Changes in Relative Abundance and Size Composition of Sablefish (*Anoplopoma fimbria*) in Coastal Waters of California, 1980-82

by

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November 1983

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ABSTRACT

Sablefish (Anoplopoma fimbria) index sites off California were surveyed using traps in 1980-82. Sablefish catch rates on Patton Escarpment off San Diego, California, showed a decline of just over 50% between 1980 and 1982 surveys. Catches of sablefish at the Bodega Canyon index site northwest of San Francisco increased by 10%; the numbers of large sablefish taken at the Bodega Canyon site, however, declined markedly.

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INTRODUCTION

The Pacific west coast domestic sablefish (Anoplopoma fimbria) fishery has grown sporadically since 1977 (Table 1). The large increase in catch in 1979 resulted from expansion of the conical trap fishery in Oregon, the longline fisheries in Oregon and Washington, and attractive foreign markets. Sharply reduced sablefish prices, beginning in mid-1979, led to a substantial reduction in domestic effort and catch in 1980 and 1981.

Sablefish landings remained relatively stable in California between 1976 and 1981, ranging from a low of 5,333 metric tons (t) in 1980 to 7,172 t in 1978. Landings increased to approximately 9,500 t in 1982. Trap and longline catches made up much of the landings from 1976 to 1979; but in 1980-82 the percentage of sablefish taken by trawl was 54-57%. The percentage of sablefish landed by trawl also increased off Oregon and Washington in 1982 (Table 1) due largely to a strong market and attractive price for small sablefish. Intensive fishing continued until late October 1982, when the optimum yield figure of 17,420 t was met and the Pacific Fishery Management Council set a sablefish trip limit of 3,000 lb. The economic importance of the sablefish fishery and the need for information to complement status of stock analyses based on fishery statistics prompted a program at the Northwest and Alaska Fisheries Center (NWAFC) to monitor annual changes in distribution, relative abundance, size composition, biological characteristics, and migratory movements of sablefish in the northeastern Pacific Ocean. The study began in southeast Alaskan waters in 1978. It was expanded to include Washington and Oregon waters in 1979 and waters off California in 1980. These surveys have been conducted in accordance with guidelines established in a coastwide research plan developed in consultation with the state fishery management agencies (Hughes 1980).

Background information on survey methods and gear were described by Parks and Hughes (1981). The 1979-81 results of sablefish surveys in the Washington-California region have been reported in Parks and Hughes (1981), and Parks (1982).

Table l.--Domestic landings of sablefish by state and gear type, 1976-82.

State and gear	Sablefish landings, round weight (t) 1976	1977	1978	1979	1980	1981	1982
Washington							
Trawl	314	480	676	669	441	571	1,774
Trap	121	359	491	435	387	1,305	1,621
Longline	204	299	666	1,564	577	676	677
Troll	1	2	-	-	1	1	2
Shrimp trawl	1	6	-	-	7	11	27
Set net	-	-	-	-	45	29	141
Handline	-	-	-	-	4	4	1
Total	641	1,146	1,833	2,668	1,462	2,597	4,243
Oregon							
Trawl	443	326	958	1,494	1,024	1,318	2,961
Trap	44	40	290	4,351	1,241	303[a]	1,457
Longline	0	6	268	1,819	379	682	641
Troll	-	-	28	-	-	1	1
Shrimp trawl	20	13	70	77	63	36	40
Total	507	385	1,614	7,741	2,707	2,340	5,100
California							
Trawl	1,854	2,474	2,345	2,272	2,902	3,572	5,432
Trap and longline[b]	4,206	3,579	4,827	4,772	2,431	3,097	4,065
Total	6,060	6,053	7,172	7,044	5,333	6,669	9,497
Grand Total	7,208	7,584	10,619	17,453	9,502	11,606	18,840

[a]Includes 26 t taken by set net.
[b]Longline catch in California was a very small percentage of combined trap and longline catch until 1980 when longline catch rose to 28%.

SURVEY METHODS AND GEAR

The abundance indexing techniques employed in this study and the trap gear used are described in detail by Parks and Hughes (1981). Information on changes in relative abundance from year to year was determined from the catch per unit of effort (CPUE) obtained from standardized trap catches at index sites monitored during the October-November period. The California sites were on Patton Escarpment west of San Diego and near Bodega Canyon just northwest of Point Reyes (Fig. 1).

Strings of 10 traps each were set as near as possible to the 225, 300, 375, 450, and 550 fathom isobaths. The gear was to be set for 24-h intervals five times at each depth, resulting in a total of 50 traps hauled at each depth interval and 250 traps hauled at each site. Loran C and depth sounders were used to locate all replicate sets near the positions initially established. The 1980 California survey was conducted by the 127-ft NOAA ship Chapman and the 1981 and 1982 surveys by the 93-ft NOAA ship John N. Cobb.

Data collected during the surveys included:

1. Number of sablefish and all other species captured in each trap;
2. Fork lengths of all sablefish; and
3. Biological data to support life history studies which included length-weight relationships, age structures[1], sex ratio, and sexual maturity.

All sablefish not required for biological samples were tagged and released in support of ongoing coastwide migration studies.

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[1]Age determinations are being postponed until present techniques are more fully evaluated.

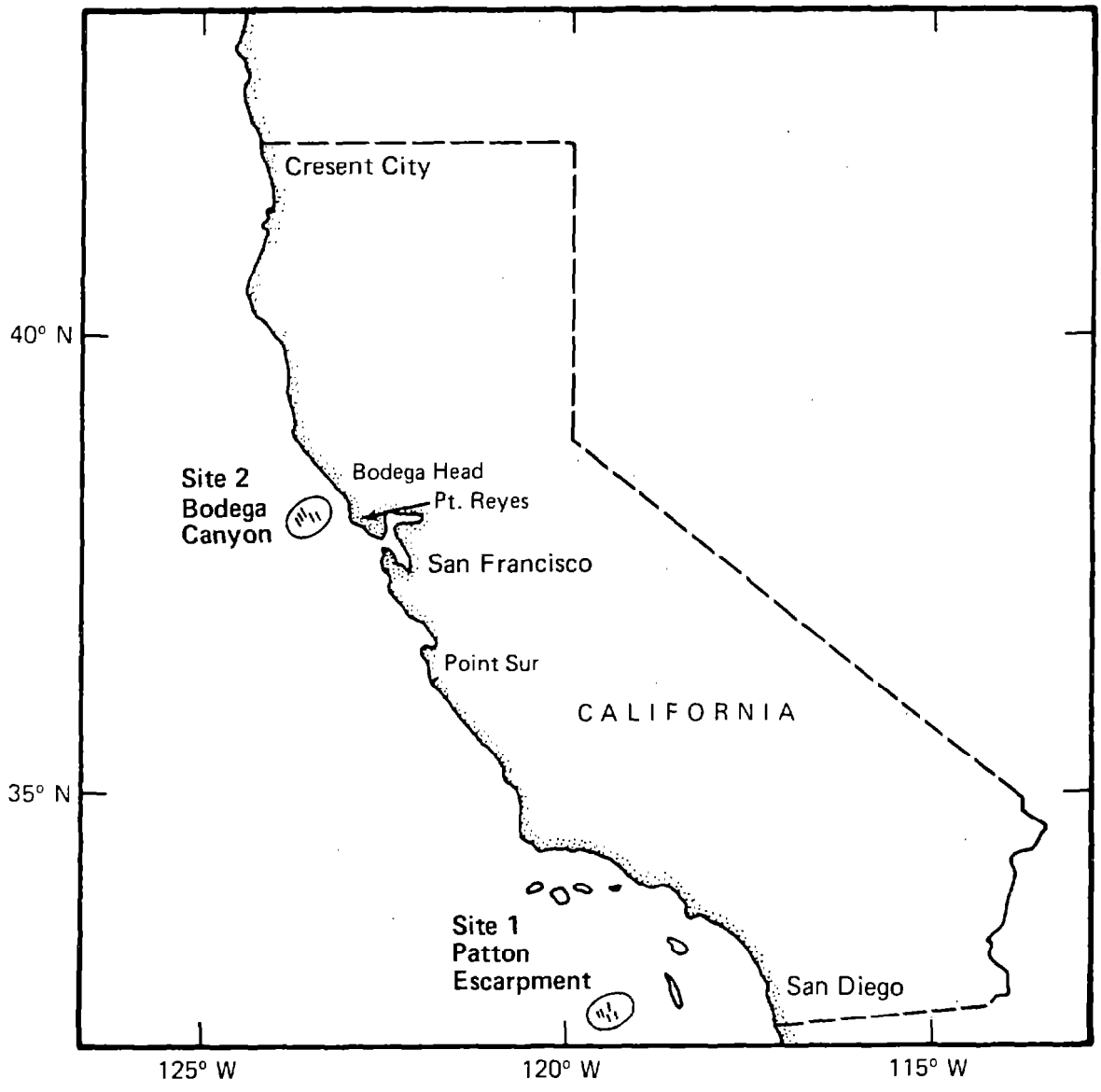

Figure 1.--Sites fished off California during the 1980-82 sablefish index surveys by the NOAA ships Chapman and John N. Cobb.

For characterizing California catches we adopted size categories utilized by groundfish buyers; sablefish under 4.25 lb round weight were classified as small, 4.25-7.0 lb as medium, and those over 7.0 lb as large.

RESULTS

Patton Escarpment

The sablefish index surveys at the Patton Escarpment site were completed successfully during all three survey years. Sablefish catch rates decreased moderately between the 1980 and 1981 surveys and the decrease occurred in all size categories, especially medium and large (Table 2). The decrease occurred at all depth intervals except at 550 fathoms where the catch rate was higher in 1981 (Table 3). Sablefish catch rates declined further at this site in 1982 with a 40% decrease from 1981. Catch rates of both small and medium size sablefish decreased while there was an increase in the catch rates of large size sablefish taken in 1982 although the number caught was small. Catch rates in 1982 were down very sharply at the 225, 300, and 375 fathom depth intervals, remained stable at 450 fathoms, and dropped slightly at the 550 fathom depth interval (Table 3). Since the baseline year (19801, catch rates of all sablefish at the Patton Escarpment site decreased 51% and decreases occurred for all size categories. Small sablefish were dominant in all 3 yr, comprising 90-93% of the catch. On the average, 8% of the catch was medium sablefish and less than 1% was large sablefish (Table 4). The length composition for the entire sample (Fig. 2) is characterized by a pronounced single mode and illustrates the great abundance of small sablefish. Mean length was 51-52 cm on all three surveys. The length composition, mean lengths by sex, and the percent males and females for a subsample are shown in Figure 3. There was a preponderance of females in the sablefish catches during all 3 yr. Sablefish maturity data is presented in Figure 4. The predicted proportions which are mature at any given length

Table 2.--Total numbers of sablefish and numbers of small, medium, and large sablefish captured at California index sites during the 1980-82 surveys. Annual percentage change in numbers of sablefish and percentage change from the baseline year 1980 are indicated by site and size category.

	Total sablefish			Large sablefish			Medium sablefish			Small sablefish		
Site/year	No.	Annual change (%)	Change from baseline year (%)	No.	Annual change (%)	Change from baseline year (%)	No.	Annual change (%)	Change from baseline year (%)	No.	Annual change (%)	Change from baseline year (%)
Patton Escarpment												
1980	1,524			7			139			1,378		
		-18			-57			-31			-17	
1981	1,247		-18	3		-57	96		-31	1,148		-17
		-40			+67			-49			-39	
1982	753		-51	5		-29	49		-65	699		-49
Bodega Canyon												
1980	1,255			72			206			977		
		--			--			--			--	
1981[a]	--		--	--		--	--		--	--		--
		--			--			--			--	
1982[b]	1,379		+10	22		-69	210		+2	1,147		+17

[a]The Bodega Canyon site was not fished in 1981 because of adverse weather conditions.

[b]Since two complete strings of gear were lost on the fourth repetition at the 225 and 450 fathom depth intervals, and a third string was lost on the fifth repetition at the 300 fathom depth interval at the Bodega Canyon site in 1982, all to drag vessels, means of catch values for the second and third repetitions at 225 and 450 fathoms and second through fourth repetitions were substituted for the missing data in the 1982 survey.

Table 3.--Total number of sablefish captured by depth and set at the Patton Escarpment, California, site during the 1980-82 abundance index surveys. Each catch was obtained from one string of 10 sablefish traps fished for 24 hours.

Year and set	Depth (fathoms) 225	300	375	450	550	Total catch
	----------Number of fish----------					
1980						
1	85	139	92	69	35	420
2	60	100	99	92	38	389
3	54	68	72	40	25	259
4	77	78	21	30	25	231
5	74	48	36	52	15	225
Total	350	433	320	283	138	1,524
Mean	70	87	64	57	28	305
1981						
1	76	146	97	39	53	411
2	74	86	35	50	23	268
3	64	87	55	33	31	270
4	18	45	28	17	36	144
5	36	38	14	32	34	154
Total	268	402	229	171	177	1,247
Mean	54	80	46	34	35	249
1982						
1	34	53	25	47	18	177
2	37	38	18	24	10	127
3	17	44	44	23	25	153
4	27	30	22	50	28	157
5	16	23	22	27	51	139
Total	131	188	131	171	132	753
Mean	26	38	26	34	26	151

Table 4.--Percentage abundance of small, medium, and large sablefish captured at the Patton Escarpment and Bodega Canyon, California, index sites during the 1980-82 annual surveys.

Site and Year	Small[a] (%)	Medium[b] (%)	Large[c] (%)	Total (%)
Patton Escarpment				
1980	90	9	<1	100
1981	92	8	<1	100
1982	93	7	<1	100
Average	92	8	<1	100
Bodega Canyon				
1980	78	16	6	100
1981[d]	-	-	-	-
1982	83	15	2	100
Average	80	16	4	100

[a]Less than 4.25 lb round weight = less than 59 cm fork length.

[b]4.25-7.0 lb round weight = 59-68 cm fork length.

[c]More than 7.0 lb round weight = 69 cm or greater fork length.

[d]Bodega Canyon was not fished in 1981 because of adverse weather conditions.

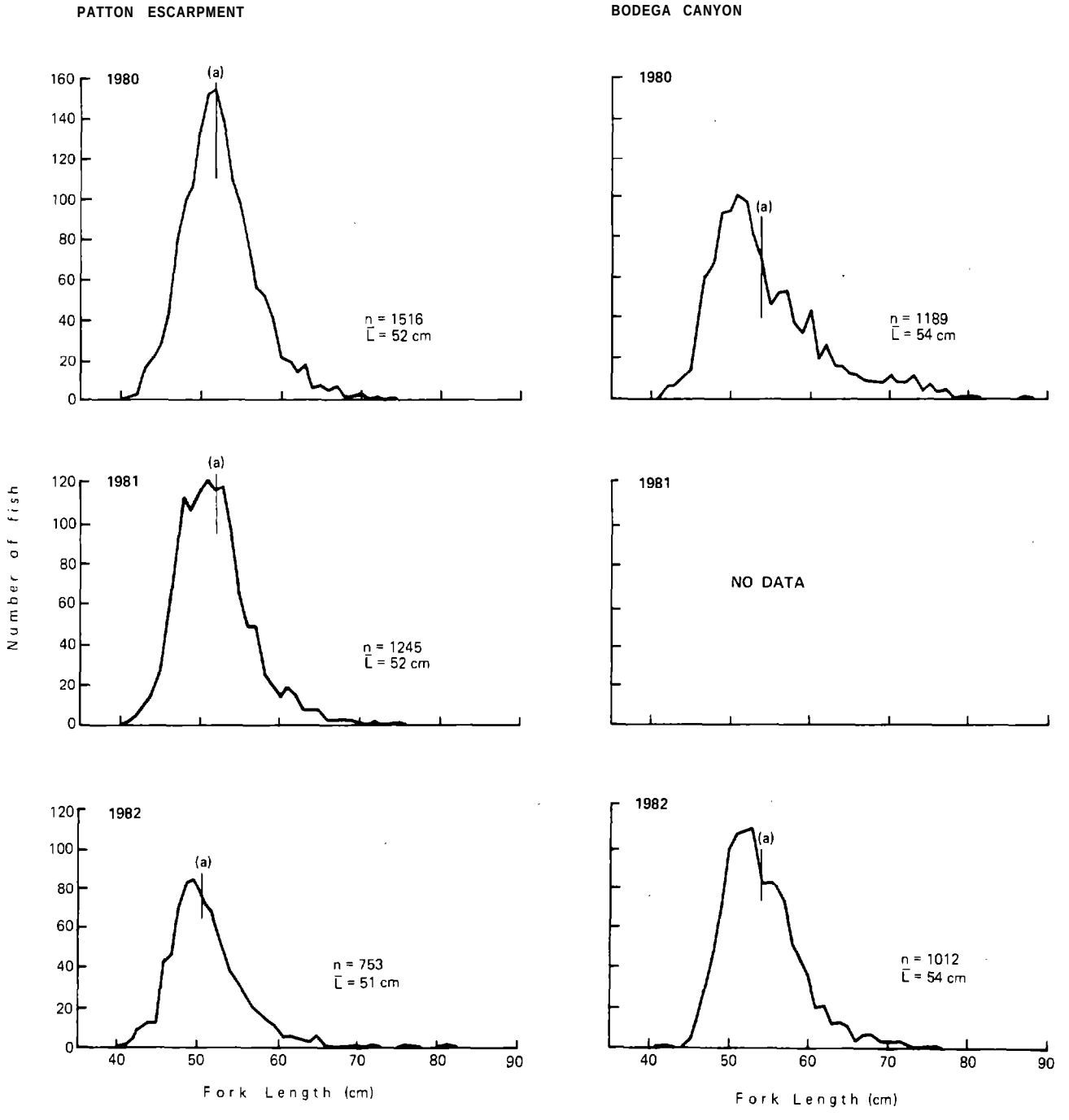

Figure 2.--Length composition of sablefish captured at the Patton Escarpment and Bodega Canyon, California, index sites during the 1980-82 index surveys. Vertical line (a) is the mean length.

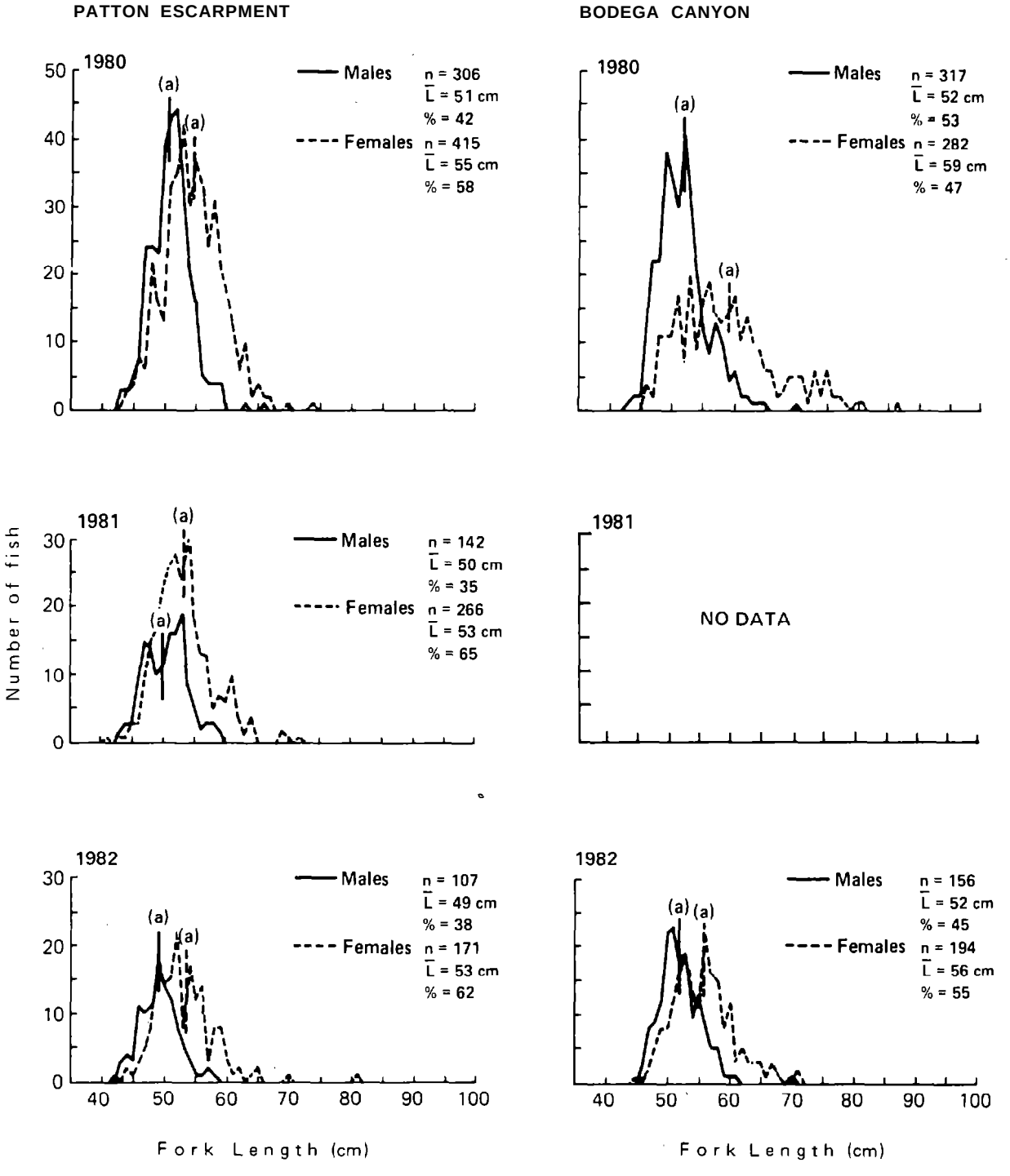

Figure 3.--Length composition of male and female sablefish captured at the Patton Escarpment and Bodega Canyon, California, index sites during the 1980-82 surveys. Vertical lines (a) are the mean lengths.

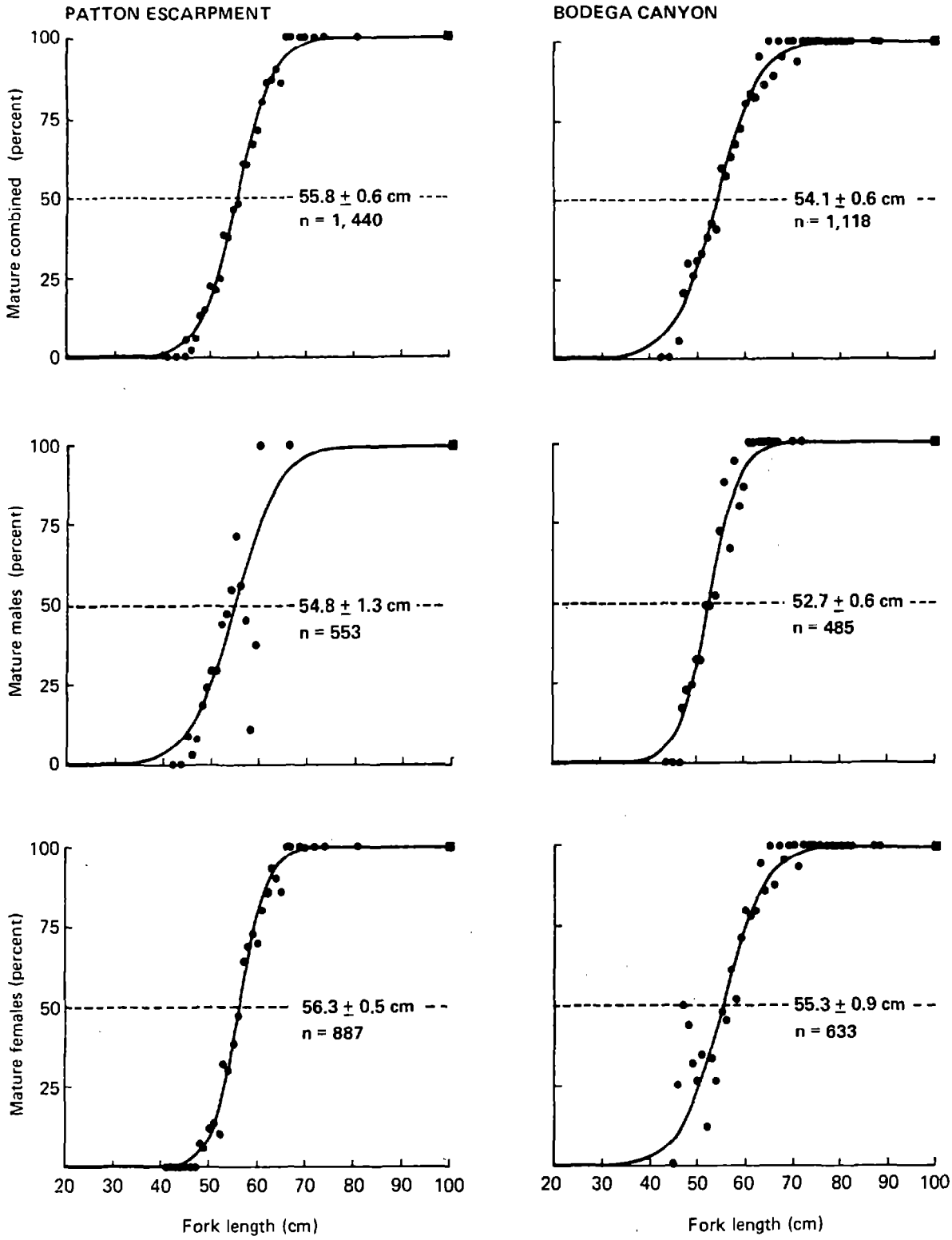

Figure 4.--Percentage of sexually mature sablefish by length, combined and by sex, for the Patton Escarpment and the Bodega Canyon, California, index sites, all years combined. Values in the graphs are lengths at 50% maturity at 95% confidence limits.

are derived from the formula $P_x = \frac{1}{1 + e^{ax+b}}$, where P_x = proportion mature at length x, and a and b are constants derived by the maximum likelihood method (Gunderson et al. 1980). Using data from all years, the size at 50% maturity occurred at 55.8 + 0.6 cm, 54.8 + 1.3 cm, 56.3 + 0.5 cm, for sexes combined, males, and females, respectively, at the 95% level of confidence.

Bodega Canyon

Extended adverse weather precluded sampling in 1981 at the Bodega Canyon site, and the loss of three strings of trap gear prevented completion of some sampling scheduled in 1982. To render the 1982 data useful for comparison with the 1980 results, means of values for the second and third repetitions at 225 and 450 fathoms, and the second through fourth repetitions at 300 fathoms were substituted for the missing data in the 1982 survey (Table 5). Catches from the first set were not used in calculating substitute mean values because these catches are usually considerably higher than those in replicate sets.

Total sablefish catch rates at the Bodega Canyon site increased 10% between the 1980 and the 1982 surveys (Table 2). The increase was almost entirely a result of the extraordinarily large catch on the first set at the 300 fathom depth interval (Table 5). If this value is considered aberrant or an outlier, one could substitute a catch of 116; a value calculated from the average rate of decline between the first and second sets for the other four depth intervals. This results in a total catch of 1,259, indicating little change in total sablefish abundance between 1980 and 1982. Catch rates of both small and medium sablefish increased slightly; but catch rates of large sablefish were down 69% (Table 2). Small sablefish made up 78% of the catch in 1980 and 83% of the catch in 1982. The proportion of medium sablefish was 15-16% in both years,

Table 5.--Total number of sablefish captured by depth and set at the Bodega Canyon, California, site during the 1980-82 abundance index surveys. Each catch was obtained from one string of 10 sablefish traps fished for 24 hours.

Year and set	Depth (fathoms) 225	300	375	450	550	Total catch
	Number of fish					
1980						
1	39	112	115	32	37	335
2	54	81	34	18	66[a]	253
3	49	82	60	29	25	245
4	61	61	38	14	12	186
5	57	87	52	16	24[a]	236
Total	260	423	299	109	164	1,255
Mean	52	85	60	22	33	251
1981[b]	-	-	-	-	-	-
1982						
1	59	236	110	56	32	493
2	43	83	77	31	28	262
3	56	92	75	23	18	264
4	50[c]	46	17	27[c]	25	165
5	50[c]	74[c]	23	27[c]	21	195
Total	258	531	302	164	124	1,379
Mean	52	106	60	33	25	276

[a]This string had only 5 traps; therefore, the catch was doubled to equal the standard 10 traps per string.
[b]Bodega Canyon was not fished in 1981 because of adverse weather conditions.
[c]These repetitions were not completed due to lost gear. Missing data are means of values for the second and third repetitions at 225 and 450 fathoms, and the second through fourth repetitions at 300 fathoms.

but the contribution of large sablefish went from 6% of the catch in 1980 to 2% in 1982 (Table 4). The length composition is shown in Figure 2. The mean length of all sablefish was 54 cm in both 1980 and 1982. The length distributions, mean lengths by sex, and the percent of males and females is shown in Figure 3. Although males were slightly more abundant at the Bodega Canyon site in 1980, females predominated (55%) in 1982. The proportion nature is presented in Figure 4 by sex and year. The estimated size at 50% maturity occurred at 54.1 + 0.6 cm, 52.7 + 0.6 cm, and 55.3 + 0.9 cm, for sexes combined, males, and females, respectively, at the 95% level of confidence.

SUMMARY AND CONCLUSIONS

Results of the 1980-82 surveys indicate a persistent decline in sablefish abundance in the Patton Escarpment region off southern California. CPUE in that area decreased 51% during the 3 yr period. Large sablefish made up less than 1% of the catches in all years. Mean lengths of both males and females generally declined throughout the period of the surveys. At the Bodega Canyon site, the 1982 catch rates suggest a slight increase in sablefish abundance, but this trend is the result of one unusually high catch at a single depth interval. There nay, therefore, be some question whether there was any increase in abundance. Increases occurred in both small and medium sablefish, but the numbers of large sablefish declined markedly. The percentage of small sablefish increased from 78% to 83% between 1980 and 1982. The mean length of males remained constant while the mean length of females, decreased by 3 cm.

We are presently at a point of evaluating past indices of abundance and assessing the future of abundance indexing. Four years (1978-81) of indexing data from Alaska, Washington, Oregon, and California provided the basis for evaluating the sampling design in terms of precision and the survey's ability

to detect various magnitudes of annual changes in abundance (Kimura and Balsiger 1983). California data were inadequate for examining survey sensitivity, but analysis of Washington-Oregon data indicates that some of the observed annual differences in catch may not be significant or indicative of real changes in population size. The study suggests that the survey would be sensitive to substantially smaller annual changes in abundance if index sites were increased to 9-12 in each area where monitoring of population trends is desired. The analysis also indicates that little loss of precision occurs when the number of sets at each location is reduced from 5 to 2 or 3. These results will influence the design of abundance indexing surveys in 1983 and in subsequent years. As more data points (years) are accumulated, the significance of annual difference in catch will be more fully evaluated.

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