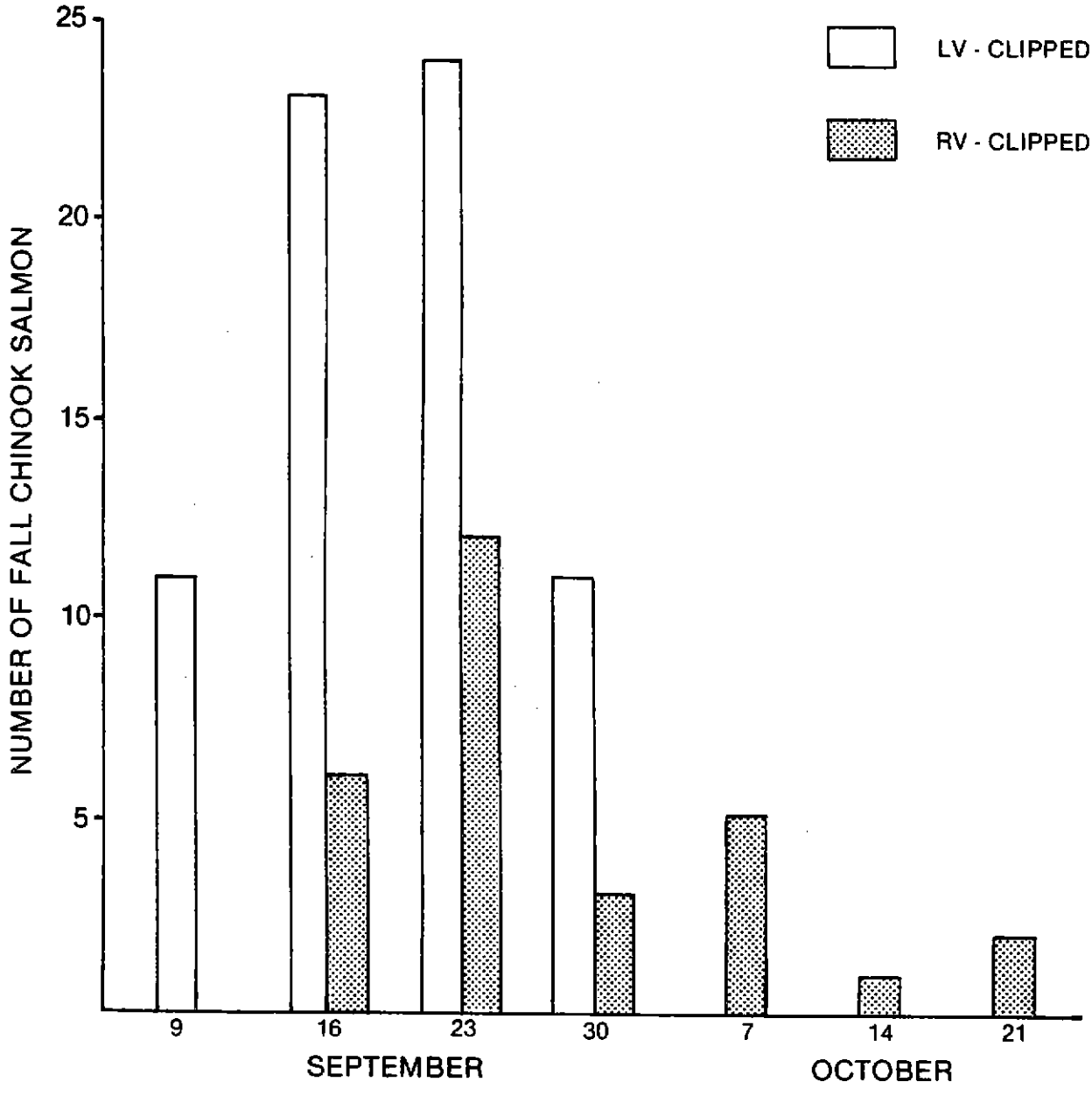


FIGURE 27. Number of LV- and RV-clipped fall chinook salmon observed in the Upper Klamath Area gill net fishery in 1983.

TABLE 12. Numbers of fin-clipped fall chinook salmon observed in the 1983 Indian gill net fishery on the Klamath River portion of the Hoopa Valley Reservation.

Area	Mark Sample	FIN CLIPS					
		AD		LV		RV	
		n	%	n	%	n	%
Estuary	341	19	5.6	10	2.9	1	0.3
Middle Klamath	813	47	5.8	17	2.1	13	1.6
Upper Klamath	1,502	127	8.5	69	4.6	29	1.9
TOTAL	2,656	193	7.3	96	3.6	43	1.6

Length-frequency comparisons of fall chinook harvested in the three Klamath areas reveal that a higher proportion of smaller salmon were taken in the upriver fisheries (Figure 28). As was the case in 1981 and 1982, the mean length of adult chinook taken in the Estuary Area was significantly greater ($p < 0.05$) than those taken in upriver Klamath areas. Adult chinook captured in the Middle Klamath Area were significantly larger ($p < 0.05$) than those taken in the Upper Klamath Area. Grilse displayed no significant differences ($p > 0.05$) in mean length between the three areas. Based on catches in the Upper Klamath fishery, Indian fishers using set nets appeared to harvest a higher proportion of smaller salmon than those drifting gill nets (Figure 29).

As discussed in the 1981 Annual Report (USFWS 1982a), possible explanations for the harvest of proportionally larger numbers of smaller-size salmon in the upriver fisheries included: (1) differences in net mesh size between fisheries; (2) size-selective effects of high harvest in the lower river; and (3) size-selectivity differences between tidewater and eddy fisheries. USFWS personnel have observed near uniformity in the use of 7 1/4-inch stretch mesh net by Indian fishers throughout the reservation during the fall season. With the limited harvests in the Estuary and Middle Klamath "A" fisheries in 1983, it appears reasonable to assume that significant differences in sizes of harvested fish between lower and upper river areas were due primarily to the size-selectivity differences in nets fished in tidewater and eddy areas.

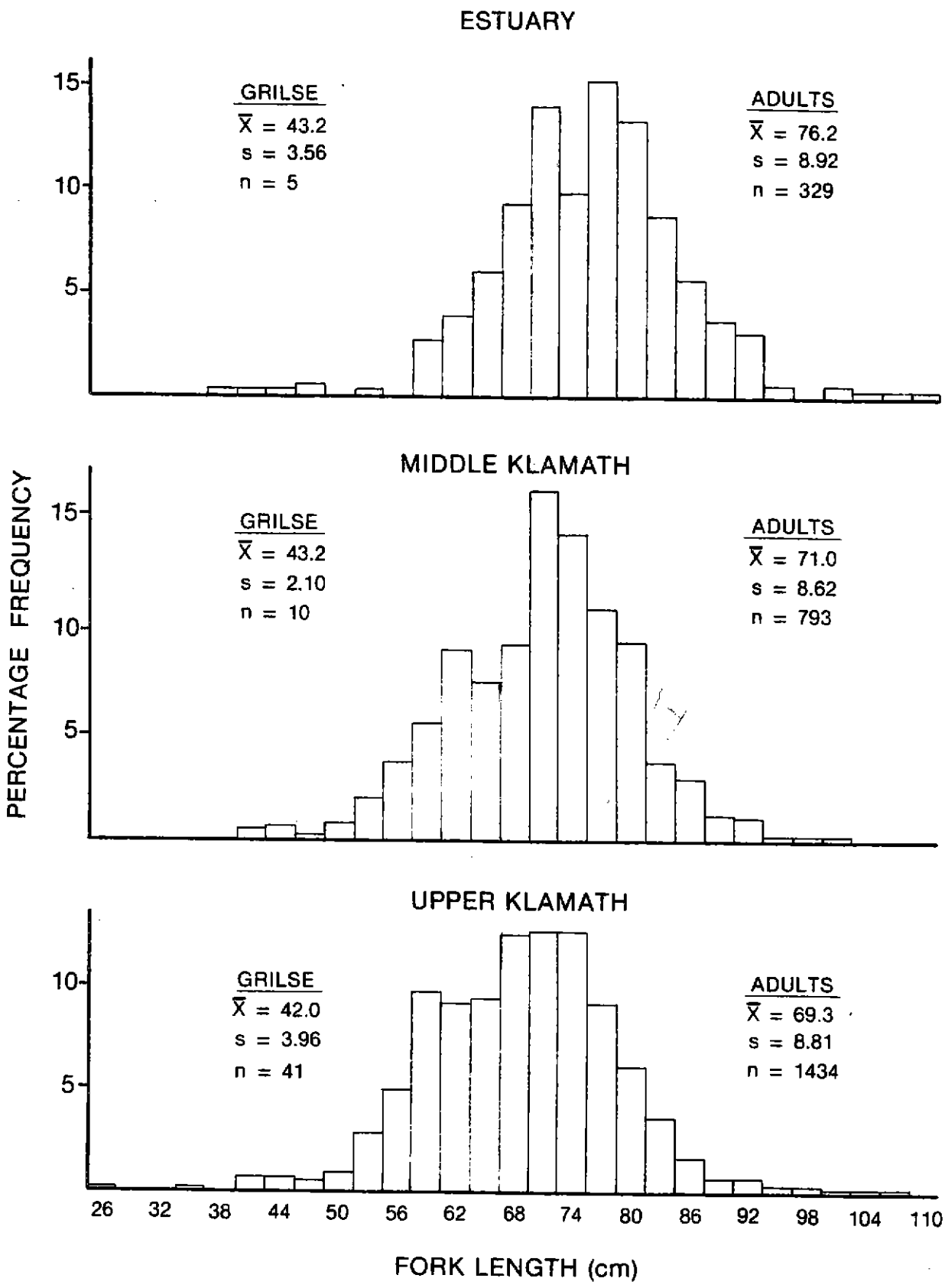


FIGURE 28. Length frequency distributions of fall chinook salmon caught by Indian gill netters in the Estuary, Middle Klamath and Upper Klamath areas of the Hoopa Valley Reservation in 1983.

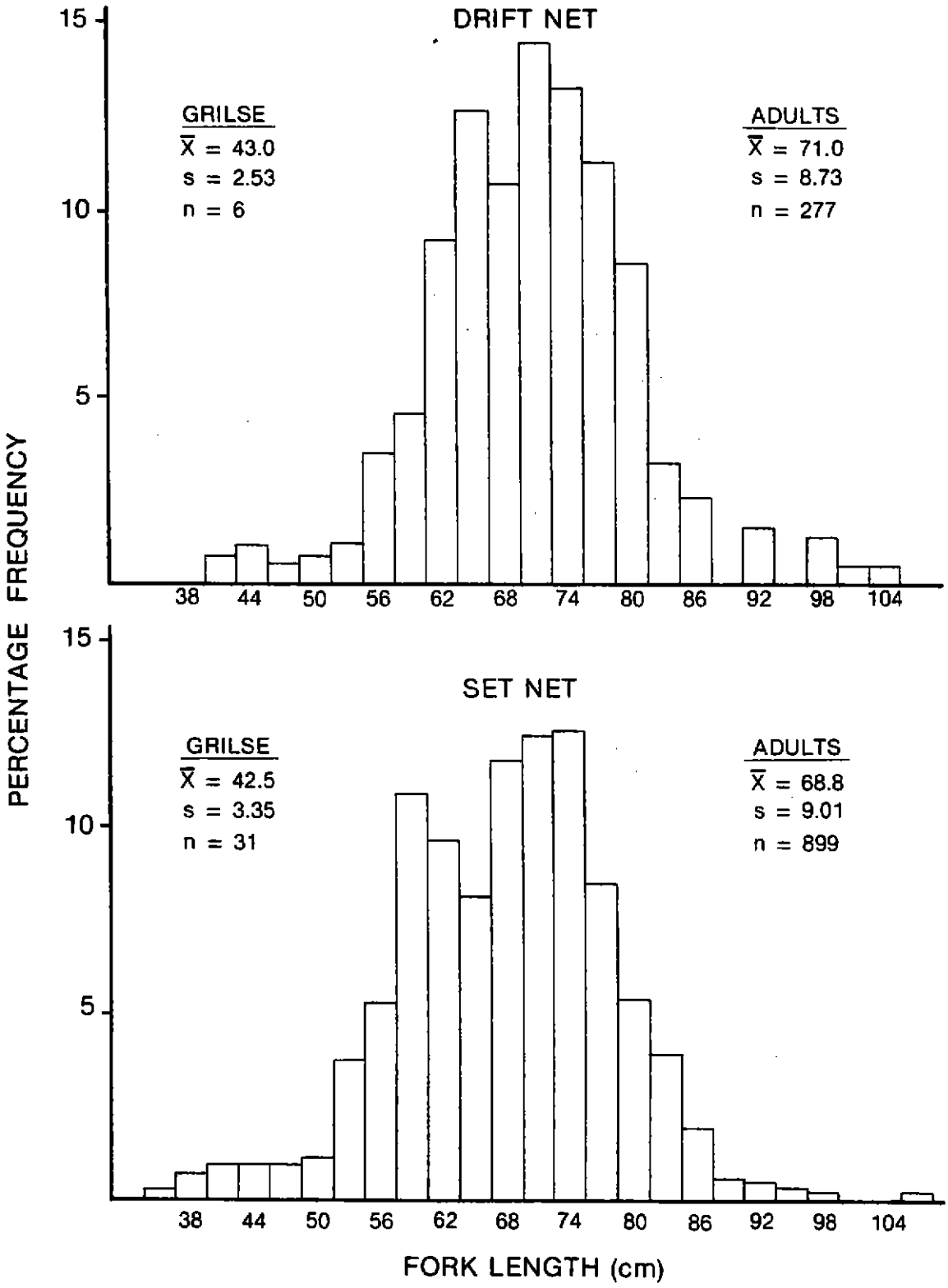


FIGURE 29. Length frequency distributions of fall chinook salmon caught in drift and set gill nets of the Upper Klamath Area fishery in 1983.

Length-frequency distributions of fall chinook taken in the 1981, 1982 and 1983 net fisheries of the Klamath river are presented in Figure 30. Mean lengths of adult and grilse chinook captured in 1983 were significantly smaller ($p < 0.05$) than in either 1981 or 1982.

A high incidence of seal depredation on chinook salmon taken in the lower Klamath net fisheries was evident in 1983. In the Estuary Area, 14.2% of the sampled fall chinook harvest was observed with seal (presumably Phoca vitulina) bites (Table 13), compared to 5.3% in 1981. No comparable information was collected in 1982. In the Middle Klamath "A" section, 30.2% of the sampled harvest displayed bite marks in 1983, compared to only 1.0% in 1981. It should be noted that seal depredation percentages presented here represent minimum values, which do not take into account fish completely removed from nets or severely damaged fish discarded and not reported by Indian fishers.

No seal depredation was reported on salmon taken in the upriver net fisheries; however, many of the netted fish exhibited bite marks apparently from river otter (Lutra canadensis). Netted fish were also observed being removed and eaten by black bear (Ursus americanus).

Spring Chinook Salmon

FAO-Arcata biologists examined 107 spring chinook salmon on the Klamath River in 1983. Based on nearly 650 contacts with Indian fishers, the Klamath River portion of the reservation net harvest was estimated at 515 spring chinook salmon, including 510 adults (99.0%) and 5 grilse (<52 cm).

The harvesting of spring chinook began in April and continued through July with the majority of the catch occurring in June (Figure 31). The Middle Klamath Area fishery accounted for 63.1% of the Klamath River harvest, followed by the Upper Klamath (25.2%) and Estuary (11.7%) Area fisheries, respectively (Table 14).

For 1983, adipose fin-clipped salmon comprised 51.4% of the total Klamath River sampled spring chinook harvest and 66.5%, 48.5% and 85.7% of the Estuary, Middle Klamath and Upper Klamath Area harvests, respectively. Adipose-clipped adult spring chinook, averaging 71.6 cm in length, displayed no significant difference ($p > 0.05$) in mean length from non-clipped adults, 71.9 cm (Figure 32).

Adult spring chinook harvested in the net fishery in 1983 were significantly smaller ($p < 0.05$) than fish taken in 1980 and 1982 (Figure 33). Spring chinook captured in 1981 did not differ significantly ($p > 0.05$) from the mean length of the 1983 adult catch.

Although considered reasonably accurate, net harvest monitoring techniques used by FAO-Arcata biologists for the past four seasons have resulted in point estimates of the net harvest with no associated error value. In an attempt to standardize and simplify harvest monitoring techniques and to allow calculation of confidence intervals around point estimates of net harvest, FAO-Arcata biologists are planning to employ a stratified random sampling methodology to assess net harvest levels beginning in the fall of 1984.

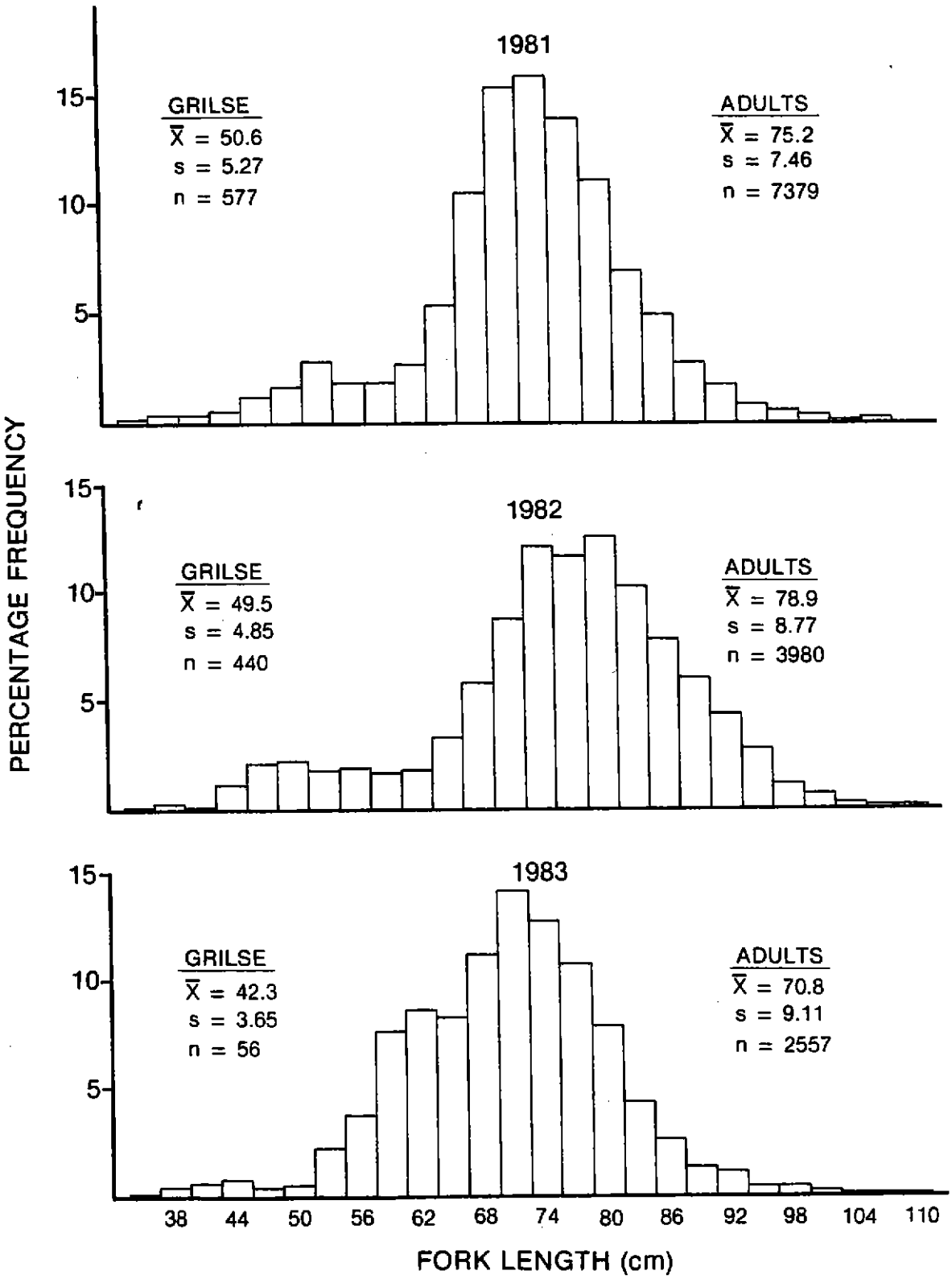


FIGURE 30. Length frequency distributions of fall chinook salmon caught by Indian gill netters in the Klamath River from 1981-1983.

TABLE 13. Incidences of seal depredation on netted fall chinook salmon in the 1983 gill net fisheries of the lower Klamath River.

Time Period		ESTUARY AREA			MIDDLE KLAMATH A		
		Sample Size	Number Bitten	Percent Bitten	Sample Size	Number Bitten	Percent Bitten
Aug.	1-15	5	2	40.0	0	0	0.0
	16-31	93	14	15.1	2	0	0.0
Sept.	1-15	263	35	13.3	32	4	12.5
	16-30	68	10	14.7	29	15	51.7
TOTAL		429	61	14.2	63	19	30.2

TABLE 14. Monthly net harvest estimates of spring chinook salmon captured in the Klamath River monitoring areas of the Hoopa Valley Reservation.

Month	NET HARVEST MONITORING AREA			Cumulative Monthly Total (All Areas)	Seasonal Total
	Estuary	Middle Klamath	Upper Klamath		
April	5	25	5	35	35
May	10	40	15	65	100
June	40	225	70	335	435
July	5	35	40	80	515
TOTAL	60	325	130	515	
PERCENTAGE	11.7	63.1	25.2	100.0	

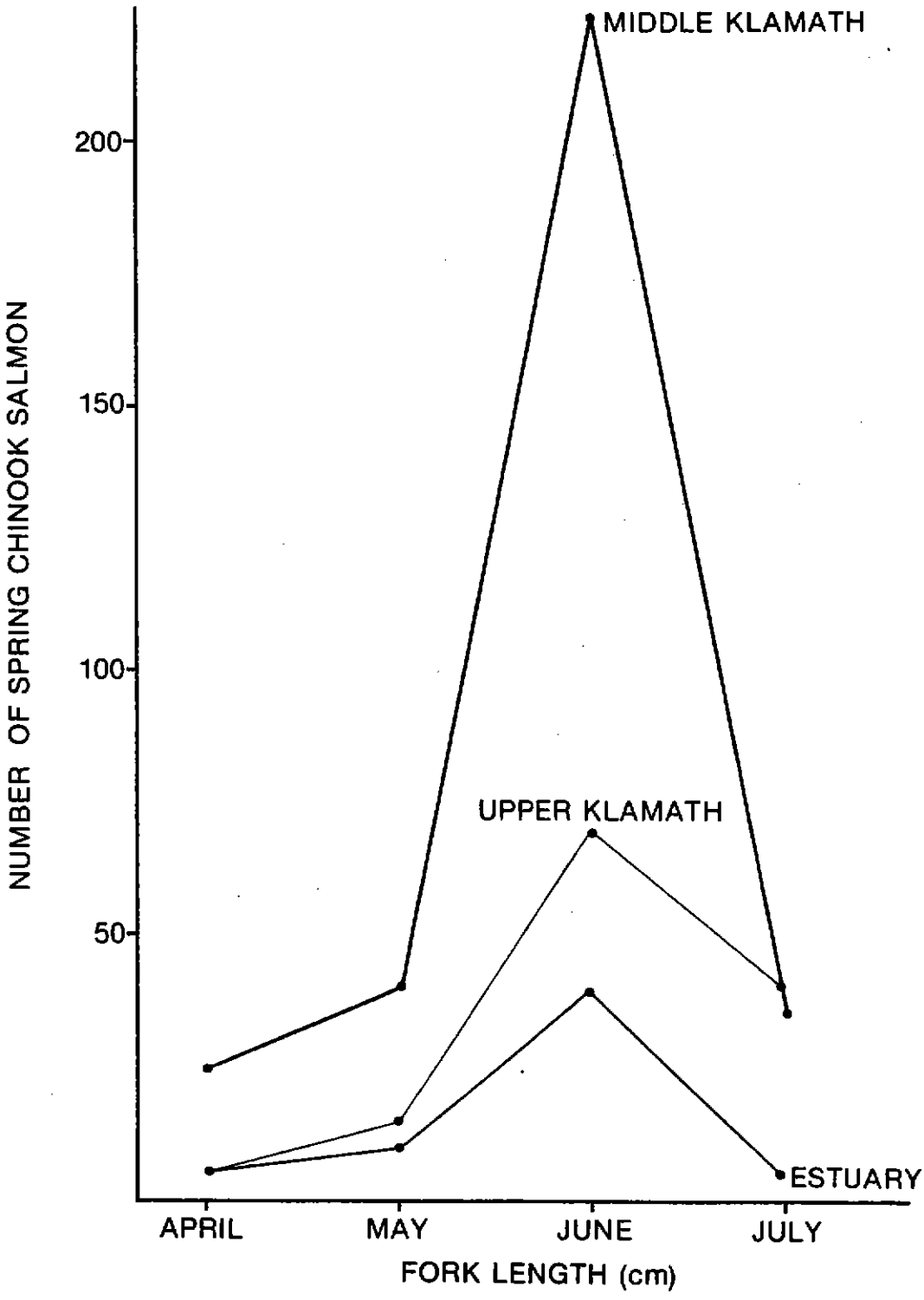


FIGURE 31. Estimated monthly Indian gill net harvests of spring chinook salmon in the Klamath River monitoring areas of the Hoopa Valley Reservation in 1983.

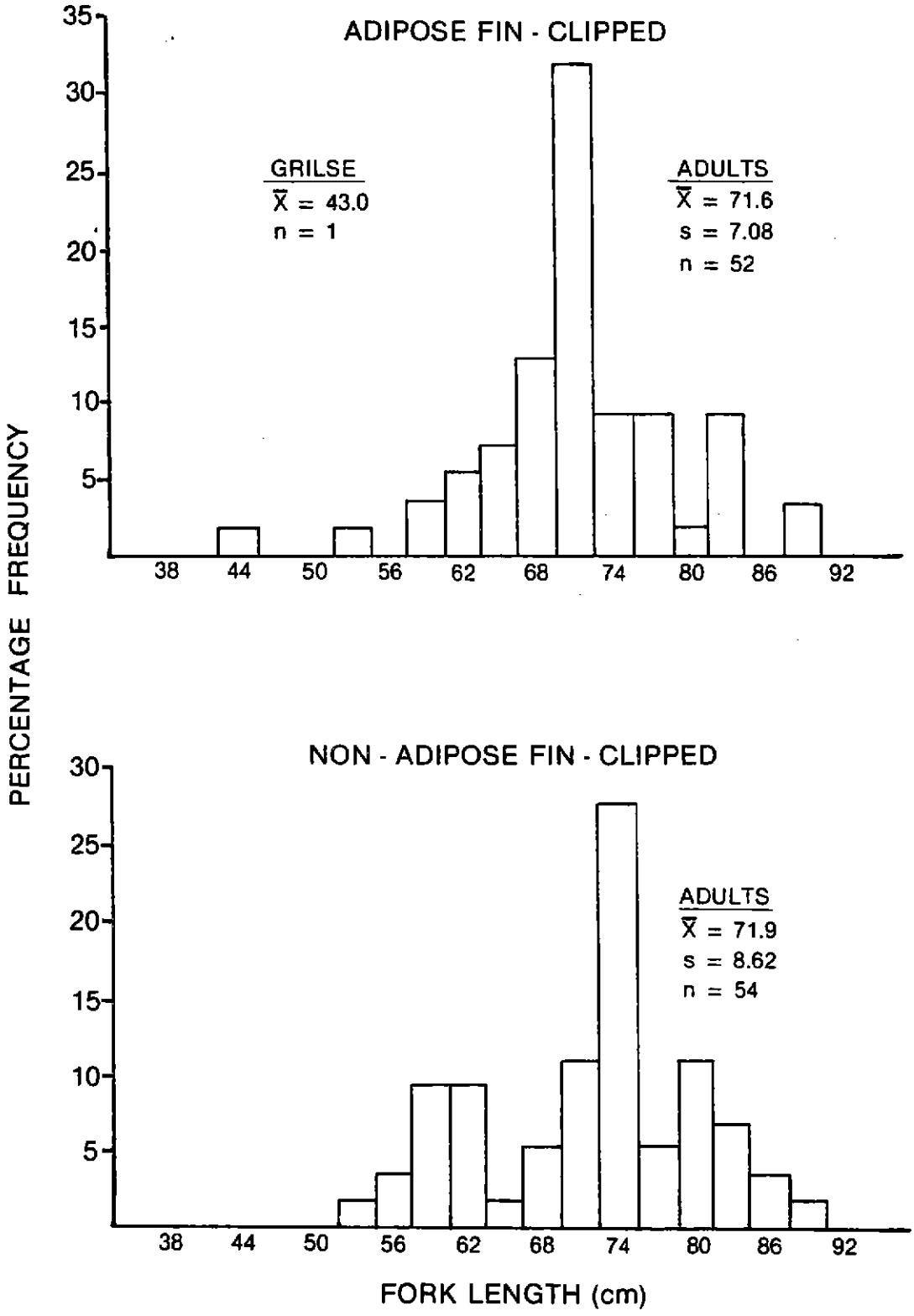


FIGURE 32. Length frequency distributions of adipose-clipped and non-clipped spring chinook salmon caught by Indian gill netters on the Klamath River portion of the Hoopa Valley Reservation in 1983.

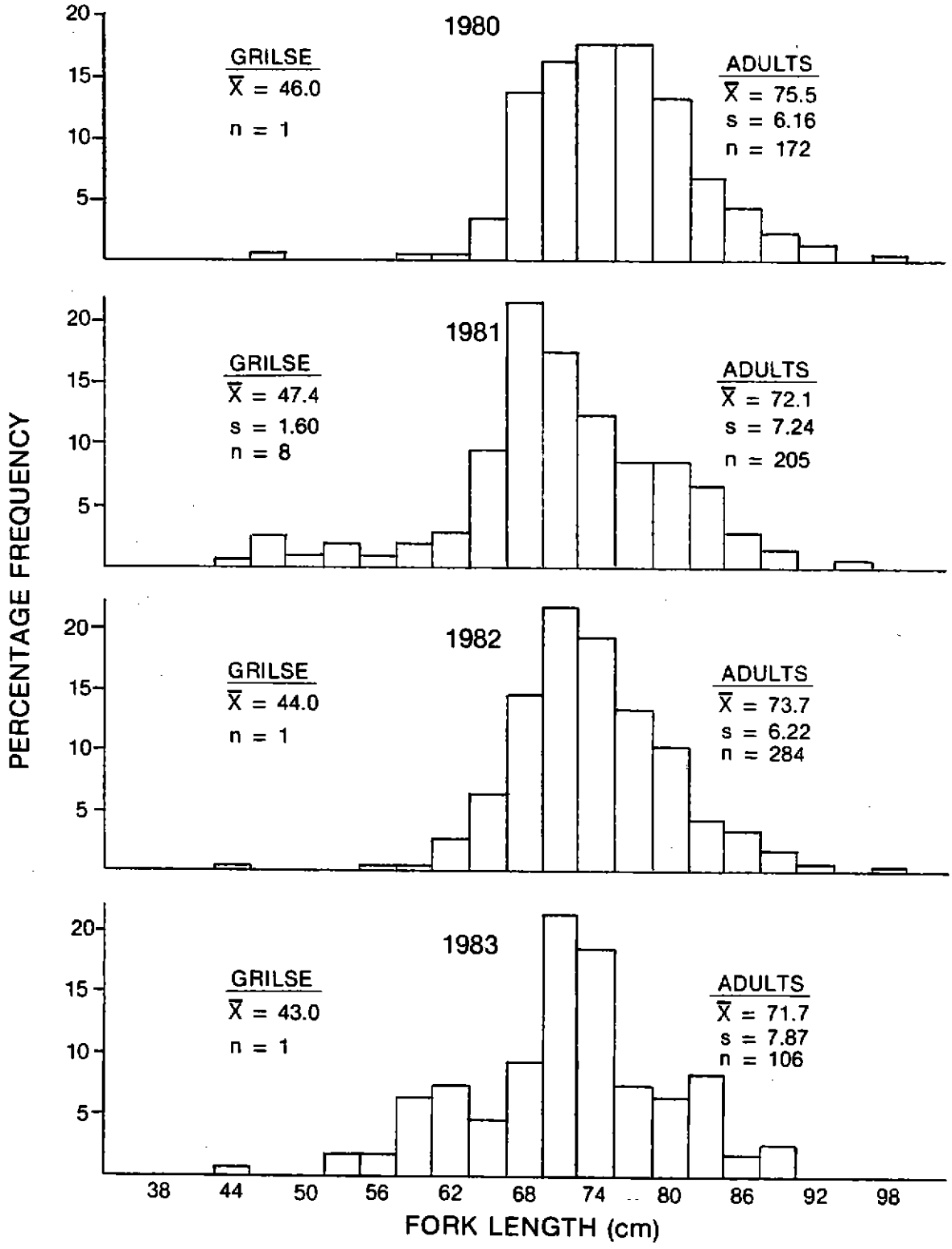


FIGURE 33. Length frequency distributions of spring chinook salmon caught by Indian gill netters in the Klamath River portion of the Hoopa Valley Reservation from 1980-1983.

AGE COMPOSITION

INTRODUCTION

Continuous monitoring of the age composition of a fish stock impacted by major fisheries is essential to sound resource management. Age data, in conjunction with length and weight measurements, provide information on stock composition, age at maturity, mortality, growth and production. As part of a continuing effort to evaluate age composition of chinook salmon runs in the Klamath basin, scale samples were again collected from fall chinook salmon through a beach seining program near the mouth of the Klamath River. However, due to reduced funding in the spring chinook harvest evaluation program, age analysis of the spring chinook net harvest was not conducted in 1983. A summary of age information collected on fall chinook entering the Klamath since 1979 is presented herein.

METHODS

Percentage age composition of the fall chinook run was determined through data collected in beach seining operations conducted near the mouth of the Klamath during 1979-1983 return years. Age composition was assessed through scale analysis each year except 1980, when no scales were collected and age composition was derived through length frequency distribution. Assignment of age group contribution to in-river runs by brood and return years was determined by applying the percentage age composition of fall chinook captured in beach seining operations to total fall chinook in-river run estimates as reported by the Pacific Fishery Management Council (PFMC 1984).

Age structure of the fall chinook run in 1983 was assessed through analysis of 546 scale samples from chinook salmon seined during July 15 to October 5. This sample is assumed to represent the entire 1983 fall chinook run entering the Klamath River.

Cellulose acetate impressions of fall chinook scales were made utilizing a Carver Model C laboratory press, and viewed on a Bell and Howell ABR-1020 dual lens projector. Scale impressions were analyzed independently by two interpreters, with a third reading by both when the initial two interpretations differed. Scales not aged with confidence after the third reading were excluded from the analysis. Scales from known age fish (coded-wire tag recoveries) were used to assist in age evaluation.

RESULTS AND DISCUSSION

Fall Chinook Salmon

The age composition of fall chinook returning in 1983 showed a preponderance of 3-year-old (54.3%), followed by 4- (31.4%), 2- (12.9%) and 5-year-old (1.4%) salmon (Table 15). As depicted in Figure 34, most evident in comparing the 1983 and 1982 runs was the increasing proportion of age 3 fish (32.0% to 54.3%) and the coinciding decrease of age 2 grilse (29.1% to 12.9%). The percentage of age 2 fish in the 1983 run was the lowest in the 5-year database for returning grilse and represents a percentage less than half the value of the 5-year average.

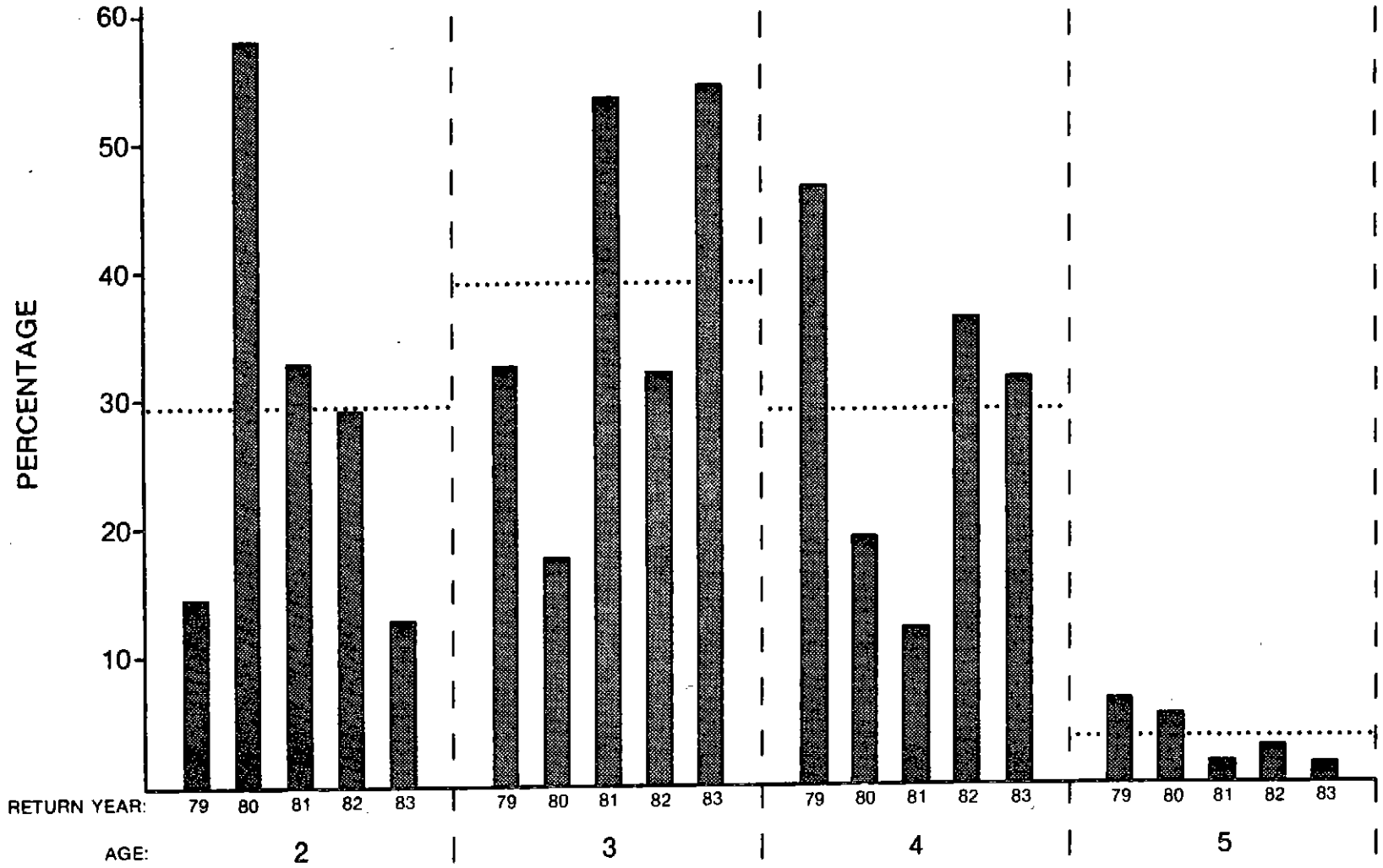


FIGURE 34. Percentage age composition of fall chinook salmon returning to the Klamath River from 1979-1983. Dotted line represents the average return percentage of each age group.

TABLE 15. Percentage age composition of Klamath River fall chinook as derived from scale analysis and length-frequency information during 1979-1983 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
1979-1983 Average	29.5	38.1	29.0	3.4

1/ Includes some 6-year-old fish.

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

Estimates of age group contribution of fall chinook in-river runs during the 1979-1983 return years are given in Table 16. It should be noted that California Department of Fish and Game (CDFG) estimates of grilse/adult components in the in-river run estimate are not always in relative agreement with age contribution data from USFWS scale analysis. Therefore, a decision was made to apply USFWS age group percentages as derived through scale analysis and length frequency information to CDFG total run size estimates (as given in PFMC 1984), in attempt to remain consistent with the age contribution analysis.

For 1983, the returns of age 2 and age 5 chinook were the lowest for their respective ages in the 5-year database. The 2-year-old contribution for 1983 was 68% lower than the 5-year average indicating potential weakness of the 1981 brood. The estimated number (33,536) of age 3 chinook returning in 1983 represented the second highest return in 5 years, but only 8% above the 5-year average. The 1983 return of age 4 chinook (19,393) was 12% below the 1979-1983 average.

TABLE 16. Estimated number of fall chinook by age entering the Klamath River during the 1979-1983 return years.

Return Year	AGE 2	3	4	5	Total
1979	8,735	19,895	28,266	3,761	60,657
1980	45,166	13,861	14,874	3,972	77,873
1981	34,567	56,315	12,608	1,576	105,066
1982	28,749	31,614	35,665	2,766	98,794
1983	7,967	33,536	19,393	865	61,761
1979-1983 Average	25,037	31,044	22,161	2,588	80,830

As illustrated in Figure 35, the 1978 brood dominated in-river returns among brood years since 1976. With an adult return of 92,845, the 1978 brood had an in-river return over 2.5 times and 3 times greater than adult returns of the depressed 1976 (36,345) and 1977 (29,235) brood years, respectively. The dominance of the 1978 brood appears to be attributable to the larger escapement of 71,451 adult fall chinook to the basin in 1978, compared to 45,683 or fewer in subsequent years.

The 1979 and 1980 brood years appear to be intermediate in strength compared to the dominate 1978 brood and the depressed broods of 1976 and 1977. The strength of the 1980 brood, with a combined 2- and 3-year-old return of 62,285 chinook, compares closely with the 1979 brood year which had a combined 2- and 3-year old total of 66,181 chinook.

Based upon a grilse return of only 7,967 chinook, the 1981 brood appears to be weaker than the severely depressed returns of 1976 and 1977 brood years.

The average age composition of fall chinook based upon the completed returns of the 1977 and 1978 brood years was 27.9% age 2, 38.6% age 3, 29.5% age 4 and 4.0% age 5. The mean ages at return of fall chinook from the 1977 and 1978 broods were 3.25 and 2.94, respectively, averaging 3.10 for the two brood years.

Mean length of fall chinook (aged by scale analysis) returning at each age to the Klamath River in 1979, 1981, 1982 and 1983 is given in Table 17. Age 2, age 3 and age 4 chinook returning in 1983 were significantly smaller ($p < 0.05$) than respective age grouped chinook taken in each previously reported return year. Age 5 fish in 1983 were significantly smaller ($p < 0.05$) than 5-year-old salmon taken in 1979 and 1981. While the mean length of age 5 chinook in 1983 was less than 1982, no significant size difference ($p > 0.05$) could be detected.

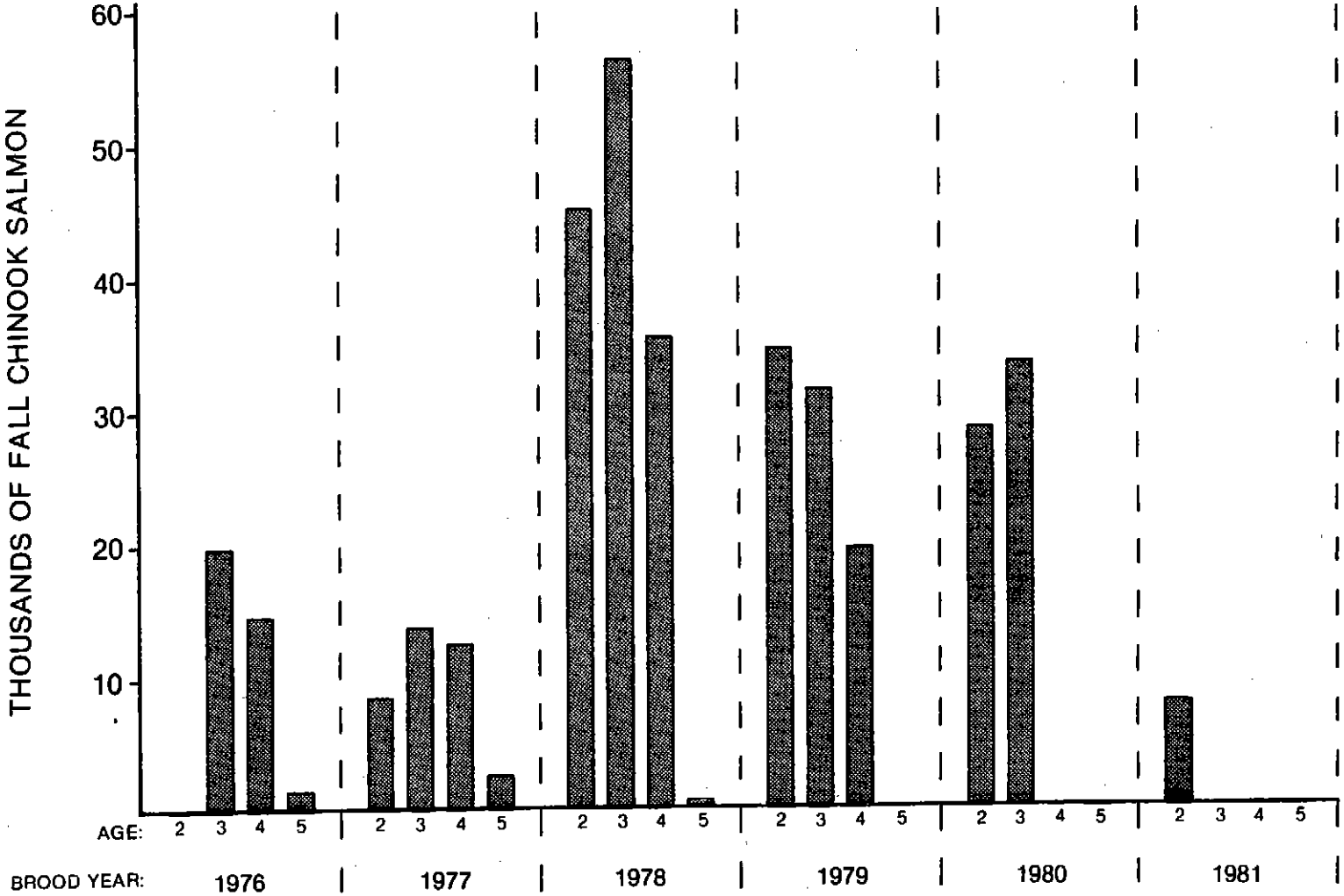


FIGURE 35. Brood year contribution by age of fall chinook salmon to the 1979-1983 Klamath River returns.

TABLE 17. Mean length of fall chinook returning at each age in 1979, 1981, 1982 and 1983 return years.

Age at Return	MEAN LENGTH AT RETURN IN 1979			MEAN LENGTH AT RETURN IN 1981			MEAN LENGTH AT RETURN IN 1982			MEAN LENGTH AT RETURN IN 1983		
	n	$\bar{X}$ ± 95% CI		n	$\bar{X}$ ± 95% CI		n	$\bar{X}$ ± 95% CI		n	$\bar{X}$ ± 95% CI	
2	97	48.8	1.3	176	50.2	0.7	161	48.3	0.7	80	41.9	0.8
3	221	70.1	0.8	287	68.1	0.8	177	69.3	1.0	338	60.3	0.5
4	314	80.3	0.6	64	80.5	1.5	200	83.2	1.0	195	71.5	0.9
5	42	88.7	2.0	8	89.0	5.0	13	87.2	4.5	9	82.2	5.5

The small size of chinook returning in 1983 may be primarily attributable to a reduction in available food in the ocean as a result of warmer-than-normal water conditions off the Pacific coast. This warm water phenomenon, "El Nino", and some of the effects on salmon are discussed in a subsequent section.

RUN SIZE ESTIMATION PROGRAM

INTRODUCTION

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

METHODS

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

RESULTS AND DISCUSSION

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

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

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

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

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

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

Assumption number (1) appears to pose no problem in this instance. Of 201, 93 and 10 coded-wire tags (CWT) recovered from fall chinook captured in the estuarine gill net fisheries during 1981-1983 net harvest monitoring programs, 99.5%, 98.9% and 100% respectively were of Klamath River origin. It does not appear that chinook from other rivers of origin frequent the Klamath River during the fall run period. Similarly, jaw tag recovery and length frequency information

does not seem to imply that large numbers of immature Klamath River chinook frequent the river during this period.

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

Assumptions number (3) and (4) may be difficult to satisfy; however, direct discussion of the data available would appear the best means of validation.

Information on adult fall chinook run sizes in the Klamath-Trinity basin has been available through the CDFG since 1978. Portions of the information are based on weir counts, other portions on mark and recapture or spawning ground survey data. Since counts at weirs appear more likely to satisfy the fourth assumption here, a logical approach would seem to segregate counts from estimates in the run size information and explore two separate relationships between these and beach seine catch/effort data (Table 18).

For discussions of the methods utilized in indexing beach seine catch/effort data for use in in-season abundance estimates, see USFWS 1982a and USFWS 1983. Basically, the following seasonal fall chinook run strength indices were developed by multiplying catch/effort in the peak three sets during run peak periods by the seasonal duration of these periods (number of consecutive days) as follows:

Grilse	1980	Run Strength Index = 9.90 x 24 = 237.60
	1981	Run Strength Index = 6.28 x 29 = 182.12
	1982	Run Strength Index = 8.14 x 32 = 260.48
	1983	Run Strength Index = 1.32 x 37 = 48.84
Adults	1980	Run Strength Index = 8.57 x 24 = 205.68
	1981	Run Strength Index = 14.38 x 29 = 417.02
	1982	Run Strength Index = 21.80 x 32 = 697.60
	1983	Run Strength Index = 8.95 x 37 = 331.15

The relationships between these indices and post-season run size information from CDFG may be defined by fitting least squares linear regressions through the corresponding data sets. As might be expected, catch/effort indices developed were poorly correlated with individual return sites in the basin (Shasta weir, IGH and TRH compared separately). Correlations with pooled weir count data and with total run size estimates proved somewhat more promising, especially for grilse (Figures 36 and 37). Unfortunately, indices were poorly correlated with data on adult returns to the basin. Either of the previously stated assumptions [number (3) or number (4)], or both in combination may therefore be suspect.

TABLE 18. Post-season run size estimates for Klamath River fall chinook during 1980-1983[1/].

Weir Counts	1980[2/] GRILSE	1980[2/] ADULT	1981[2/] GRILSE	1981[2/] ADULT	1982[3/] GRILSE	1982[3/] ADULT	1983[3/] GRILSE	1983[3/] ADULT
IGH	451	2,412	540	2,055	1,833	8,353	514	8,371
TRH	2,256	4,099	1,004	2,370	3,916	2,063	276	5,765
Shasta	4,334	3,762	4,330	7,890	1,912	6,531	753	3,119
Subtotal	7,041	10,273	5,874	12,315	7,661	16,947	1,543	17,255
Estimated Balance[4/] Basin	28,739	31,820	21,894	64,983	28,437	45,749	2,303	40,660
TOTAL RUN SIZE BASIN	35,780	42,093	27,768	77,298	36,098	62,696	3,846	57,915

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

2/ Final estimates for these years.

3/ Estimates preliminary.

4/ Estimates for Trinity River, Bogus Creek and Scott River partially from weir counts but included in this column since substantial data portions were estimated during 1980-1983 period.

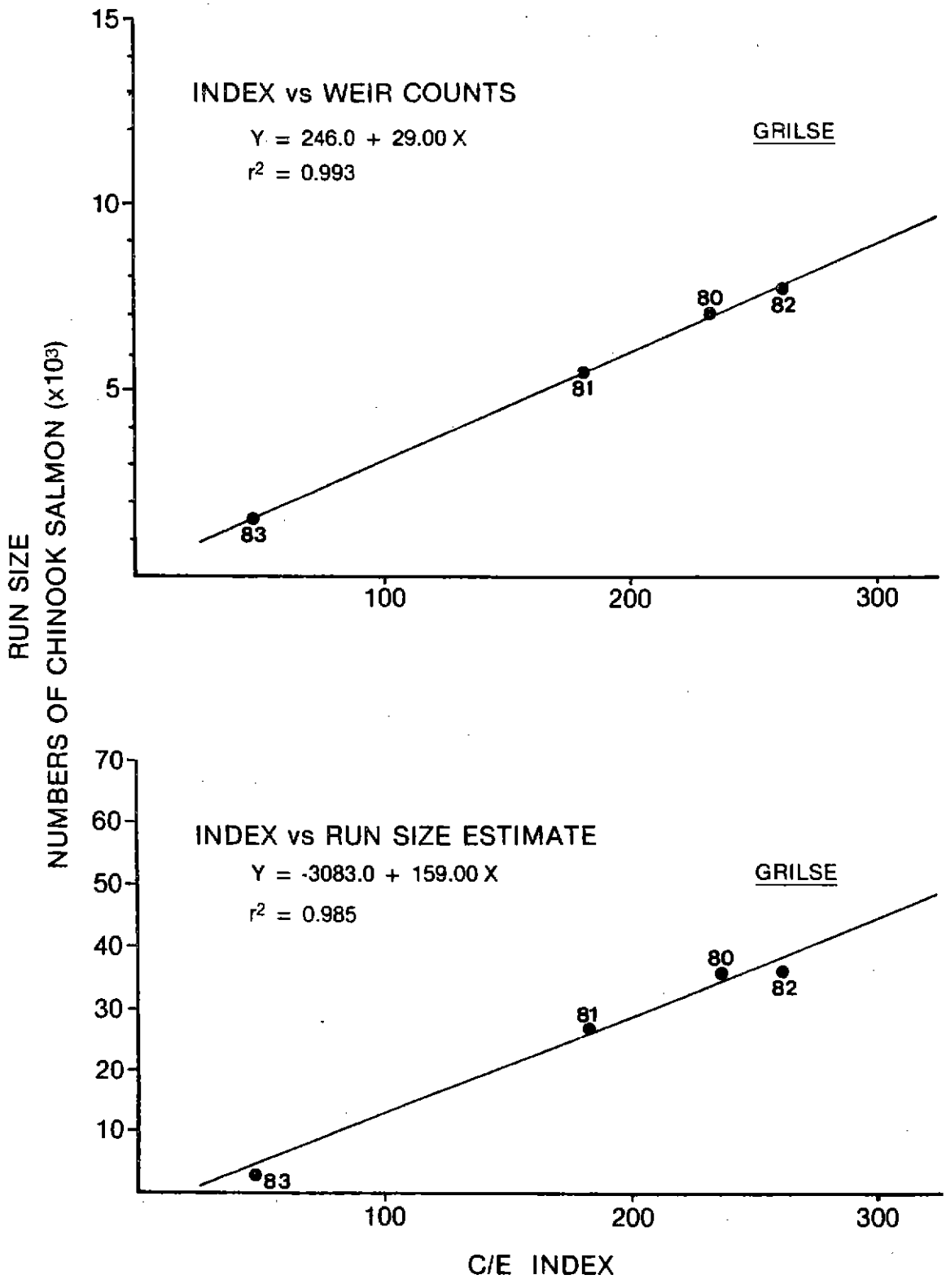


FIGURE 36. Linear relationships between beach seine C/E indices and run size estimates of chinook returning as grilse in 1980-1983.

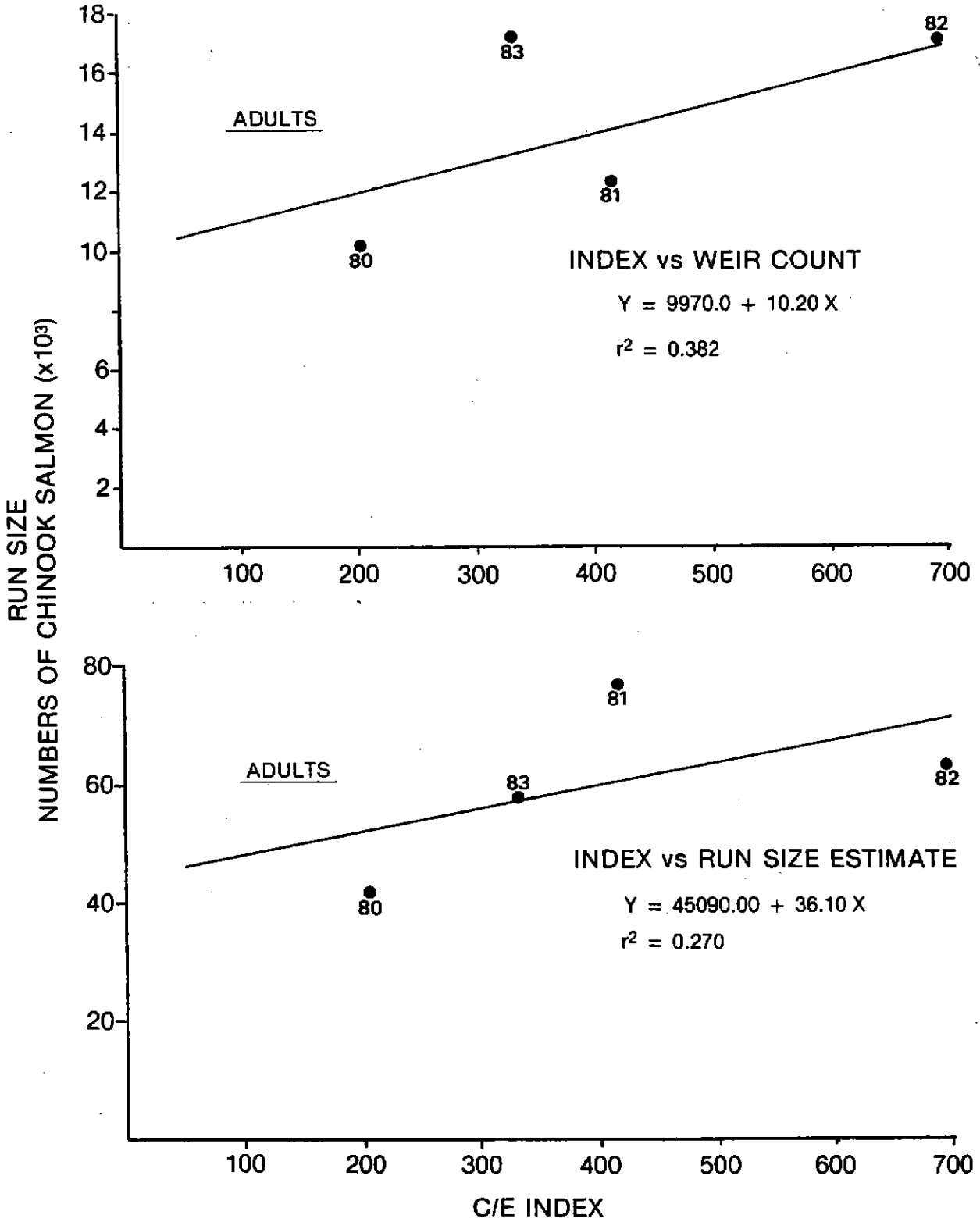


FIGURE 37. Linear relationships between beach seine C/E indices and run size estimates of chinook returning as adults in 1980-1983.

It is difficult to understand how derived indices correlate highly with grilse data (r^2=0.993, 0.985), yet poorly with adult data (r^2=0.382, 0.270). It is unlikely that such high correlation in the case of grilse would be the result of random variation, especially with 4 years of data included. Considering assumption number (3) as suspect, and presuming that the high grilse correlations are real rather than random artifacts of the data, would imply that for some reason adult (and not grilse) chinook are difficult to capture in an unbiased manner in the beach seine. No strong evidence was found to support this possibility. Considering assumption number (4) as suspect, in the same light, would imply that there is a similar problem with adult (but not grilse) run size estimates in the basin. Recently, the Salmon Plan Development Team of the Pacific Fishery Management Council, in compiling a list of concerns, reviewed coded-wire tag data on Klamath River stocks and questioned whether adult fall chinook run size estimates in the Trinity River above Willow Creek had not indeed been overestimated (PFMC 1984). They suggested, further, that the run above this point be counted and not estimated in future years. The Trinity River adult fall chinook estimates for the area above Willow Creek have accounted for an average of 26% of the total adult in-river run since 1978 (CDFG data in PFMC 1984). An error here could therefore seriously impact the total database. In fact, referring to Figure 37 and considering the years 1980-1983, Trinity River estimates for 1981 and 1983 in particular accounted for substantially larger portions of the total basin estimates (24.0% and 35.5% respectively) than those for 1980 and 1982 (20.7% and 17.7% respecively). Overestimates in the 1981 and 1983 seasons would substantially lower the overall 4-year correlation with derived abundance indices. Additional years of data might perhaps refine these relationships to the point where such questions can be answered.

If these relationships eventually prove useful the catch/effort indices on which the defined relationships are based must also be estimated in-season. In 1983, a method was derived through which a critical in-season date can be chosen at which time an estimate of the final season catch/effort index can be made with confidence (USFWS 1983). For this, cumulative daily adult chinook catch/effort in the daily peak three sets were plotted through each of the 1980, 1981 and 1982 run peak periods (Figure 38). It was shown that seasonal cumulative catch/effort values during the run peaks varied less than 5% from respective final season indices as of 9/01/80, 9/02/81 and 8/25/82. These dates fell 14, 15 and 17 days into or 58.3%, 51.7% and 53.2% of the way through 1980, 1981 and 1982 run peak periods respectvely. Since major portions of the in-river harvest occurred further upriver in areas where even smaller percentages of the annual run would have passed by these dates, the timeliness for use in in-season adjustment was made apparent. For example 45.7%, 54.6% and 22.1% of the total in-river fall chinook net harvest occurred by the 1980, 1981 and 1982 critical (5% error) dates respectively.

Using such information, a test was run based on the regression equation describing the relationship between indices and total adult run size during the 1980-1982 seasons ($y=43729.1 + 37.221x$, r^2=.296). A critical date of August 30 was selected 17 days into the 1983 run peak period which began August 13, at which time an index value of 91.22 was calculated by applying a catch/effort value of 3.22 adults per seine haul to a figure of 28.33 days to represent average run peak duration. An estimate of 47,124 adults was generated, which proved to be in error 18.6% from the eventual post-season estimate of 57,915 provided by the CDFG. In this instance selection of the critical date appears to have been the primary reason

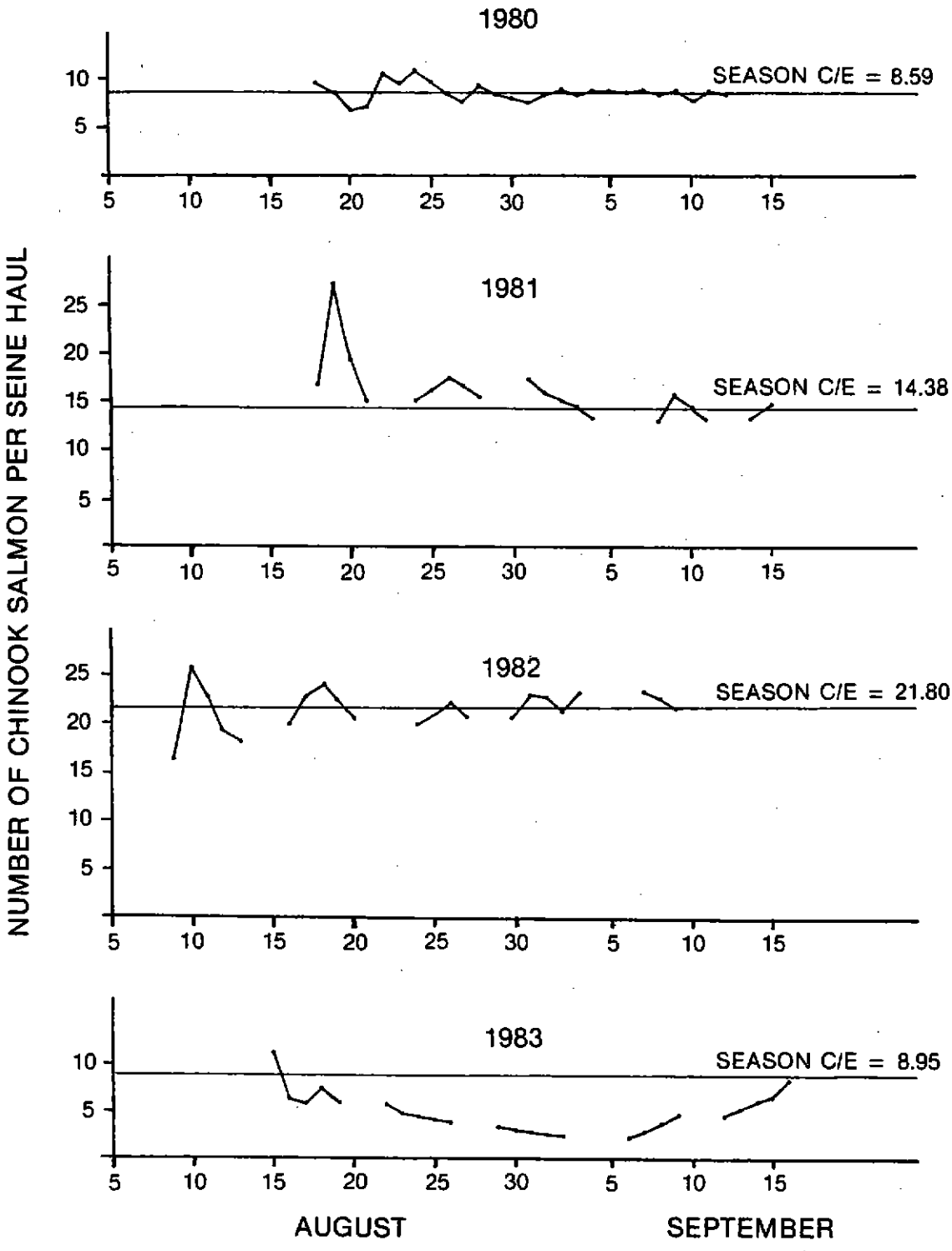


FIGURE 38. Cumulative daily adult chinook salmon catch/effort (C/E) values during peak three sets of run peak periods in 1980-1983 beach seining operations, relative to final season C/E values.

for failure of the predictor. While previous seasons had shown great promise in ability to predict final catch/effort indices early in the run, in 1983 the 5% error level was not reached until the virtual end of the run peak period due to an unusual timing of entry pattern exhibited in the fall chinook run.

The data discussed here and in the beach seine section of this report indicate clearly the problems encountered in attempting to estimate in-season abundance during a year when timing of entry varies widely from patterns exhibited during years on which the model is based. During the years 1980-1982 the timing of entry of fall chinook into the Klamath River, as viewed by beach seine catch and effort data collected during the run-peak periods, followed, roughly, a normal or at least symmetrical distribution. Anticipation of a normal distribution for run entry timing during a year when the pattern is actually positively skewed would result in an overestimate of run size in-season. Conversely, anticipation of a normal distribution during a year when the entry pattern is actually negatively skewed, as in 1983, would result in an underestimate of run size in-season.

Whether the abnormal entry pattern observed in 1983 is a frequent occurrence in the Klamath River fall chinook population or something which happens rarely, during such occasions as the strong 1982-1983 El Nino phenomenon, is a matter for conjecture which only further years of data will illuminate. Because of the low correlation between beach seine catch and effort data and post-season adult fall chinook run size estimates, and due to the difficulties encountered in attempting to predict run entry timing patterns, in-season prediction of Klamath River fall chinook run size through the FAO-Arcata data base does not appear feasible for 1984. However, considering the strong correlation exhibited in the grilse data, and that the unusual entry pattern of 1983 may have been a unique result of the 1982-1983 El Nino, further research into in-season forecasting potential may be warranted, and another test of the model is suggested during 1984.

CODED-WIRE TAG RECOVERY INVESTIGATIONS

INTRODUCTION

Two hatcheries operated by the California Department of Fish and Game (CDFG) are located in the Klamath River basin. Trinity River Hatchery (TRH), at the base of Lewiston Dam, lies 249 river kilometers from the mouth of the Klamath River. Located near the base of Iron Gate Dam on the Klamath River, Iron Gate Hatchery (IGH) lies 306 river kilometers from the mouth. In recent years, these hatcheries have released on-site (at the hatchery) three basic groups of coded-wire tagged (CWT) juvenile chinook salmon; fingerlings in June, yearlings in October, and yearling-plus in March. Trinity River Hatchery also trucked CWT fingerlings 137 and 156 river kilometers downriver to release at off-site (away from the hatchery) locations. Additionally, CWT fingerlings from IGH were distributed to Indian fish culturists to grow to the yearling stage at off-site rearing ponds. Since these release programs differ as to site, time and size release, differing environmental conditions between release and maturity result in varying biological characteristics upon return. These variations between groups must be analyzed in order to evaluate the effectiveness of the hatchery release programs and the impacts of fisheries operating on the stocks. In conjunction with 1983 net harvest monitoring activities, FAO biologists conducted CWT recovery efforts involving the Indian gill net fishery on the Klamath River portion of the Hoopa Valley Reservation.

METHODS

Coded-wire tags were dissected from chinook salmon utilizing a magnetic field detector and read with the aid of an American Optical 507 dissecting microscope. Recovery data for each CWT group were expanded to estimate total contribution to the net harvest by time and area employing a procedure similar to that used by the Oregon Department of Fish and Wildlife (ODFW) in estimating contributions of CWT to the Oregon troll fishery. The expansion first adjusts for non-recovered tags from mark-sampled adipose fin-clipped fish and then adjusts for that portion of the harvest not mark-sampled.

$$(1)\ \text{TAG RECOVERY RATE} = \frac{\text{NUMBER OF TAGS RECOVERED}}{\text{NUMBER OF ADIPOSE FIN-CLIPPED CHINOOK OBSERVED}}$$

$$(2)\ \text{HARVEST SAMPLING RATE} = \frac{\text{NUMBER OF FISH EXAMINED FOR MARKS}}{\text{TOTAL ESTIMATED NET HARVEST}}$$

The two derived rates were multiplied to yield an expanded tag factor for each CWT group by area and time. The recovery data were then divided by the respective expanded tag factors to produce the contribution estimates.

Harvest estimates of CWT groups were generally derived monthly (April-June) or semi-monthly (July-October) by area, except when low sampling rates or abbreviated sampling schedules called for deviations from these time periods.

Contribution rates of CWT groups to the Indian net fishery were calculated for each tag code.

$$(3)\ \text{CONTRIBUTION RATE (\%)} = \frac{\text{ESTIMATED CWT HARVEST}}{\text{NUMBER OF ADIPOSE-CLIPPED JUVENILES RELEASED}} \times 100$$

The estimated CWT harvest assumes 0% tag loss; however, the number of marked juveniles released includes adipose-clipped fish that shed the CWT before release. The contribution rate compensates for unequal release size bias and allows comparison of release strategies, hatchery effectiveness and age composition. Age composition was determined by summing individual CWT group contribution rates and then calculating the percentage contribution of groups in each age class.

RESULTS AND DISCUSSION

Fall Chinook Salmon

Coded-wire tag recoveries from fall chinook in the 1983 Indian net harvest totaled 108, all of which were obtained through the net harvest mark-sampling program (Table 19). The mark-sampled recoveries expand to an estimated harvest of 468 fall chinook representing 16 release groups: 5 from the Trinity River Hatchery, 5 from Iron Gate Hatchery and 6 from the ponding program.

Fall chinook contribution rates of Trinity River Hatchery CWT release groups harvested during the 1980-1983 Indian net fishery varied with the type and site of release (Table 20). Juveniles released at a large size contributed to the net fishery at a higher rate. For on-site hatchery releases, the highest contribution rate occurred among the yearling-plus groups (0.254%), followed by yearling (0.145%) and fingerling (0.023%) groups. Release site comparisons show fingerlings planted off-site (0.061%) contributed at over twice the rate of on-site releases (0.023%).

Fall chinook contribution rates from Iron Gate Hatchery CWT release groups harvested during the 1980-1983 Indian net fisheries also varied by release type (Table 21). Iron Gate Hatchery did not release off-site. For the 1979 brood year, the yearling release (0.105%) contributed at a higher rate than the fingerling release (0.063%). The 3-year-old returns of the 1980 brood year had near equal contribution rates for yearling (0.036%) and fingerling (0.033%) releases.

Iron Gate Hatchery and Trinity River Hatchery CWT releases contributed at near equal rates to the 1983 Klamath River net fishery. Combining release types for each hatchery yielded overall contribution rates of 0.028% for TRH and 0.035% for IGH. In past years, IGH had a higher contribution rate than TRH, primarily attributed to the strong returns from the 1978 brood.

In 1983, the first significant CWT fall chinook recoveries from the Klamath River ponding program entered the Indian net fishery. The ponding program is a cooperative rearing program between the CDFG and the Karok Indian Tribe, who rear IGH fingerlings to the yearling stage and release them into the upper Klamath River tributaries. The ponding program provides additional rearing capacity above hatchery levels and increases spawner returns to the tributaries where the rearing ponds are located.

An estimated 55 age 3 fall chinook representing six tag codes 6-59-12 to 6-59-17, were captured in the Klamath River Indian net fishery. Pond-reared fish comprised 11.8% of the expanded CWT returns. The contribution of pond-reared fish to the Klamath net fishery was probably greater but incidental tag loss proved

TABLE 19. Actual and expanded (underlined) CWT groups recovered during mark-sampling of fall chinook salmon in the 1983 gill net fishery in the Klamath River portion of the Hoopa Valley Reservation.

Tag Code	Brood Year	Hatchery of Origin[1]	Release Type[2]	RESERVATION MONITORING AREA							
				Estuary		Middle Klamath		Upper Klamath		All Areas	
6-59-01	1978	IGH	Y	1	4	1	6	2	7	4	17
6-59-02	1979	IGH	Y	1	5	3	37	10	35	14	77
6-59-03	1979	IGH	F	3	14	0	0	5	17	8	31
6-61-09	1979	TRH	Y	0	0	2	22	6	19	8	41
6-61-16	1979	TRH	F	0	0	0	0	1	5	1	5
6-61-17	1979	TRH	F[3]	1	4	6	27	8	28	15	59
6-61-20	1979	TRH	Y+	1	4	2	9	11	37	14	50
6-59-05	1980	IGH	F	2	9	2	22	10	35	14	66
6-59-06	1980	IGH	Y	0	0	2	22	4	14	6	36
6-59-12	1980	IGH	F[4]	1	5	0	0	0	0	1	5
6-59-13	1980	IGH	Y[5]	0	0	0	0	2	6	2	6
6-59-14	1980	IGH	Y[6]	0	0	0	0	5	17	5	17
6-59-15	1980	IGH	F[7]	0	0	0	0	2	7	2	7
6-59-16	1980	IGH	F[7]	0	0	0	0	2	7	2	7
6-59-17	1980	IGH	Y[8]	0	0	1	6	2	7	3	13
6-61-21	1980	TRH	Y	0	0	1	6	8	25	9	31
TOTALS				10	45	20	157	78	266	108	468

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

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

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

4/ Accidental fingerling release - Beaver Creek Ponding Program (Klamath)

5/ Thompson Creek Ponding Program (Klamath)

6/ Redcap Creek Ponding Program (Klamath)

7/ Accidental fingerling release - Indian Creek Ponding Program (Klamath)

8/ Redcap and Camp Creek Ponding Program (Klamath)

TABLE 20. Contribution rates of age 3 and 4 adult fall chinook to the Indian net fishery on the Klamath River portion of the Hoopa Valley Reservation for fingerling and yearling juveniles released from Trinity River Hatchery.

Release Type		AGE(S) AT HARVEST 3 & 4	3 & 4	3 & 4	
	Tag Code	6-61-02	6-61-08	6-61-16	Total
Fingerling on-site	Number Harvested[1/]	67	57	10	134
	Number Released[2/]	189,215	191,374	191,019	571,608
	Contribution Rate (%)[3/]	0.035	0.030	0.005	0.023
	Tag Code	6-61-03	6-61-10	6-61-17	Total
Fingerling off-site	Number Harvested	40	182	133	355
	Number Released	192,014	193,808	196,650	582,472
	Contribution Rate (%)	0.021	0.094	0.068	0.061
	Tag Code	6-61-05	6-61-14	6-61-09	Total
Yearling	Number Harvested	385	250	82	717
	Number Released	192,014	209,161	91,821	492,996
	Contribution Rate (%)	0.201	0.120	0.089	0.145
	Tag Code	6-61-07	6-61-15	6-61-20	Total
Yearling plus	Number Harvested	651	348	127	1,126
	Number Released	195,080	163,749	84,503	443,332
	Contribution Rate (%)	0.334	0.213	0.150	0.254

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

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

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

TABLE 21. Contribution rates of age 3 and 4 adult fall chinook to the Indian net fishery on the Klamath River portion of the Hoopa Valley Reservation for fingerling and yearling juveniles released from Iron Gate Hatchery.

Release Type		AGE(S) AT HARVEST 3 & 4	3 & 4	3	Total
	Tag Code	6-59-01	6-59-02	6-59-06	
	Brood Year	1978	1979	1980	
	Number Harvested[1/]	1,075	105	36	1,216
Yearling on-site	Number Released[2/]	203,700	100,000	99,150	402,850
	Contribution Rate (%)[3/]	0.528	0.105	0.036	0.302
	Tag Code	6-59-03		6-59-05	Total
	Brood Year	1979		1980	
	Number Harvested	129		66	195
Fingerling on-site	Number Released	205,000		202,901	407,901
	Contribution Rate (%)	0.063		0.033	0.049

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

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

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

to be a problem. During the time period when 84.6% of the pond-reared chinook were harvested in 1983, the CWT recovery rate was only 71.2%. In comparison, in 1982 when there were no significant returns of tagged pond-reared chinook, the CWT recovery rate was 87.5%. Additionally, the actual release size of some tag codes was unknown. Since contribution rate calculations rely on accurate release and tagging data, estimates for tag codes 6-59-12 through 6-59-17 were too speculative and therefore are not presented.

The age composition of CWT fall chinook salmon harvested in the 1983 Indian net fishery was 1.0% 5-year-olds, 27.5% 4-year-olds and 71.6% 3-year-olds. No CWT 2-year-olds were caught in the 1983 fishery. Age class composition in the net catch shifted from mostly 4-year-olds in 1982 to predominantly 3-year-olds in 1983. The shift in age composition was probably due to the strong influence of the 1978 brood year which resulted in a large proportion of 4-year-olds in the 1982 fishery, and a higher than normal return of 5-year-olds in 1983. Age composition comparisons between sampling areas showed the same trends as in previous years with salmon caught in the lower river being older than those caught in the upper Klamath (Figure 39).

As in past years, IGH CWT groups entered the net fishery earlier than TRH CWT groups (Figure 40). In the Upper Klamath Area fishery, about 75% of the CWT groups caught during the first half of September originated from IGH compared to near 50% during the second half of September. By early October, the catch was almost exclusively of TRH origin.

In past years, CWT groups have shown an inverse relationship between size at release and size at harvest. In 1983, within each age class, the mean length at harvest generally decreased from fingerling to yearling releases (Table 22). However, because of small sample sizes, none of the comparisons were significant ($p > 0.05$). Mean length of fingerling on- and off-site releases also showed no significant differences ($p > 0.05$).

Coded-wire tag recoveries from 4-year-old chinook groups were of smaller mean length in 1983 than in 1982. Significant ($p < 0.05$) mean length decreases for 4-year-olds in 1983 versus 1982 were evident for four comparable groups: a 9.1 cm decrease for IGH yearling (6-59-1 vs 6-59-2), a 9.0 cm decrease for TRH fingerling on- and off-site (6-61-8/10 vs 6-61-16/17), a 7.4 cm decrease for TRH yearling (6-61-14 vs 6-61-9) and a 6.4 cm decrease for TRH yearling-plus (6-61-15 vs 6-61-20). Significant decreases in mean length for age 3 chinook were evident for three comparable groups: a 8.4 cm decrease for IGH fingerling (6-59-3 vs 6-59-5), a 9.4 cm decrease for IGH yearling (6-59-2 vs 6-59-6) and a 7.0 cm decrease for TRH yearling (6-61-9 vs 6-61-21).

Coded-wire tagged groups harvested in 1983 were generally of a smaller mean length than any of the three previous years. Prior to 1983, CWT group recoveries from 1980 were of the smallest mean length. To compare mean length differences between tag recoveries in 1980, when only lower river fisheries were sampled, with tag recoveries in 1983, when CWT group sample sizes were small, all available CWT length data were combined from groups of the same brood year taken in the Estuary Area. In 1983, 3-year-old chinook had a mean length of 61.0 cm while in 1980 the mean length was 63.3 cm, a difference of 2.3 cm. In 1983, 4-year-old chinook had a mean length of 74.2 cm while 1980 chinook had a mean length of 75.9 cm, a difference of 1.7 cm.

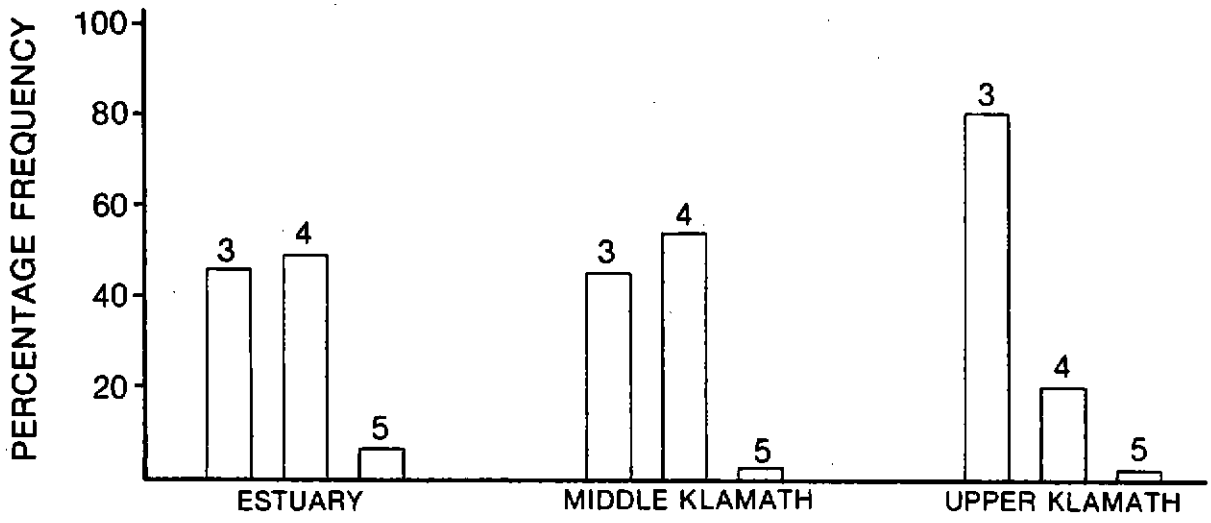


FIGURE 39. Age composition of Trinity River and Iron Gate Hatchery groups harvested in the three monitoring areas of the Klamath River portion of the Hoopa Valley Reservation in 1983 (percentages corrected for unequal size of CWT release groups in their respective brood years).

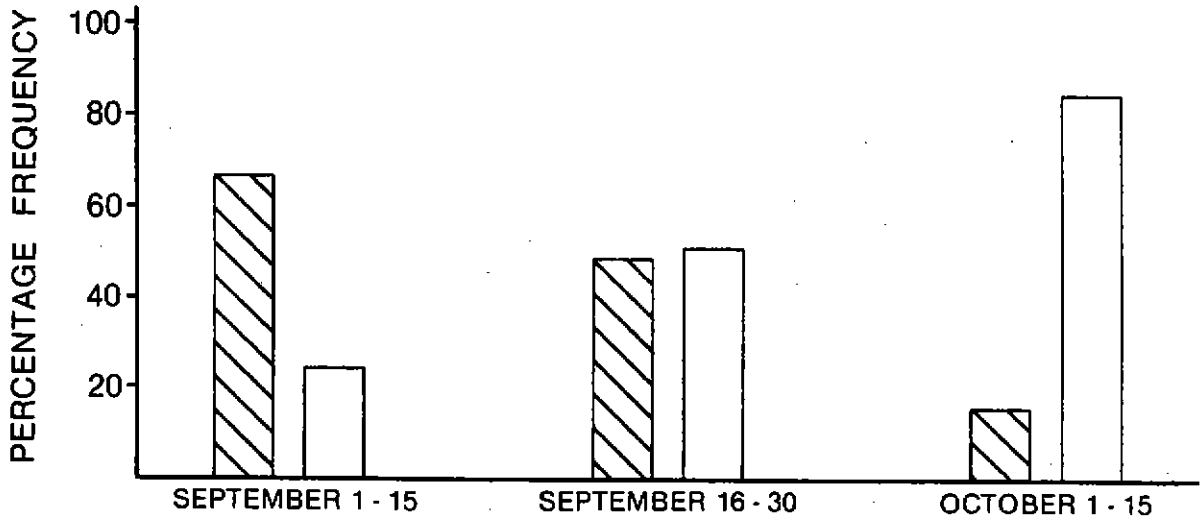


FIGURE 40. Percentage contribution of Iron Gate Hatchery CWT groups (lined) and Trinity River Hatchery CWT groups (plain) to the estimated Upper Klamath fall chinook CWT net harvest in 1983.

TABLE 22. Mean fork length, standard deviation and number of recoveries for 16 fall chinook CWT groups harvested in the Klamath River portion of the Hoopa Valley Reservation in 1983.

Tag Code	Year	Hatchery[1] Of Origin	Release[2] Type	HARVEST MONITORING AREA			
				Estuary	Middle Klamath	Upper Klamath	All Areas
6-59-1	1978	IGH	Y	100.0[4]	95.0	75.5	86.5
				---[5]	---	0.71	12.87
				1[6]	1	2	4
6-59-2	1979	IGH	Y	60.0	75.3	75.1	74.1
				---	8.74	4.87	6.67
				1	3	10	14
6-59-3	1979	IGH	F	80.0	---	73.8	76.1
				1.00	---	3.03	3.98
				3	0	5	8
6-61-9	1979	TRH	Y	---	77.0	73.0	74.0
				---	7.07	3.85	4.60
				0	2	6	8
6-61-16	1979	TRH	F	---	---	72.0	72.0
				---	---	---	---
				0	0	1	1
6-61-17	1979	TRH	F[3]	75.0	71.8	75.1	73.8
				---	3.55	6.13	5.10
				1	6	8	15
6-61-20	1979	TRH	Y+	70.0	71.5	72.4	72.1
				---	2.12	4.41	3.97
				1	2	11	14
6-59-5	1980	IGH	F	62.0	61.5	65.4	64.4
				2.83	2.12	5.76	5.18
				2	2	10	14
6-59-6	1980	IGH	Y	---	57.5	59.8	59.0
				---	7.77	4.27	4.94
				0	2	4	6
6-59-12	1980	IGH	F[3]	59.0	---	---	59.0
				---	---	---	---
				1	0	0	1
6-59-13	1980	IGH	Y[3]	---	---	62.0	62.0
				---	---	7.07	7.07
				0	0	2	2
6-59-14	1980	IGH	Y[3]	---	---	59.2	59.2
				---	---	6.22	6.22
				0	0	5	5
6-59-15	1980	IGH	F[3]	---	---	65.5	65.5
				---	---	4.95	4.95
				0	0	2	2
6-59-16	1980	IGH	Y[3]	---	---	62.0	62.0
				---	---	12.73	12.73
				0	0	2	2
6-59-17	1980	IGH	Y[3]	---	63.0	56.0	58.3
				---	---	4.24	5.03
				0	1	2	3
6-61-21	1980	TRH	Y	---	57.0	58.4	58.1
				---	---	4.96	4.34
				0	2	7	9

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

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

3/ Offsite release

4/ Mean fork length

5/ Standard deviation

6/ Number in sample

Spring Chinook Salmon

Coded-wire tag recoveries from spring chinook salmon in the 1983 Indian net harvest in the Klamath River totaled 25, all of which were obtained through the net harvest mark-sample program (Table 23). The mark-sample recoveries expanded to an estimated harvest of 256 spring chinook representing eight release groups: six from TRH, one from Cole Rivers Hatchery (CRH) and one from Burnt Hill Salmon Ranch (BHSR).

Spring chinook contribution rates of Trinity River Hatchery CWT release groups harvested during 1980-1983 Klamath River Indian net fishery varied with the type and site of release (Table 24). Juveniles released at a larger size contributed to the Indian net fishery at a higher rate. For on-site hatchery releases, the highest contribution rate occurred for yearling-plus (0.256%) followed at a slightly lower rate for yearling release (0.238%). The contribution rate for fingerling on-site releases (0.024%) was only 10% of the yearling or yearling-plus contribution rates. Fingerling off-site releases (0.103%) contributed at over four times the rate as fingerling on-site releases (0.024%).

The age composition of CWT spring chinook salmon harvested in the 1983 Indian net fishery was 4% 5-year-olds, 84% 4-year-olds and 12% 3-year-olds. No CWT 2-year-olds were caught in the 1983 fishery. The 1982 spring chinook catch was also dominated by 4-year-old salmon.

The straying of a Rogue River (CRH) CWT group (7-20-23) into the Klamath River during the spring season is not considered unusual. In 1982, about 5% of spring chinook CWT returns originated from the Rogue River system, and in 1980 and 1981, respective 48% and 11% incidences were noted. The single CRH recovery in 1983 represents 4% of the total CWT recoveries taken in the spring. The occurrence of a Burnt Hills Salmon Ranch (southern Oregon coast) CWT group (62-18-4) in 1983 represented the first and only BHSR salmon ever recovered in the Klamath River net fishery.

Coded-wire tag recoveries from groups of TRH 3- and 4-year-old spring chinook were of smaller mean length in 1983 than in 1982. As a result of the low numbers of tag recoveries in 1983, only four release groups could be statistically compared. Of the four between year age class comparisons, two were significant ($p < 0.05$): a 8.8 cm decrease for 1983 4-year-old yearling-plus (6-61-31 vs 6-61-36), and an 11.6 cm decrease for 1983 3-year-old yearling (6-61-34 vs 6-61-39). Two other mean length comparisons, a 1.5 cm decrease for 1983 4-year-old yearling (6-61-30 vs 6-61-34) and a 2.2 cm decrease for combined on- and off-site fingerling (6-61-11 vs 6-61-32/33) were not significant ($p > 0.05$). Comparison of release types in 1983 showed an inverse relationship between time of release and size at capture between yearling and yearling-plus releases. The yearling-plus 6-61-34 release was significantly smaller ($p < 0.05$) at return than the yearling 6-61-34 release (63.0 cm vs 73.8 cm). Mean lengths of fingerling and yearling release types were not significantly different with yearlings (6-61-34) 0.2 cm smaller than fingerlings (6-61-32/33).

In-River Net Versus Ocean Fisheries

Overall annual ratios of ocean (commercial and sport troll combined) versus Klamath River Indian gill net harvest of Klamath River CWT fall chinook for 1980-1983 were 9.0:1, 3.6:1, 8.5:1 and 7.0:1 respectively. Ratio calculations

TABLE 23. Mean fork length, standard deviation, and actual and expanded (underlined) CWT recoveries for eight spring chinook CWT groups harvested in the Klamath River portion of the Hoopa Valley Reservation in 1983.

Tag Code	Brood Year	Hatchery[1/] of Origin	Release[2/] Type	CWT Recoveries		Mean Fork Length	Standard Deviation
6-61-30	1978	TRH	Y	1	10	76.0	- - -
6-61-32	1979	TRH	F	1	10	82.0	- - -
6-61-33	1979	TRH	F[3/]	13	133	73.4	6.20
6-61-34	1979	TRH	Y	4	41	73.8	3.50
6-61-36	1979	TRH	Y+	2	21	63.0	1.41
62-18-4	1979	BHSR	Y	1	10	82.0	- - -
7-20-23	1980	CRH	Y+	1	10	43.0	- - -
6-61-39	1980	TRH	Y	2	21	56.0	1.41
TOTALS				25	256		

1/ BHSR - Burnt Hill Salmon Ranch
CRH - Cole Rivers Hatchery (Rogue River System)
TRH - Trinity River Hatchery

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

3/ Off-site release at Trinity River Kilometer 40.0 (Willow Creek)

TABLE 24. Spring chinook contribution rates to the Indian net fishery on the Klamath River portion of the Hoopa Valley Reservation for age 3 and 4 adults of the four release types from the Trinity River Hatchery.

Release Type		AGE(S) AT HARVEST 3 & 4	3 & 4	3 & 4	
	Tag Code		6-61-12	6-61-32	Total
Fingerling on-site	Number Harvested[1/]		82	10	92
	Number Released[2/]		188,313	190,349	376,662
	Contribution Rate (%)[3/]		0.044	0.005	0.024
	Tag Code		6-16-11	6-61-33	Total
Fingerling off-site	Number Harvested		218	179	397
	Number Released		200,000	186,544	386,544
	Contribution Rate (%)		0.109	0.096	0.103
	Tag Code	6-61-04	6-61-30	6-61-34	Total
Yearling	Number Harvested	40	796	92	928
	Number Released	99,301	204,166	86,594	390,061
	Contribution Rate (%)	0.040	0.390	0.106	0.238
	Tag Code		6-61-31	6-61-36	Total
Yearling plus	Number Harvested		443	21	464
	Number Released		144,206	36,845	181,051
	Contribution Rate (%)		0.307	0.057	0.256

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

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

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

reported in past USFWS annual reports were adjusted to eliminate past years' Trinity River net harvests and therefore provide comparative data. In 1982 and 1983 a higher proportion of IGH CWT groups (Table 25) were harvested in-river than comparable TRH CWT groups (Table 26). In 1983, the ratio of ocean/net harvest of CWT 3-year-olds (5.5:1) was lower than the ratio of returning 4-year-olds (8.7:1) (Table 27). Conversely, in 1982 the ocean/river net ratio of 3-year-olds (21.8:1) was over 6 times greater than for 4-year-olds (3.4:1). Harvest ratios for 3-year-olds returned to a near normal level in 1983 after the abnormal trend in the 1982 data. As in past years, 2-year-old CWT groups in 1983 contributed little to either the ocean or net fisheries.

Klamath River CWT fall chinook groups contriubted to the fisheries operating between Fort Bragg, California, and Newport, Oregon, with over 90% of the ocean recoveries occurring between these ports. Relative contribution indices of CWT Klamath River fall chinook to 1983 ocean landings by coastal port are present in Figure 41. These contribution indices, compared with those derived in 1981 and 1982, demonstrate a continued northerly shift in ocean distribution of tagged Klamath River fall chinook from 1981 to 1983 (USFWS 1983, USFWS 1982a).

The overall annual ratio of ocean to Klamath River gill net harves of CWT Klamath River spring chinook in 1983 increased slightly from 1982 (Table 28). The 1983 harvest ratio of 3.0:1 is similar to the 1980-1983 average of 3.1:1. Ocean troll fisheries have in the past harvested a larger proportion of 3-year-olds versus 4-year-olds in comparison with the net fishery. However, in 1983 the trend reversed and the ratio of 3-year-olds (2.7:1) harvested in the troll fishery was smaller than 4-year-olds (3.2:1). Reduced catches in the 1983 ocean troll fisheries may have reduced the harvest of immature 3-year-old spring chinook. Grilse CWT groups contributed little to the ocean and net fisheries.

TABLE 25. Estimated contributions of Iron Gate Hatchery fall chinook CWT groups to the 1981-1983 ocean and Indian gill net fisheries.

Tag Code	Brood Year	Return Year	Ocean[1/] Harvest	Gill Net[2/] Harvest	Harvest Ratio Ocean/Gill Net
6-59-01	1978	1981	2,405	302	8.0:1
		1982	1,802	517	3.5:1
		1983	6	17	0.4:1
6-59-02	1979	1982	1,026	20	36.6:1
		1983	572	77	7.4:1
6-59-03	1979	1981	5	9	0.6:1
		1982	1,759	98	17.9:1
		1983	199	31	6.4:1
6-59-05	1980	1982	7	11	0.6:1
		1983	347	66	5.3:1
6-59-06	1980	1982	15	0	- - -
		1983	181	36	5.0:1
6-59-12	1980	1983	45	5	9.0:1
6-59-13	1980	1983	8	6	1.3:1
6-59-14	1980	1983	24	17	1.4:1
6-59-15	1980	1983	33	7	4.7:1
6-59-16	1980	1983	72	7	10.3:1
6-59-17	1980	1983	26	13	2.0:1
6-59-07	1981	1983	2	0	- - -
6-59-18	1981	1983	2	0	- - -
6-59-19	1981	1983	2	0	- - -
TOTALS AND OVERALL RATIOS		1981	2,410	311	7.7:1
		1982	4,609	646	7.1:1
		1983	1,519	282	5.4:1

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

2/ Includes only those fish landed on the Klamath River portion of the Hoopa Valley Reservation.

TABLE 26. Estimated contributions of Trinity River Hatchery fall chinook CWT groups to the 1980-1983 ocean and Indian gill net fisheries.

Tag Code	Brood Year	Return Year	Ocean[1/] Harvest	Gill Net[2/] Harvest	Harvest Ratio Ocean/Gill Net
6-61-09	1979	1981	14	0	- - -
		1982	1,234	42	29.4:1
		1983	329	41	8.0:1
6-61-16	1979	1981	8	6	1.3:1
		1982	187	5	37.4:1
		1983	93	5	18.6:1
6-61-17	1979	1981	4	34	0.1:1
		1982	2,279	74	30.8:1
		1983	417	59	7.1:1
6-61-20	1979	1981	0	14	- - -
		1982	607	77	7.9:1
		1983	640	50	12.8:1
6-61-18	1980	1982	3	6	0.5:1
		1983	36	0	- - -
6-61-21	1980	1982	16	24	0.7:1
		1983	241	31	7.8:1
Other[3/] Tag Codes		1980	5,068	562	
		1981	4,387	1,533	
		1982	913	279	
		1983	11	0	
TOTALS AND OVERALL RATIOS		1980	5,068	562	9.0:1
		1981	4,413	1,587	2.8:1
		1982	5,239	507	10.3:1
		1983	1,767	186	9.5:1

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

2/ Includes only those fish landed on the Klamath River portion of the Hoopa Valley Reservation.

3/ Summary of contribution from tag codes not included in the table.

TABLE 27. Estimated contributions of age 3 and 4 adult fall chinook CWT groups to the 1980-1983 ocean and Klamath River gill net fisheries.

	AGE AT HARVEST					
	3			4		
	Ocean[1/] Harvest	Gill Net[2/] Harvest	Ratio Ocean/Gill Net	Ocean Harvest	Gill Net Harvest	Ratio Ocean/Gill Net
1980	2,521	263	9.6:1	2,547	270	9.4:1
1981	4,109	871	4.7:1	2,599	878	3.0:1
1982	7,092	324	21.8:1	2,707	786	3.4:1
1983	997	188	5.3:1	2,247	263	8.5:1
TOTAL	14,719	1,646	8.9:1	10,100	2,197	4.6:1

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

2/ Gill net harvest in 1980-1982 adjusted to reflect only those fish caught on the Klamath River portion of the Hoopa Valley Reservation.

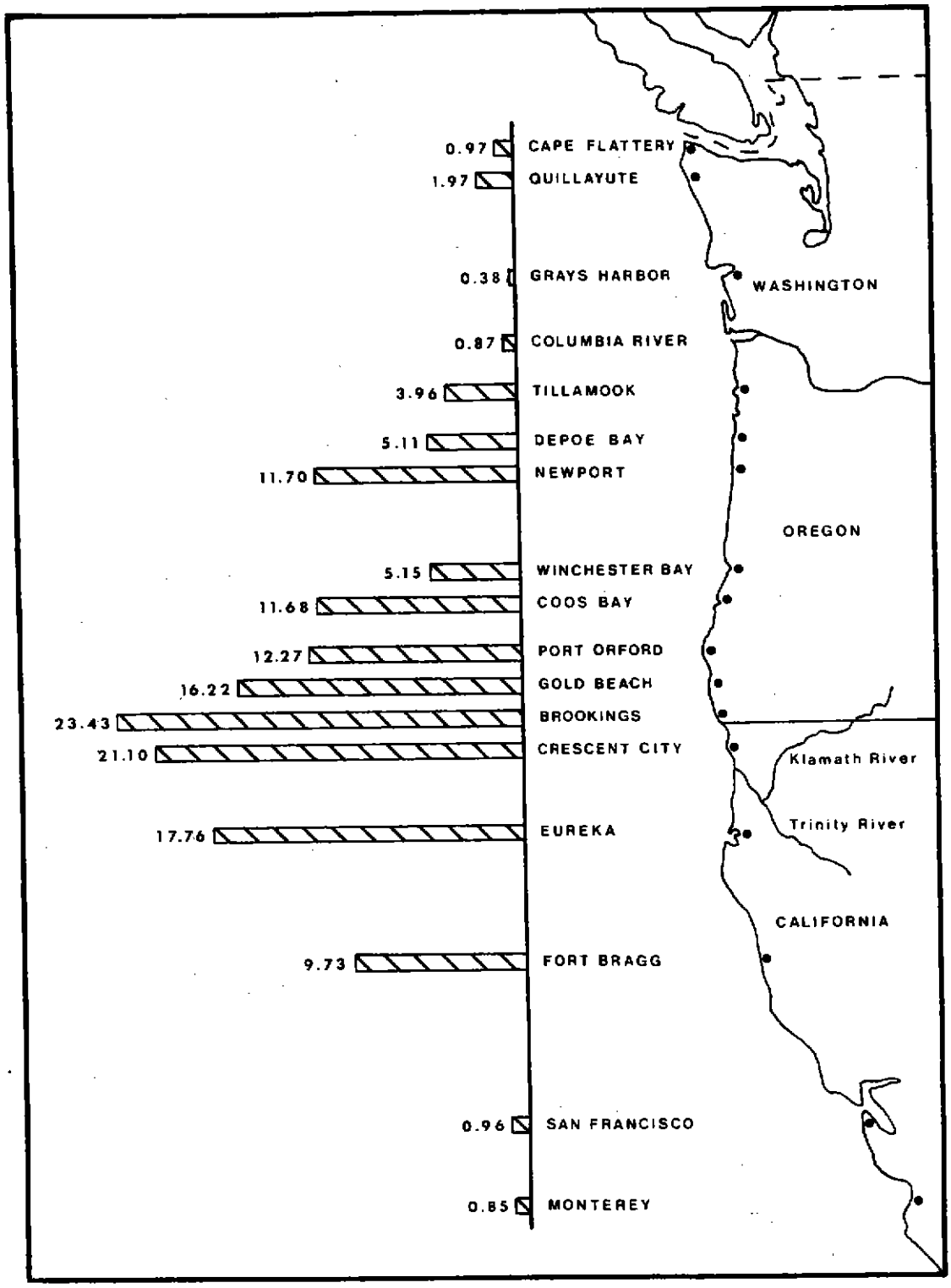


FIGURE 41. Relative contribution indices of CWT Klamath River fall chinook to 1983 ocean landings, by California, Oregon and Washington ports. (Calculated from preliminary data provided by CDFG, ODFW and WDF.)

TABLE 28. Estimated contributions of Trinity River Hatchery spring chinook CWT groups to the 1980-1983 ocean and Indian gill net fisheries.

Tag Code	Brood Year	Return Year	Ocean[1/] Harvest	Gill Net[2/] Harvest	Harvest Ratio Ocean/Gill Net
6-61-30	1978	1981	993	126	7.9:1
		1982	178	670	0.3:1
		1983	0	10	- - -
6-61-31	1978	1981	178	25	7.1:1
		1982	143	418	0.3:1
		1983	3	0	- - -
6-61-32	1979	1981	13	0	- - -
		1982	162	0	- - -
		1983	33	10	3.3:1
6-61-33	1979	1981	2	7	0.3:1
		1982	1,440	46	31.3:1
		1983	197	133	1.4:1
6-61-34	1979	1981	0	5	- - -
		1982	810	51	15.9:1
		1983	261	41	6.4:1
6-61-36	1979	1981	0	0	- - -
		1982	26	0	- - -
		1983	149	21	7.1:1
6-61-39	1980	1982	10	0	- - -
		1983	57	21	2.7:1
6-61-35	1981	1983	7	0	- - -
6-61-37	1981	1983	10	0	- - -
Other[3/] Tag Codes		1980	588	167	
		1981	1,087	4	
		1982	24	68	
TOTALS AND OVERALL RATIOS		1980	588	167	3.5:1
		1981	2,273	419	5.4:1
		1982	2,793	1,253	2.2:1
		1983	717	236	3.0:1

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

2/ Includes only those fish landed on the Klamath River portion of the Hoopa Valley Reservation.

3/ Summary of contributions from tag codes not included in the table.

CHINOOK SALMON HARVEST OVERVIEW

The 1983 California ocean commercial troll fishery was regulated through various in-season closures and gear restrictions. The total of 274,400 chinook landed in 1983 represents a decline of 64% from 1982, and is only 49% of the 1971-1975 average. North Coast landings (Fort Bragg, Eureka and Crescent City ports) of 109,700 chinook were 68% below 1982 and only 37% of the 1971-1975 average. California 1983 ocean recreational landings of 62,100 chinook were down 58% from 1982 landings, including North Coast landings of 10,000 down 52% from 1982 (PFMC 1984).

The 1983 Oregon ocean commercial troll fishery was regulated through various in-season closures and gear restrictions. Landings for the year totaled 79,600 chinook, a decline of 66% from 1982 and 62% below the 1971-1975 average. Landings in 1983 south of Coos Bay totaled 41,800 chinook, a decline of 77% from 1982. Oregon 1983 ocean recreational landings totaled 24,700 chinook, 36% below 1982 and 56% below the 1974-1975 average. The 1983 recreational landings south of Coos Bay totaled 19,000 chinook, a 26% decline from 1982 (PFMC 1984).

The Klamath River 1983 sport fishery harvest of 4,695 fall chinook was 76% below 1982 and the smallest catch since 1979. The 1983 adult harvest of 4,342 was the smallest since 1980, comprising 7.5% of the total in-river adult run. In-river fall chinook sport fishery harvest levels had risen steadily from 1978 to 1982 before the 1983 deline (CDFG preliminary data, in PFMC 1984).

Klamath River Indian gill net combined spring and fall chinook harvest, previously discussed in this report, declined 56% from 19,481 in 1982 to 8,648 in 1983.

Several estimates of the contribution rate of Klamath River chinook to the ocean fisheries operating between Fort Bragg, California and Coos Bay, Oregon have been used by the Pacific Management Council (PFMC) and California Department of Fish and Game (CDFG) to analyze the influence of offshore regulations on Klamath River stocks during recent years - 40% (CDFG 1980), 30% (PFMC 1982) and 21% (CDFG 1983). Since it appears the Klamath stock contribution rate may have dropped during this period, the intermediate figure may be most useful in representing average contribution during the 1979-1983 period. Additionally, coded-wire tag return data suggest that about 90% of the 1979-1982, and 80% of the 1983 total ocean harvest of Klamath River chinook occurred in this area. The lower rate during 1983 may reflect a northward shift of Klamath stocks due to special ocean conditions (El Nino) prevailing during that season. Noncatch mortality of chinook in the ocean fishery has been reported by Ricker (1976) and others, and appears to approximate 40% to 50% of the coastwide ocean harvest. Barbless hooks used in the 1983 ocean fisheries may have lowered the rate of non-catch mortality somewhat. Using the various estimates and assumptions available, the 1979-1983 ocean commercial and recreational fisheries appear to have accounted for approximately 214,920 Klamath River chinook annually (Table 29). The numbers, however, appear to have declined annually during this period reaching an extremely low level in 1983.

Annual Klamath River sport and Indian gill net harvests have averaged approximately 10,770 and 19,100 respectively since 1979 while chinook run size and spawner escapement in the basin have averaged a respective 87,760 and 57,890

annually. These data result in mean annual ratios of 1.8:1 ocean landings to river returns, 2.5:1 total ocean fishing losses to river returns, and 4.2:1 total fishing losses to spawner escapement (Table 30, Figure 42).

Most noticeable from the available data is the sharp drop in harvest in all chinook salmon fisheries during 1983. Low abundance of Klamath River stocks entering the season appears to have accounted for part of the decline, and had generally been anticipated. However, the remainder of the impacts on harvest appear due to a myriad of influences on age structure, growth, mortality and behavior exerted by special conditions occurring in the ocean during 1983. These ocean conditions, commonly referred to as El Nino, will be discussed in more detail in the following section.

TABLE 29. Estimated numbers of Klamath River chinook salmon lost through ocean fisheries in 1979-1983.

Year	TOTAL CHINOOK LANDINGS[1/] N. CA Troll	S. OR Troll	N. CA Sport	S. OR Sport	Sub Total	Number Of[2/] Klamath R. Chinook Landed In N. CA And S. OR	Total[3/] Ocean Landings Of Klamath R. Chinook	Non-Catch[4/] Mortality	Total Number Of Klamath R. Chinook Lost Through The Ocean Fisheries
$\bar{X}$ 1971-75	298,600	153,000	15,800	17,400[5/]	484,800	145,440	161,600	64,640	226,240
1979	438,100	192,500	14,000	10,900	655,500	196,650	218,500	87,400	305,900
1980	300,400	143,200	8,000	10,100	461,700	138,510	153,900	61,560	215,460
1981	292,500	110,400	11,300	13,400	527,600	128,280	142,530	57,010	199,540
1982	344,200	178,700	20,900	25,600	569,400	170,820	189,800	75,920	265,720
1983	109,700	41,800	10,000	19,000	180,500	54,150	67,690	20,310	88,000
$\bar{X}$ 1979-83	296,980	133,320	12,840	15,800	458,940	137,680	154,480	60,440	214,920

1/ Landings in northern California (N. CA) include Fort Bragg, Eureka and Crescent City ports and in southern Oregon (S. OR) include Brookings and Coos Bay.

2/ Contribution of Klamath River chinook assumed to be 30% of landings between Fort Bragg, CA and Coos Bay, OR.

3/ Ninety percent of 1979-1982 and 80% of 1983 ocean landings of Klamath River chinook assumed to occur between Fort Bragg, CA and Coos Bay, OR.

4/ Shaker incidence = legal incidence.
Shaker mortality rate = 0.40 for 1979-1982, 0.30 for 1983 reduced to reflect use of barbless hooks (PFMC, 1984).
Legal size non-catch mortality rate = 0.

5/ 1974-75 Average only, Oregon ocean sport.

TABLE 30. Contribution estimates of Klamath River chinook salmon (adults and grilse) to the ocean, inland sport and Indian gill net fisheries in 1979-1983.

Year	Losses To Ocean Fisheries[1/]	Run Size in Klamath R.[2/]	Klamath R. Sport Catch[2/3/]	Indian Gill Net Catch[3/]	Spawner Escapement[2/]	Ratio Between Ocean Fishing Losses and River Returns	Ratio Between Total Fishing Losses and Spawner Escapement
1979	305,900	68,730	5,620	15,000	48,110	4.5:1	6.8:1
1980	215,460	83,120	7,610	14,000	61,510	2.6:1	3.9:1
1981	199,540	116,190	15,390	38,360	62,440	1.7:1	4.1:1
1982	265,720	108,380	20,540	19,480	68,360	2.5:1	4.5:1
1983	88,000	62,360	4,700	8,650	49,010	1.4:1	2.1:1
$\bar{X}$ 1979-83	214,920	87,760	10,770	19,100	57,890	2.5:1	4.2:1

1/ From Table 29.

2/ Preliminary data from PFMC (1984) and CDFG (personal communication).

3/ Noncatch mortality rate assumed for inside fisheries = 0.

NOTE: Contributions to ocean and Indian fisheries include spring and fall chinook. Run size, spawner escapement and sport catch values include basin-wide estimates for fall chinook (all years), and spring chinook estimates for Trinity River above Junction City (1979-1982 only).

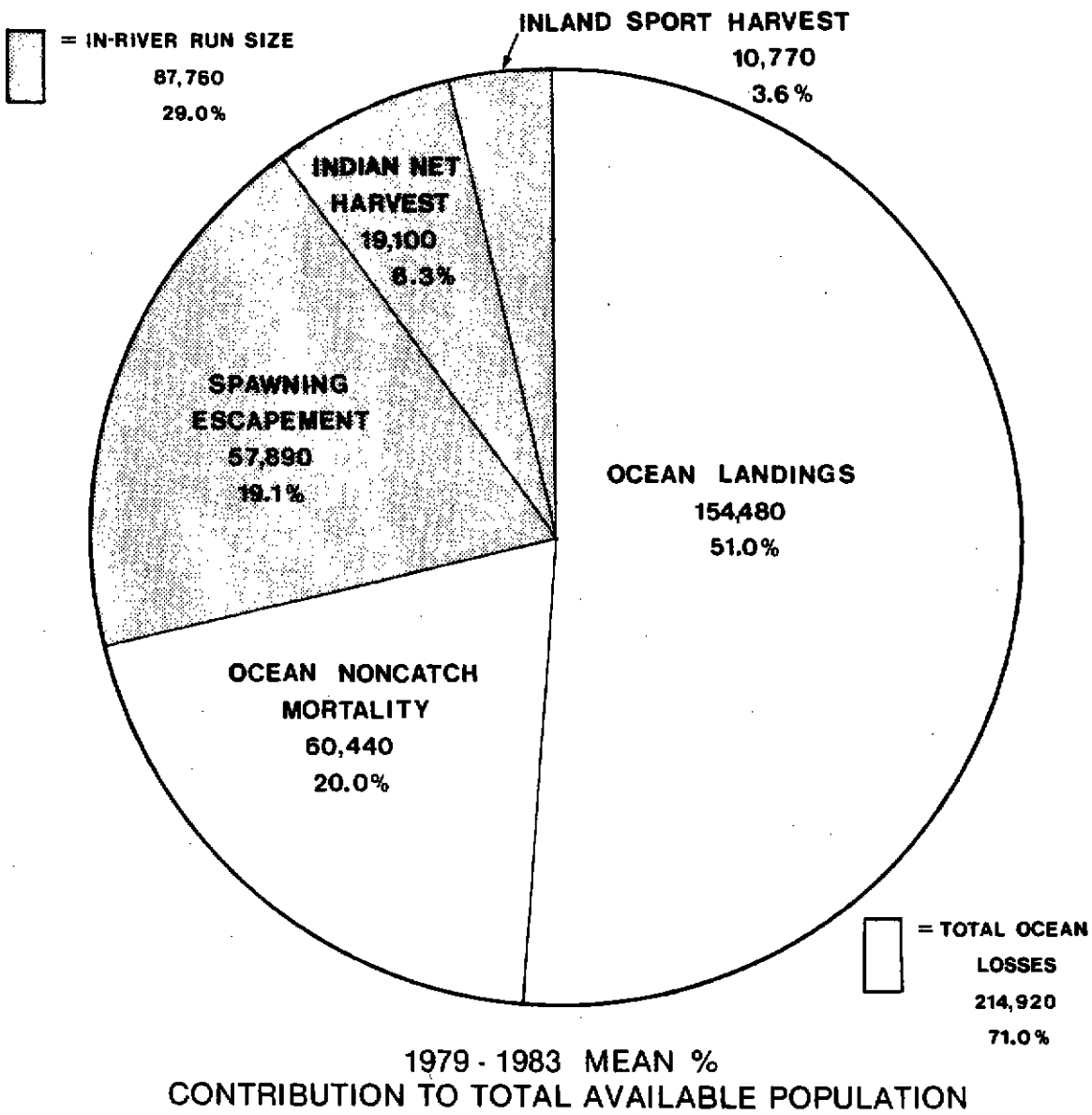


FIGURE 42. Estimated mean annual contributions of Klamath River chinook salmon (adult and grilse combined) to the ocean, in-river sport and Indian gill net fisheries compared with spawning escapement during 1979-1983.

EL NINO

INTRODUCTION

The El Nino phenomenon that occurred off the Pacific coast of North and South America during 1982-1983 was possibly the worst of eight such occurrences since 1945. The exact cause of such phenomena has not been identified, but during El Nino a breakdown in normal weather patterns produces a shifting of wind and water currents which, through a phenomenon known as a Kelvin wave, causes warm water to build up in the eastern Pacific along the South American coast. In the 1982-1983 El Nino, this shifting of currents and wind patterns became quite pronounced, extending throughout the Central Pacific and along the North American coast. Along with unusual local weather patterns, a direct result was elevated water temperatures due to a reduction in the currents responsible for causing the upwelling that normally occurs along the North Coast.

Coastal upwelling is the major agent for bringing nutrient rich cold water from the depths of the ocean to the surface. When upwelling does not occur, the reduced availability of nutrients causes a reduction in phytoplankton production which causes a reduction in the numbers of plantonic animals and crustaceans that are the basic food source of fish, including salmonids. Anticipated effects of such conditions on ocean fish populations would include elevated mortality rates, reduced growth rates, altered maturity schedules and unusual behavior patterns.

In 1983 these conditions apparently contributed to a decrease in salmon landings along the Pacific coast from California to southeast Alaska. Ocean commercial salmon landings in northern California during 1983 were only 37% of the 1971-1975 average (PFMC 1984). Along with the low catch, salmon caught in the ocean were of smaller than usual size.

The effects of these adverse conditions on Klamath River fall chinook were evident in data collected by FAO-Arcata field programs. Following is a summary of some of the impacts on Klamath River fall chinook based on data collected during 1983. The full scope of impacts will not, of course, be known for several more years.

METHODS

Methods utilized in treating beach seine, coded-wire tag recovery (CWT), age composition and length frequency data for use in describing El Nino impacts were the same as described in previous sections of this report.

RESULTS AND DISCUSSION

The influence of the El Nino ocean conditions was anticipated to be exhibited in the FAO-Arcata database on Klamath River chinook stocks as changes in growth rate, length frequency and relative abundance of age classes. Data collected in 1983 were analyzed in attempt to identify changes along these lines.

Data collected in the beach seining program gave the first indication of the effects of El Nino on Klamath River fall chinook. As discussed in the beach seine

section of this report, mean fork lengths of grilse and adults in 1983, 41.1 cm and 64.9 cm respectively, were significantly less than those in 1982, 48.5 and 77.3 (t-test, $p < 0.05$). Similarly, mean fork lengths of grilse and adult fall chinook in 1983 were significantly less than corresponding figures from the 1979, 1980 and 1981 beach seining programs.

Length frequency data collected at the Shasta River weir in a cooperative effort between United States Fish and Wildlife Service (USFWS) and California Department of Fish and Game (CDFG) during 1982 and 1983 (Figure 43) also showed that mean lengths of fall chinook grilse and adults in 1983, 42.4 cm and 64.3 cm respectively, were significantly less than those in 1982, 49.4 cm and 73.3 cm (t-test, $p < 0.05$). It is noteworthy that these data represent a discreet upstream stock of fall chinook, primarily of natural origin, and therefore generally corroborate trends exhibited in the beach seining data which represent a combination of basin wide stocks of both natural and hatchery origin.

Two potential impacts of El Nino appeared during analysis of FAO-Arcata CWT data on Klamath River chinook groups. First, growth rates of 3- and 4-year-old fingerling and yearling CWT release type fall chinook during the last three growing seasons were compared (Figure 44). Both yearling and fingerling fall chinook grew at considerably slower rates in 1983 than in either 1981 or 1982, an indication of poor ocean growing conditions in 1983. The 1981 and 1982 growing seasons appeared very similar for both age brackets. Second, 1983 CWT return data on coastal distribution of Klamath River fall chinook groups indicated a northward shift in abundance. While in 1982 approximately 90% of all CWT returns of Klamath chinook in the ocean fishery occurred between Fort Bragg, California, and Coos Bay, Oregon, the corresponding figure for 1983 was closer to 80% in this area. Additionally, the index of relative contribution of CWT Klamath River fall chinook to landings at Newport, north of Coos Bay, increased from 7.65 in 1982 to 11.70 in 1983 (see CWT investigations section). Presumably, this may indicate a northerly shift in migration toward cooler ocean temperatures.

Table 31 presents mean lengths of fish returning to the Klamath in 1979-1983 by age class, and the combined means for years 1979-1982. The difference between the 1979-1982 and 1983 means for each age class indicates decreases ranging from 12.05% to 14.66%. Figure 45 presents the data from Table 31 as a function of the inverse of time spent in the ocean. This relationship proved significant (F-test, $p < 0.05$). Two-year-olds, which showed the greatest percent change in mean length, also have been influenced by El Nino during a greater percent of their life in the ocean than either 3- or 4-year-olds. Similarly, 3-year-olds were impacted more severely than 4-year-olds. As discussed in the Age Composition section of this report, 2-year-old fall chinook returns to the Klamath River in 1983 were the lowest in any year since FAO-Arcata began monitoring of age classes in 1979. This may indicate that chinook cohorts at yearling and 2 years of age in the ocean during 1983 would produce depressed returns of 2- and 3-year-olds to the river in 1984, and depressed returns of 3- and 4-year-olds in 1985.

It is evident that fish entering the Klamath River in 1983 were adversely impacted by the El Nino conditions prevailing along the Pacific coast. The data presented have exhibited a significant decrease in size at age, reduced growth rates, and the comparative impact of El Nino between age classes in 1983. Continuing effects of 1982-1983 ocean conditions on chinook abundance could last through 1985 or beyond. Recovery of mean size at age for chinook returning in 1984 and 1985 could theoretically occur as a result of compensatory growth.

Delineation of the full scope of impacts of the 1982-1983 El Nino will require continued monitoring of stocks for several years.

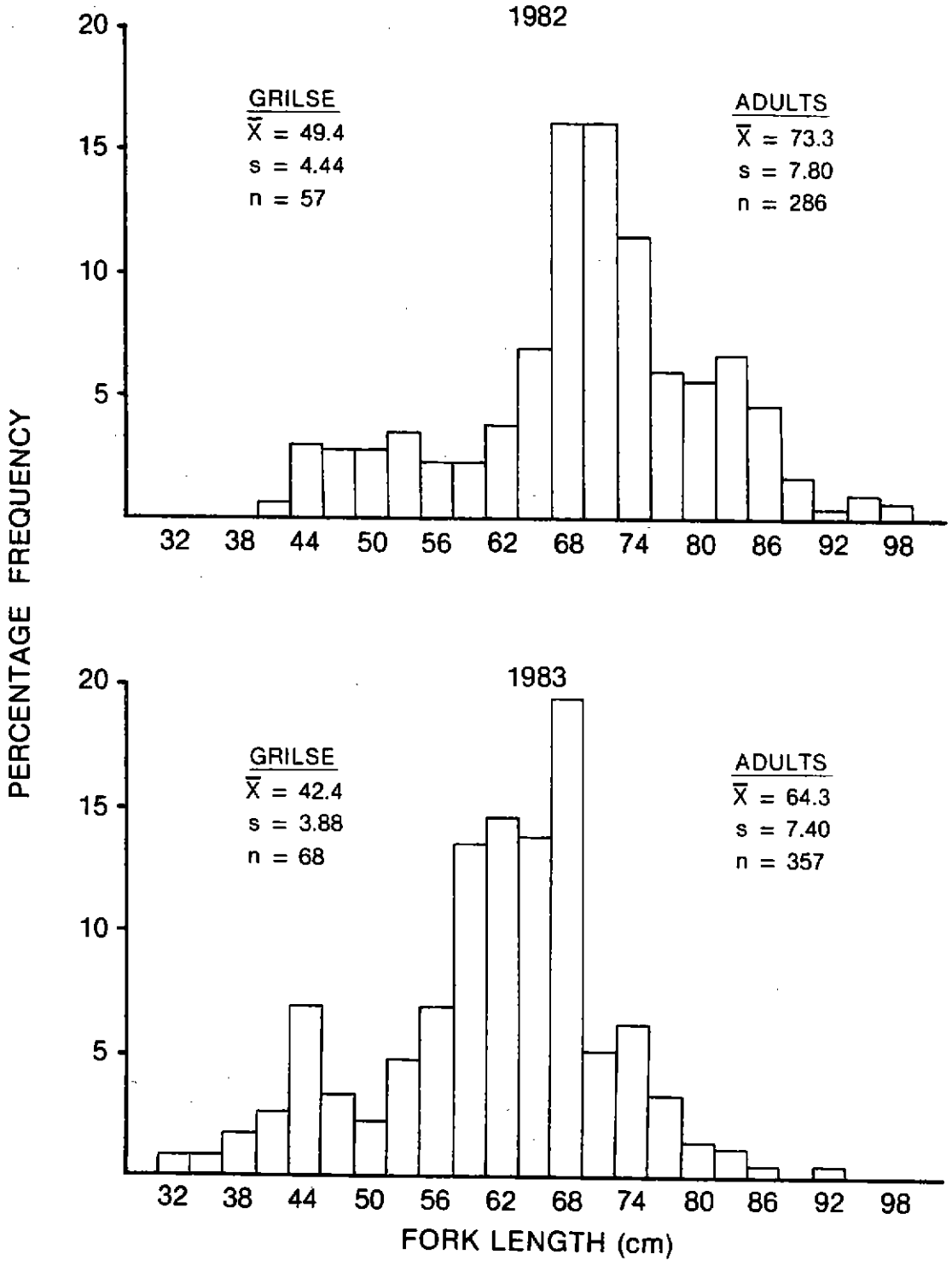


FIGURE 43. Length frequency distributions of fall chinook salmon measured at the Shasta River weir in 1982 and 1983 (3 cm groupings).

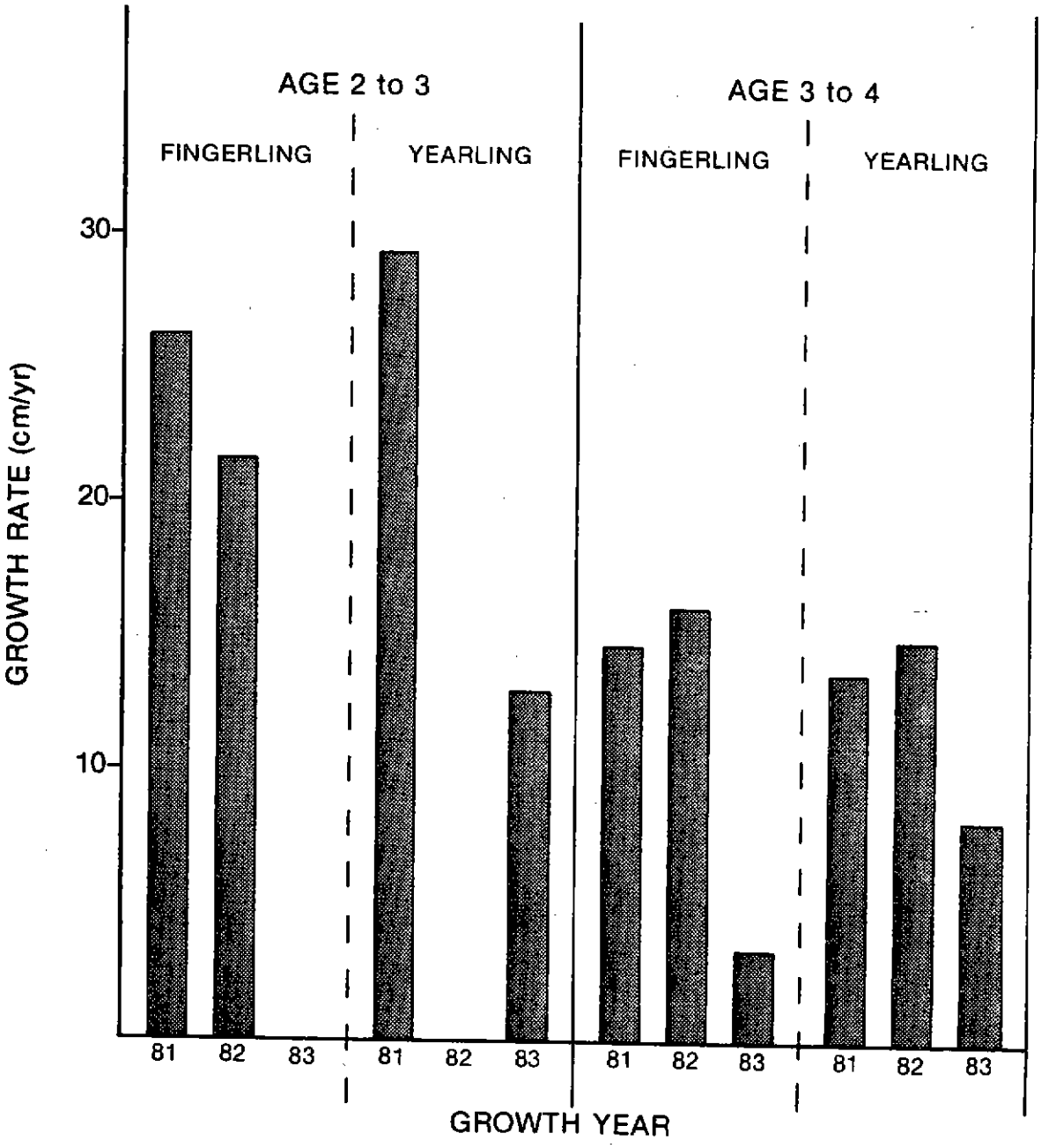


FIGURE 44. Growth between age 2 to 3 and 3 to 4 CWT fall chinook captured by Indian fishers on the Klamath River portion of the Hoopa Valley Reservation from 1980 to 1983.

TABLE 31. Mean lengths of 2-, 3- and 4-year-old fall chinook returning in 1979, 1981, 1982 and 1983, and the percent change in mean lengths of 1983 fall chinook from those of fall chinook returning in 1979-1982 by age group.

	RETURN YEAR					
Age	1979	1981	1982	Mean 1979-1982	1983	Percent Change
2	48.8	50.2	48.3	49.1	41.9	14.66
3	70.1	68.1	69.3	69.2	60.3	12.86
4	80.3	80.5	83.2	81.3	71.5	12.05

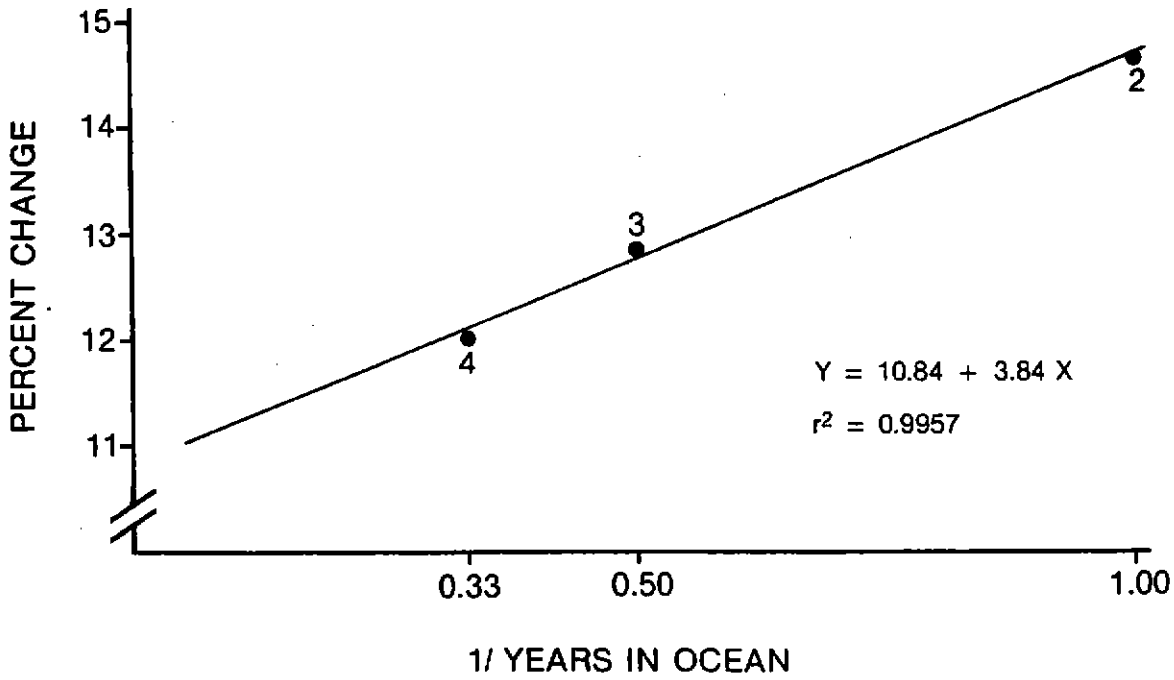


FIGURE 45. Linear relationship between the inverse of years in ocean and percent change in mean lengths of 2-, 3- and 4-year-old fall chinook returning in 1983.

COHO SALMON INVESTIGATIONS

ABSTRACT

A total of 42 coho salmon, including 25 grilse, were captured during 1983 beach seining operations in the Klamath River estuary. An estimated 73 coho salmon, including 2 grilse, were harvested in the Indian gill net fishery on the Klamath River portion of the Hoopa Valley Reservation in 1983. Adipose fin-clipped coho comprised 31.2% of the harvest sample. A total of 7 coded-wire tags (CWT) representing three release groups from Iron Gate and Trinity River hatcheries were recovered, expanding to an estimated Klamath River harvest of 23 CWT marked coho salmon. Coho returning in their third year accounted for 87.0% of the estimated CWT harvest, with the remaining 13.0% representing grilse.

COHO SALMON

INTRODUCTION

The 1983 coho salmon run in the Klamath River was monitored through the previously described net harvest monitoring and beach seining programs. Although a target species for some Indian fishers, coho salmon remain relatively unimportant to the net fishery. The bulk of the coho run enters the river when many fishers have curtailed seasonal fishing activity.

METHODS

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

RESULTS AND DISCUSSION

Beach Seining

Coho salmon entering the Klamath River were captured in the beach seine from early August through late September. A total of 42 coho, including 25 grilse (<44 cm), were sampled from early August to late September 1983 during beach seining operations near the mouth of the Klamath River. Mean lengths of adult and grilse coho salmon in the 1983 sample were 56.4 cm and 37.5 cm respectively (Figure 46). Of the 42 coho examined, 38.1% were adipose fin-clipped, and 31.0% were hook scarred. Jaw tags were placed on 8 of the 42 fish examined.

The capture of 42 coho salmon during 1983 beach seining activities represents the largest coho catch during any season since the program began in 1979. Coho were observed in the estuary at an earlier date in 1983 than in any of the past five seasons of study with the first capture occurring on August 9. The bulk of the Klamath River coho population typically enters the river after seasonal beach seining efforts, which target on fall chinook, have been terminated. An earlier run timing in 1983 may have accounted for the increased beach seine catch of coho salmon.

Net Harvest

Coho salmon first entered the Klamath River net fishery in August and were observed in the harvest through October. Peak harvest occurred during late September and early October (Table 32). Based on over 2,400 contacts, Indian gill net harvest of coho salmon on the Klamath River portion of the Hoopa Valley Reservation was estimated at 73 fish with grilse (<44 cm) accounting for 3.1% of the catch.

A total of 32 coho, including one grilse were sampled during the 1983 net harvest monitoring operations. Adult coho salmon sampled in the 1983 net fishery

were signficantly smaller than adult coho salmon observed in the net fishery during the previous 3 years (Figure 47) (t-test; $p < 0.05$) .

Adipose fin-clipped coho salmon comprised 31.3% of the harvest sample. As in 1981 and 1982, adipose fin-clipped adults and grilse in the 1983 sample did not differ significantly in mean length from non-clipped fish ($p > 0.05$).

A total of seven CWT's were recovered from the Klamath River Indian net fishery in 1983. These CWT recoveries expand to an estimated Klamath River harvest of 23 CWT marked coho representing three release groups from Iron Gate Hatchery (IGH), and two from Trinity River Hatchery (TRH) (Table 33). Coho salmon returning in their third year (1980 brood) accounted for 87.0% of the estimated harvest of CWT groups, with the remaining 13.0% representing grilse (1981 brood). The three adult IGH fish ranged in size from 61-70 cm, while a sample of three adults from TRH varied from 57-62 cm (Table 34).

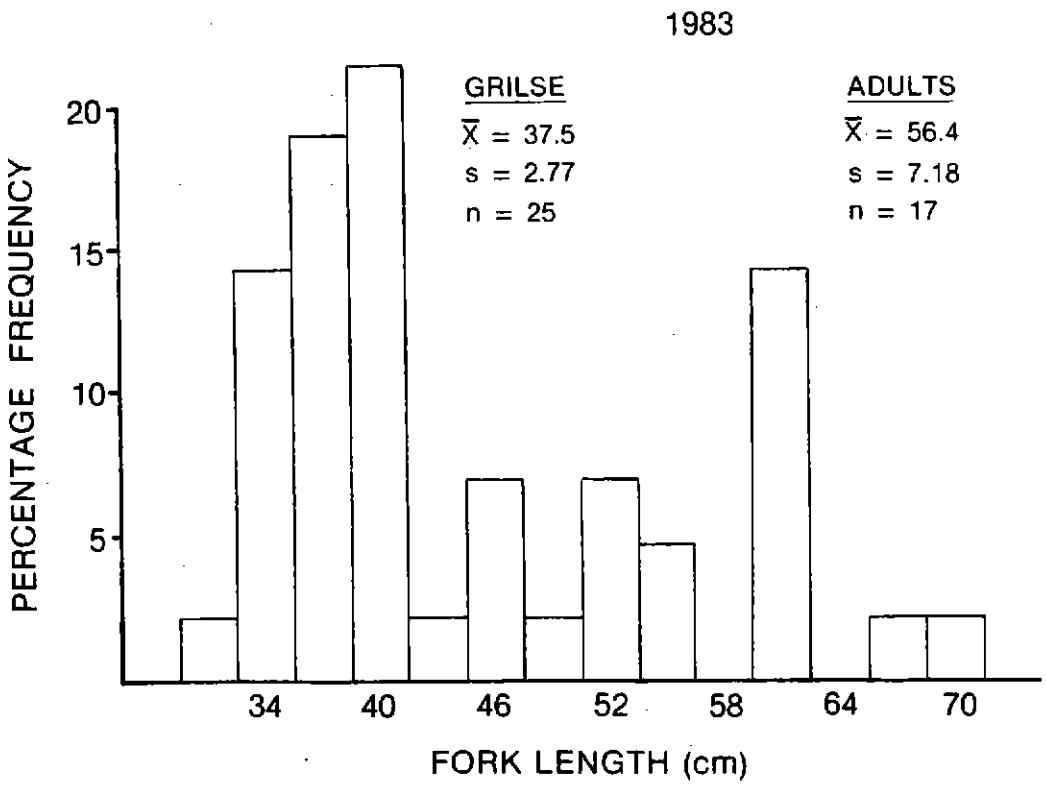


FIGURE 46. Length frequency distribution of coho salmon captured during beach seining operations in the Klamath River estuary during 1983 (3 cm groupings).

TABLE 32. Semi-monthly net harvest estimates of coho salmon captured in the 1983 Indian gill net fishery on the Klamath River portion of the Hoopa Valley Reservation.

Time Period		RESERVATION MONITORING AREA			Semi-Monthly Total (All Areas)	Cumulative Total
		Estuary	Middle Klamath	Upper Klamath		
Aug.	1-15	0	0	0	0	0
	16-31	2	0	0	2	2
Sept.	1-15	1	0	8	9	11
	16-30	0	12	6	18	29
Oct.	1-15	0	3	33	36	65
	16-31	0	0	8	8	73
TOTAL		3	15	55	73	
PERCENTAGE		4.1	20.6	75.3	100.0	

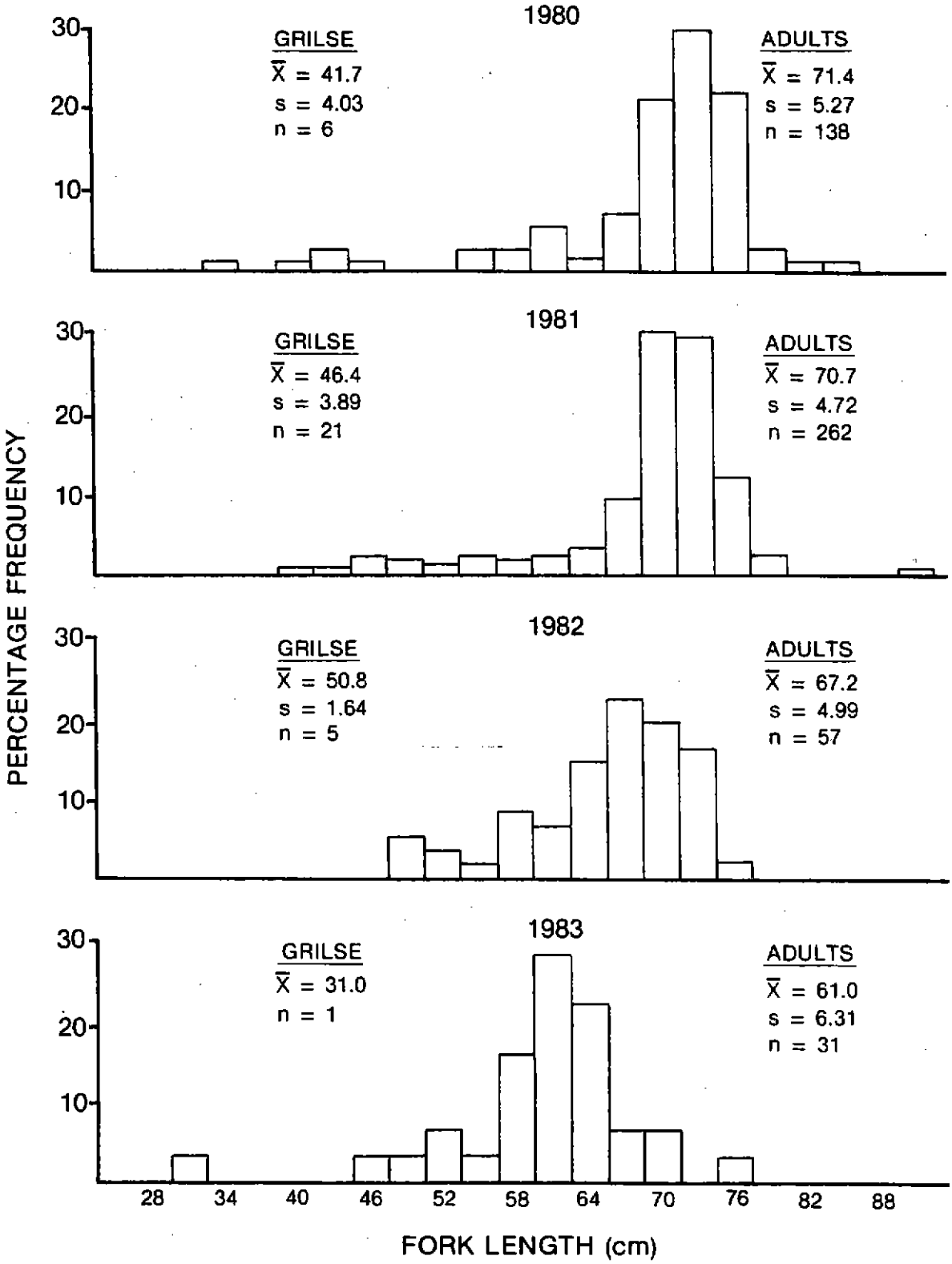


FIGURE 47. Length frequency distributions of coho salmon caught by Indian gill netters on the Klamath River portion of the Hoopa Valley Reservation from 1980-1983. (Note: During 1980, only the lower Klamath areas were sampled.)

TABLE 33. Actual and expanded (underlined) CWT groups recovered during mark-sampling of coho salmon in the 1983 gill net fishery on the Klamath River portion of the Hoopa Valley Reservation.

Tag Code	Brood Year	Hatchery[1/] of Origin	All Areas	
6-59-49	1980	IGH	2	7
6-59-50	1980	IGH	1	3
6-61-62	1980	TRH	1	3
6-61-63	1980	TRH	2	7
6-59-53	1981	IGH	1	3
TOTAL			7	23

1/ All fish released as yearlings from March through April from:

TRH - Trinity River Hatchery

IGH - Iron Gate Hatchery

TABLE 34. Tag code contribution rates and fork lengths of five coho salmon release groups harvested by the 1983 Indian gill net fishery on the Klamath River portion of the Hoopa Valley Reservation.

Tag Code	Harvest[1/] Estimate	Number[2/] Released	Contribution[3/] Rate %	Size Range (cm)	Sample Size
6-59-49	7	23,103	0.030	64-70	2
6-61-63	7	49,593	0.014	57-62	2
6-59-53	3	20,000	0.015	34	1
6-59-50	3	23,225	0.013	61	1
6-61-62	3	50,375	0.006	62	1

1/ Assumes 0% tag loss.

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

3/ Contribution rate % = number harvested / number released X 100.

STEELHEAD TROUT INVESTIGATIONS

ABSTRACT

A total of 194 fall steelhead trout, including 84 half-pounders, were captured during 1983 beach seining operations in the Klamath River estuary. Adult and half-pounder fall steelhead averaged 53.8 cm and 34.7 cm fork length, respectively, in the beach seine sample. Peak capture in the beach seine occurred from mid-August to early September. An estimated 260 adult and 23 half-pounder fall steelhead were harvested in the Indian gill net fishery on the Klamath River portion of the Hoopa Valley Reservation in 1983. Adult and half-pounder fall steelhead averaged a respective 58.2 cm and 34.0 cm fork length in the net harvest sample.

STEELHEAD TROUT

INTRODUCTION

The 1983 fall steelhead trout run in the Klamath River was monitored through the previously described net harvest monitoring and beach seining programs. Due to the concurrent run of larger fall chinook salmon, fall steelhead are seldom targeted by Indian netters and harvest of this species is considered incidental to the fall chinook salmon fishery. Similarly, fall steelhead have not been the target species of FAO-Arcata beach seine operations in the estuary.

METHODS

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

RESULTS AND DISCUSSION

Beach Seining

A total of 194 fall steelhead trout, including 84 half-pounders (<40 cm), were captured during 1983 beach seining operations (Table 35). This represents an overall catch/effort value of 0.64 steelhead per seine haul, which is the lowest catch per effort value observed since the program began in 1979.

Length frequency distributions of fall steelhead sampled in the 1980-1983 beach seining operations are presented in Figure 48. Adult steelhead captured in 1983 showed a mean length significantly larger than those sampled in 1980, 1981 or 1982 ($p < 0.05$). The mean length of half-pounder steelhead captured in 1983 was significantly smaller than those sampled in each of the previous 3 years (t-test; $p < 0.05$).

Length information on fall steelhead half-pounders captured in the beach seine should be viewed with caution as many smaller half-pounders were released unmeasured. This practice is necessitated by the simultaneous occurrence of large numbers of fall chinook in the beach seine which often physically damage the smaller steelhead and because half-pounders tend to become gilled in the seine and are too stressed to handle. This technique inflates the sample mean length of half-pounders, but is necessary to minimize half-pounder mortality.

Steelhead were captured in the seining operation from late July to late September. The bulk of the 1983 Klamath River fall steelhead run appears to have entered the river in three peak pulses occurring from mid-August to early September (Figure 49).

Past information collected by FAO-Arcata biologists has shown differences in river entry pattern between Klamath River fall steelhead and fall chinook (USFWS 1983). This information, describing behavior difference between species, may be of interest to researchers wishing to target on fall steelhead in the Klamath River estuary.

Net Harvest

Fall steelhead were observed in the Klamath River Indian net fishery from July to mid-October with the highest catches occurring during the first half of September (Table 36). The 1983 net harvest of fall steelhead in the Klamath River portion of the Hoopa Valley Reservation was estimated at 283 fish, with half-pounders (<40 cm) comprising 8.4% of the total.

Adult steelhead harvested in the 1983 net fishery were significantly larger than fish sampled in 1982 (t-test; $p < 0.05$), but not significantly larger than those sampled in 1980 or 1981 ($p > 0.05$) (Figure 50). Half-pounder steelhead sampled from the net fishery in 1983 did not differ significantly in mean length from those measured in 1980, 1981 or 1982 ($p > 0.05$) (Figure 50).

TABLE 35. Numbers of steelhead captured during beach seining operations from 1979 to 1983 (catch per seine haul in parenthesis).

Year	Half Pounders (40 cm)		Adults		Total	
1979[1/]	318	(0.81)	345	(0.88)	663	(1.69)
1980	87	(----)	547	(----)	758	(1.18)[2/]
1981	174	(0.56)	238	(0.77)	412	(1.34)
1982	59	(0.22)	240	(0.92)	299	(1.15)
1983	84	(0.28)	110	(0.36)	194	(0.61)

1/ Includes data from two sites:

South Spit - 12 half-pounders, 48 adults

North Spit - 306 half-pounders, 297 adults

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

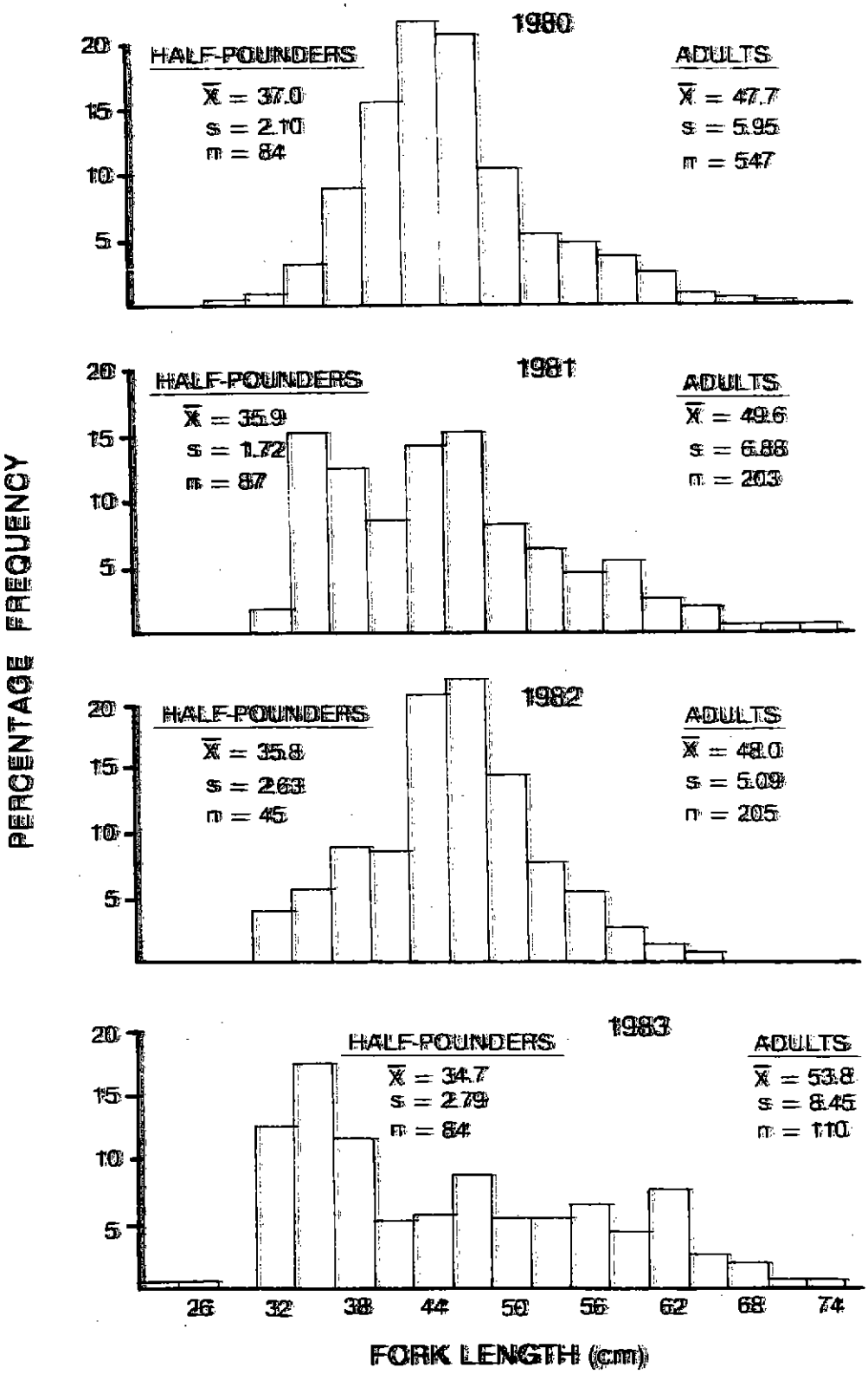


FIGURE 48. Length frequency distributions of fall steelhead trout captured during beach seining operations in the Klamath River estuary from 1980–1983 (3 cm groupings).

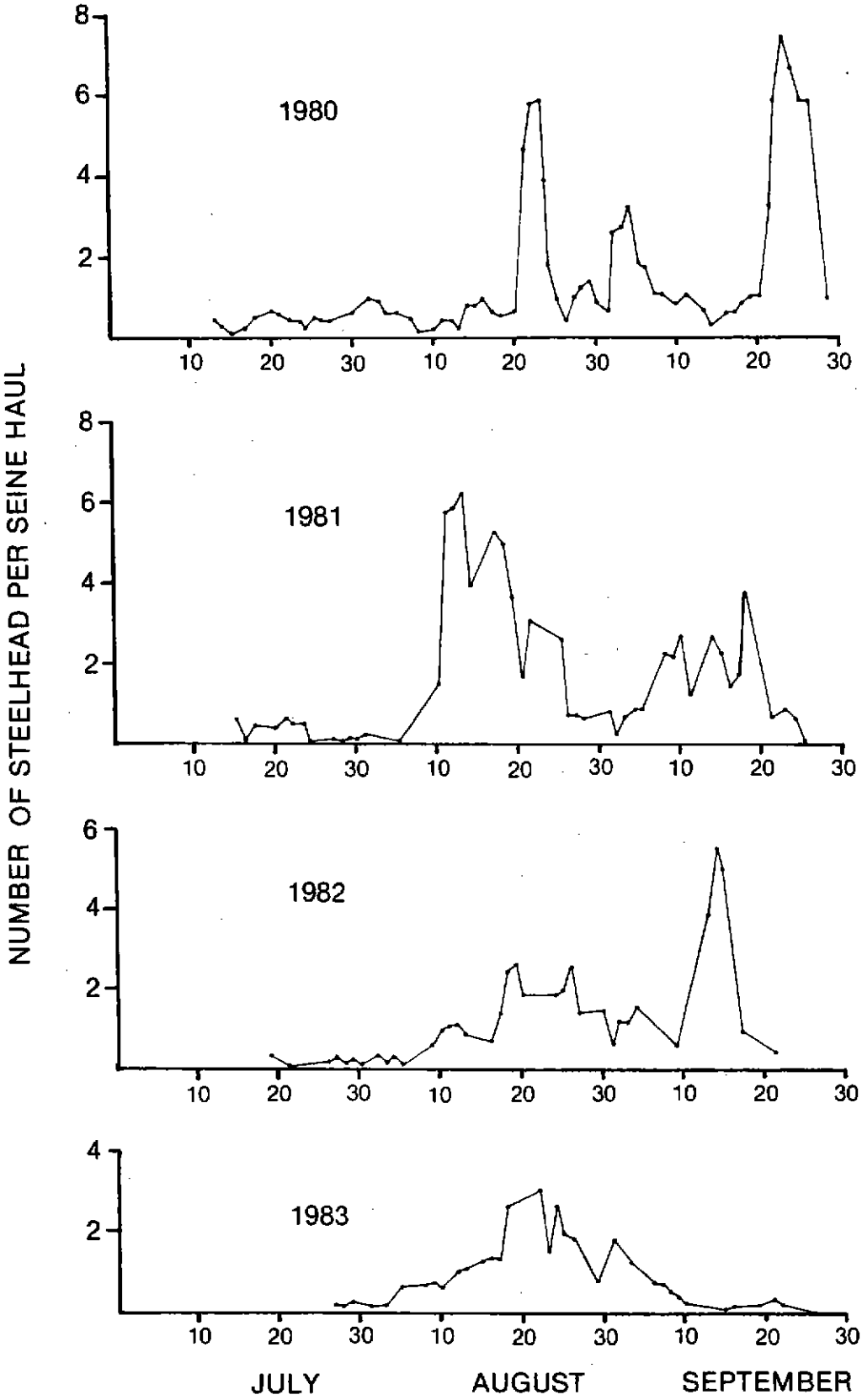


FIGURE 49. Three-day moving average of the numbers of fall steelhead trout captured per beach seine haul in the Klamath River estuary from 1980-1983.

TABLE 36. Semi-monthly harvest estimates of fall steelhead captured in the 1983 Indian gill net fishery in the Klamath River portion of the Hoopa Valley Reservation.

Time Period		RESERVATION MONITORING AREA			Semi-Monthly Total	Cumulative Total
		Estuary	Middle Klamath	Upper Klamath		
Jul.	1-15	0	0	0	0	0
	16-31	0	0	2	2	2
Aug.	1-15	5	0	6	11	13
	16-31	14	0	31	45	58
Sept.	1-15	54	21	82	157	215
	16-30	5	8	26	39	254
Oct.	1-15	0	5	24	29	283
TOTAL		78	34	171	283	
PERCENTAGE		27.6	12.0	60.4	100.0	

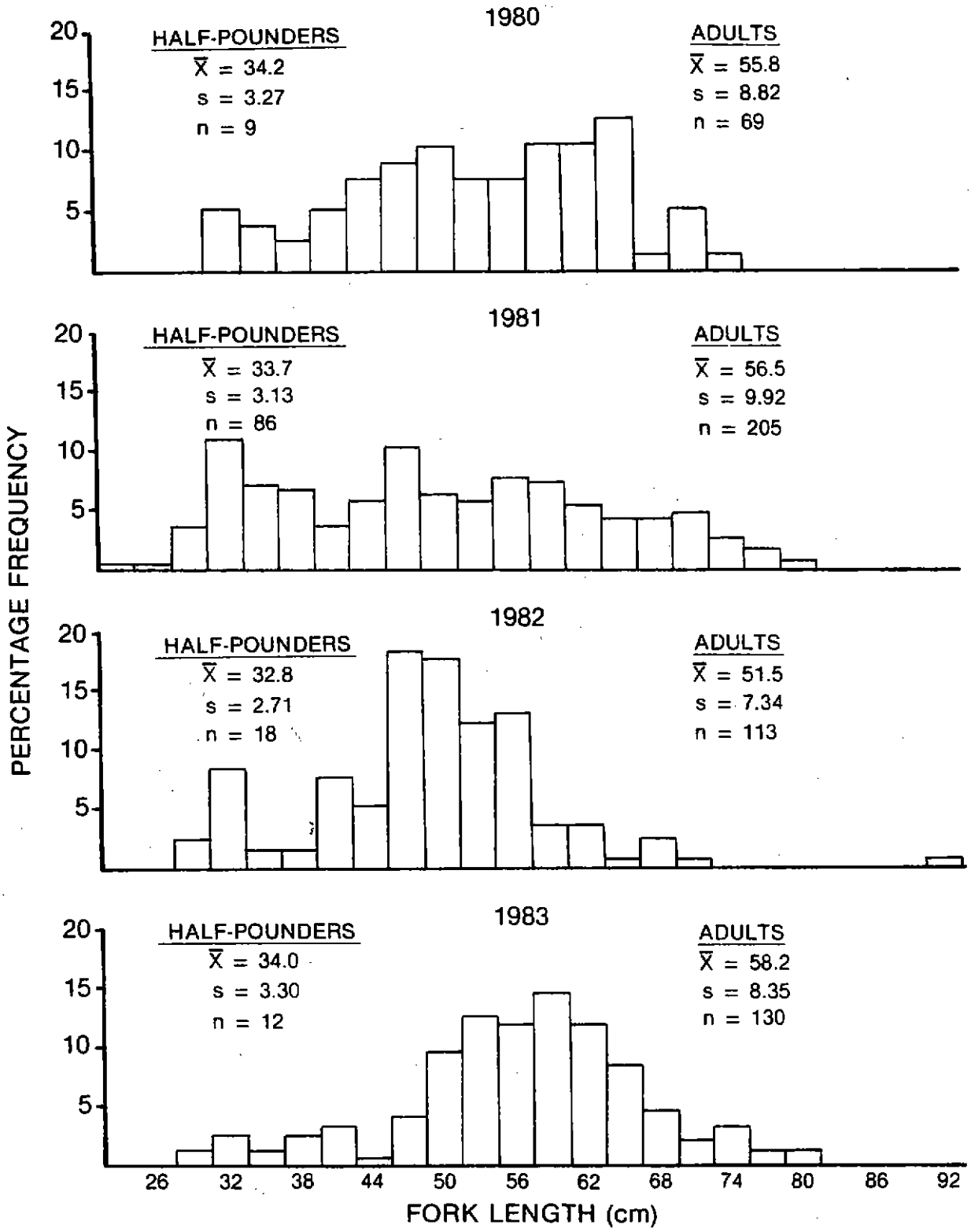


FIGURE 50. Length frequency distributions of fall steelhead trout harvested in the Indian gill net fishery on the Klamath River portion of the Hoopa Valley Reservation from 1980-1983. (Note: During 1980, only the lower Klamath areas were sampled.)

STURGEON INVESTIGATIONS

ABSTRACT

An estimated 10 white and 490 green sturgeon were harvested in the Indian gill net fishery on the Klamath River portion of the Hoopa Valley Reservation in 1983. Peak net harvest occurred during the April-July period during the annual upstream spawning migration. White sturgeon examined ranged from 116 cm to 218 cm total length. Adult green sturgeon examined ranged in total length from 145 cm to 208 cm, with a mean of 170.9 cm. Data suggest that male green sturgeon were more numerous than females during the 1983 spawning run. Numerous immature green sturgeon were encountered in the lower Klamath River during the July-September period.

STURGEON INVESTIGATIONS

INTRODUCTION

A sturgeon investigation program initiated by FAO-Arcata in 1979 to gather baseline data on population characteristics and harvest within the Klamath basin continued during 1983. Results of investigations during the period 1979-1982 were included in previous Annual Reports (USFWS 1981, USFWS 1982a, USFWS 1983). During 1983, as in previous years, green sturgeon (Acipenser medirostris) were far more numerous than white sturgeon (A. transmontanus) within the Klamath basin. Historical information indicates that green sturgeon have long outnumbered white sturgeon in the drainage.

METHODS

The majority of sturgeon sampling in 1983 occurred through net harvest monitoring program activities conducted from April through October. The net harvest monitoring program has previously been described, and methods of contacting fishermen for sturgeon data were essentially the same as those for the various salmonid species. Sturgeon were also sampled in 1983 through a beach seining program conducted near the mouth of the Klamath River.

Sturgeon net harvest estimates were derived in a similar fashion to those for fall chinook. Interviews with fishers as well as net counts and actual observations of catches per net were used in the derivation of these estimates.

Whereas in previous seasons estimates of illegal harvest of sturgeon by snagging on the Hoopa Valley Reservation (HVR) were generated by this office, no such information is available for 1983. Manpower levels available for spring field work precluded the collection of a sufficient amount of data to warrant generating such estimates. It is believed, however, that such harvest continues.

Sturgeon were identified to species by lateral scute count, measured and examined for any distinguishing marks or tags. When possible, sex and sexual maturity condition were noted. Biological data such as weight, fecundity, age determination, stomach content analysis and mark-recapture information were not collected in 1983 as baseline information from 1979-1982 appeared adequate to address these characteristics. A comprehensive report on the first 5 years of sturgeon data collected by FAO-Arcata is currently being prepared for publication. As requested by the Bureau of Indian Affairs (BIA), study plans are also being prepared to address other questions concerning Klamath River green sturgeon which have arisen during the 1979-1983 baseline period. These questions concern location of spawning areas, migration behavior and juvenile production of the population.

RESULTS AND DISCUSSION

Harvest

An estimated 10 white and 490 green sturgeon were harvested in the Hoopa Valley Reservation Indian gill net fishery between Weitchpec and the river mouth

during 1983 (Table 37). As noted in previous sections of this report, coverage of gill net harvest by FAO-Arcata biologists during 1983 no longer included the Trinity River portion of the reservation as it had in previous seasons through 1982. Estimates for the Trinity River in 1983 were generated by the Hoopa Valley Business Council, Fisheries Department.

All of the white and all of the immature green sturgeon were captured in the lower 10 km of the Klamath River, and may have been coastal migrant rather than spawning migrant. Some of these may have been individuals originating from other river systems.

An estimated 401 adult green sturgeon were netted on the Klamath River portion of the HVR in 1983 with harvest of upstream migrants during the April-July period accounting for 85.3% of the total. Most of the adult green sturgeon netted during the August-October period were apparently downstream migrant post-spawners. The 1983 estimate of 401 adults is up 22.6% from the corresponding net harvest of 327 adults in 1982, down 43.5% from that of 710 in 1981, and up 33.7% from that of 300 in 1980. No sturgeon harvest data is available for years prior to 1980. The 4-year average net harvest of adult green sturgeon between Weitchpec and the river mouth on the HVR accordingly is 435. Using 1983 data provided by the Hoopa Valley Business Council, Fisheries Department, the corresponding 4-year average net harvest of adults on the entire HVR is 466 (Table 38).

As noted, no estimates were generated during 1983 for illegal harvest of sturgeon on the HVR. Illegal snag harvest of green sturgeon below Coon Creek Falls has been a recurring problem since a debris slide created the migration obstacle in 1977. When the magnitude of the problem became apparent from observations of illegal activities in the area during the spring of 1980, FAO-Arcata staff recommended that a feasibility study for debris removal be undertaken. After an on-site examination in May 1981, the in-river obstacle was blasted in a cooperative effort between the California Department of Fish and Game (CDFG), Bureau of Indian Affairs (BIA) and U.S. Fish and Wildlife Service (USFWS). Examinations during 1982 indicated that these efforts were only partially successful in removing the debris. Moveover, high water conditions during the spring of 1982 made it difficult to assess exactly what the success of the blasting operation was. With even higher water conditions during the spring of 1983, it now appears necessary to observe the area during a normal to low flow year in order to accurately evaluate the success of the 1981 blasting operation. It is during low flow years that sturgeon passage, and therefore snag harvest potential, becomes most critical at this site. Further attention should be paid to this problem area.

FAO-Arcata biologists observed no legal hook and line harvest of sturgeon on the HVR during 1983. The extent of legal hook and line fisheries for sturgeon in the Klamath basin is unknown.

Population Characteristics

As discussed, only limited biological data were collected on sturgeon observed in the Klamath River during 1983. Previous information presented in 1980-1982 FAO-Arcata Annual Reports provides baseline data on population characteristics within the basin.

TABLE 37. Harvest estimates for green and white sturgeon on Hoopa Valley Reservation in 1983.[1/]

	HARVEST PERIOD, SPECIES, AND RUN COMPONENT											
	April - July				August - October				Season			
	White		Green		White		Green		White		Green	
	Juv	Adult	Juv	Adult	Juv	Adult	Juv	Adult	Juv	Adult	Juv	Adult
Estuary	5	0	27	39	5	0	60	4	10	0	87	43
Middle Klamath	0	0	2	178	0	0	0	48	0	0	2	226
Upper Klamath	0	0	0	125	0	0	0	7	0	0	0	132
All Areas[2/]	5	0	29	342	5	0	60	59	10	0	89	401

1/ Estimates for gill net harvest on the Klamath River Portion of the HVR only - no snag harvest coverage, no Trinity River coverage for 1983.

2/ See Net Harvest Monitoring section for explanation of change in coverage areas during 1983.

TABLE 38. Harvest estimates for green and white sturgeon on the Hoopa Valley Reservation, 1981-1983.

		WHITE			GREEN		
		Juv	Adult	Total	Juv	Adult	Total
1980:	Gill Net	10	3	13	30	300	330
	Snag	0	2	2	0	400	400
	TOTAL	10	5	15	30	700	730
1981:	Gill Net	10	5	15	25	810	835
	Snag	0	0	0	0	70	70
	TOTAL	10	5	15	25	880	905
1982:	Gill Net	10	5	15	53	347	400
	Snag	0	0	0	5	50	55
	TOTAL	10	5	15	58	397	455
1983[3/]:	Gill Net	10	0	10	89	406	495

3/ Total 1983 HVR estimate - includes Trinity River data provided by the HVBC, Fisheries Department

Total lengths were recorded for 2 white and 65 green sturgeon observed during harvest monitoring activities, and 2 white and 2 green sturgeon captured during beach seining activities in 1983.

The four white sturgeon examined ranged from 116 cm to 218 cm total length. Of these, three were immature with a mean total length of 119.7 cm, and the other was a 218 cm adult captured on September 30 in the beach seine near the river mouth.

A total of 45 adult green sturgeon were examined, ranging from 145 cm to 208 cm total length with a mean of 170.9 cm (Figure 51). This mean is smaller than that observed in two of the past three seasons and smaller than the overall 4-year sample mean of 173.6 cm (Figure 52). Respective female and male 4-year known sex sample mean total lengths are 189.6 cm and 166.0 cm (Figure 53). Although no known sex sample was obtained during 1983, the data presented appear to suggest that male green sturgeon were more numerous than females during the 1983 spawning run. Numerical dominance of males was documented in each of the 1980-1982 seasons.

In 1983, as in 1979-1982, numerous coastal migrant marine resident immature green sturgeon were encountered in the lower Klamath River. During 1983, these ranged from 77 cm to 127 cm total length, with a mean of 103.0 cm (Figure 54). Most (95%) were observed during the months of July-September in the estuarine gill net fishery or the beach seine operation. Data from previous seasons indicate that abundance of immature green sturgeon peaks in the estuary during this time period. Potential impact on future green sturgeon population levels from incidental harvest of juvenile sturgeon in the fall chinook net fishery during this period should be carefully considered. An estimated 167 immature individuals were harvested in this fashion during 1981-1983. The gradual increase in mean length of juveniles oberved in the sample from 52.8 cm in 1979 to 103.0 cm in 1983 may also indicate recruitment problems for the population during the past few years. Care should be taken to avoid over-harvest of this important species as time to recovery would be long for a population with such multiple age class representation.

No data was collected on outmigration of Klamath River green sturgeon yearlings and young-of-the-year during 1983. As mentioned in previous annual reports, strong production during the past few seasons was documented only for the 1980 brood.

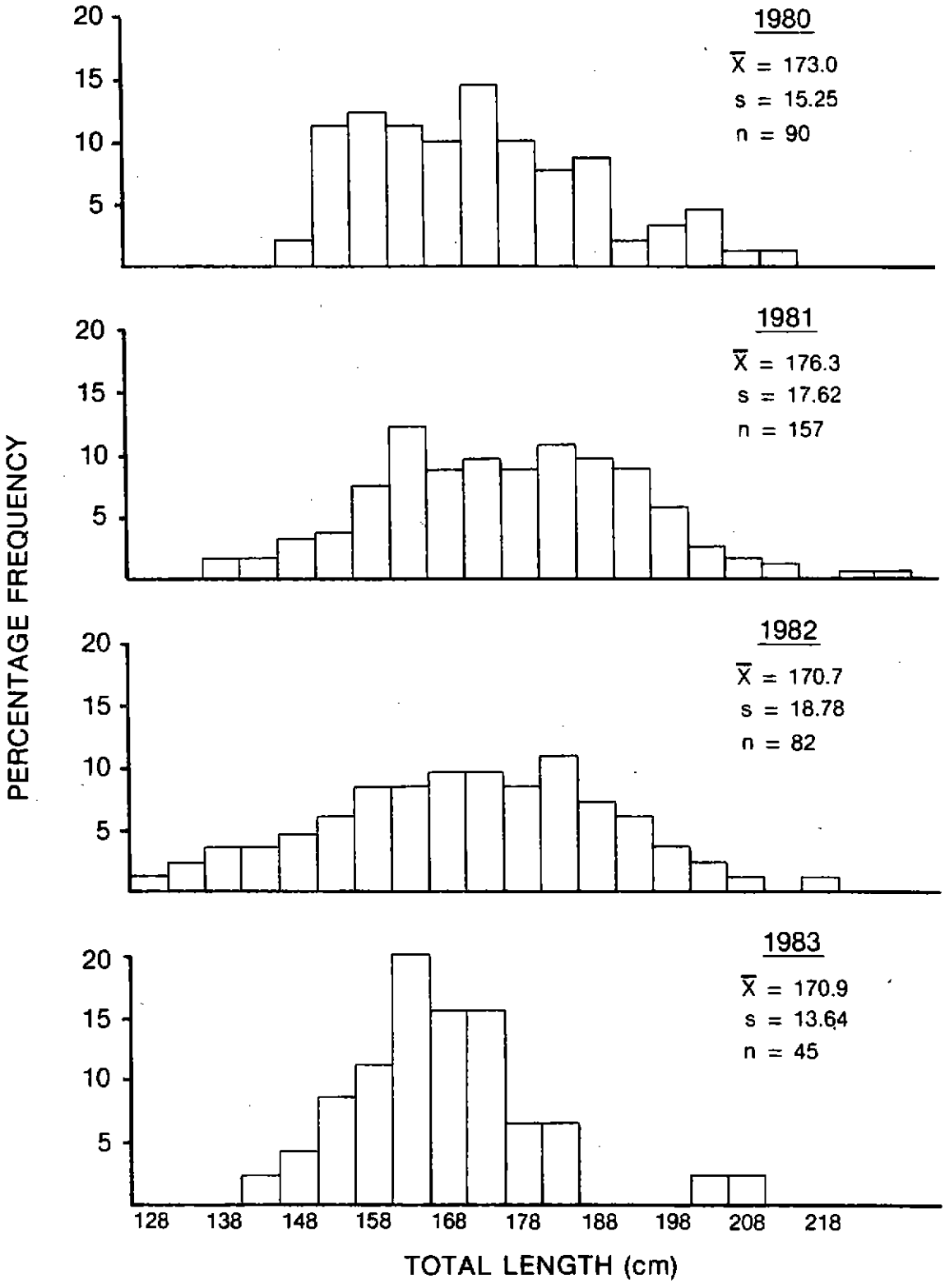


FIGURE 51. Length frequency distributions of Klamath River adult green sturgeon captured by beach seine, gill net, and hook and line during 1980-1983 (5 cm groupings).

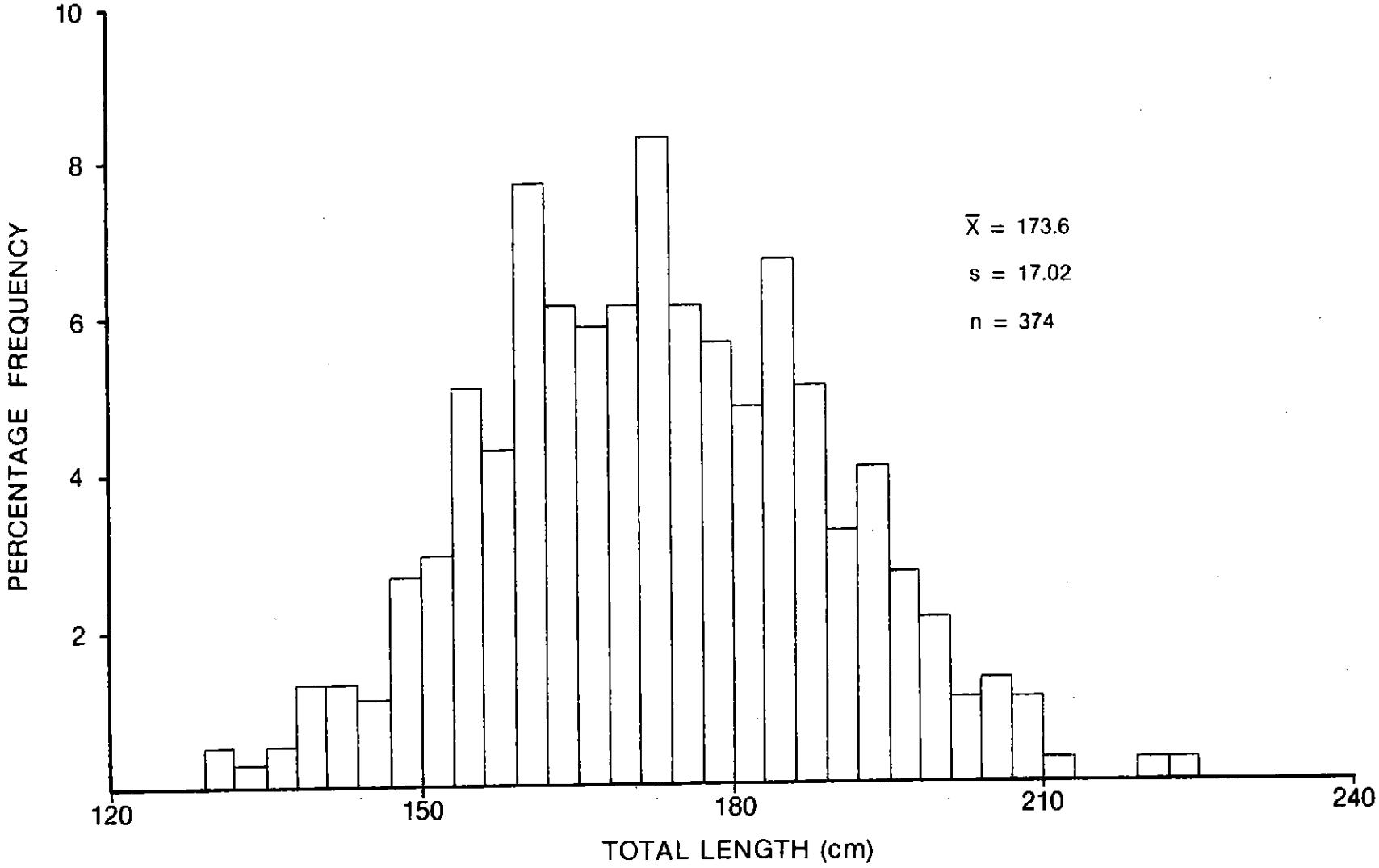


FIGURE 52. Combined length frequency distribution of Klamath River adult green sturgeon captured by beach seine, gill net, and hook and line during 1980-1983 (3 cm groupings).

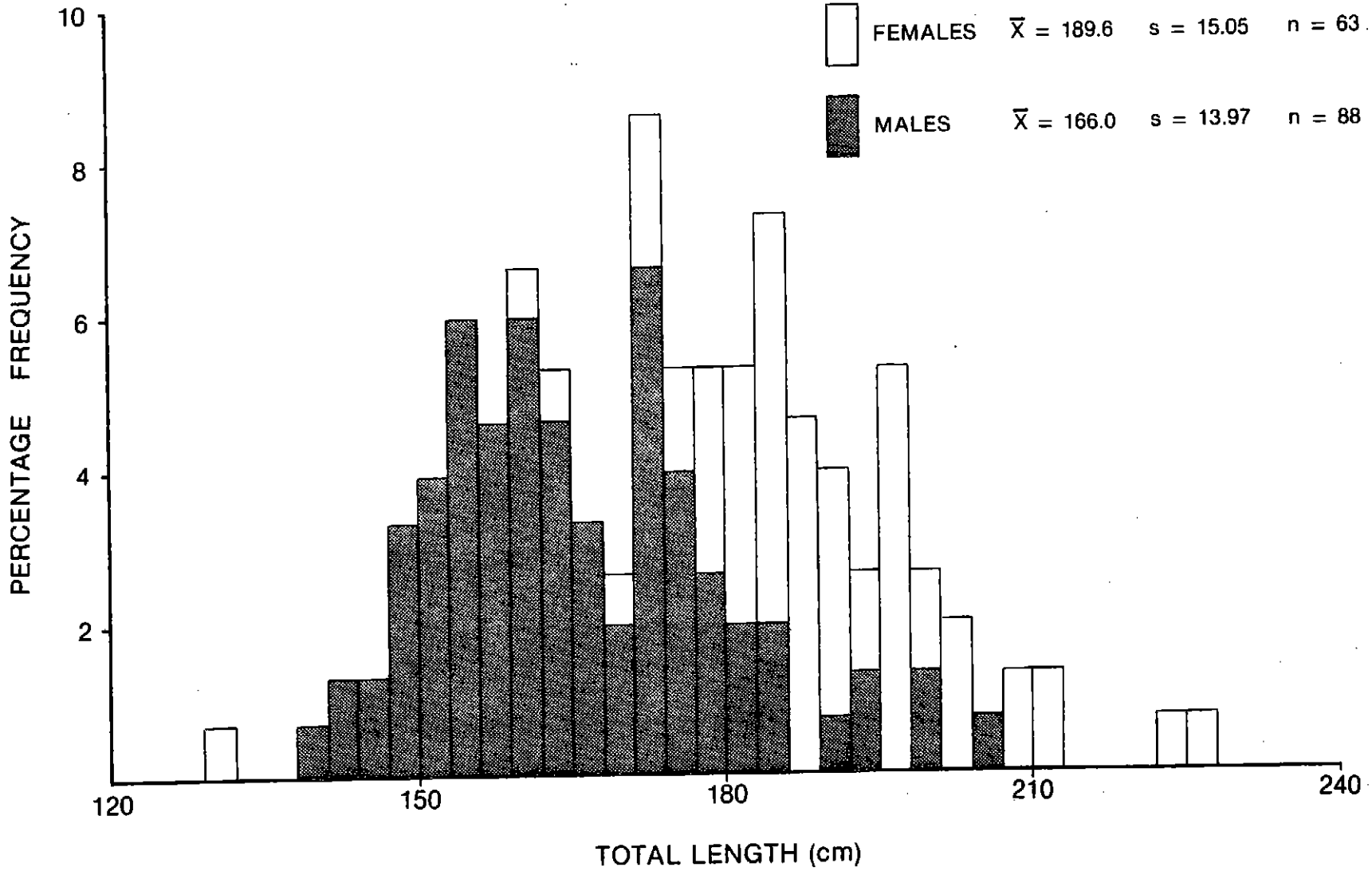


FIGURE 53. Combined length frequency distribution of Klamath River adult male and female green sturgeon captured during 1980-1982 by beach seine, gill net, and hook and line (3 cm groupings).

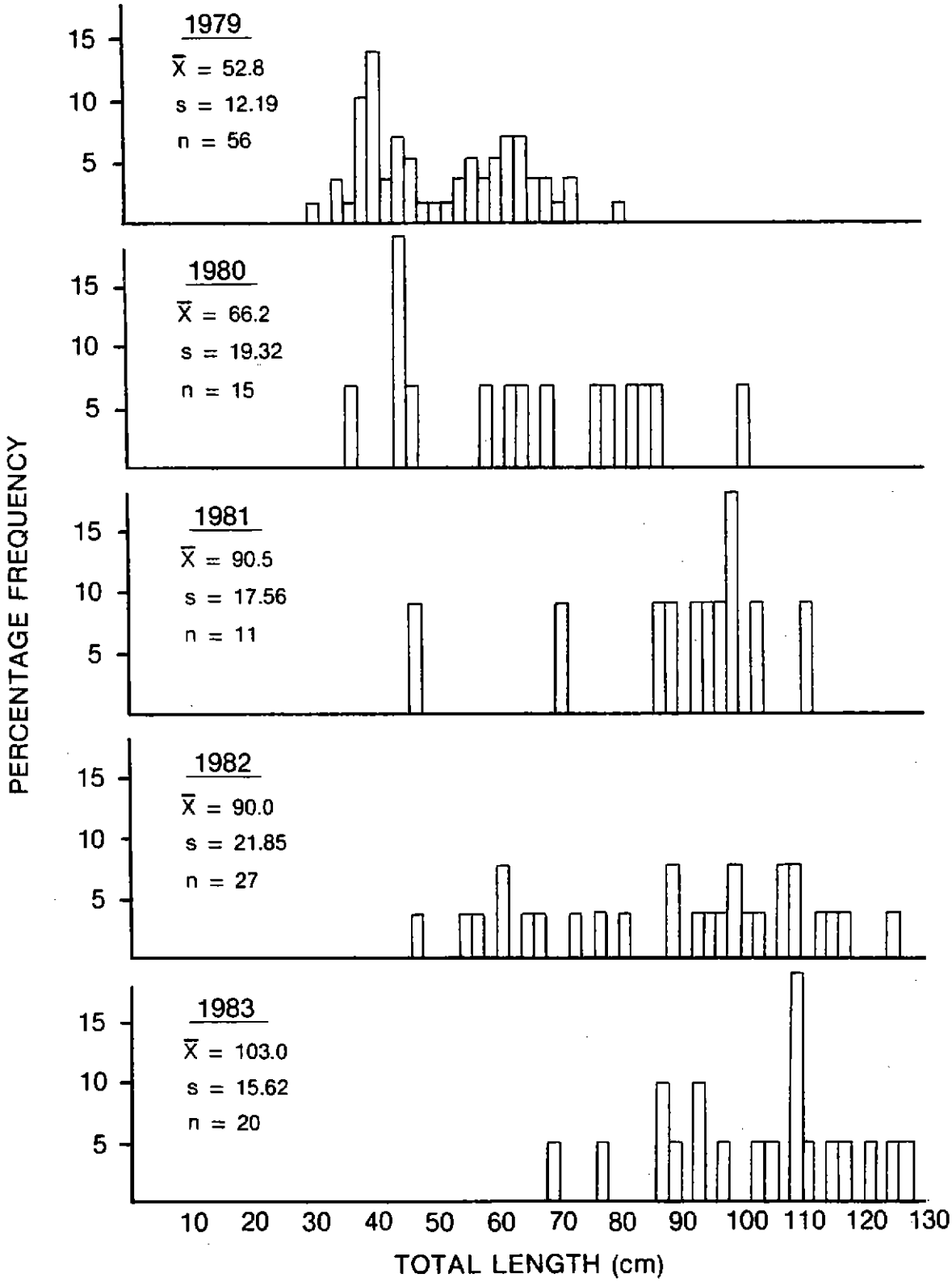


FIGURE 54. Length frequency distributions of coastal migrant marine resident immature green sturgeon captured by beach seine and gill net in the Klamath River estuary during 1979-1983 (2 cm groupings).

PROGRAM PLANNING, DIRECTION, AND COORDINATION

INTRODUCTION

The course of the Klamath River Fisheries Investigation Program, and the role of FAO-Arcata in addressing resource-related issues involving the Klamath River basin, have evolved in response to Departmental direction through pertinent Memoranda of Understanding (MOU) and the Critical Issues Management System (CIMS), the USFWS Management By Objectives (MBO) program, and a variety of other departmental and external factors. Further direction has been received through the preparation of a Regional Resource Plan by the USFWS Region One directorate (USFWS 1982b). Bureau of Indian Affairs (BIA) planning processes involving fisheries resources of the Hoopa Valley Indian Reservation (HVR) have and will continue to exert a strong influence on program direction. Currently, the BIA is involved in contracts with the National Park Service (NPS) for preparation of an Environmental Impact Statement (EIS) concerning a proposal to modify Indian fishing regulations authorizing the commercial harvest of anadromous fish on the HVR, and with CH_2M Hill, a private consulting firm, for preparation of a Klamath River Fisheries Resource Plan. Details of these and other actions with potential relevance to FAO-Arcata programs have been presented in previous Annual Reports (USFWS 1982a, USFWS 1983), and no further discussion appears necessary at this time. The interested reader is referred to these documents for clarification on a myriad of internal and external factors influencing program direction.

LONG-TERM PLANNING

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

Certain priorities have been identified and are not expected to change radically in the near future. Anadromous fishes of the Klamath-Trinity basin have been identified as high priority and have been listed in order of preference for investment in restoration (USFWS 1982b). The KRFIP has and will continue to focus on five of these stocks: fall chinook, spring chinook, fall steelhead, coho salmon and green sturgeon. These have been recognized as best fitting the criteria of being depressed stocks largely of natural origin with high value to fisheries and good restoration potential. Program operations could, however, be expanded with relative ease to cover additional species occurring in the basin. The BIA has shown some interest in expanded programs to cover winter steelhead and Pacific lamprey (Lampetra tridentata).

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

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

(1) Beach Seining Operations are considered of a monitoring nature and should be continued on a yearly basis. Primary emphasis will remain with fall chinook. In-season fall chinook run strength indices derived from beach seine catch/effort data appear to have potential in management of the in-river fisheries and research into their development and use should continue. Monitoring of fall chinook migration patterns within the basin by mark and recapture studies also appears useful in management and should continue. Collection of scales for age analysis of fall chinook provides critical information on this important species and should continue on a yearly basis. Because of the size selective nature of the gill net fishery, an unbiased scale sample cannot be taken from this source. Collection of data on a variety of other population characteristics is also seen as valuable and should continue through beach seining operations. It should be clearly understood that the beach seining and harvest monitoring programs together provide two key interactive components of the FAO-Arcata database. Elimination of either from the program would seriously impact the other as well as overall ability to address fishery problems in the basin. Both should be viewed as on-going monitoring programs to be continued indefinitely and not as baseline programs which will soon reach a point where necessary input has been supplied. The importance of data collected by these programs is substantiated by the use of same by the Pacific Fishery Management Council (PFMC) in analysis of the Klamath River fall chinook stock for management of ocean fisheries.

(2) Harvest Monitoring Operations provide the only presently available estimates of Indian gill net harvest within the Klamath River portion of the Hoopa Valley Reservation and collection of this critical information should continue. Research begun in 1983 should continue into methods of improving the accuracy of harvest estimates and of generating estimates in such a manner that they can be placed within statistical confidence limits. Care should be taken, however, that alteration of methodology does not jeopardize comparability with past estimates. Collection of a variety of baseline biological data from the net harvest, including recaptures of fish tagged during beach seine opearations, appears valuable and should continue. Research into the development of a model for use of

harvest data in in-season fall chinook run strength indexing should continue. Recoveries of coded-wire tags (CWT) through monitoring of the net fishery is important to management of the fisheries and of hatchery stocks within the basin and should continue.

(3) Sturgeon Investigations during the 1979-1982 period have provided much needed baseline information on green sturgeon within the Klamath-Trinity basin. The initial baseline period having been completed, future direction should tend toward continued monitoring of annual spawning migrations and net harvest levels. Major questions remaining unanswered include definition of population levels occurring within the basin, location of major spawning areas and assessment of juvenile production levels. A study proposal, currently in preparation, will detail actions recommended to address such unresolved questions.

(4) Juvenile Salmonid Investigations were discontinued after Fiscal Year 1982 due to lack of funding. Monitoring of juvenile populations of priority species in the basin, however, provides important information for management. At present, limited studies on juvenile populations are being conducted by the CDFG and the Hoopa Tribe in the basin, but information is still incomplete. Expansion of such studies would provide needed information on migration, production, growth, survival, hatchery-natural interactions and other characteristics of juvenile populations in the basin. The CDFG has expanded juvenile studies within the basin during 1984. It is recommended that such studies also be expanded through FAO-Arcata and/or other groups researching the Klamath.

(5) Other Programs are currently under consideration for potential inclusion in FAO-Arcata activities. As requested by the BIA under the Fiscal Year 1984 MOA, study proposals are being 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. The BIA has also considered the funding of an additional fishery biologist position at FAO-Arcata for the purpose of full time involvement in the rapidly expanding fishery enhancement programs now occurring in the basin. The status of these new programs for Fiscal Year 1985 is not known at the time of this writing.

(6) Program Planning, Direction and Coordination will remain essential and on-going parts of FAO-Arcata activities. Coordination of programs with and dissemination of information to other groups involved with the Klamath-Trinity fishery resource are recognized as high priorities. It was recommended last year that FAO-Arcata obtain data and word processing equipment to aid in streamlining analysis and transmittal of information collected through field programs. Steps have been taken to initiate purchase of such equipment, and it is hoped that such capacity will be available soon to assist in the role of providing fisheries assistance.

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