CHANGES IN RELATIVE ABUNDANCE AND SIZE COMPOSITION OF SABLEFISH IN COASTAL WATERS OF WASHINGTON AND OREGON, 1979-89

by

Norman B. Parks

and

Franklin R. Shaw

Alaska Fisheries Science Center
Resource Assessment and Conservation Engineering Division
7600 Sand Point Way NE.
BIN C15700, Building 4
Seattle, WA 98115-0070

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Abstract: Changes in relative abundance and size composition of sablefish have been monitored in the Washington-California region by abundance indexing surveys since 1979. Survey results indicate that sablefish abundance off Oregon (north of 43 deg min) and Washington, after having increased between 1981 and 1983, declined sharply between 1983 and 1989 to record low levels. Survey catch rates declined 79% between 1979 and 1989, with a decrease of 68% between 1985 and 1989 alone. The mean length of sablefish have declined steadily from 56.7 cm in 1979 to 52.6 cm in 1989. Large numbers of sablefish (approximately 50% of landings) are being harvested before they have an opportunity to reach sexual maturity.

ABSTRACT

Changes in relative abundance and size composition of sablefish have been monitored in the Washington-California region by abundance indexing surveys since 1979. Survey results indicate that sablefish abundance off Oregon (north of 43°00'N) and Washington, after having increased between 1981 and 1983, declined sharply between 1983 and 1989 to record low levels. Survey catch rates declined 79% between 1979 and 1989, with a decrease of 68% between 1985 and 1989 alone. The mean length of sablefish have declined steadily from 56.7 cm in 1979 to 52.6 cm in 1989. Large numbers of sablefish (approximately 50% of landings) are being harvested before they have an opportunity to reach sexual maturity. There is no sign of any strong year class off Oregon and Washington to increase recruitment in the near future.

CONTENTS

INTRODUCTION

Sablefish (Anoolonoma fimbria) has become one of the single most valuable commercial groundfish species landed on the U.S. west coast in recent years. From 1985 through 1989, the ex-vessel value of landings has averaged approximately $11.4 million[1]. High demand and high prices persisted throughout most of this period. Based on 1986 and 1987 survey results by the Alaska Fisheries Science Center (AFSC) and other supporting information, the Groundfish Management Team (GMT) declared in November 1987 that the west coast sablefish fishery cannot support long-term landings of the same magnitude observed in recent years (13,000 to 18,000 metric tons (t))[2]. Methot and Hightower (1988, 1989) determined that maximum sustainable yield (MSY) was approximately 8,000 t for 1989 and 6,770 t for 1990. The 1989 optimum yield (OY) was set by the Pacific Fishery Management Council at 10,400 t with a reserve of 600 t, and was reduced to 8,900 t in 1990.

Surveys to measure changes in sablefish relative abundance have been conducted off the coasts of Oregon and Washington since 1979, and off the California coast since 1980. The primary

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[1] Pacific Coast Fisheries Information Network (PacFIN) as of November 20, 1989. Pacific Marine Fisheries Commission, Metro Center, Suite 170, 2000 S.W. First Avenue, Portland, OR 97201-5346.

[2] Groundfish Management Team (GMT) for Pacific Fishery Management Council. 1987. GMT statement on signs of biological stress on sablefish. Supplemental Exhibit c.3.b at November 18, 1987 meeting of PFMC, 3 p. Metro Center, Suite 420, 2000 SW. First Avenue, Portland, OR 97201.

objective of these surveys was to obtain catch per unit effort (CPUE) indices of sablefish abundance at predetermined index sites. Secondary objectives included collection of data on the state of maturity and determination of weight, length, and age composition. Fish have been tagged to study their movements and to identify potential management areas. The results of the 1979-88 surveys in the Washington-California region have been reported by Parks and Hughes (1981), Parks (1982, 1984), and Parks and Shaw (1983, 1985, 1987, 1988a, 1988b, 1989). This report presents results of the 1989 survey off Washington and Oregon and compares them with results of previous surveys.

In 1989, a workshop was held with the age readers from the AFSC, Southwest Fisheries Center, and the Canadian Department of Fisheries and Oceans to establish uniform age determination criteria for west coast sablefish. The AFSC age determination unit is using radioisotope dating methods to validate these criteria. This validation study has slowed production work so the ages for specimens sampled during the 1989 survey are not available at this time.

SURVEY METHODS AND EQUIPMENT

The survey was conducted from south to north at eight index sites off Oregon and Washington (Fig. 1). The original survey design and sampling gear are described in detail by Parks and Hughes (1981). Other modifications to the original survey design are described in Kimura and Balsiger (1985) and Parks and Shaw (1987). A summary of the sites fished, including dates, depths,

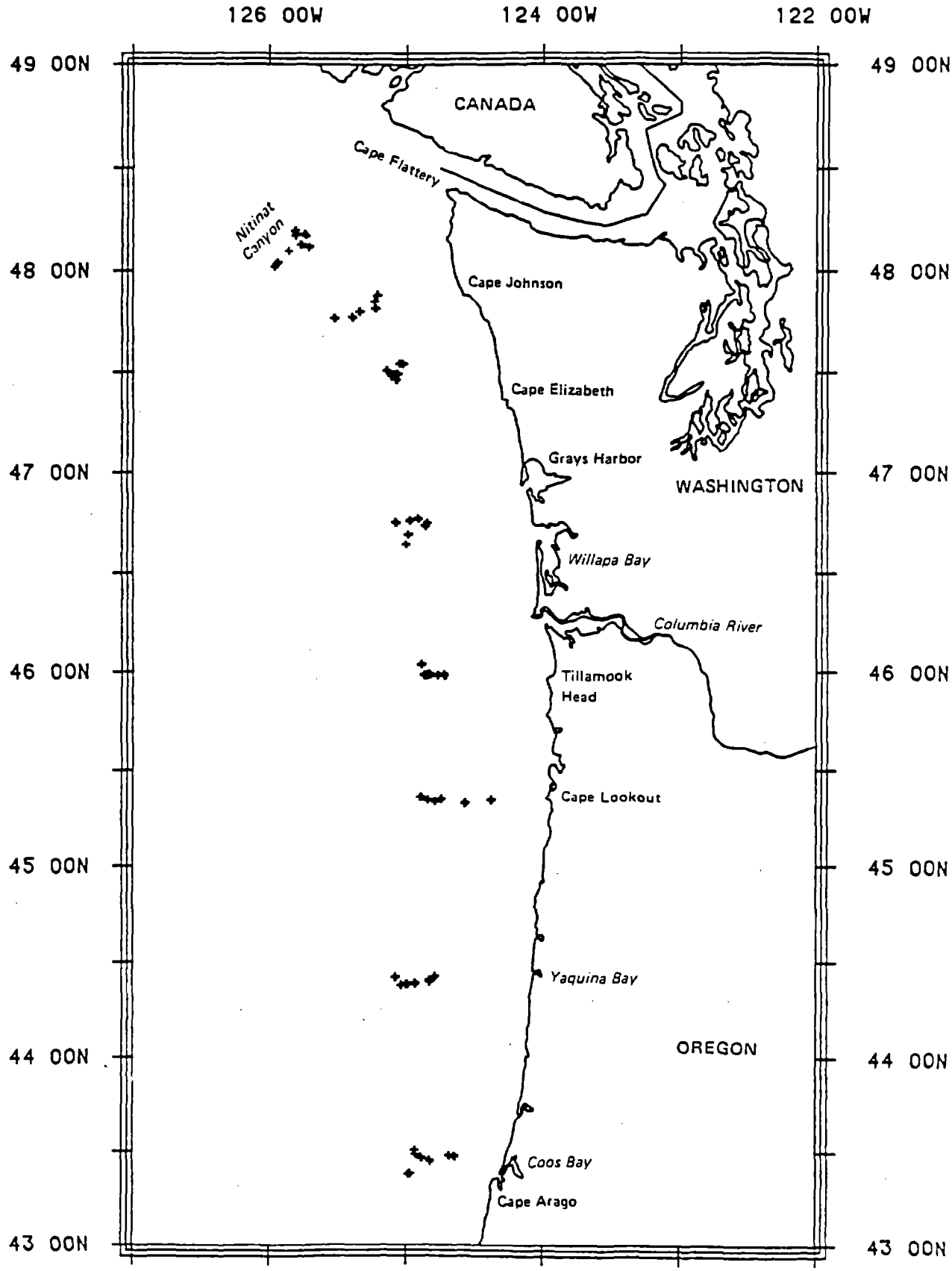

Figure 1.--Location of sablefish abundance indexing sites off Oregon and Washington, RV Alaska Cruise 89-3.

and number of sets and traps fished during sablefish indexing surveys off Washington and Oregon in 1979-89, is presented in Table 1. The conical traps and associated gear, as well as tunnel configuration and baiting procedures, are described in detail in Parks and Shaw (1988b).

A string of 10 traps was fished twice at each of 5 standard depths (150, 225, 300, 375, and 450 fathoms) at each indexing site. Fishing time was standardized to 24 hours per set. Loran C and depth sounders were used to position the replicate sets as near as possible to the same locations and depths of the first sets, as well as those made in previous surveys. Sampling was conducted from south to north during September-October 1989. Additional strings of traps were fished at 525 fathoms and opportunistically between 580 and 790 fathoms at sites off Washington to obtain data from beyond standard survey depths. Data collected in 1989 were similar to those collected in previous years and included: 1) number and weight of sablefish and other species captured in each trap, 2) lengths of all sablefish, and 3) otoliths and sexual maturity observations from a random sample of 20 sablefish from each depth at each site. Each of the 802 sablefish from which otoliths were taken were weighed to the nearest gram using a high resolution triple beam balance. All sablefish not required for biological samples were held in live tanks, tagged as soon as possible, and then released near the capture site.

Table 1.--Summary of sampling information for sablefish abundance indexing surveys conducted off Washington and Oregon, 1979-89.

Site	Dates fished	Depths fished (fm)	Sets (No.)	No. of traps fished	
				Rectangular	Conical
		1979			
Cape Arago, OR	8-13 Aug	150-450	5	250	0
Cape Lookout, OR	17-23 Aug	150-450	5	250	0
Willapa Bay, WA	6-13 Sep	150-450	5	250	0
Cape Johnson, WA	16-21 Sep	150-450	5	250	0
		1980			
Cape Arago, OR	6-10 Aug	150-450	5	250	0
Cape Lookout, OR	12-19 Aug	150-450	5	250	0
Willapa Bay, WA	10-16 Sep	150-450	5	250	0
Cape Johnson, WA	21-26 Sep	150-450	5	250	0
		1981			
Cape Arago, OR	5-11 Aug	150-450	5	250	0
Cape Lookout, OR	13-19 Aug	150-450	5	250	0
Willapa Bay, WA	19-28 Sep	150-450	5	250	0
Cape Johnson, WA	11-16 Sep	150-450	5	250	0
		1983			
Cape Arago, OR	26-28 Oct	150-450	2	50	50
Cape Lookout, OR	23-24 Oct	150-450	2	50	50
Willapa Bay, WA	16-18 Oct	150-450	2	50	50
Cape Johnson, WA	13-14 Oct	150-450	2	50	50
		1985			
Cape Arago, OR	16-18 Aug	150-450	2	50	50
Yaquina Bay, OR	20-21 Aug	150-450	2	50	50
Cape Lookout, OR	23-24 Aug	150-450	2	50	50
Tillamook Head, OR	27-28 Aug	150-450	2	50	50
Willapa Bay, WA	2- 3 Sep	150-450,525	2	50	70
Cape Elizabeth, WA	5- 7 Sep	150-450,525	2	50	70
Cape Johnson, WA	9-10 Sep	150-450,525	2	50	70
Nitinat Canyon, WA	13-14 Sep	150-450,525	2	50	70
		1987			
Cape Arago, OR	22-23 Aug	150-450,525,>600	2	0	140
Yaquina Bay, OR	25-26 Aug	150-450,525,>600	2	0	140
Cape Lookout, OR	29-30 Aug	150-450,525,>600	2	0	140
Tillamook Head, OR	1- 2 Sep	150-450,525,>600	2	0	140
Willapa Bay, WA	6- 7 Sep	150-450,525,>600	2	0	140
Cape Elizabeth, WA	9-10 Sep	150-450,525,>600	2	0	140
Cape Johnson, WA	11-13 Sep	150-450,525,>600	2	0	140
Nitinat Canyon, WA	17-18 Sep	150-450-525,>600	2	0	130
		1989			
Cape Arago, OR	10-11 Sep	150-450,525	2	0	120
Yaquina Bay, OR	13-14 Sep	150-450,525	2	0	120
Cape Lookout, OR	16-17 Sep	150-450,525	2	0	120
Tillamook Head, OR	19-20 Sep	150-450,525	2	0	120
Willapa Bay, WA	24-25 Sep	150-450,525,>580	2	0	130
Cape Elizabeth, WA	28-29 Sep	150-450,525,>580	2	0	140
Cape Johnson, WA	1- 2 Oct	150-450,525	2	0	120
Nitinat Canyon, WA	3- 5 Oct	150-450,525,>580	2	0	140

fn = fathons

RESULTS AND DISCUSSION

The data from all sampling sites were combined to provide a measure of sablefish relative abundance and size composition for the entire Washington and Oregon survey area. Results from individual sampling sites are not discussed here, although catch and size data by site are presented in the Appendix.

Catch Rates and Size Composition

Annual trends in relative population abundance have been identified by examining data collected from the four original index sites from 1979 to 1983 and all eight sites from 1985 to 1989. Catch rate comparisons indicate that overall sablefish abundance dropped sharply from 1979 to 1981, increased markedly between 1981 and 1983, and has declined sharply since 1983, although the decline appears to have moderated between 1987 and 1989 (Fig. 2). Catch rates (average number of fish per trap), based on data from standard depths (150-450 fathoms) at the eight sites, decreased 14% from 1987 to 1989. The 1989 mean catch rate of 2.4 fish per trap represents a decrease of 79% from the 1979 mean catch rate of 11.4 fish per trap (Fig. 2). Standard errors and coefficients of variation associated with 1983, 1985, 1987, and 1989 mean catches per trap are shown in Table 2. Pair-wise comparisons between the catch rates (average number of sablefish per trap) from various survey years we-a tested at a level of significance (a = 0.05). The Bonferroni joint testing procedure (Neter et al. 1985) was used to adjust for the multiple

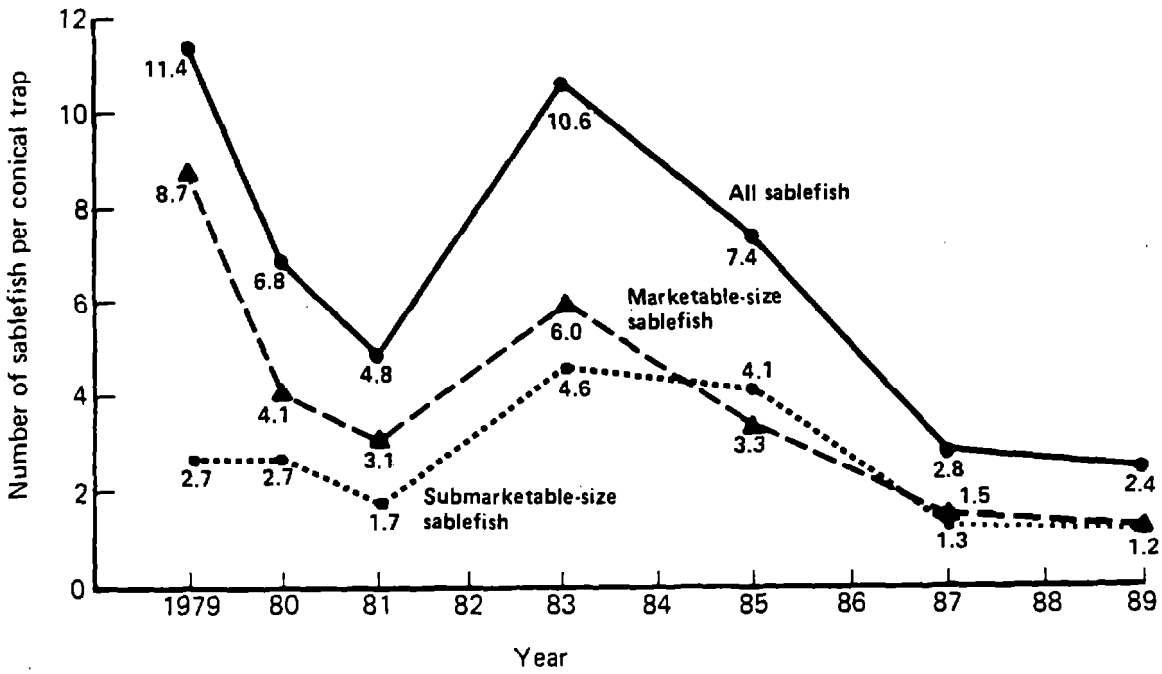

Figure 2.--Mean catch rates (fish/trap) of all sablefish, submarketable-size sablefish (<52 cm fork length), and marketable-size sablefish (> 52 cm fork length) at the four original index sites in 1979-83 and at all eight sites in 1985-89 (standard depths 150-450 fathoms).

Table 2.--Mean catch rates, standard errors, and coefficients of variation for sablefish at index sites off Oregon and Washington from 1983 to 1989 (standard depths 150-450 fathoms).

Year	Mean catch rate	Standard error	Coefficients of variation
1983	10.6	1.410	13.3
1985	7.4	0.795	10.7
1987	2.8	0.288	10.3
1989	2.4	0.266	11.1

Table 3.--Pair-wise comparisons between the catch rates (average numbers of sablefish/trap) from various survey years. Significance judged at 0.05% probability level.

Year	Difference between average catch rates	Standard Error of difference	95% Confidence interval	Statistically significant
1983-85	3.2	1.62	(-1.07, 7.47)	No
1983-87	7.8	1.44	(4.00, 11.60)	Yes
1983-89	8.2	1.43	(4.41, 11.99)	Yes
1985-87	4.6	0.85	(2.37, 6.83)	Yes
1985-89	5.0	0.84	(2.79, 7.21)	Yes
1987-89	0.4	0.39	(-0.63; 1.43)	No

comparisons. Only two of the six possible year combinations were not significantly different (1983-85 and 1987-89, Table 3). Catch rates expressed in average catch per trap dropped 81% from nearly 45 pounds (20.4 kg) per trap in 1979 to 8.3 pounds (3.8 kg) per trap in 1989 (Fig. 3).

Catch rates by size group followed the overall trend. The catch rate of marketable-size sablefish (>52 cm fork length) decreased from 8.7 fish per trap in 1979 to 1.2 fish per trap in 1989. The catch rate of submarketable-size sablefish (<52 cm fork length)[3] declined from 4.6 fish per trap in 1983 to 1.2 fish per trap in 1989 (Fig. 2). The proportion of submarketable-size sablefish in the catches increased from 24% of the catch in 1979 to 48% during the last survey year (Table 4). Catch rates for all marketable-size groups were lower in 1989 than in any previous survey year (Fig. 4). The decline was most dramatic for the medium (62-67 cm) and large (>68 cm) size sablefish, where catch rates dropped 42 and 47%, respectively, between 1987 and 1989. This decline in catch rates and the proportion of medium and large sablefish has been severe since the earlier surveys (Fig. 4 and Table 4). Catch rates have declined 93% for medium and 96% for large sablefish since the 1979 survey. Combined they now make up 7% of the catch compared to 22% in 1979.

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[3] The submarketable size category (<52 cm fork length) is a coastwide sablefish minimum size for which landing limits are set by the Pacific Fishery Management Council.

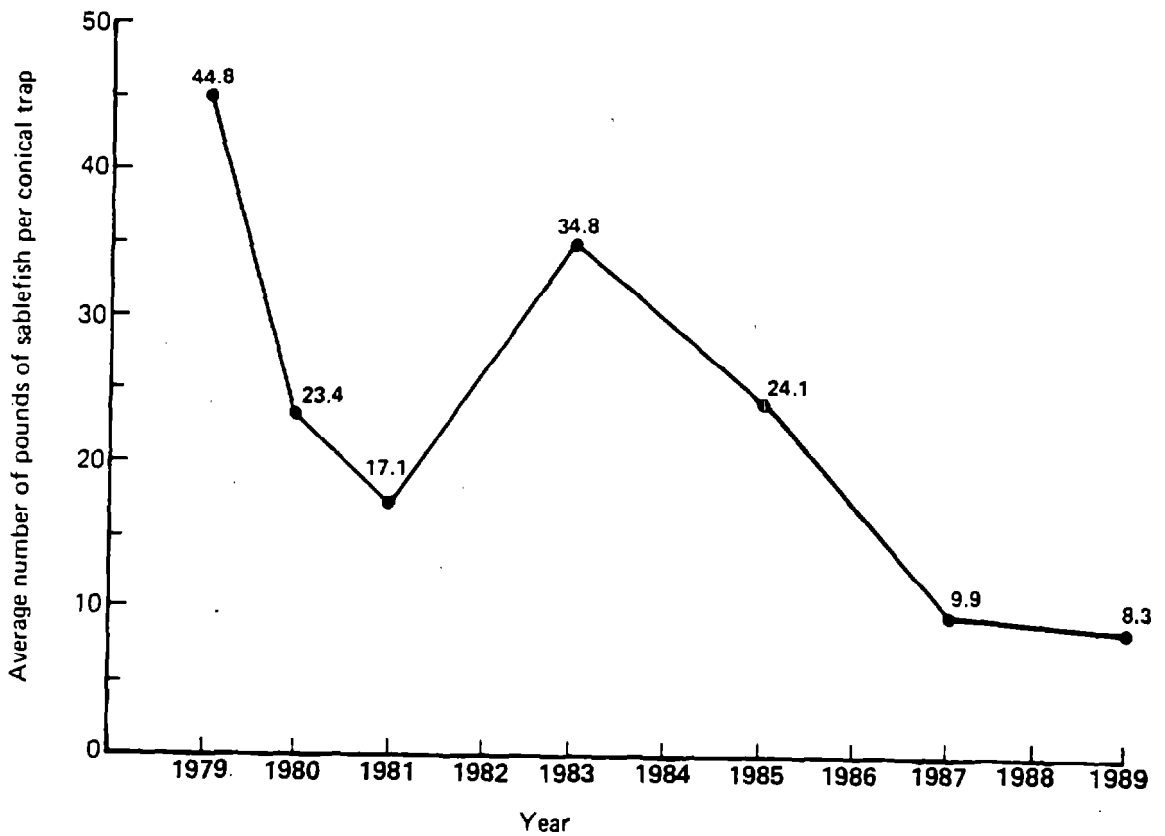

Figure 3. --Mean catch rates (lb/trap) of sablefish at the four original index sites off Oregon and Washington 1979-83, and at all eight sites in 1985, 1987, and 1989 (standard depths 150-450 fathoms).

Table 4.--Average percentage abundance by numbers of submarketable and marketable-size sablefish at abundance indexing sites during the 1978-89.

Year and sites	sub-marketable[a] (%)	Marketable			Total (%)
		Small[b] (%)	Medium[c] (%)	Large[d] (%)	
1979 (Original four sites)	24	54	12	10	100
1980 (Original four sites)	37	47	8	8	100
1981 (Original four sites)	37	49	8	6	100
1983 (Original four sites)	44	45	7	4	100
1985 (Original sites)	59	35	4	2	100
1985 (All eight sites)	56	36	5	3	100
1987 (Original four sites)	44	46	7	3	100
1987 (All eight sites)	45	44	7	4	100
1989 (Original four sites)	54	41	4	1	100
1989 (All eight sites)	48	45	5	2	100

[a] less than 52 cm fork length = less than 3.0 lb round weight
[b] 52-61 cm fork length = 3.0-5.0 lb round weight
[c] 62-67 cm fork length = 5.0-7.0 lb round weight
[d] 68 cm or greater fork length = more than 7.0 lb round weight

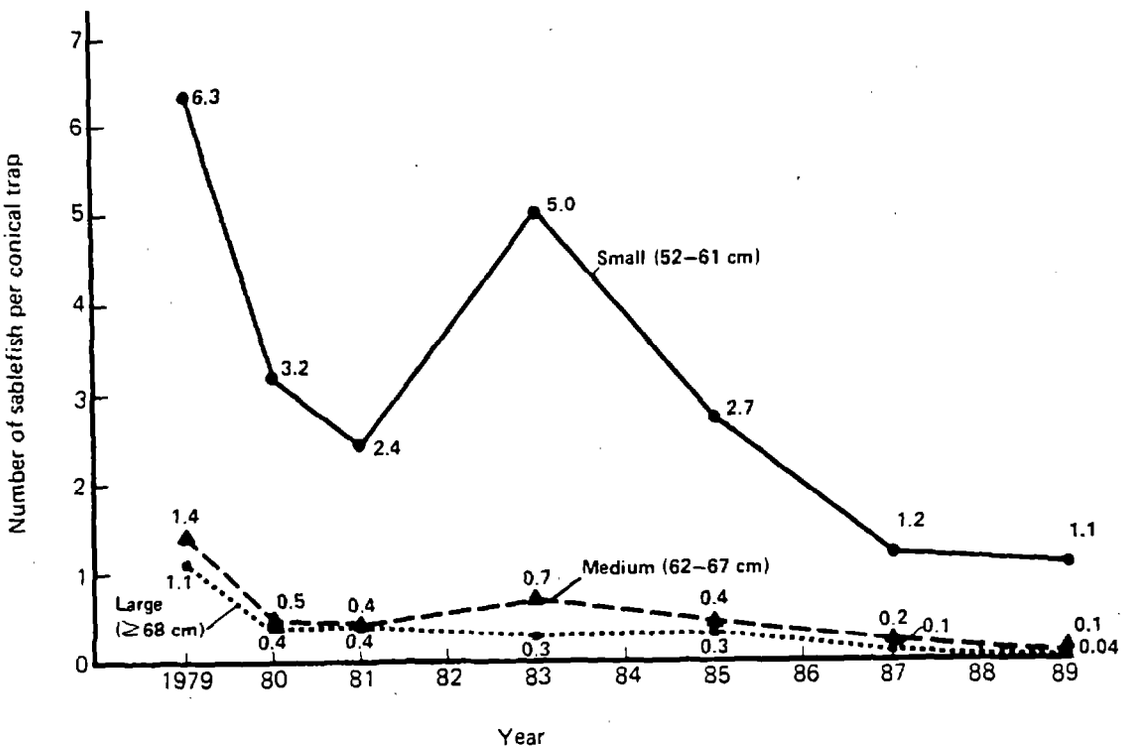

Figure 4.--Mean catch rates (fish/trap) of small, medium, and large sablefish at the four original index sites off Oregon and Washington, 1979-83, and at eight sites in 1985, 1987, and 1989 (standard depths 150-450 fathoms).

A comparison of sablefish size composition at the standard depths over the history of the survey is shown in Figure 5. The alteration of the survey design in 1985 (Table 1) necessitates comparing data from the first two sets at each of four original sites in 1979-83 with data from both sets at all eight sites since 1985. Parks and Shaw (1987) showed that there was no difference in size selectivity by rectangular and conical traps. Mean fork length has generally decreased since the surveys began and is shown by year in Figure 5. Figure 6 illustrates the portions comprising the submarketable, small, medium, and large size categories. In 1979, the mean fork length was 56.7 cm; it has since declined to 52.6 cm in 1989 (Figs. 5 and 6).

Sablefish length compositions by sex for the 1989 survey (Fig. 7) were weighted by the total catch number at each depth and site. The mean lengths for all sites pooled were 51.7 cm for males and 54.3 cm for females which are, as in 1987, very close to lengths at 50% maturity (50.8 cm for males and 55.3 cm for females) in this region (Parks and Shaw 1987). Using the length compositions by sex we calculated that approximately 53% of the males and 35% of the females captured in the survey are sexually mature.

Distribution by Depth

Sablefish distribution by depth in 1989 was different from the distribution in the 1987 survey. Catch rates at the three shallowest depths (150-300 fathoms) combined were approximately 12% higher in 1989 than in 1987, whereas catch rates at the four

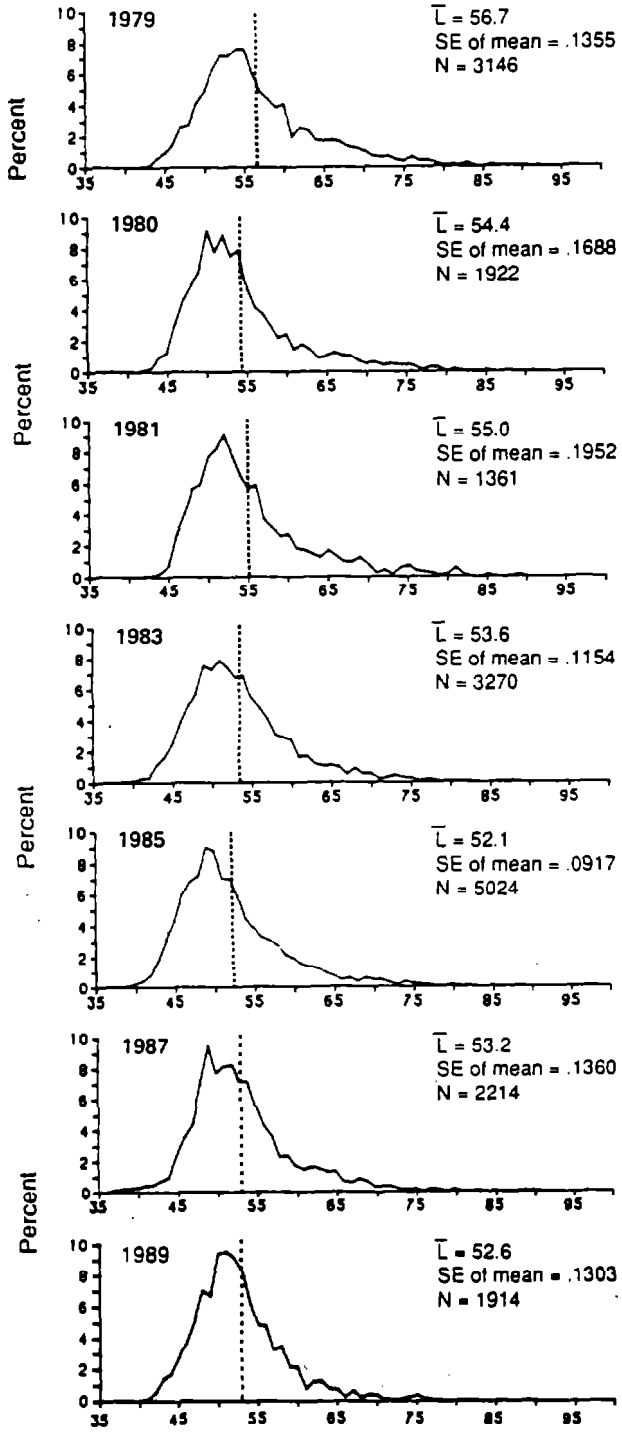

Figure 5. --Length composition of sablefish captured in the first two sets at the original sites off Oregon and Washington during the 1979, 1980, 1981, 1983, and at all eight survey sites in 1985, 1987, and 1989 (standard depths 150-450 fathoms). Vertical dotted lines indicate mean length.

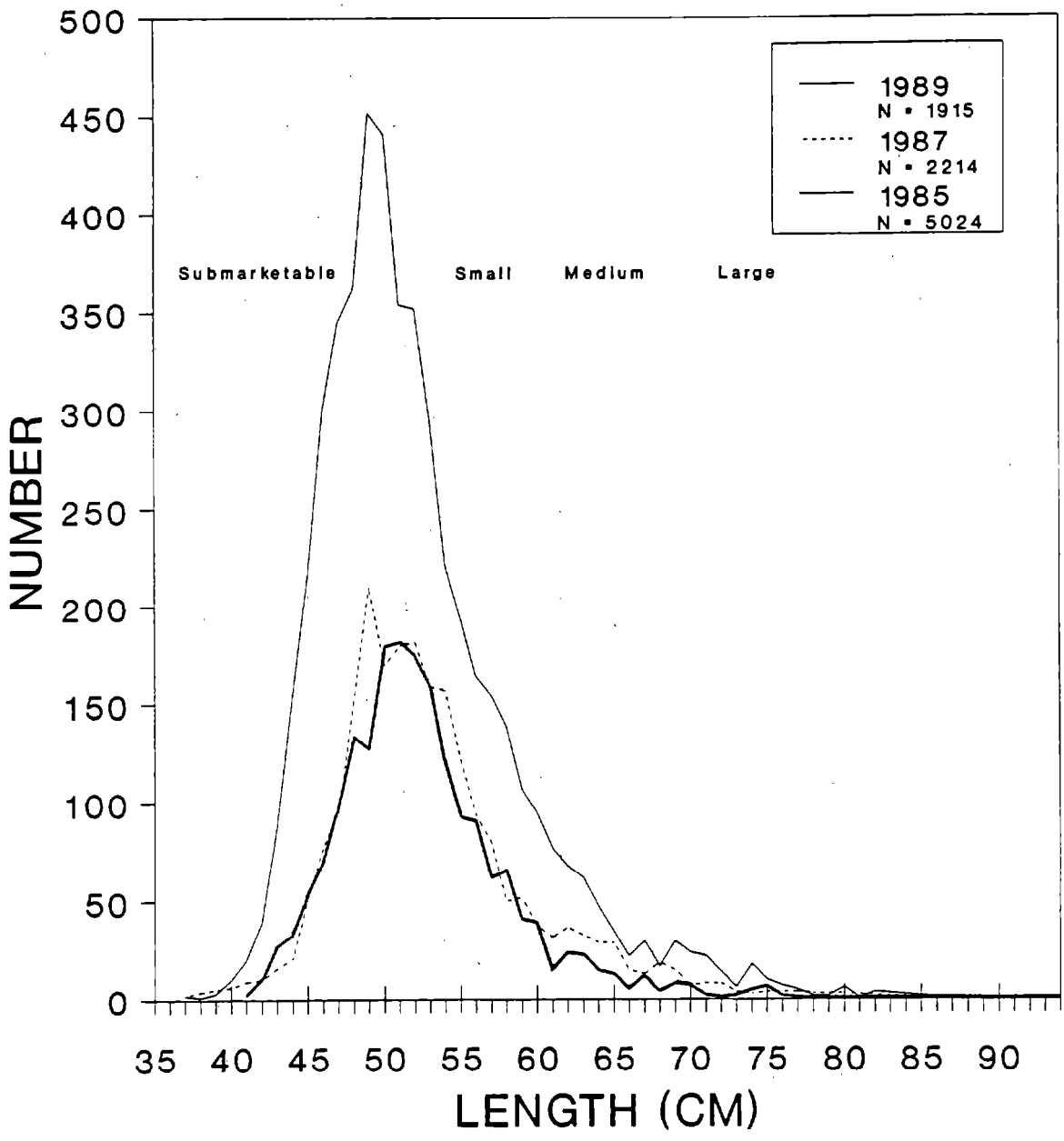

Figure 6.--Length composition of all sablefish captured in 1985, 1987, and 1989 abundance index survey off Oregon and Washington (standard depths 150-450 fathoms).

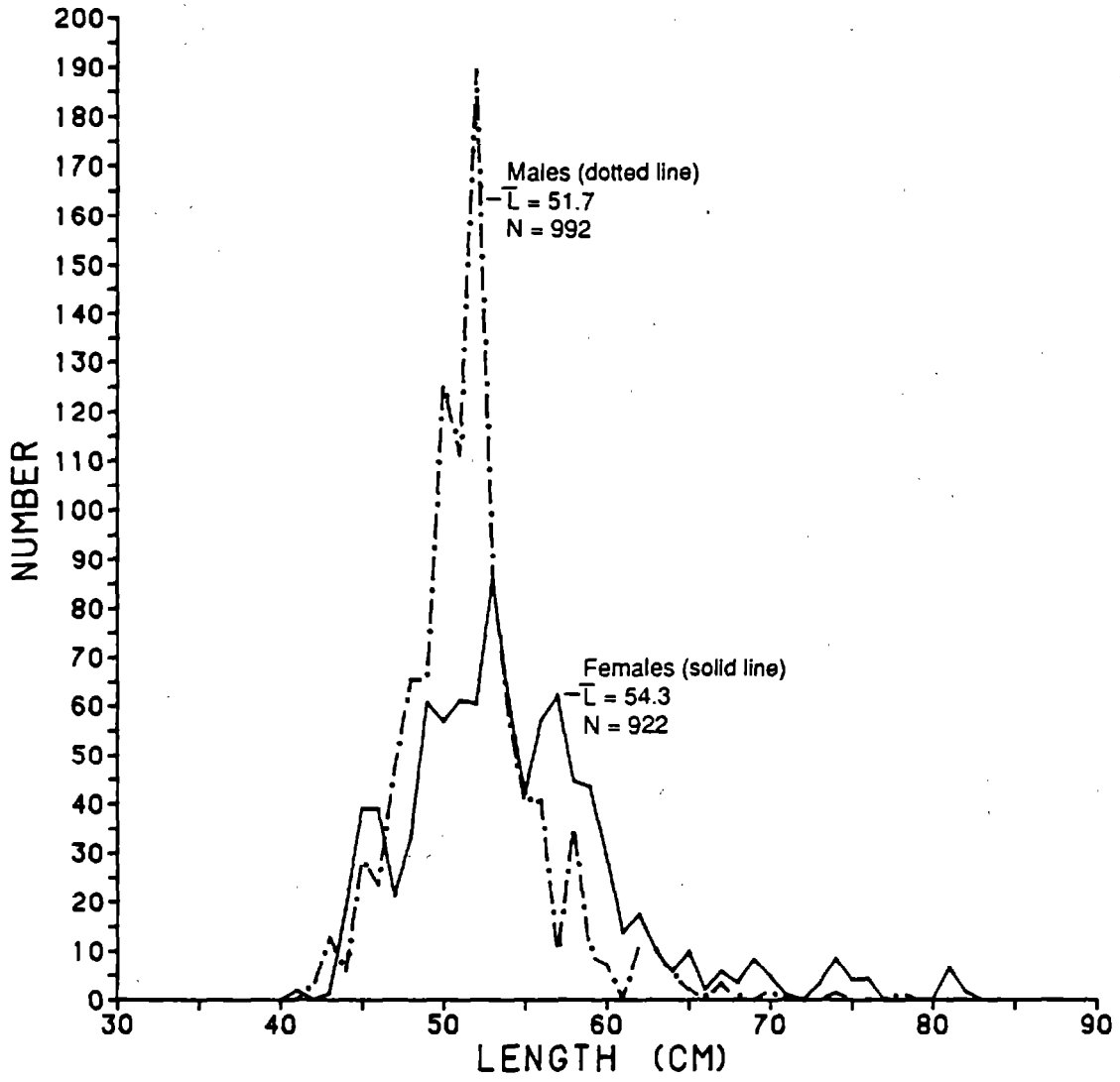

Figure 7.--Sablefish length compositions by sex based on random samples at standard depths (150-450 fathoms) and then weighted by the total number of sablefish captured per site from the 1989 abundance index survey.

deepest depth intervals (375 - >580 fathoms) combined, declined by approximately 54% in 1989 (Table 5). The highest mean catch rates within the standard sampling depths (150-450 fathoms) were observed at 300 and 225 fathoms in 1989 (Fig. 8). Catch rates were much lower at all other standard depths with the lowest catch rate occurring beyond the standard depths at depths greater than 580 fathoms (Table 5). Catch rates have varied greatly with depth over the survey years, with all depths, except 375 fathoms, producing the highest catch rate during one or more years. For all years combined, 225 and 300 fathoms produced much higher catch rates (>26% of the catch each) followed by 375 and 450 fathoms (>16% each). Lowest was 150 fathoms (14% of the catch).

Klein (1985) reports that in the Nitinat Canyon area, sablefish tend to move up the continental slope in June or July and remain in shallower areas until mid-September to mid-October when they move back down the slope into deeper water. He found that the timing of these migrations varies by a month or so from year to year. If these migrations occur coastwide, changes in depth distribution as we have found between the survey years should not be surprising.

Changes in Size by Depth

Length compositions by depth for 1989 are shown in Figure 9. Mean length generally increased with depth (Fig. 10) with the 1987 and 1989 results showing very similar trends. Sablefish captured in depths greater than 580 fathoms were much larger than those captured in shallower depths.

Table 5.--Mean catch rates of sablefish (fish/trap) by depth in 1987 and 1989.

	Depth in fathoms						
	150	225	300	375	450	525	>580
Average No. per trap							
1987	1.4	3.0	3.9	2.4	3.3	2.8	1.5
1989	1.8	3.5	4.0	1.7	1.1	1.1	0.7

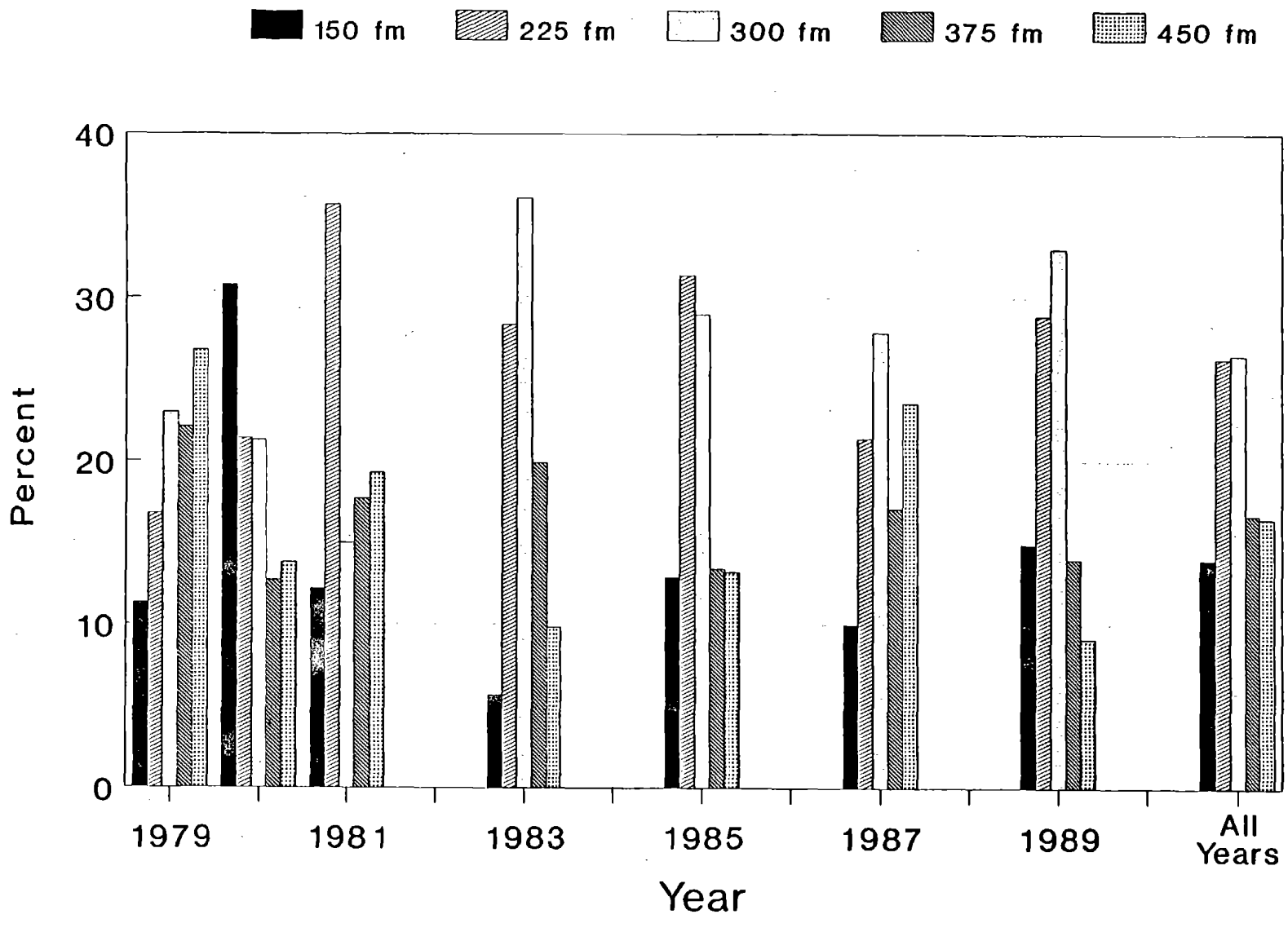

Figure 8.--Catch rates by depth by year for all years combined for sablefish captured during Washington and Oregon abundance index surveys at standard depths (150-450 fathoms) expressed as percent captured at each depth.

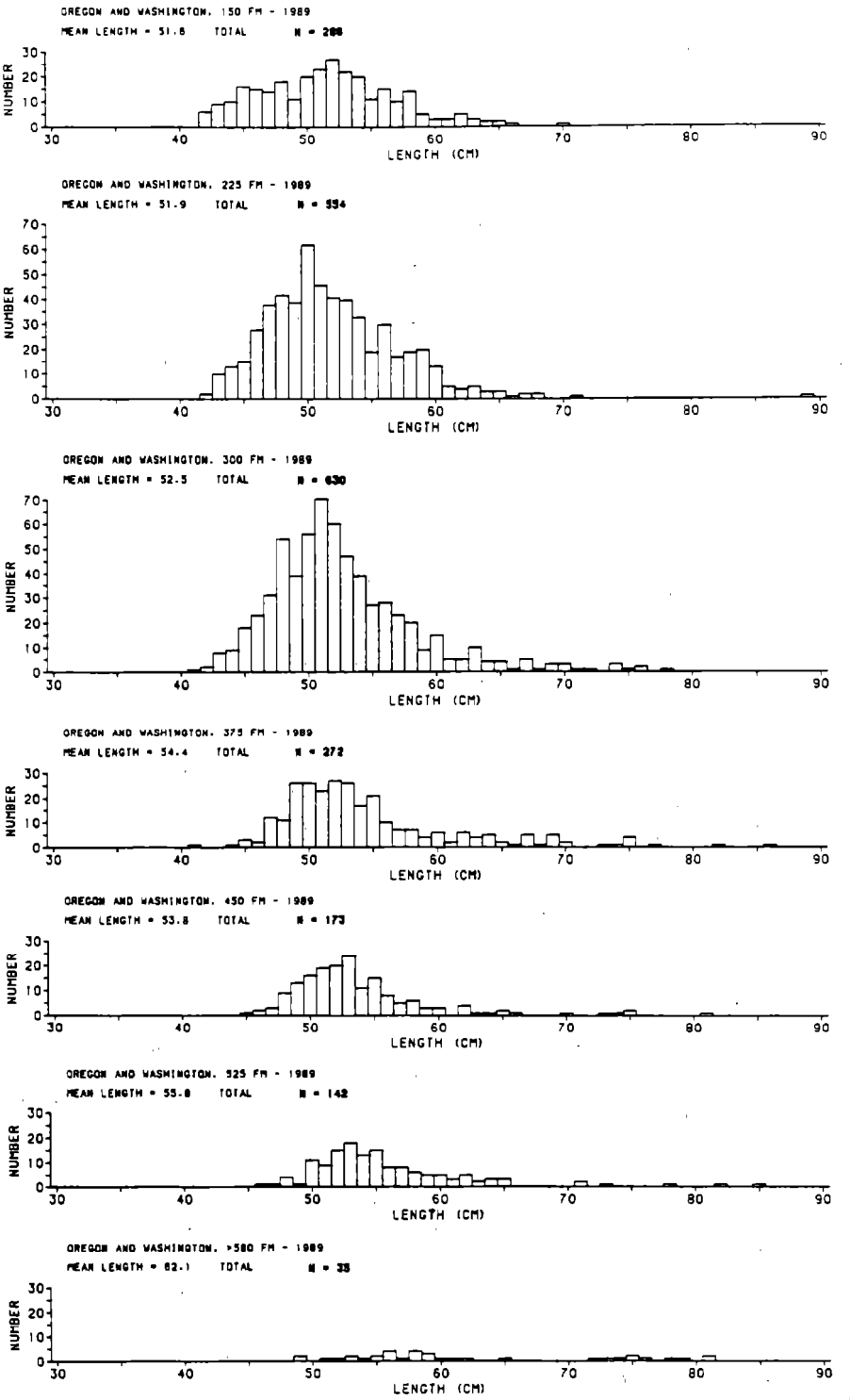

Figure 9.--Sablefish length compositions by depth, 1989 survey.

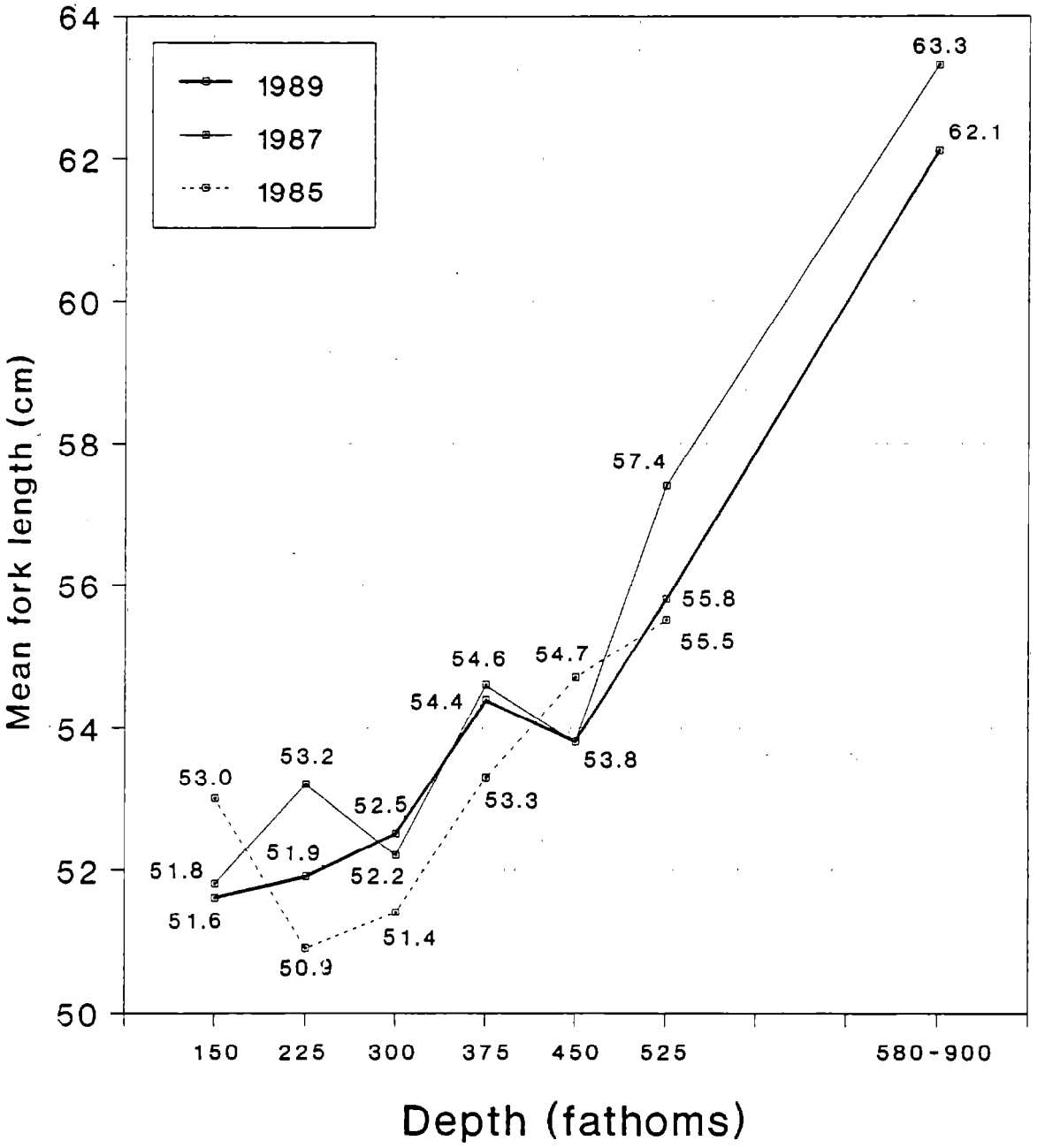

Figure l0.--Mean sablefish fork lengths (cm) by depth in 1985, 1987, and 1989.

Length-Weight Relationship

Male and female length-weight relationships could not be distinguished graphically as has been the case since 1985 (Parks and Shaw 1987, Parks and Shaw 1988b). Therefore, data for both sexes are combined and presented in Figure 11. The length-weight relationship is $W = 0.0024419 \times L^{3.34694}$ where W = weight in grams and L = length in centimeters. The 1989 predicted weights are lower for sablefish less than 82 cm than those predicted from our pooled 1979-87 surveys and are slightly higher for fish 82-85 cm. Predicted weights for 40, 50, 60, 70, 80, and 85 cm sablefish were 4, 3, 2, 1 and 0.1% lighter and 0.3% heavier, respectively, in 1989 than those weights predicted from the length-weight relationship calculated from the pooled 1979-87 data. ($W = 0.0031828 \times L^{3.286705}$).

SUMMARY AND CONCLUSIONS

Survey catch rates indicate that sablefish abundance off Oregon and Washington has continued the decline observed since 1983 (Fig. 2). Overall mean catch rates have declined from 11.4 fish per trap in 1979 to 2.4 in 1989, indicating a decrease of about 79%; a decrease of 68% was observed between 1985 and 1989 alone. Mean catch rates for all size groups, which set new lows in 1987, dropped even lower in 1989. The catch rates of submarketable-size, small, medium, and large sablefish have declined 56, 83, 93 and 96%, respectively, from 1979 levels (Fig. 2 and Fig. 4). These greater declines in numbers of larger

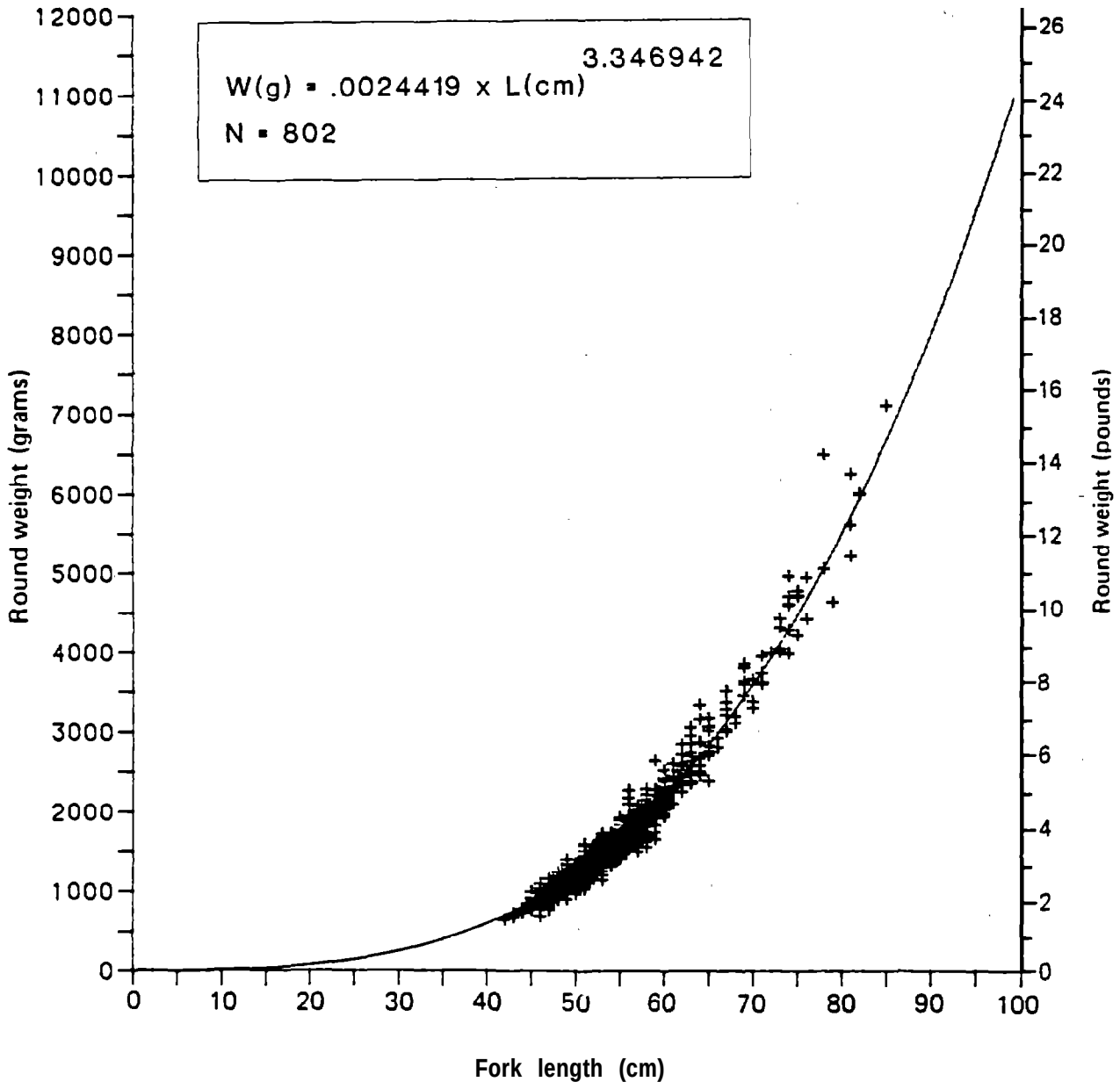

Figure 11.--Length-weight relationship derived from sablefish collected off Oregon and Washington in September and October 1989.

sablefish indicate juvenation of the stock as described by Zirges (1985).

The mean lengths of sablefish have declined steadily from 56.7 cm in 1979 to 52.6 cm in 1989 (Fig. 5). The mean length of males in 1989 was 51.7 cm, and females averaged 54.3 cm (Fig. 7); mean lengths for both sexes are very close to lengths at 50% maturity. Length generally increased with depth and fish captured at 580-900 fathoms were much larger than those captured at the standard survey depths (Fig. 9).

Estimates of percent immature sablefish landed by the fishery in 1987 were calculated by Parks and Shaw (1989) from data reported by Methot and Hightower (1988). The percentage of sablefish harvested at sizes below 50% maturity by gear type in 1987 are shown in Figure 12. The sex ratio of sablefish captured by gear type was 53.2% male for trawls and 47.8% male for fixed gear (pot and longline combined). Using sablefish landings by gear type from 1989 Pacific Fishery Information Network (PacFIN) data, we calculated that 49% of the fish were captured before reaching the length at 50% maturity. These values do not include the discards of small and sub-marketable fish which, if included, would make the percentages considerably higher, especially for trawl gear which is known to select for small fish (Klein 1986). Large numbers of sablefish (approximately 50% of landings) are being harvested before they have an opportunity to reach sexual maturity. This and the fact that the population of mature sablefish seems to have been significantly reduced since 1979, raises concerns that the reproductive potential of the population

may be adversely impacted. Survey catch rates have declined markedly since 1983 and there is no sign of any strong year class off Oregon and Washington which would recruit in the near future.

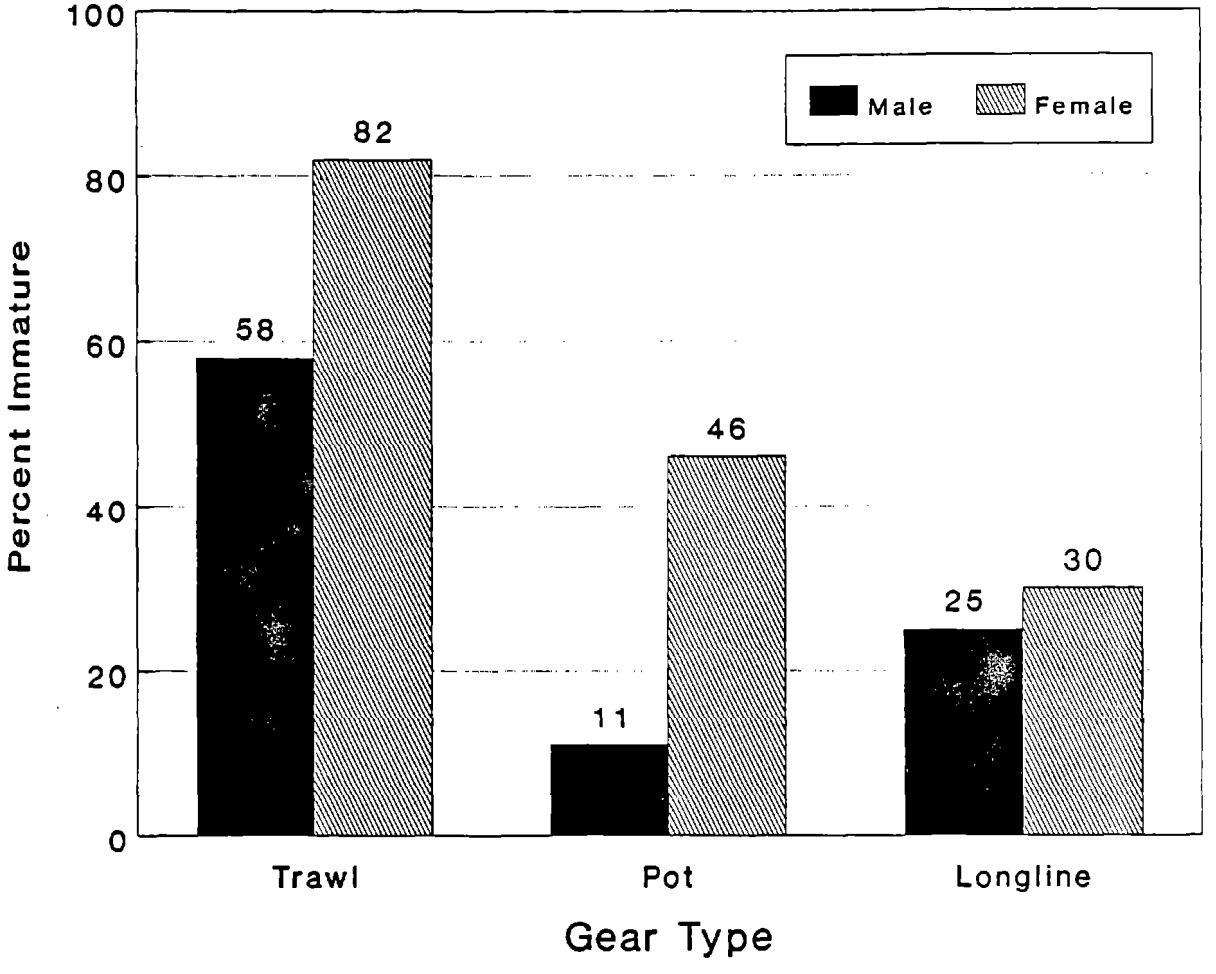

Figure 12. --Estimates of the percentage of sablefish harvested at sizes which are below 50% maturity by gear type in 1987.

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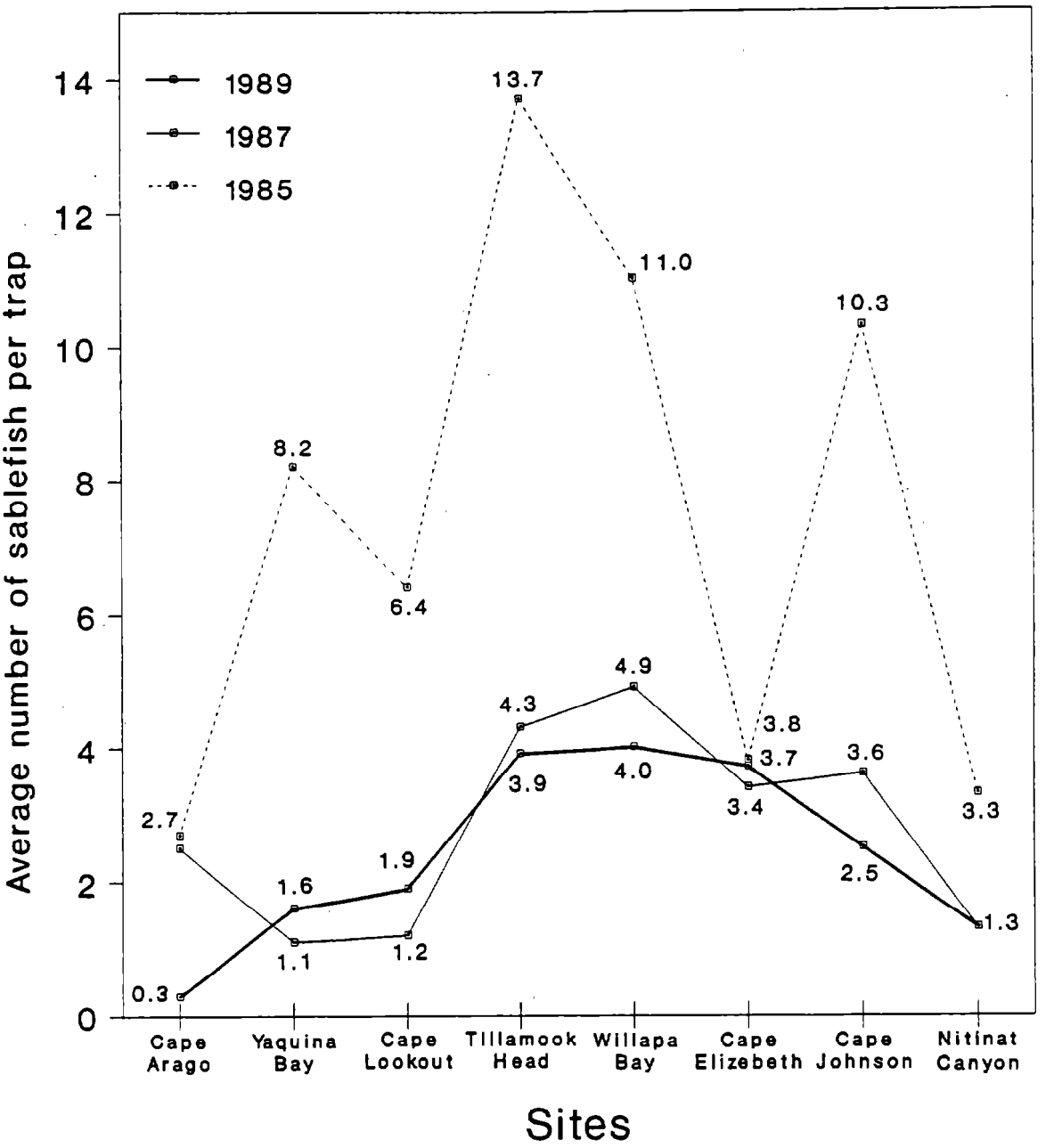
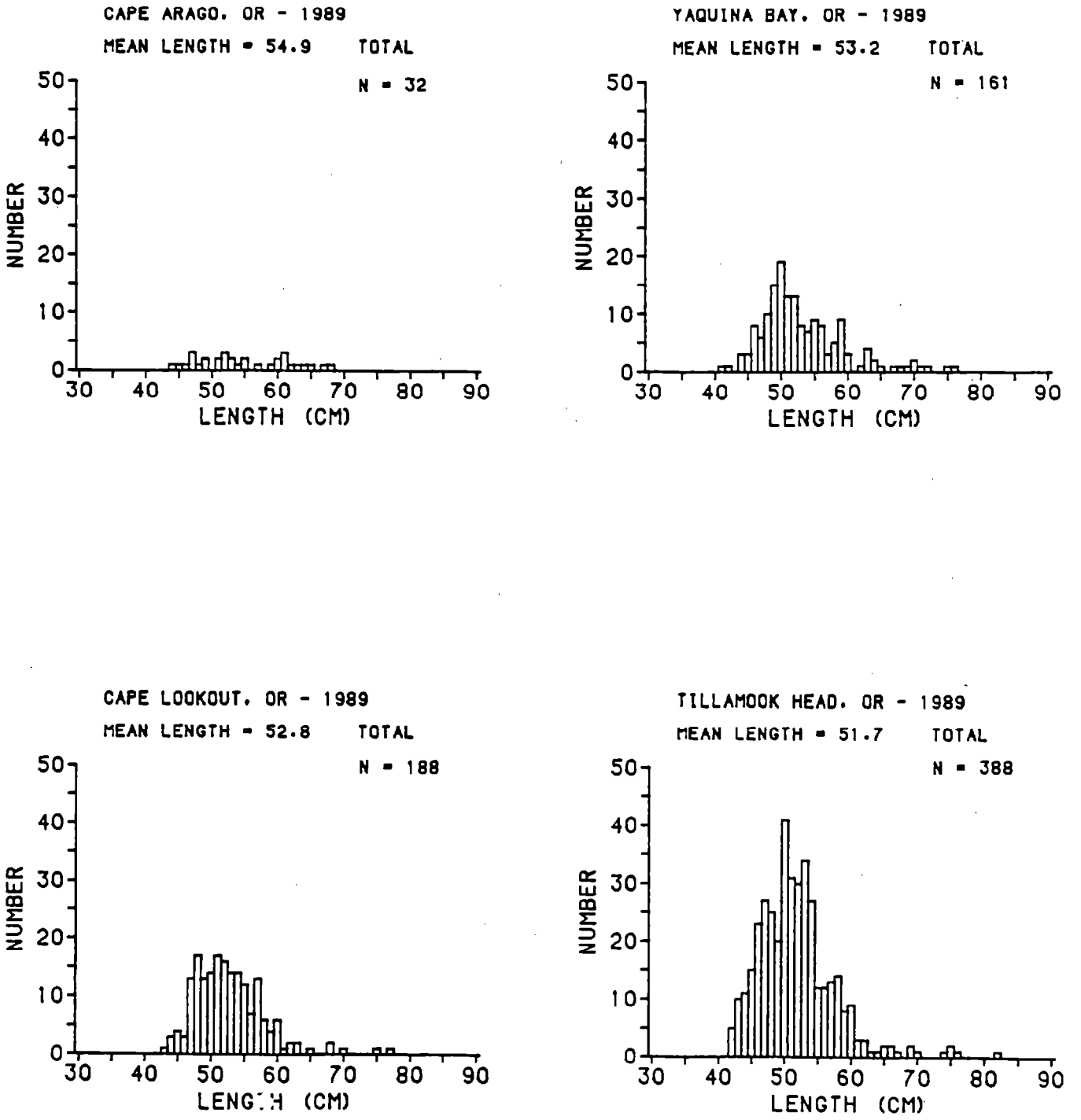
APPENDIX

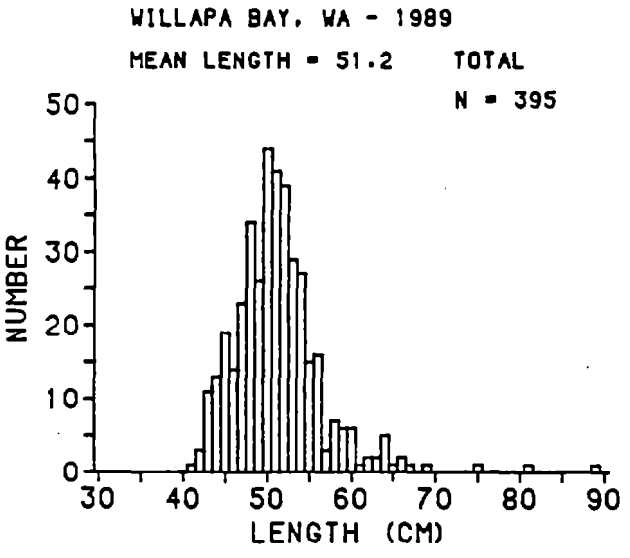
Individual Index Site Data

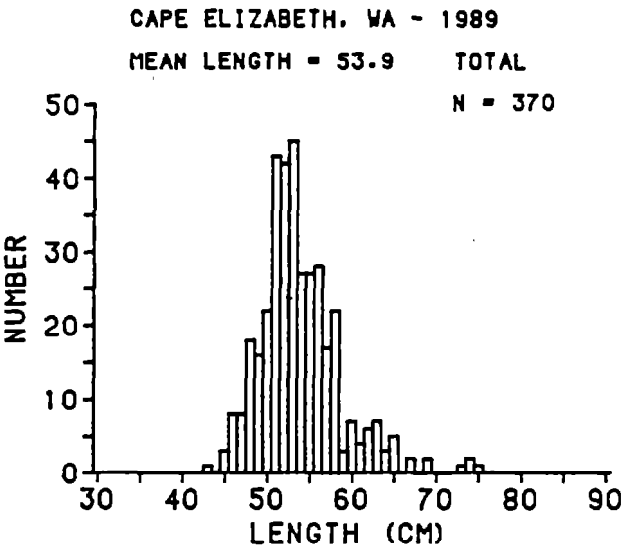


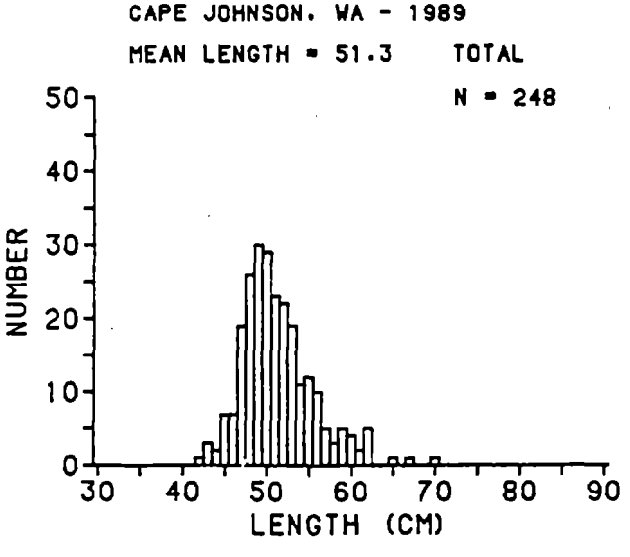
Appendix Figure 1.--Mean catch rates of sablefish at eight index sites fished off Oregon and Washington in 1985, 1987, and 1989.

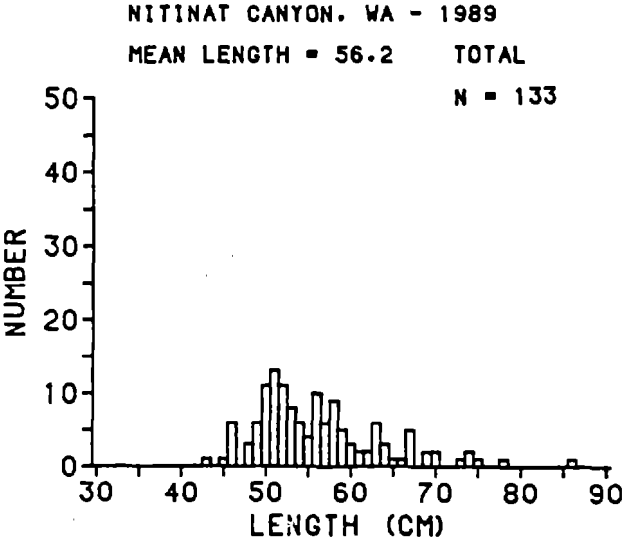


Appendix Figure 2.--Sablefish length compositions and mean lengths by indexing site at the standard depths (150-450 fathoms) from 1989 survey.









Appendix Figure 2.--Continued.

Appendix Table 1.--Catch rates of sablefish by year, sampling site, and size group at the standard depths (150450 fathoms). The number caught are the estimated mean numbers of sablefish captured per conical trap unit based on the relative efficiencies of conical and rectangular traps observed in 1985. The 1987 and 1989 catch rates are observed values.

		Average number per trap					
		Submarket-able-sized	Marketable-sized			Total	
Site	Year	< 52 cm	Small 52-61 cm	Medium 62-67 cm	Large > 67 cm	marketable sized	Total sablefish
OREGON							
Cape Arago	1979	1.6	4.2	1.1	0.7	6.0	7.6
	1980	4.8	3.5	0.5	0.4	4.4	9.2
	1981	1.1	1.1	0.2	<0.1	1.3	2.4
	1983	3.8	5.2	0.3	0.2	5.7	9.5
	1985	1.6	1.0	<0.1	<0.1	1.1	2.7
	1987	0.7	1.4	0.3	<0.1	1.8	2.5
	1989	0.1	0.1	<0.1	<0.1	0.2	0.3
Yaquina Bay	1985	3.7	3.6	0.6	0.2	4.5	8.2
	1987	0.7	0.4	<0.1	<0.1	0.4	1.1
	1989	0.8	0.6	<0.1	<0.1	0.7	1.6
Cape Lookout	1979	4.1	12.6	3.0	2.1	17.7	21.8
	1980	2.5	3.0	0.6	0.5	4.1	6.6
	1981	1.0	2.2	0.6	0.6	3.4	4.4
	1983	4.5	4.9	0.8	0.5	6.2	10.7
	1985	3.5	2.4	0.4	0.1	2.9	6.4
	1987	0.5	0.6	0.1	0.1	0.8	1.3
	1989	0.8	0.9	<0.1	<0.1	0.9	1.9
Tillamook Head	1985	8.9	4.0	0.4	0.4	4.8	13.7
	1987	2.2	1.6	0.3	0.2	2.1	4.3
	1989	2.1	1.6	0.1	<0.1	1.5	3.9
WASHINGTON							
Willapa Bay	1979	3.9	5.2	0.7	0.7	6.6	10.5
	1980	1.8	3.0	0.4	0.5	3.9	5.7
	1981	1.8	2.7	0.5	0.6	3.8	5.6
	1983	6.0	6.0	0.9	0.4	7.3	13.3
	1985	6.3	3.8	0.5	0.4	4.7	11.0
	1987	2.2	2.3	0.3	0.2	2.7	5.0
	1989	2.3	1.5	0.1	<0.1	1.3	4.0
Cape Elizabeth	1985	2.1	1.3	0.2	0.2	1.7	3.8
	1987	1.8	1.3	0.2	0.1	1.6	3.4
	1989	1.2	2.2	0.2	<0.1	2.1	3.7
Cape Johnson	1979	1.3	3.1	0.6	0.7	4.4	5.7
	1980	1.5	3.2	0.5	0.4	4.1	5.6
	1981	2.8	3.5	0.4	0.2	4.1	6.9
	1983	4.1	3.9	0.6	0.3	4.8	8.9
	1985	6.6	3.0	0.4	0.3	3.7	10.3
	1987	2.0	1.4	0.1	<0.1	1.6	3.6
	1989	1.5	1.0	<0.1	<0.1	0.8	2.5
Nitinat Canyon	1985	0.4	2.0	0.5	0.3	2.9	3.3
	1987	0.1	0.8	0.3	0.1	1.2	1.3
	1989	0.4	0.6	0.2	0.1	0.8	1.3

Appendix Table 2.--Percentage abundance of submarketable-size and marketable-size sablefish from standard depths (150-450 fathoms) at four original Oregon and Washington abundance index sites during the 1979-81, and 1983 and from all eight sites in 1985, 1987, and 1989.

Year and area	Sub-marketable[a] (%)	Marketable			
		Small[b] (%)	Medium[c] (%)	Large[d] (%)	Total (%)
1979					
Cape Arago	24	54	12	10	76
Cape Lookout	19	57	13	11	81
Willapa Bay	35	51	7	7	65
Cape Johnson	20	55	13	12	80
Average	24	54	12	10	76
1980					
Cape Arago	47	39	8	6	53
Cape Lookout	38	44	9	9	62
Willapa Bay	31	52	8	9	69
Cape Johnson	31	54	8	7	69
Average	37	47	8	8	63
1981					
Cape Arago	47	44	6	3	53
Cape Lookout	29	46	12	13	71
Willapa Bay	34	52	7	7	66
Cape Johnson	39	52	6	3	61
Average	37	49	8	6	63
1983					
Cape Arago	43	49	5	3	57
Cape Lookout	39	47	8	6	61
Willapa Bay	44	44	7	5	56
Cape Johnson	48	42	7	3	52
Average	44	45	7	4	56
1985					
Cape Arago	59	39	1	1	41
Cape Lookout	55	37	6	2	45
Willapa Bay	57	34	5	4	43
Cape Johnson	64	30	3	3	36
Yaquina Bay	45	44	8	3	55
Tillamook Head	65	29	3	3	35
Cape Elizabeth	54	34	6	6	46
Nitinat Canyon	13	62	16	9	87
Average	55	36	5	4	45

Appendix Table 2.--Continued.

Year and area	Sub-marketable[a] (%)	Marketable			
		Small[b] (%)	Medium[c] (%)	Large[d] (%)	Total (%)
1987					
Cape Arago	30	54	13	3	70
Cape Lookout	36	44	9	11	64
Willapa Bay	45	47	5	3	55
Cape Johnson	56	39	4	1	44
Yaquina Bay	62	32	3	3	38
Tillamook Head	50	38	7	5	50
Cape Elizabeth	54	38	5	3	46
Nitinat Canyon	8	64	20	8	92
Average	45	44	7	4	55
1989					
Cape Arago	34	41	19	6	66
Cape Lookout	45	49	3	3	55
Willapa Bay	58	38	3	1	42
Cape Johnson	59	38	3	<1	41
Yaquina Bay	49	40	6	5	51
Tillamook Head	53	42	3	2	47
Cape Elizabeth	32	60	6	2	68
Nitinat Canyon	31	48	13	8	69
Average	48	45	5	2	52

[a] less than 52 cm fork length = less than 3.0 lb round weight
[b] 52-61 cm fork length = 3.0-5.0 lb round weight
[c] 62-67 cm fork length = 5.0-7.0 lb round weight
[d] 68 cm or greater fork length = more than 7.0 lb round weight