Northwest and Alaska Fisheries Center

National Marine Fisheries Service

U.S. DEPARTMENT OF COMMERCE

NWAFC PROCESSED REPORT 85–16

Abundance and Size Composition of Sablefish (*Anoplopoma fimbria*) in the Coastal Waters of California and Oregon in 1984

August 1985

NOTICE

Abundance and Size Composition of Sablefish (*Anoplopoma fimbria*) in the Coastal Waters of California and Southern Oregon in 1984

by

Norman B. Parks

and

Franklin R. Shaw

National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northwest and Alaska Fisheries Center
Resource Assessment and Conservation Engineering Division
7600 Sand Point Way NE
BIN C15700, Building 4
Seattle, Washington 98115

August 1985

CONTENTS

INTRODUCTION

The sablefish (Anoplopoma fimbria) has, in recent years, become one of the most valuable species in the Pacific west coast groundfish fishery with an estimated landed value of $8,000,000 in 1983. Landings have generally increased since 1977 with the highest catches occurring in 1979 and 1982 (Table 1). In 1982, the optimum yield (OY) figure of 13,400 metric tons (t) was exceeded and, in mid-October the Pacific Fishery Management Council (PFMC) set a sablefish trip limit of 3,000 lb for the remainder of the year. Effective 30 November 1982 the Council increased the sablefish OY by 30% to 17,400 t for 1982 and this limit remained through 1983 and 1984. In 1985 the PFMC reduced the OY to 13,400 t on the basis of recommendations made by the Groundfish Plan Maintenance Team which expressed concern about the ability of the sablefish resource to sustain higher catch rates.[1] The market demand and price for sablefish (including small sizes <4 lb) was quite strong throughout most of 1984. If this market remains strong in 1985, it is likely that the current OY figure could be reached sometime in late 1985.

The economic importance of the sablefish fishery and the need for information to complement status of stock analyses based on fishery statistics were responsible for the initiation of a program at the Northwest and Alaska Fisheries Center (NWAFC) to monitor annual changes in distribution, relative abundance, size composition, and biological characteristics and to determine migratory movements of sablefish in the northeastern Pacific Ocean. Surveys to periodically measure relative change in sablefish abundance began in

---

[1] Robert C. Francis. 1985. Status of the sablefish resource of the U.S. west coast and recommendations for management in 1985. Unpublished manuscript. Northwest and Alaska Fisheries Center, National Marine Fisheries Service, NOAA, 7600 Sand Point Way NE, Seattle, WA 98115.

Table 1.--Domestic landings of sablefish by state and gear type, 1976-84.

State and gear	Sablefish landings, round weight, in metric tons (t)								
	1976	1977	1978	1979	1980	1981	1982	1983	1984
Washington									
Trawl	314	480	676	669	441	571	1,774	1,377	2,472
Trap	121	359	491	435	387	1,305	1,621	1,470	1,015
Longline	204	299	666	1,564	577	676	677	495	882
Troll	1	2	-	-	1	1	2	3	5
Shrimp trawl	1	6	-	-	7	11	27	41	3
Set net	-	-	-	-	45	29	141	185	377
Handline	-	-	-	-	4	4	1	-	-
Total	641	1,146	1,833	2,668	1,462	2,597	4,243	3,571	4,754
Oregon									
Trawl	443	326	958	1,494	1,024	1,318	2,961	2,782	2,775
Trap	44	40	290	4,351	1,241	303[a]	1,457	1,309	1,828
Longline	0	6	268	1,819	379	682	641	543	227
Troll	-	-	28	-	-	1	1	-	-
Shrimp trawl	20	13	70	77	63	36	40	22	8
Total	507	385	1,614	7,741	2,707	2,340	5,100	4,656	4,838
California									
Trawl	1,854	2,474	2,345	2,272	2,902	3,572	5,432	3,100	2,903
Trap and Longline[b]	4,206	3,579	4,827	4,772	2,431	3,097	4,065	3,409	1,912
Total	6,060	6,053	7,172	7,044	5,333	6,669	9,497	6,509	4,815
Grand Total	7,208	7,584	10,619	17,453	9,502	11,606	18,840	14,736	14,407

[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% of the total.

southeastern Alaska waters in 1978, and were extended southward to include Oregon and Washington waters in 1979 and waters off California in 1980. The results of sablefish surveys during 1979-83 in the Washington-California region have been reported by Parks and Hughes (1981), Parks (1982), Parks and Shaw (1983), and Parks (1984). This report updates the results given by these authors by including the 1984 survey off California and southern Oregon (Fig.1).

SURVEY METHODS AND GEAR

The methods used in earlier surveys and the trap gear employed through 1982 are described in detail by Parks and Hughes (1981). In 1983, the experimental design was modified in an effort to improve operational efficiency and the precision of abundance estimates. Analysis of past Washington-Oregon survey data indicated that the surveys would be able to detect substantially smaller changes in abundance if the number of index sites were increased in each area where monitoring of population trends is desired (Kimura and Balsiger 1985). The analysis also indicated that little loss of precision occurs when the number of sets at each depth location within a site is reduced from five to two. By reducing the number of sets, time was provided for sampling at additional sites. The number of sites was increased from four to eight off Washington and Oregon in 1983 and from two to nine off California and southern Oregon in 1984 (Fig. 1).

In an effort to find more efficient and less labor intensive sampling gear, conical (Korean) style traps were employed during the 1983 Washington-Oregon survey and the 1984 California-southern Oregon survey. Catch rates and size compositions were found to be similar when the two trap types were

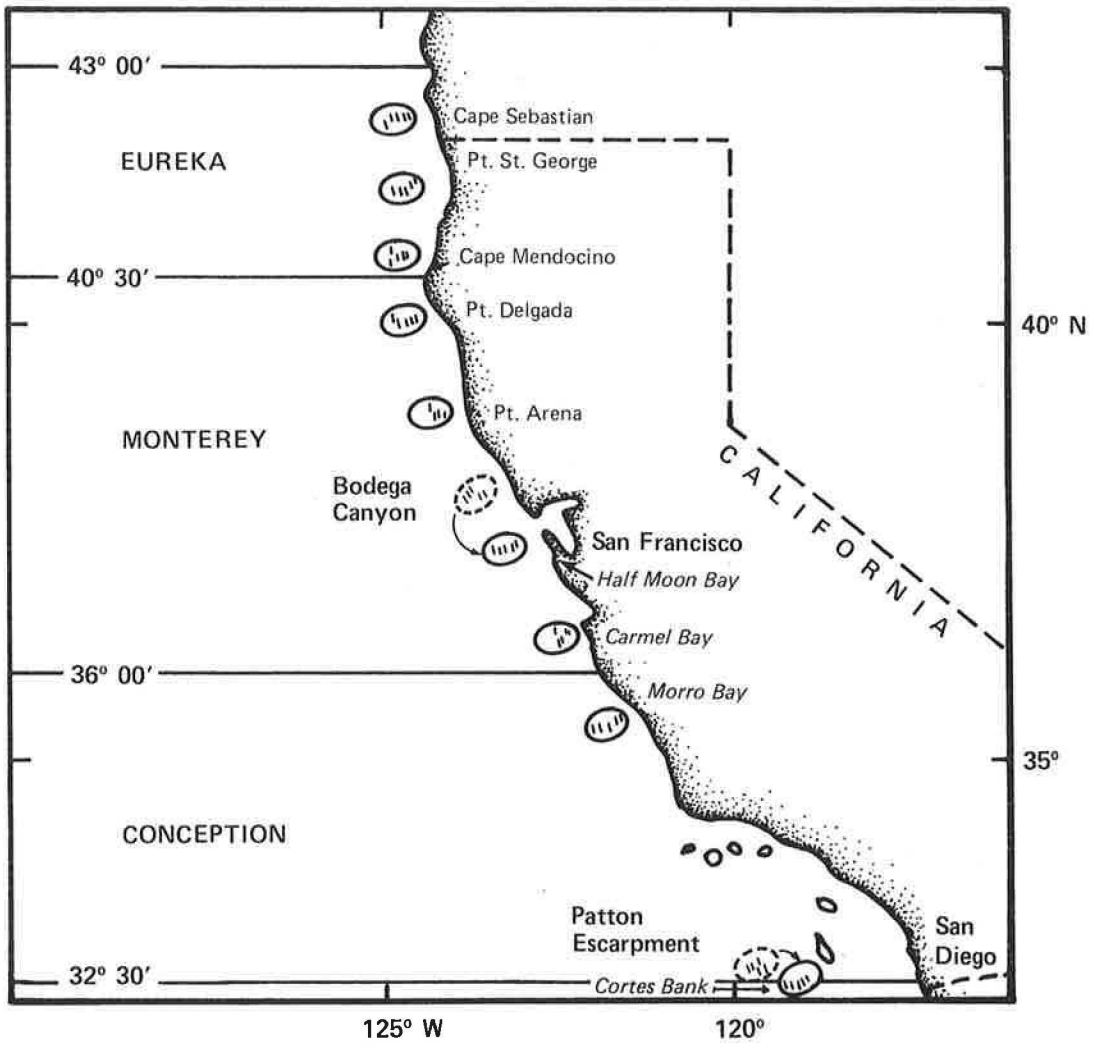


Figure 1.--Sites fished off California and southern Oregon, (International North Pacific Fisheries Commission statistical areas Eureka, Monterey, and Conception) during the 1984 sablefish abundance indexing survey. Curved arrows denote relocation of Bodega Canyon and Patton Escarpment sites (old sites in dashed lines).

compared at sampling sites off southeastern Alaska (Clausen and Fujioka 1985) even though differences in trap configuration, physical size and tunnel entrance are substantial. Rectangular traps are 34 in x 34 in x 8 ft, and have a single tunnel located on one end. The conical traps have a bottom ring 54 in outside diameter, a top ring 33.5 in outside diameter, a height of 28 in, and the tunnel entrance on the side.

The traps are attached to groundlines of 5/8 in diameter line and 550 fathoms in length and were spaced at intervals of 50 fathoms. Trap bridles were attached to the groundline by means of gangions using brummel hooks or "C" hooks.

In the 1983 and 1984 surveys, 25 rectangular and 25 conical traps were used. The two trap types were alternated on each string (five rectangular and five conical per string) to compare the catching efficiencies between the two trap types. This was necessary since the 1983 test results relative to the comparative fishing efficiences of the two trap types were inconclusive (Parks 1984).

In 1984, a string of 10 traps was fished twice at each of five depths (225, 300, 375, 450 and 525 fathoms) within a site. Fishing time for each set was standardized to 24 h. Loran C and depth sounders were used to position all replicate sets near depths and locations of first sets. In addition, optional sets using only conical traps were made at 150 fathoms at the four southern sites.

Data collected during the surveys included:

1. Number and weight 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 age stuctures (otoliths), sex ratios, and sexual maturity.

Results from individual sites are presented for those interested in local Catch per unit effort (CPUE) and size data, but population trends will be analyzed using grouped site data. For size breakdown of sablefish catches we adopted size categories utilized by 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

Sampling was conducted from north to south during September-November, 1984. The traditional sites at Bodega Canyon and Patton Escarpment sampled in 1980, 1981 and 1982, had to be abandoned because intensive trawling and drift gillnet fishing, respectively, precluded working in those areas. Alternate sites were located approximately 35 to 45 nm southeast of the original sites (Fig. 1) so continuity and the ability to compare results with previous years were lost. As a result of the major changes in the survey design in 1984 and the fact that both previously fished sites could not be occupied, 1984 will be considered as a baseline year for comparison with results of future surveys.

Comparison of Trap Types

There was considerable variation in catches between trap types on individual strings (Fig. 2). Differences ranged from 73% of the sablefish per string taken in the rectangular traps to 89% taken in the conical traps. Overall, conical traps captured 26.5% more sablefish than rectangular traps.

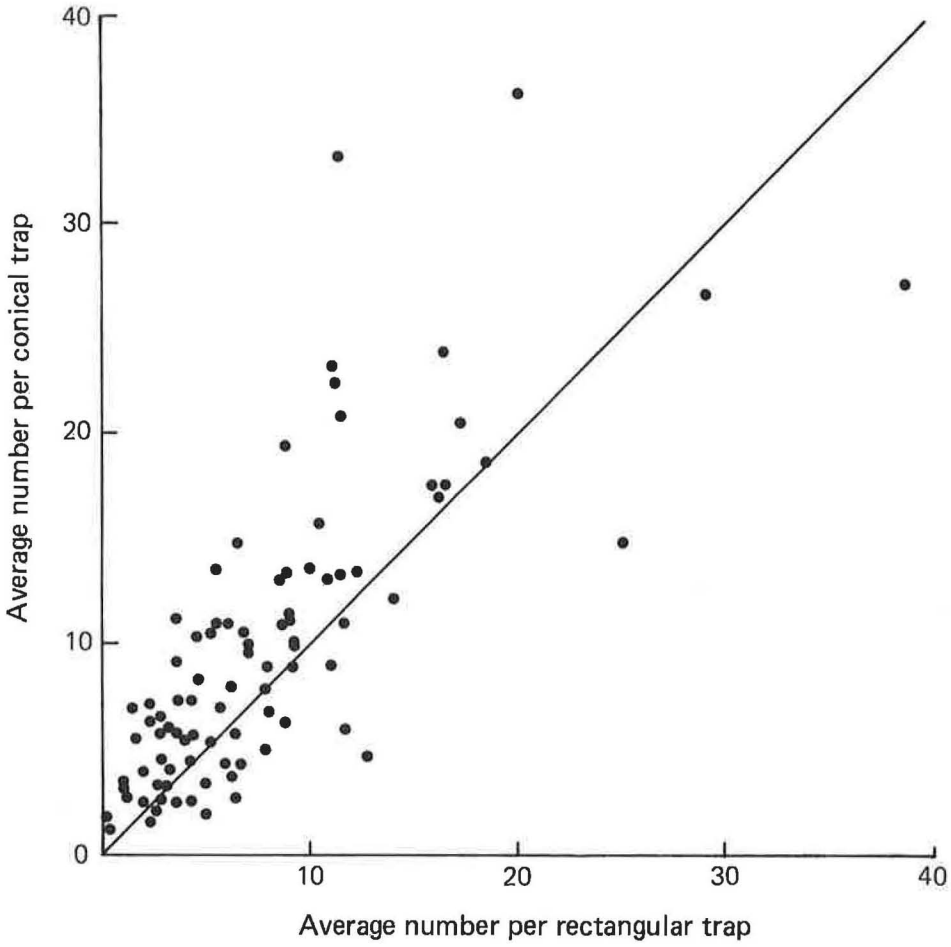


Figure 2.--Catch of sablefish in conical traps vs. catch of sablefish in rectangular traps off California and southernmost Oregon, U.S. Dominator Cruise 84-1. Each data point represents the average catch of each of 5 conical and 5 rectangular traps on a single longline.

Statistical analyses were applied to survey results to determine the statistical significance of differences in conical and rectangular trap catches. The ratio estimator used was:

$$\hat{R} = \frac{\sum_{i=1}^{89} c_i}{\sum_{i=1}^{89} r_i} = 1.265$$

where c_i= catch (n) of sablefish in conical traps in haul i and r_i= catch (n) of sablefish in rectangular traps in haul i.

An approximate 95% confidence interval for $\hat{R}$ is (1.123, 1.407) (Cochran 1977: equations 6.13, 6.15). The value $\hat{R}$ is significantly different from 1.0. We have assumed that $\hat{R}_{1984}$ is a representative overall measure of relative fishing power and have applied the correction factor of 1.265 to all 1984 rectangular trap catches so that catch rates are expressed in terms of catch per conical trap. However, by using such a correction factor, we do not account for possible significant changes which may have occurred in $\hat{R}$ as a function of changes in location and depth. Methods to assess the statistical significance of such changes are being further investigated. Additional comparisons between rectangular and conical trap catches also are planned in 1985 off Washington and Oregon to further examine relative fishing powers in this region.

Mean lengths of sablefish captured in conical and rectangular traps were nearly identical at 53.12 and 53.08 cm, respectively. Length ranges and distributions were also very similar (Fig. 3). These results are consistent with previous observations (Parks 1984, Clausen and Fujioka 1985) and strongly suggest that the two trap types sample the same size components of the population.

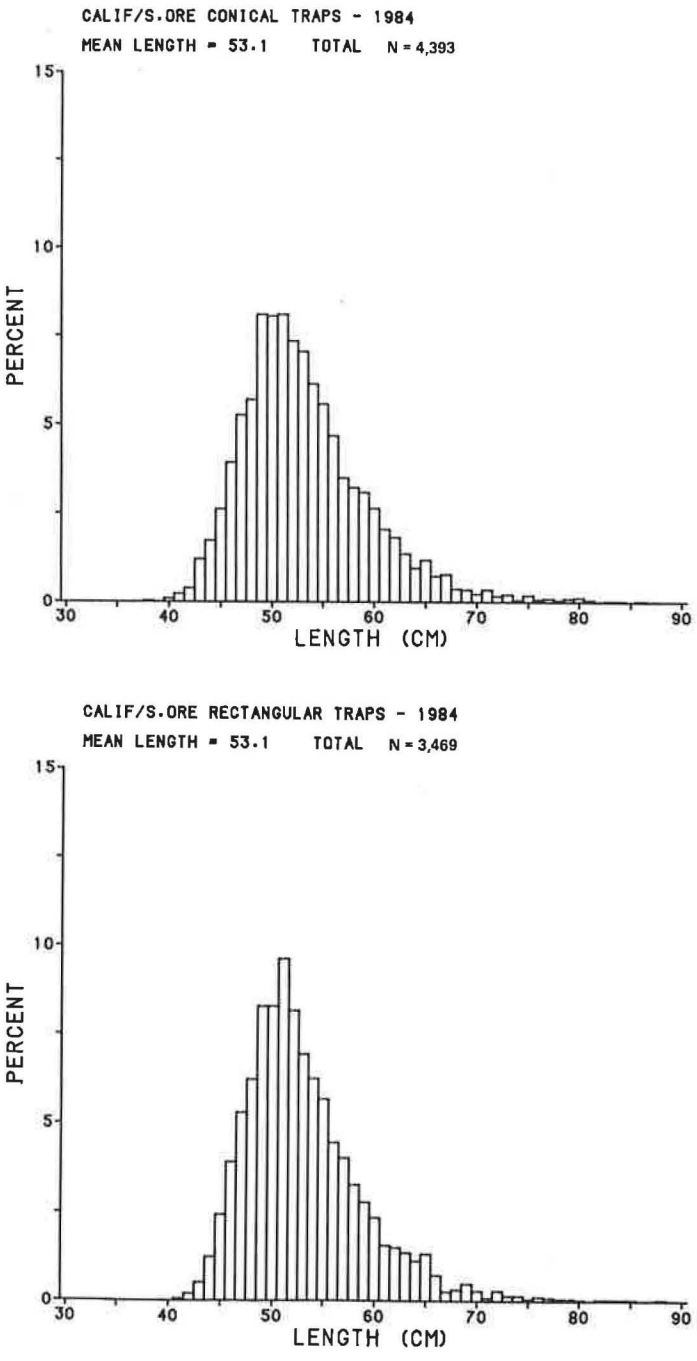


Figure 3.--Sablefish length compositions and mean lengths by trap type, U.S. Dominator Cruise 84-1.

Catches by Index Site

Total numbers of sablefish and numbers of small, medium, and large sablefish captured by site during the survey are shown in Table 2. Highest catches were made at the Half Moon Bay and Cortes Bank sites and lowest catches at Morro Bay, Pt. Delgada, and Cape Sebastian. When the site data are combined, catches decreased by depth and were highest at the 225 and 300 fathom depths. Standardized fishing effort at 225, 300, 375, 450, and 525 fathoms produced 31%, 29%, 17%, 14%, and 9%, respectively, of the total number of sablefish captured. Mean lengths, however, increased with depth, ranging from 52.4 cm at 225 and 300 fathoms to 56.8 cm at 525 fathoms (Fig. 4). In the optional sets made at 150 fm at the four southern-most sites using only conical traps, catches averaged 87 sablefish per string (8.7 sablefish per trap) at the Half Moon Bay and Carmel Bay sites, but only 18 sablefish per string (1.8 sablefish per trap) at the Moro Bay and Cortes Bank sites.

At the four northernmost sites, the percentages of small, medium, and large sized sablefish in catches were generally similar. Small sablefish made up 72-75% of the catch, medium 19-23%, and large 3-7%. From Pt. Arena southward, sizes were notably smaller with small fish comprising 79-89% of the catch, medium 10-20%, and large <1-2%. The catch by size category for all areas combined was 81% small, 17% medium and 2% large (Table 2). Sablefish length compositions and mean lengths by abundance indexing site are shown in Figure 5. Mean lengths ranged from 53.9 to 54.9 cm at the four northern sites, and then generally decreased toward the south ranging from 53.7 at Pt. Arena to 50.9 cm at the Cortes Bank site. Sablefish length composition for all sites combined is shown in Figure 6. Sablefish length compositions and mean lengths by depth for all sites combined are shown in Figure 4.

Table 2.--The numbers of sablefish, average numbers and weight per trap, and numbers of sablefish by size captured at southernmost Oregon and California index sites in 1984[a]. Percentages are shown in parentheses.

Site	Total no. sablefish	Avg. no. Sablefish per trap	Avg. wt. (lb) per trap	Large sablefish[b]	Medium sablefish[c]	Small sablefish[d]
Cape Sebastian, OR	748[e]	7.5	31.5	55 (7)	140 (19)	553 (74)
Pt. St. George, CA	843	8.4	31.7	23 (3)	187 (22)	633 (75)
Cape Mendocino, CA	819	8.2	32.8	41 (5)	188 (23)	590 (72)
Pt. Delgada, CA	735	7.4	29.1	32 (4)	169 (23)	534 (73)
Pt. Arena, CA	928	9.3	33.9	12 (1)	186 (20)	730 (79)
Half Moon Bay, CA	1,525	15.2	51.5	14 (<1)	229 (15)	1,282 (84)
Carmel Bay, CA	1,094	10.9	36.7	8 (<1)	156 (14)	930 (85)
Morro Bay, CA	664	6.6	24.5	14 (2)	110 (17)	540 (81)
Cortes Bank, CA	1,470	14.7	44.0	10 (<1)	148 (10)	1,312 (89)
All sites combined	8,826	9.8	35.1	209 (2)	1,513 (17)	7,104 (81)

[a] These numbers are the result of upward adjustment of rectangular trap catches by 1.265 plus conical trap catches.
[b] Over 7.0 lb round weight.
[c] 4.25-7.0 lb round weight.
[d] Less than 4.25 lb round weight.
[e] Since a complete string of gear was lost on the 2nd set at 450 fathoms, the catch value shown was obtained as follows: Before upward adjustment (footnote a), the ratio of the sum of catches in the 2nd haul at the other 4 depths to the sum of catches in the 1st haul at those depths was calculated. The catch in the 1st set at 450 fathoms was multiplied by this ratio to estimate the total catch in the 2nd set. The number of fish caught by each trap type in the 2nd set was assumed to be proportional to the numbers caught by each type in the 1st set. The resulting estimated rectangular trap catch was adjusted upward (footnote a).

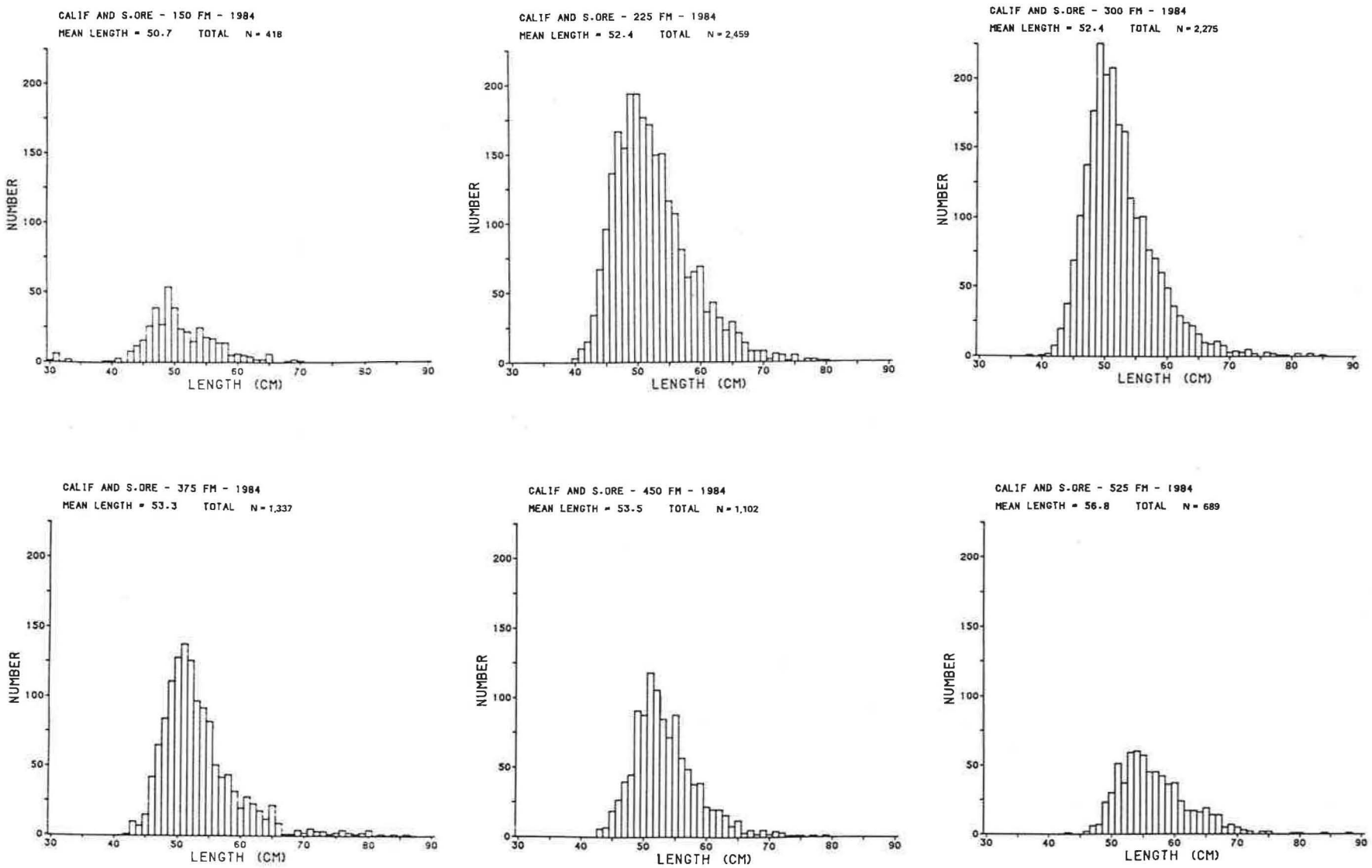


Figure 4.--Sablefish length compositions and mean lengths by depth for all sites combined, U.S. Dominator Cruise 84-1. (Optional sets using only conical traps were made at 150 fathoms at the four southern sites).

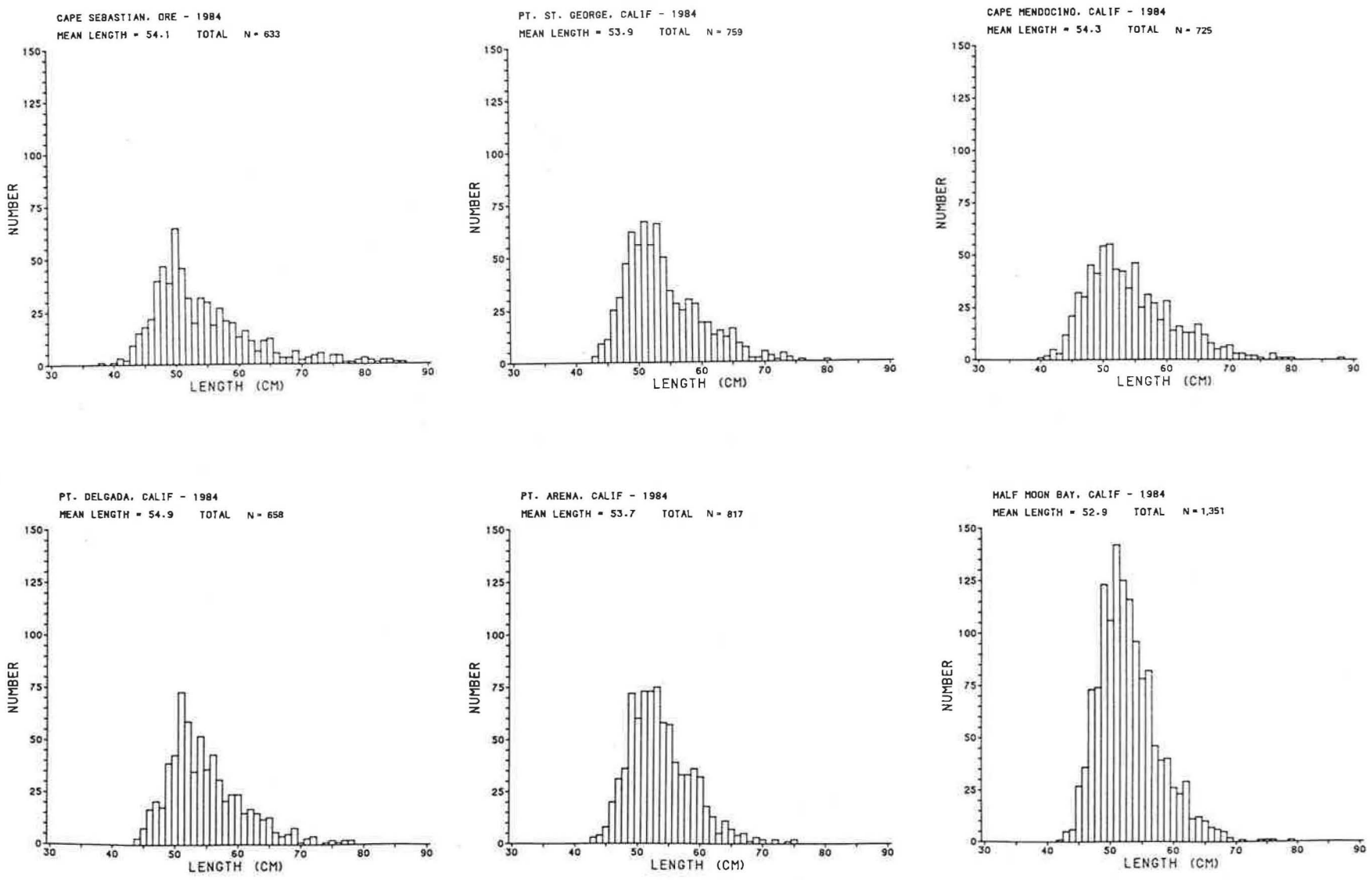
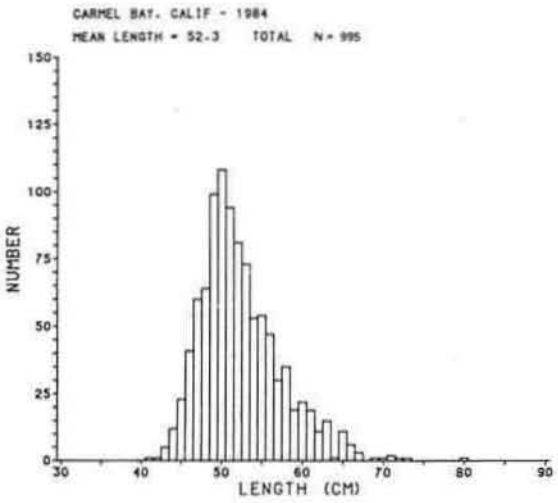
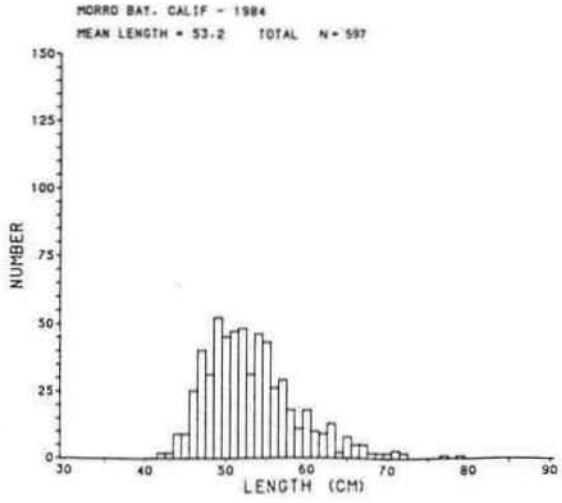


Figure 5.--Sablefish length compositions and mean lengths by abundance indexing site, U.S. Dominator Cruise 84-1.





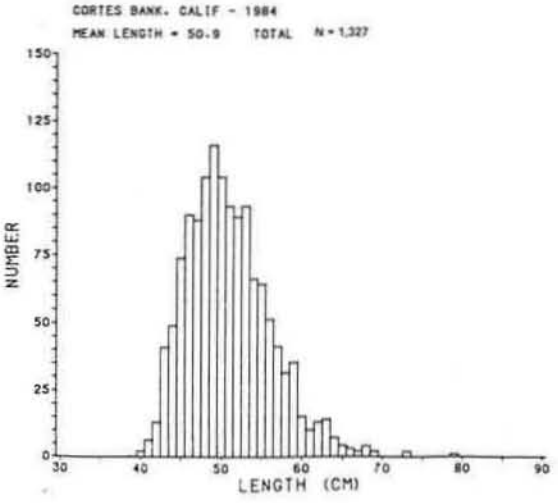


Figure 5.--(continued)

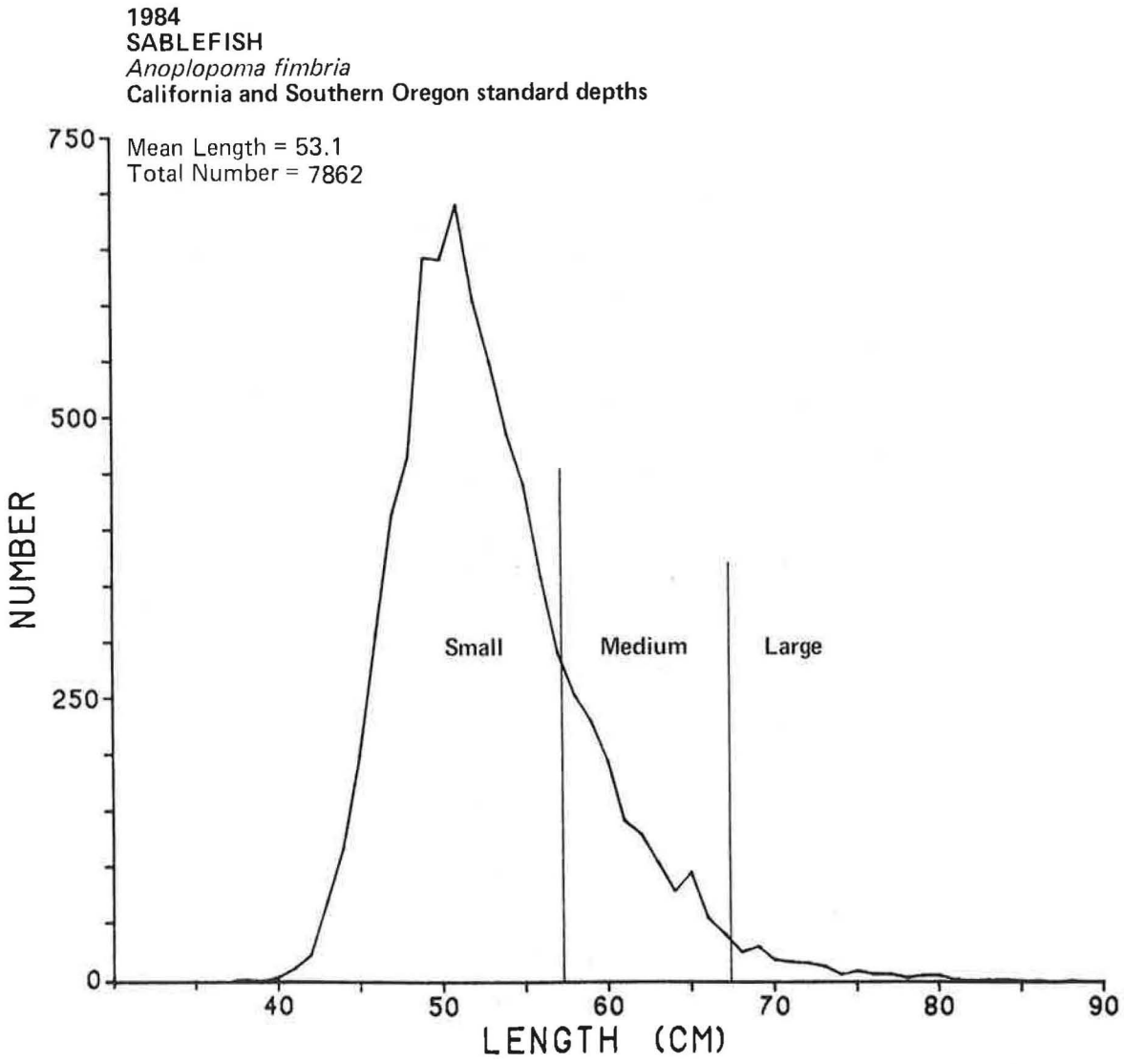


Figure 6.--Total sablefish length composition for all southernmost Oregon and California sites combined, U.S. Dominator Cruise 84-1.

The traps are generally selective for sablefish greater than 40 cm and, therefore, cannot detect relative strengths of the two most recent year classes (ages 1 and 2).

The sablefish catches from 150 fm at the Half Moon Bay site contained 24% medium and large sablefish, whereas those from 150 fm at the Carmel Bay, Morro Bay, and Cortes Bank sites contained 1%, 10%, and 3% medium and large sablefish, respectively. Sablefish catches and mean lengths by individual site and for all sites combined by depth are shown in Table 3.

Table 3.--Sablefish catches and mean lengths by indexing site and for all sites combined by depth, U.S. Dominator Cruise 84-1.

Depth (fathoms)	No. of fish	Mean length (cm)	No. of fish	Mean length (cm)	No. of fish	Mean length (cm)
	Cape Sebastian, OR		Pt. St. George, CA		Cape Mendocine, CA	
225	95	52.3	150	54.6	196	53.0
300	301	52.5	338	52.0	227	52.8
375	158	57.1	160	55.0	106	55.3
450	72[1]	53.9	70	56.3	113	54.6
525	38	59.2	41	59.3	83	60.1
Total	664	54.1	759	53.9	725	54.3
	Pt. Delgada, CA		Pt. Arena, CA		Half Moon Bay, CA	
225	295	55.2	382	53.6	513	53.0
300	152	54.2	177	54.3	241	50.5
375	90	52.2	160	52.3	159	52.0
450	90	56.7	54	53.3	301	53.2
525	31	58.1	47	56.6	143	56.9
Total	658	54.9	820	53.7	1,357	52.9
	Carmel Bay, CA		Morro Bay, CA		Cortes Bank, CA	
225	277	50.8	174	54.8	383	47.1
300	307	52.3	132	52.0	402	52.3
375	144	52.7	93	52.1	268	51.9
450	129	52.2	120	51.6	184	52.6
525	138	55.2	78	55.7	90	54.5
Total	995	52.3	597	53.2	1,327	50.9
	All sites combined					
225	2,465	52.4				
300	2,277	52.4				
375	1,338	53.3				
450	1,133	53.3				
525	689	56.8				
Total	7,902	53.1				

1/ Adjusted upward for lost string of gear on second set at the same rate as catches made at this site on the second set (see Table 2, footnote e).

SUMMARY AND CONCLUSIONS

Because both previously fished sites could not be sampled in 1984 the comparison of results with those from previous surveys is considered to be of questionable value. Therefore we prefer to view the 1984 survey as providing baseline results for comparison with data from future surveys as appropriate for tracking population trends.

Mean length of sablefish captured in conical and rectangular traps were, for practical purposes, identical, and on the average conical traps captured 26.5% more sablefish than rectangular traps. An overall fishing power coefficient for the 1984 California survey was used to calibrate rectangular trap catches to conical trap catches. There was, however, considerable variation between catches by trap type at individual depths and sites; this variation is being assessed for statistical significance.

Highest catches occurred at the Half Moon Bay and Cortes Bank sites and the lowest catches at the Morro Bay, Pt. Delgado, and Cape Sebastian sites. Catches generally decreased by depth and were highest at 225 and 300 fathoms. Standardized fishing effort at 225, 300, 375, 450, and 500 fathoms produced 31%, 29%, 17%, 14%, and 9%, respectively, of the total number of sablefish captured.

The percentage abundance of small, medium, and large size sablefish was generally similar at the four northernmost sites, while the sizes were notably smaller at the four southernmost sites. The size breakdown for all areas combined was 81% small, 17% medium, and 2% large.

Future plans include surveying the nine sites off California and southernmost Oregon (the Eureka, Monterey, and Conception statistical areas of the International North Pacific Fisheries Commission (INPFC)), and eight sites off Oregon and Washington (the Vancouver and Columbia INPFC areas) during alternate

years. Comparison of catches by conical and rectangular trap types will be conducted during the 1985 survey off Oregon and Washington to examine regional differences in trap type performance and to further assess the possible trap x location x depth interaction. We will continue to make two sets at each abundance index site rather than five as before. Survey results will be compared with any commercial CPUE data or other indices of abundance as those become available to assess the performance of the survey design.

ACKNOWLEDGMENTS

We acknowledge Charles D. Knechtel, operations research analyst with the Resource Assessment and Conservation Engineering Division of the Northwest and Alaska Fisheries Center, for his statistical analysis of the sablefish catches by trap type.

REFERENCES

Auke Bay Laboratory.

1983. Resource assessment of sablefish population in outside waters of southeastern Alaska. Cruise Report, NOAA Fishery Research Vessel John N. Cobb, JC-83-02, 13 p. Auke Bay Laboratory, Northwest and Alaska Fish. Cent., Natl. Mar. Fish. Serv., NOAA, P.O. Box 210155, Auke Bay, AK 99821.

Clauson, David M., and J. T. Fujioka.

1985. Fishing performance of rectangular and conical sablefish traps off southeastern Alaska. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-76, 22 p.

Cochran, W.G.

1977. Sampling techniques. John Wiley, New York, 428 p.

Kimura, Daniel K., and J. W. Balsiger.

1985. Bootstrap methods for evaluating sablefish pot index surveys. N. Am. J. Fish. Manage. 5:47-56.

Parks, N. B., and S. E. Hughes.

1981. Changes in relative abundance and size composition of sablefish in coastal waters of Washington and Oregon, 1979-80. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-8, 25 p.

Parks, N. B.

1982. Changes in relative abundance and size composition of sablefish in coastal waters of Washington and Oregon, 1979-81, and California, 1980-81. U.S. Dep. Commer., NOAA Tech. Memo. NMFS, F/NWC-26, 28 p.

Parks, N. B., and F. R. Shaw.

1983. Changes in relative abundance and size composition of sablefish (Anoplopoma fimbria) in coastal waters of California, 1980-82. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-51, 16 p.

Parks, N. B.

1984. Changes in relative abundance and size composition of sablefish in coastal waters of Washington and Oregon, 1979-83. U.S. Dep. Commer., NOAA Tech. Memo. NMFS F/NWC-61, 23 p.