ASSESSMENT OF GULF OF ALASKA SABLEFISH AND OTHER GROUNDFISH BASED ON THE DOMESTIC LONGLINE SURVEY, 1987

by

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ABSTRACT

The Northwest and Alaska Fisheries Science Center conducted a domestic longline survey of sablefish (Anoplopoma fimbria) and other groundfish along the upper continental slope of the Gulf of Alaska for the first time in 1987. This survey replicated as closely as practical a Japan-U.S. cooperative longline survey conducted in the Gulf of Alaska from 1979 to 1989. Fifty-one stations were sampled from 15 July to 21 September.

Sablefish was the most abundant groundfish species both in numbers and weight: the relative population number (RPN) and relative population weight (RPW) for sablefish were 72 and 80%, respectively, of the totals for the Gulf of Alaska. The 1984 year class may be relatively strong based on length compositions of fish caught at 101-200 m.

Other commercially important species caught along the upper continental slope were the shortraker rockfish (Sebastes borealis), rougheye rockfish (S. *aleutianus),* and thornyheads *(Sebastolobus* spp.). The RPN and RPW for the rockfishes were 4.5 and 2.2%, respectively, and for thornyheads, 4.2 and 0.9%, respectively, of the totals for the Gulf of Alaska.

F-Relative numbers of Pacific halibut *(Hippoglossus stenolepis)* were 0.75% of sablefish numbers for depths greater than 301 m, indicating the potential for halibut-by-catch in the longline fishery from July to September.

Catch rates for sablefish from this survey and the Japan-'U.S. cooperative longline survey were compared. Geometric mean regression indicates that the cooperative longline survey gearcaptured about 19% more sablefish on the average than the domestic longline survey gear.

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CONTENTS

INTRODUCTION

Since 1978 Japan and the United States have cooperatively conducted an annual longline survey of sablefish (Anoplopoma fimbria) and Pacific cod *(Gadus macrocephalus).* The survey covers the upper continental slope of the eastern Bering Sea (1982-89), the Aleutian Islands (1980-89), and the Gulf of Alaska (1979-89) using Japanese commercial longline vessels chartered by the Fisheries Agency of Japan. (The first year of the survey, 1978, was experimental.) The vessels have been operated by Japanese nationals and have carried U.S. scientists. The research has supplied information needed to estimate the abundance of sablefish and other groundfish (Sasaki 1987; Sigler 1987; Wakabayashi and Teshima 1987; Mito 1987; Sasaki and Teshima 1987).

In 1987, the National Oceanic and Atmospheric Administration's Northwest and Alaska Fisheries Center initiated a survey designed to continue the time series of the Gulf of Alaska portion of the Japan-U.S. cooperative longline survey. The 1987 domestic longline survey covered the same sampling locations (Fig. 1) and season, and employed similar sampling gear as the Gulf of Alaska portion of the cooperative longline survey. A U.S. vessel and *crew* were used during this survey.

The objectives of the domestic longline survey in 1987 were threefold. The first objective was to determine the relative abundance and size composition of commercially important groundfish species caught on the upper continental slope of the Gulf of Alaska: sablefish, shortspine thornyhead (Sebastolobus alascanus), rougheye rockfish *(Sebastes aleutianus),* and shortraker rockfish (S. borealis). The second objective was to determine the relative abundance and size composition of other species caught during the survey: Pacific cod, grenadiers (Macrouridae), arrowtooth flounder *(Atheresthes stomias),* Pacific halibut *(Hippoglossus stenolepis),* and skates (Rajidae) (size compositions of Pacific halibut and skates were not recorded). The third objective was to compare the

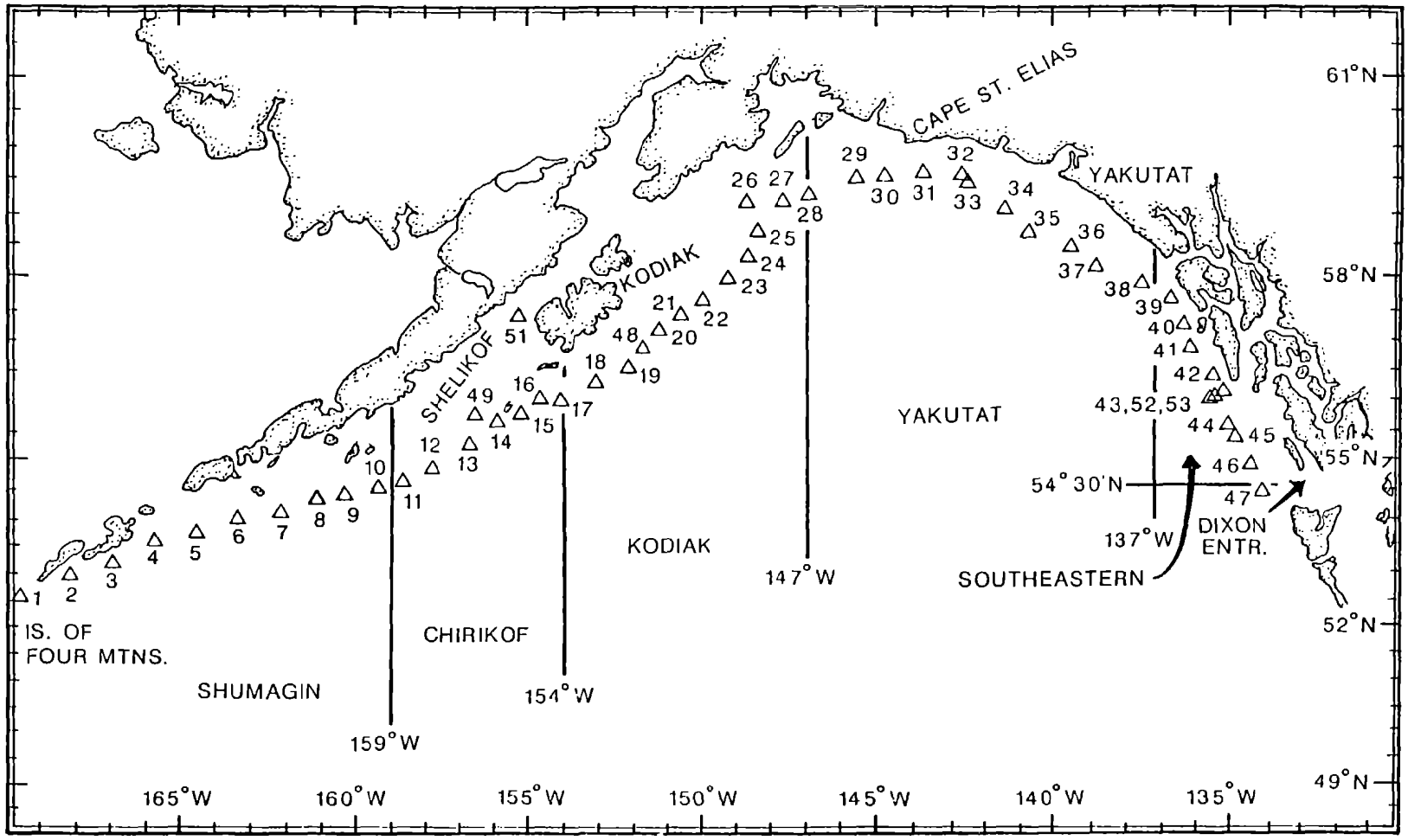


Figure 1.--Station locations for the 1987 Gulf of Alaska domestic logline survey and boundaries of International North Pacific Fisheries Commission statistical areas.

catch rates of sablefish between the domestic and the Japan-U.S. cooperative longline surveys.

The first domestic longline survey was conducted jointly by two components of NOAA's Alaska Fisheries Science Center: the Auke Bay Laboratory and the Resource Assessment and Conservation Engineering Division.

MATERIALS AND METHODS

Vessel and Gear

Survey operations were conducted using the fishing vessel *Prowler,* a chartered U.S. longline vessel. The 35 m (115 ft) vessel carried standard longline hauling equipment (Fig. 2) and was equipped with a processing line, two sets of plate freezers, and four refrigerated holds. Vessel personnel were three biologists, a captain, eight fishermen and processors, and a cook.

Total length of groundline set each day was 16 km (8.6 nmi). The groundline consisted of 160 sections, called skates; each skate was 100 m (55 fathoms) long and included 45 Eagle Claw' No. 7 circle hooks (7,200 hooks total). The hooks were attached to 38 cm (15 in) gangions that were secured to beckets tied into the groundline at 2 m (6.5 ft) intervals. Five meters (16 ft) of groundline were left bare on the end of each skate. Gangion, becket, and groundline materials were stiff lay No. 48 thread, medium lay No. 60 thread, and medium lay 9.5 mm (3/8 in) Goldline, respectively. Each end of a set started with a flag and buoy array and was followed by a buoyline made of between 183 and 1,281 m (100-700 fm) Goldline and 92 m (50 fm) polypropylene line, a 16 kg (35 lb) piece of chain (to dampen wave effects on the buoyline), 92 m (50 fm) Goldline, a 27 kg (60 lb) halibut anchor, 366 m (200 fm) Goldline, and finally

'Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

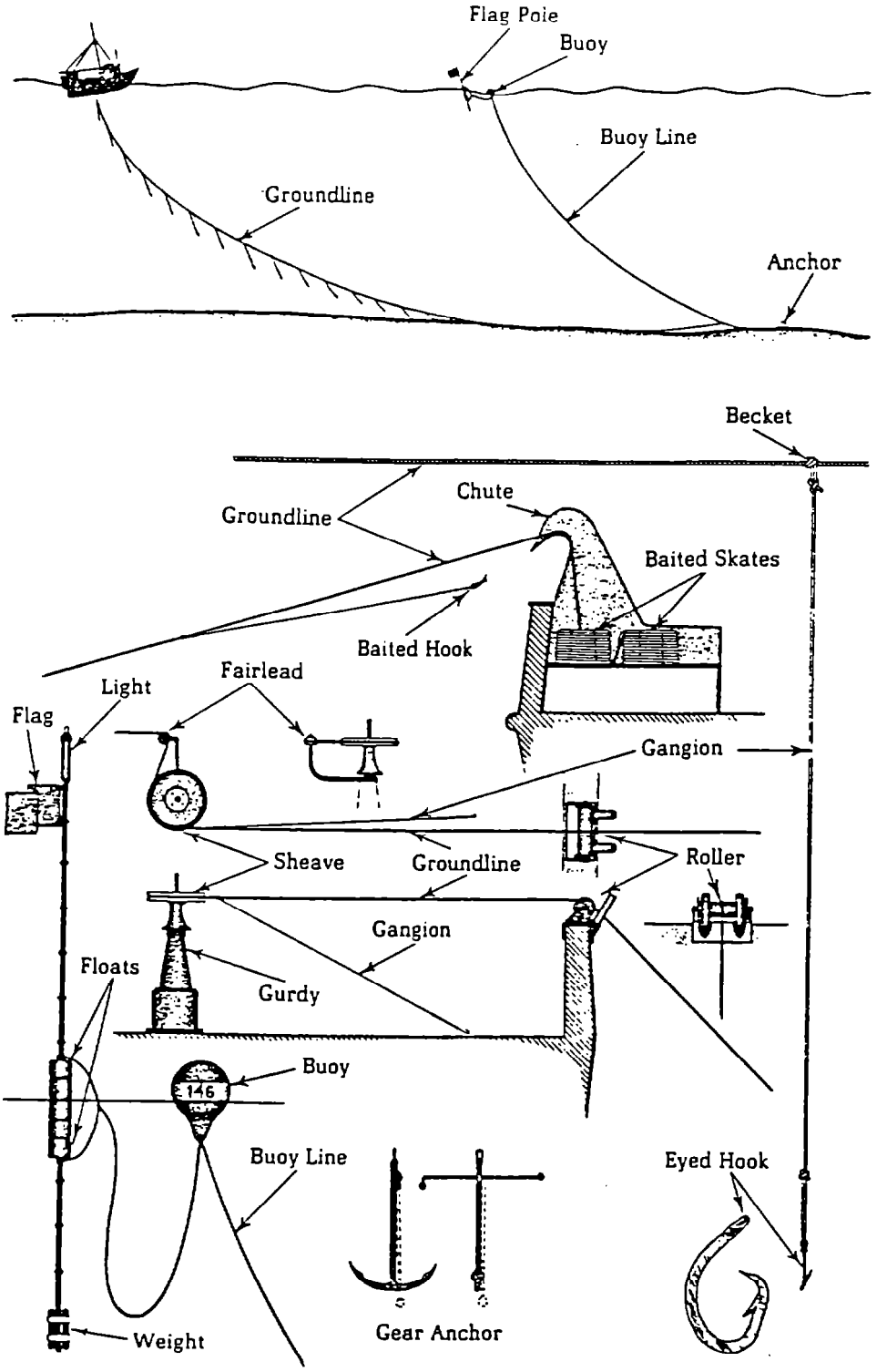


Figure 2.--Generalized description of longline fishing gear and longline hauling equipment. Adapted from drawings by Charles R. Hitz, Northwest and Alaska Fisheries Center, Resource Assessment and Conservation Division, 7600 Sand Point Way NE, BIN C15700, Seattle, WA 98115.

the groundline with hooks. The groundline was weighted with 3.2 kg (7 lb) lead balls snapped on at the end of every fourth skate and 0.5 kg (1.0 lb) of lead seine weights snapped on between the other three skates. The hooks were hand baited with chopped herring at a rate of about 5.7 kg (12.5 lb) per 100 hooks.

Some changes were made in the survey gear to more closely match methods in the domestic fishery and to adapt to differences in the Japanese and U.S. vessels. Circle hooks and herring were used on the domestic longline survey, whereas tara (J-shaped) hooks and squid were used on the cooperative longline survey. On the domestic longline survey, the gear was set in two equal parts laid end to end because the *Prowler* did not have a second line hauler to retrieve intermediate buoylines. On the Japanese survey vessel, 160 skates were set in a continuous groundline with buoys at each end and two buoylines in between. Additionally, a different weighting method was necessary because the U.S. vessel deployed the longline differently from the Japanese vessel: on the Japanese survey vessel, 3.2 kg weights were tied on at the end of every skate, whereas on the U.S. survey vessel, 3.2 kg weights were snapped on to every fourth skate, and 0.5 kg (1 lb) weights were snapped onto the intervening three skates.

Survey Area and Operations

Forty-seven stations (numbers 1-47) were sampled at depths between 101 and 1,000 m (55-554 fm) from Islands of Four Mountains (52°45'N 170°W) eastward along the upper continental slope to Dixon Entrance at a rate of one station per day (Fig. 1). The 47 stations correspond to station numbers 62-108 of the Japan-U.S. cooperative longline survey (Yoshimura and Sasaki, 1987). In addition, a test set was made at station number 48 near Kodiak Island on the first day of the survey and two stations each were sampled in Shelikof Trough (49 and 51) and Ommaney Trench (52 and 53). Shelikof Trough and Ommaney Trench

were sampled to compare sablefish abundance with that of the adjacent upper continental slope.

The survey period extended from 15 July to 21 September 1987, and was divided into two legs of 20 days each and a third leg of 25 days. Leg 1 began near Kodiak Island and progressed westward to Islands of Four Mountains, leg 2 began in Shelikof Trough and progressed eastward to Cape St. Elias, and leg 3 continued the survey southeastward to Dixon Entrance (Fig. 1).

The sampling gear was set from shallow to deep and generally was retrieved in the same order, except when groundlines parted. Setting and retrieval began about 0630 and 0930 hours, respectively, and retrieval was completed at about 2000 hours. Soak time ranged from 3 to 11 hours.

Data Collection

Fish species and hook condition were recorded as the sampling gear was retrieved. Hook condition was classified as baited or unbaited, or as missing, broken, or tangled. Time and depth were recorded when the first, last, and every fifth skate were hauled aboard,

Sablefish, Pacific cod, grenadiers, arrowtooth flounder, rockfish (Sebastes spp.), and thornyhead *(Sebastolobus* spp.) lengths were measured. Sablefish and Pacific cod were sorted into eight depth strata for measuring length and for sexing, whereas other species were not. Stratum 1 represents 0-100 m; stratum 2, 101-200 m; stratum 3, 201-300 m ; stratum 4, 301-400 m; stratum 5, 401-600 m; stratum 6, 601-800 m ; stratum 7, 801-1,000 m; and stratum 8, l,001-1,200 m. All sablefish and Pacific cod lengths were measured when catches were small to moderate; a representative subsample of sablefish and Pacific cod were measured when catches were large. Pacific halibut were not measured, but-were counted and released at the rail.

Analytical Methods

Catch data were stratified because catch rate of each species varied with depth. Catch data were assigned to a stratum based on the recorded depth for every fifth skate or the interpolated depth for the intervening four skates. The number of fish caught per skate (catch per unit effort, CPUE) was calculated by species for each stratum of a station and was corrected for missing, broken, or tangled hooks, but not for bait loss. The data for a given skate were not included in the CPUE computation when the number of missing, broken, or tangled hooks was greater than five for that skate.

Relative population numbers (RPN, an index of relative abundance in numbers) were computed from the CPUEs to determine the relative numbers of each species (Sasaki 1985; Gull and 1969; Quinn et al. 1982). The RPNs were determined for each stratum from 201 to 1,000 m and for the Shumagin, Chirikof, Kodiak, Yakutat, and Southeastern International North Pacific Fisheries Commission (INPFC) statistical areas (Fig. 1). The CPUE for each stratum of a station was multiplied by the area of the stratum (Table 1), and the resultant

Table 1.--Area (km^2) of the upper continental slope of the Gulf of Alaska by International North Pacific Fisheries Commission (INPFC) statistical area and depth (m).

	INPFC statistical area				
Depth (m)	Shumagin	Chirikof	Kodiak	Yakutat	Southeast
201-300	2,737	1,533	1,626	1,494	891
301-400	1,264	817	1,480	1,494	891
401-600	2,269	1,766	2,255	1,666	822
601-800	1,629	1,955	1,923	1,470	1,006
801-1,000	1,248	2,012	2,296	1,489	1,165
201-1,000	9,147	8,083	9,580	7,613	4,775

Sources: Shumagin, Chirikof, and Kodiak areas and Yakutat area from 147 to 144° long. (E. Brown-Alaska Fisheries Science Center, RACE Division, Seattle, WA. Pers. commun., 1985). Yakutat area from 144 to 135" long. and Southeastern area (R. Haight, Auke Bay Laboratory, Pers. commun., 1986).

values were averaged within the statistical area to obtain an RPN for each stratum and statistical area. These RPNs were summed across strata to calculate an RPN for each statistical area and then summed across statistical area to calculate an RPN for the Gulf of Alaska.

The RPNs apply only to the area surveyed and represent only the portion of each species population that is resident in the survey area. For sablefish, rougheye and shortraker rockfishes, and shortspine thornyheads, the survey area covers most of the area where these species are commercially caught and, therefore, generally represents the exploitable fraction of these species populations, whereas for Pacific cod, Pacific halibut, rockfish species other than rougheye and shortraker rockfishes, grenadiers, and arrowtooth flounders, their depth and area range is broader than that measured by the survey and the RPNs do not reflect the abundance of these species as a whole.

The depths and regions used *to* calculate RPNs for this survey differ from those used to calculate RPNs for previous surveys. Relative population numbers for this survey were calculated only for the upper continental slope at depths 201-1,000 m, which generally corresponds to the region covered by this survey. In contrast, RPN estimates from previous surveys (Sasaki 1987, Sigler 1987) included gullies and the continental shelf (which generally correspond to depths less than 200 m), even though only a small fraction of these regions was surveyed. We excluded gullies and the continental shelf because their inclusion in RPN estimates from previous surveys resulted in an apparent overestimate of the RPNs at 101-1,000 m in 1985 (Sigler 1987).

In addition, areal measurements used to calculate RPN for this survey differ from areal measurements used for previous surveys (Sasaki 1987; Sigler 1987). We used different measurements because those previously used did not include areal measurements for the upper continental slope alone (see Sigler 1988 for a comparison).

Length compositions were computed to examine the size structures of the species. For depths 201-1,000 m, a RPN weighted length frequency (RPN LF) was constructed for each stratum of a station by allocating the stratum's RPN to each centimeter increment of the stratum's length frequency distribution based on the relative numbers of fish caught at that length increment. The resultant RPN LFs by station and stratum were averaged within statistical area to calculate a RPN LF by stratum and statistical area.

Length compositions also were computed for depths 101-200 m for both sablefish and Pacific cod to look for evidence of relatively strong year classes. Length compositions for depths 101-200 m from previous Japan-U.S. cooperative longline surveys were used to document the relatively strong 1977 and 1980 year classes of sablefish; modes at lengths less than 62 cm FL often were associated with these two relatively strong year classes (Sigler and Fujioka 1988). Catch per skate weighted length frequency (CPUE LF) was computed for each statistical area by the same procedure used to compute the RPN LF. A CPUE LF was calculated instead of a RPN LF because RPNs were not estimated for these depths.

Relative population weights (RPW, an index of relative abundance in weight) were computed to assess relative biomass. Length-weight equations were available for sablefish, Pacific cod, grenadiers, arrowtooth flounders, rougheye and shortraker rockfish, and shortspine thornyheads (Table 2). For each species, the appropriate length-weight equation was applied to RPN LF by stratum and statistical area to compute corresponding RPW weighted length frequencies by stratum and statistical area. These RPW weighted length frequencies were summed across length to calculate RPWs by stratum and statistical area. The resultant RPWs were summed across strata to calculate a RPW for each statistical area and then across statistical area to calculate a RPW for the Gulf of Alaska.

Table 2.- -Length-weight parameters used to calculate relative population weight with the relationship $W = aL^b$. Length is expressed in centimeters and weight is expressed in kilograms.

Species	a	b
Sablefish	2.99×10^{-6}	3.30
Pacific cod	3.06×10^{-6}	3.21
Giant grenadiers	7.20×10^{-4}	2.54
Arrowtooth flounder	3.46×10^{-6}	3.16
Rougheye rockfish	6.41×10^{-6}	3.17
Shortraker rockfish	1.31×10^{-6}	3.42
Shortspine thornyhead	5.49×10^{-6}	3.14

Sources: Sablefish from Sasaki (1985). Giant grenadiers from Sasaki (Far Seas Fishery Research Laboratory, 1000 Orido, Shimizu 424, Japan. Pers. commun., 1987). The length-weight relationship for giant grenadiers was applied to all species of grenadiers caught. Remaining species from E. Brown (Alaska Fisheries Science Center, RACE Division, 7600 Sand Point Way NE, BIN C15700, Seattle, WA 98115. Pers. commun., 1987).

Sebastes spp. were tallied as rockfish as they were brought aboard and were not identified by species until their lengths were measured. As a result, the computation of RPN LFs and RPWs for rougheye and shortraker rockfish followed a modified procedure from that described above. We assumed that the rockfish RPN for depths greater than 201 m consisted only of rougheye or shortraker rockfish because nearly all (93%) of the rockfish caught during the survey were rougheye or shortraker rockfish and because all of the rougheye and shortraker rockfish were caught below 201 m. The RPN LFs were calculated for rougheye and shortraker rockfish for each station by allocating the station's rockfish RPN to each centimeter increment of the station's length frequency distribution based on the relative numbers of each species caught at that length increment. The resultant RPN LFs by station were averaged within statistical area to calculate

a RPN LF by statistical area. A RPW then was calculated for each species as described above.

The bootstrap method (Efron 1982; Efron and Tibshirani 1986) was used to compute confidence intervals for the RPNs. The method of calculation is similar to that used by Sigler and Fujioka (1988). In our application of the bootstrap method, stations were randomly sampled with replacement within each statistical area. A value denoted $RPN_{i,k}$*, where i = area and k = species, was computed from the CPUE of the sampled stations by the method of RPN calculation described above. Sampling with replacement and the computation of the $RPN_{i,k}$* *were* repeated 1,000 times producing a bootstrap distribution of 1,000 $RPN_{i,k}$*.

Efron and Tibshirani (1986) outlined methods for setting an approximate confidence interval from a bootstrap distribution for a statistic of interest, here $RPN_{i,t}$*. Use of the simplest method, the percentile method, is considered correct if the bootstrap distribution of the statistic of interest is described by the normal distribution (Efron and Tibshirani 1986). The normality of the bootstrap distribution was tested using the D'Agostino ***D*** Test (D'Agostino and Stephens 1986), and in most cases the null hypothesis of normality was accepted, thus justifying the use of the percentile method. In the remaining cases where the null hypothesis of normality was rejected, the bias corrected percentile method recommended by Efron and Tibshirani (1986) was applied.

Catch rates for sablefish from the 1987 domestic and cooperative longline surveys were compared to determine the relative fishing power of the two surveys. Catch rates of sablefish per skate were computed by station and stratum for each survey. The resultant catch rates were paired by matching stations and strata that were sampled successfully during both surveys. Three methods were used to estimate the catch rate relationship: robust locally

weighted regression and smoothing techniques' (Cleveland 1979); derivative-free nonlinear regression modeled on an asymptotic equation (Dixon 1985); and functional, or geometric mean regression, which was used because both sets of CPUE were measured with error and neither set measured a true independent variable (Ricker 1973).

RESULTS

Sablefish

Sablefish were the main component of the groundfish population along the upper continental slope both in numbers and weight; the RPN and RPW for sablefish were 72 and 80%, respectively, of the total RPN and RPW for the Gulf of Alaska (Tables 3, 4). These percentages were consistent for all statistical areas and strata, The RPN and RPW for sablefish were largest in the Shumagin area and smallest in the Southeastern area (Tables 5, 6; Fig. 3a). By stratum, the RPN and RPW were highest for the intermediate strata 401-600 m and 601-800 m, and lowest for the other three strata 201-300 m, 301-400 m, and 801-1,000 m (Tables 7, 8; Fig. 3b).

Most (66.9%) male sablefish were medium sized (57-66 cm FL), whereas most (71.1%) female sablefish were large (>66 cm FL) (Table 9; Fig. 4). More (10.9%) males were small (<57 cm FL) than females (4.1%). These two observations reflect the generality that the maximum size of male sablefish is less than that of female sablefish. For both sexes combined, the percentage of large fish generally increased with depth, whereas the percentage of medium fish decreased (Fig. 5).

[2]R. Kappenman, Fisheries Statistician, Alaska Fisheries Science Center, 7600 Sand Point Way N.E., BIN C15700, Seattle, WA 98115. Pers. commun., 1988.

Table 3.--Relative population number for the upper continental slope summed by International North Pacific Fisheries Commission statistical area expressed as a percentage of the RPN for the Gulf of Alaska. SF = sablefish, PC = Pacific cod, GR = grenadiers, HB = Pacific halibut, ATF = arrowtooth flounder, RF = rockfish, TH = thornyheads, SK = skates, OS = other species. Domestic longline survey, 1987.

Area	SF	PC	GR	HB	ATF	RF	TH	SK	OS
Shumagin	18.7	1.1	3.0	0.5	1.2	0.7	1.3	0.1	0.1
Chirikof	12.4	0.5	1.3	0.3	0.9	0.2	0.8	0.1	0.0
Kodiak	17.8	0.9	3.2	0.3	1.6	0.7	1.2	0.1	0.1
Yakutat	14.3	0.7	0.8	0.5	0.5	1.3	0.6	0.1	0.1
South-eastern	8.8	0.1	0.1	0.4	0.5	1.7	0.4	0.0	0.3
Gulf of Alaska	72.0	3.2	8.4	1.9	4.6	4.5	4.2	0.4	0.7

Table 4.--Relative population weight summed by International North Pacific Fisheries Commission statistical area expressed as a percentage of the RPW for the Gulf of Alaska. SF = sablefish, PC = Pacific cod, GR = grenadiers, ATF = arrowtooth flounder, RRF = rougheye rockfish, SRF = shortraker rockfish, TH = thornyheads. Domestic longline survey, 1987.

Area	SF	PC	GR	ATF	RRF	SRF	TH
Shumagin	20.5	0.7	4.9	0.7	0.2	0.2	0.3
Chirikof	13.8	0.3	1.8	0.5	0.1	0.0	0.2
Kodiak	19.8	0.5	4.9	0.8	0.2	0.1	0.2
Yakutat	16.1	0.4	0.7	0.2	0.3	0.4	0.1
South-eastern	30.1	0.1	0.3	0.6	2.1	0.4	0.3
Gulf of Alaska	80.2	2.0	12.4	2.4	1.4	0.8	0.9

Table 5.--Relative population number by species, International North Pacific Fisheries Commission statistical area, and strata. SF = sablefish/PC = Pacific cod, GR = grenadiers, HB = Pacific halibut, ATF = arrowtooth flounder, RF = rockfish, TH = thornyheads, SK = skates, OS = other species. Strata (STR) 3 = depths 201-300 m, 4 = 301-400 m, 5 = 401-600 m, 6 = 602-800 m, 7 = 801-1,000 m. Listed below each RPN are the lower (L) and upper (U) 95% confidence intervals. Domestic longline survey, 1987.

	Species								
STR	SF	PC	GR	HB	ATF	RF	TH	SK	OS
				Shumagin					
3	27,700	5,777	26	2,463	5,000	1,982	1,656	128	219
4	17,790	11	715	195	1,317	1,422	939	86	90
5	31,037	7	4,085	10	232	360	1,648	98	153
6	14,289	0	4,695	12	6	6	1,402	192	54
7	10,875	0	6,765	0	0	70	1,229	151	0
Total	101,691	5,795	16,286	2,680	6,555	3,834	6,874	655	516
L	83,575	4,023	12,501	2,091	2,997	1,621	5,670	272	311
U	121,164	7,725	19,426	3,305	11,833	6,887	7,844	1,151	731
				Chirikof					
3	15,990	2,675	0	1,232	3,160	233	841	112	48
4	9,511	0	495	226	1,199	590	603	63	35
5	20,253	0	2,008	50	367	96	973	48	135
6	21,771	0	4,398	0	58	12	1,729	225	37
Total	67,525	2,675	6,901	1,508	4,784	931	4,146	448	255
L	52,428	962	2,922	702	3,498	602	2,846	259	98
U	82,636	4,600	11,333	2,557	6,054	1,277	5,347	687	433

Table 5.--Continued.

STR	Species								
	SF	PC	GR	HB	ATF	RF	TH	SK	OS
					Kodiak				
3	8,420	4,120	0	1,108	4,920	763	467	118	215
4	7,762	762	320	574	2,517	2,782	760	150	151
5	28,313	0	907	90	910	57	1,998	66	130
6	28,338	0	2,623	0	57	13	1,664	36	52
7	23,865	0	13,661	0	59	0	1,621	57	0
Total	96,698	4,882	17,511	1,772	8,463	3,615	6,510	427	548
L	70,057	2,500	2,065	--[a]	5,952	1,580	3,911	191	427
U	112,363	7,379	23,830	--[a]	11,300	6,292	8,650	662	658
					Yakutat				
3	9,982	3,262	0	1,890	1,314	1,880	642	145	428
4	11,734	342	41	681	864	3,295	1,054	184	120
5	22,472	0	284	68	243	1,369	584	8	61
6	20,228	12	869	0	28	158	505	21	23
7	13,371	0	3,252	0	0	188	476	10	20
Total	77,787	3,616	4,446	2,639	2,449	6,890	3,261	368	652
L	65,179	1,543	1,878	2,114	1,577	5,626	2,079	218	418
U	90,113	6,032	7,650	3,212	3,455	8,398	4,551	523	915

Table 5.--Continued.

STR	Species								
	SF	PC	GR	HB	ATF	RF	TH	SK	OS
					Southeastern				
3	2,542	390	0	1,376	1,680	744	484	99	1,374
4	6,192	24	0	507	981	4,559	403	52	222
5	10,297	0	13	25	85	2,372	447	43	80
6	13,569	0	116	0	20	907	394	33	46
7	15,234	0	411	0	8	690	419	33	66
Total	47,834	414	540	1,908	2,774	9,272	2,147	260	1,788
L	39,598	94	217	1,269	1,166	7,117	1,319	171	690
U	56,818	818	922	2,587	4,885	11,679	3,359	370	2,974
					Gulf of Alaska				
3	64,634	16,225	26	8,069	16,074	5,601	4,089	603	2,284
4	52,989	1,139	1,571	2,183	6,877	12,648	3,759	536	617
5	112,371	7	7,298	244	1,837	4,255	5,649	262	258
6	98,195	12	12,702	12	169	1,096	5,694	507	213
7	63,344	0	24,089	0	66	948	3,745	251	86
Total	391,533	17,383	45,686	10,508	25,023	24,548	22,936	2,159	3,758
L	350,464	13,184	28,673	9,065	19,327	20,340	19,295	1,634	2,579
U	425,235	21,940	55,553	11,991	31,848	29,169	26,087	2,742	5,015

Total RPN for all species combined equals 543,534.
"A bootstrap confidence interval could not be calculated for grenadiers in the Kodiak area because the bootstrap distribution was trimodal.

Table 6.--Relative population weight (RPW) by species, International North Pacific Fisheries Commission statistical area, and strata. SF = sablefish, PC = Pacific cod, GR = grenadiers, ATF = arrowtooth flounder, RRF = rougheye rockfish, SRF = shortraker rockfish, TH = thornyheads. Strata (STR) 3 = depths 201-300 m, 4 = 301-400 m, 5 = 401-600 m, 6 = 601-800 m, 7 = 801-1,000 m. Domestic longline survey, 1987.

STR	SF	PC	GR	ATF	RRF	SRF	TH
			Shumagin				
3	80,965	11,211	145	8,147	1,171	1,175	1,068
4	56,638	0	3,599	2,099	1,242	900	688
5	105,931	0	20,330	351	245	366	1,201
6	51,259	0	22,450	10	3	11	1,003
7	38,435	0	33,036	0	37	95	870
Total	333,228	11,211	79,560	10,607	2,698	2,547	4,830
			Chirikof				
3	48,147	4,991	0	5,413	198	104	470
4	32,985	0	2,059	2,074	617	245	351
5	65,346	0	8,312	612	28	113	603
6	77,277	0	18,521	114	15	4	1,057
Total	223,755	4,991	28,892	8,213	858	466	2,481
			Kodiak				
3	24,248	6,778	0	7,298	576	384	239
4	23,418	1,238	1,514	3,733	2,099	1,093	413
5	77,819	0	4,666	1,349	43	39	1,147
6	101,573	0	11,926	81	5	18	924
7	95,457	0	61,768	100	0	0	936
Total	322,515	8,016	79,874	12,561	2,723	1,534	3,659
			Yakutat				
3	34,964	6,458	0	2,022	1,352	1,448	401
4	37,906	522	106	1,396	2,702	2,797	701
5	68,737	0	772	436	1,122	1,241	357
6	69,756	0	2,261	53	122	146	312
7	49,652	0	8,051	0	154	158	300
Total	261,015	6,980	11,190	3,907	5,452	5,790	2,071

Table 6.--Continued.

STR	SF	PC	GR	ATF	RRF	SRF	TH
			Southeastern				
3	7,776	763	0	1,802	946	125	302
4	21,092	32	0	1,122	5,659	1,133	296
5	34,688	0	65	120	2,978	386	349
6	46,128	0	430	30	1,103	197	328
7	53,654	0	896	10	834	159	332
Total	163,338	795	1,391	3,084	11,520	2,000	1,607
			Gulf of Alaska				
3	196,099	30,201	145	24,682	4,242	3,237	2,481
4	172,039	1,792	7,277	10,425	12,319	6,169	2,448
5	352,521	0	34,145	2,868	4,417	2,145	3,657
6	345,993	0	55,587	288	1,247	376	3,624
7	237,198	0	103,751	109	1,025	411	2,437
Total	303,850	31,993	200,905	38,373	23,250	12,338	14,648

Total RPW for all species combined equals 1,625,357.

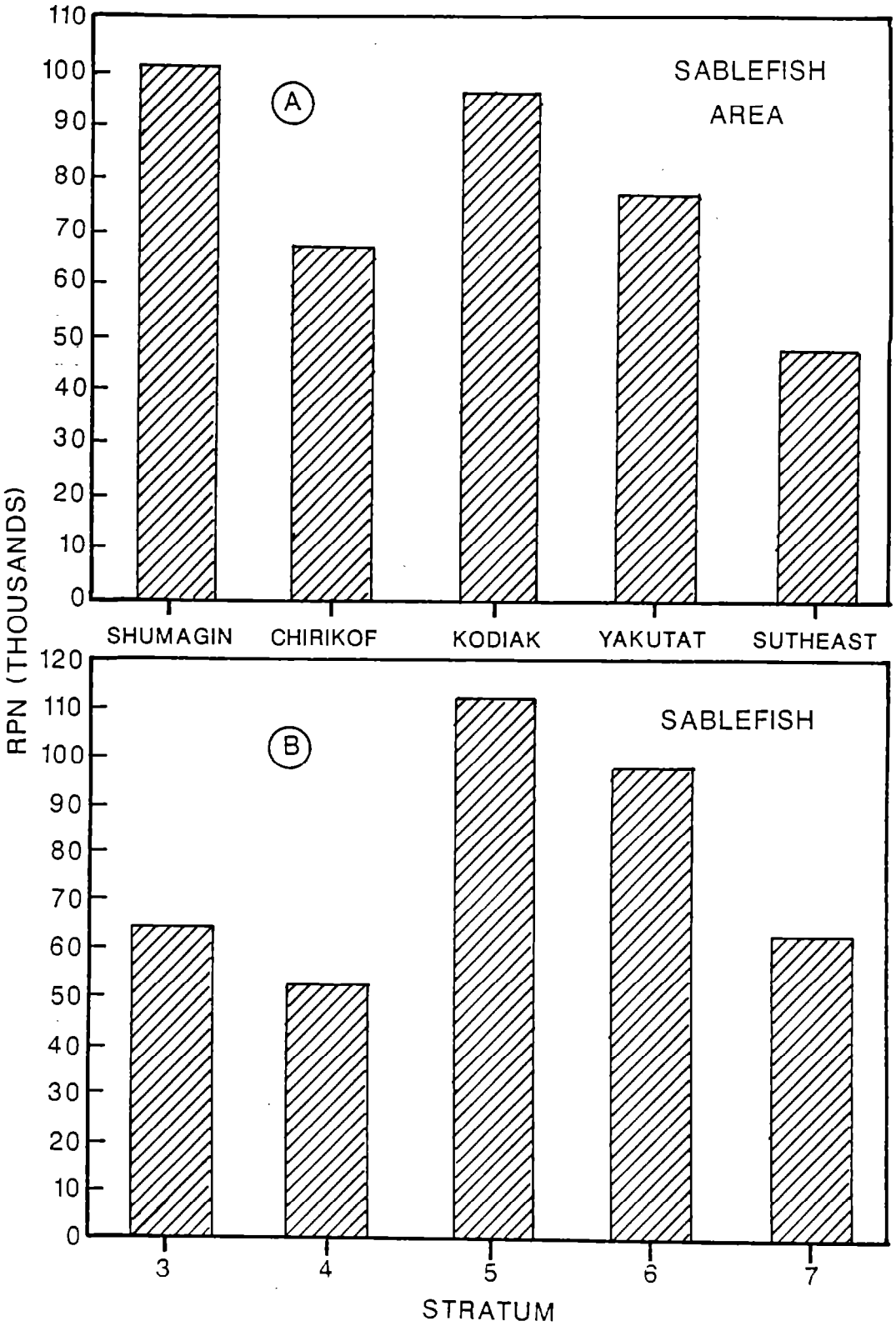


Figure 3. --Relative population number of sablefish for the upper continental slope of the Gulf of Alaska by International North pacific Fisheries Commission statistical area (A) and depth strata (B). Strata: 3 - 201-300 m, 4 - 301-400 m, 5 - 401-600 m, 6 - 601-800 m, 7 - 801-1,000 m. Domestic longline survey, 1987.

Table 7.--Relative population number (RPN) summed by strata expressed as a percentage of the RPN for the Gulf of Alaska. Strata (STR) 3 = depths 201-300 m, 4 = 301-400 m, 5 = 401-600 m, 6 = 601-800 m, 7 = 801-1,000 m. SF = sablefish, PC = Pacific cod, GR = grenadiers, HB = Pacific halibut, ATF = arrowtooth flounder, RF = rockfish, TH = thornyheads, SK = skates, OS = other species. Domestic longline survey, 1987.

STR	SF	PC	GR	HB	ATF	RF	TH	SK	OS
3	11.9	3.0	0.0	1.5	3.0	1.0	0.8	0.1	0.4
4	9.7	0.2	0.3	0.4	1.3	2.3	0.7	0.1	0.1
5	20.7	0.0	1.3	0.0	0.3	0.8	1.0	0.0	0.1
6	18.1	0.0	2.3	0.0	0.0	0.2	1.0	0.1	0.0
7	11.7	0.0	4.4	0.0	0.0	0.2	0.7	0.0	0.0

Table 8.--Relative population weight summed by International North Pacific Fisheries Commission statistical area expressed as a percentage of the RPN for the Gulf of Alaska. SF = sablefish, PC = Pacific cod, GR = grenadiers, ATF = arrowtooth flounder, RRF = rougheye rockfish, SRF = shortraker rockfish, TH = thornyheads. Strata (STR) 3 = depths 201-300 m, 4 = 301-400 m, 5 = 401-600 m, 6 = 601-800 m, 7 = 801-1,000 m. Domestic longline survey, 1987.

STR	SF	PC	GR	ATF	RRF	SRF	TH
3	12.1	1.9	0.0	1.5	0.3	0.2	0.2
4	10.6	0.1	0.4	0.6	0.8	0.4	0.2
5	21.7	0.0	2.1	0.2	0.3	0.1	0.2
6	21.3	0.0	3.4	0.0	0.1	0.0	0.2
7	14.6	0.0	6.4	0.0	0.1	0.0	0.1

Table 9.- -Sablefish percentage size composition for RPN weighted length frequencies by International North Pacific Fisheries Commission statistical area, depth, and sex. Lengths are cm fork length.

Length	Shumagin	Chirikof	Kodiak	Yakutat	South-east	Gulf of Alaska
			201-300 m, males			
<57 cm	13.6	8.4	7.0	20.0	19.9	12.4
57-66 cm	75.0	76.6	78.4	41.1	55.2	70.1
>66 cm	11.3	15.0	14.6	39.0	25.0	17.5
			201-300 m, females			
<57 cm	5.9	3.1	5.6	15.4	15.4	7.0
57-66 cm	44.1	40.9	44.4	14.9	35.4	38.4
>66 cm	50.0	56.0	50.0	69.6	49.2	54.5
			301-400 m, males			
<57 cm	8.7	1.7	16.6	11.5	7.7	9.3
57-66 cm	73.5	70.2	62.2	61.3	56.6	66.3
>66 cm	17.8	28.1	21.1	27.2	35.7	24.4
			301-400 m, females			
<57 cm	4.5	0.2	6.1	5.0	4.0	4.0
57-66 cm	30.2	18.8	37.3	28.4	29.8	28.6
>66 cm	65.3	81.0	56.5	66.6	66.2	67.4
			401-600 m, males			
<57 cm	9.0	10.1	22.7	18.2	5.7	14.8
57-66 cm	70.7	72.8	65.7	64.1	66.7	67.8
>66 cm	20.3	17.1	11.6	17.7	27.6	17.4
<57 cm	1.5	2.3	13.2	10.8	1.6	6.1
57-66 cm	21.1	20.9	37.1	26.4	32.5	26.9
>66 cm	77.4	76.7	49.8	62.9	65.9	67.0
			601-800 m, males			
<57 cm	7.2	8.7	9.2	13.5	4.8	9.0
57-66 cm	69.5	63.5	66.0	62.4	68.3	65.5
>66 cm	23.3	27.7	24.8	24.1	26.8	25.5

Table 9.- -Continued.

Length	Shumagin	Chirikof	Kodiak	Yakutat	South-east	Gulf of Alaska
			601-800 m, females			
<57 cm	0.9	2.2	1.3	5.1	0.6	2.1
57-66 cm	16.1	19.0	18.2	19.0	25.2	19.1
>66 cm	82.9	78.7	80.4	76.0	74.2	78.8
			801-1,000 m, males			
<57 cm	10.6	--	5.0	5.7	5.6	6.3
57-66 cm	67.7	--	60.2	65.7	67.0	64.6
>66 cm	21.7	--	34.8	28.6	27.3	29.1
			801-1,000 m, females			
<57 cm	2.0	--	0.6	0.6	0.6	0.8
7-66 cm	20.7	--	7.6	11.6	17.3	12.8
>66 cm	77.3	--	91.8	87.8	82.1	86.4
			201-1,000 m, males			
<57 cm	10.0	8.1	13.5	14.1	6.4	10.9
57-66 cm	71.8	70.0	65.8	60.9	65.5	66.9
>66 cm	18.3	21.9	20.8	25.0	28.1	22.2
			201-1,000 m, females			
<57 cm	3.2	2.2	4.8	7.3	2.1	4.1
57-66 cm	28.6	25.0	23.4	20.4	25.6	24.8
>66 cm	68.2	72.8	71.9	72.4	72.3	71.1

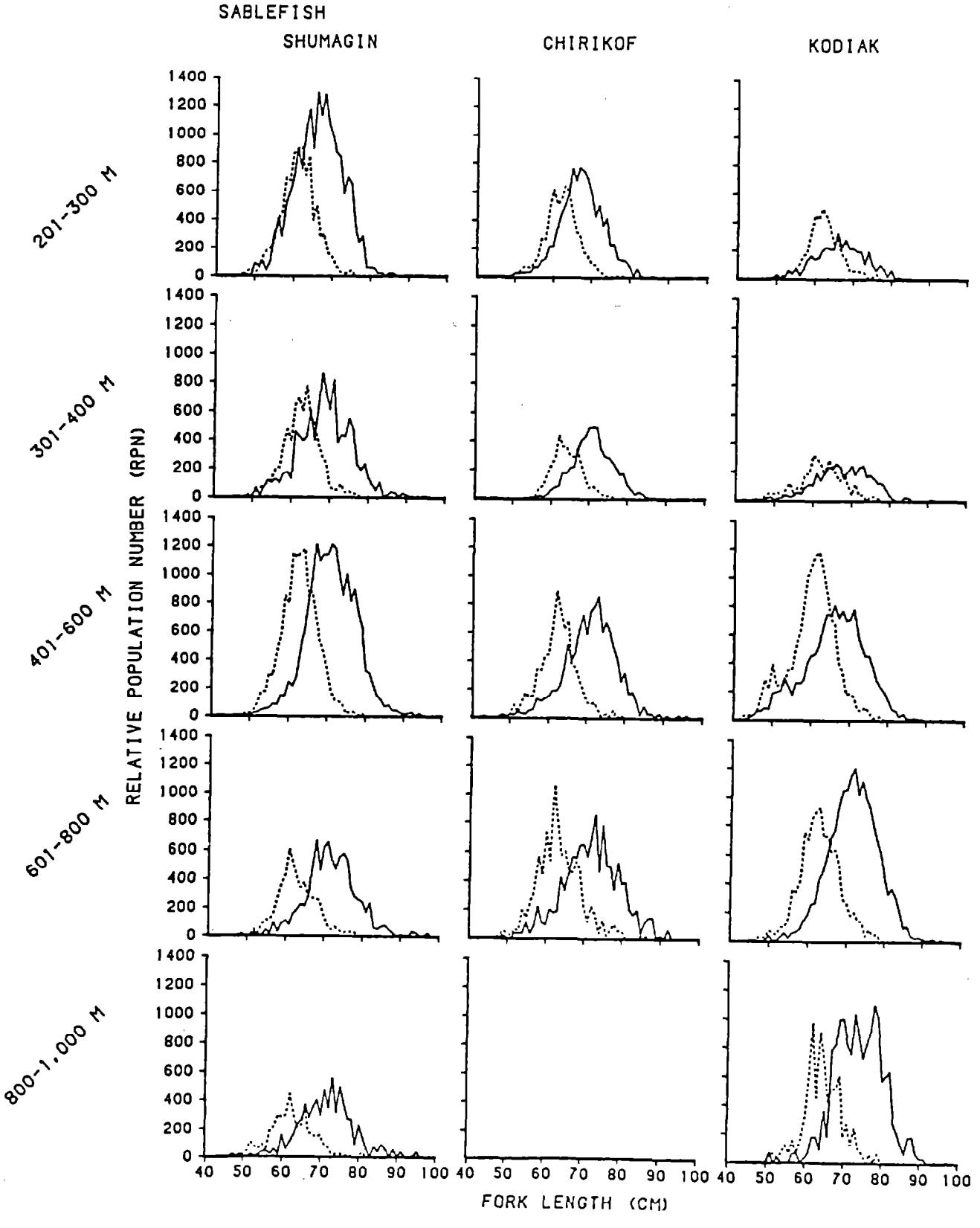
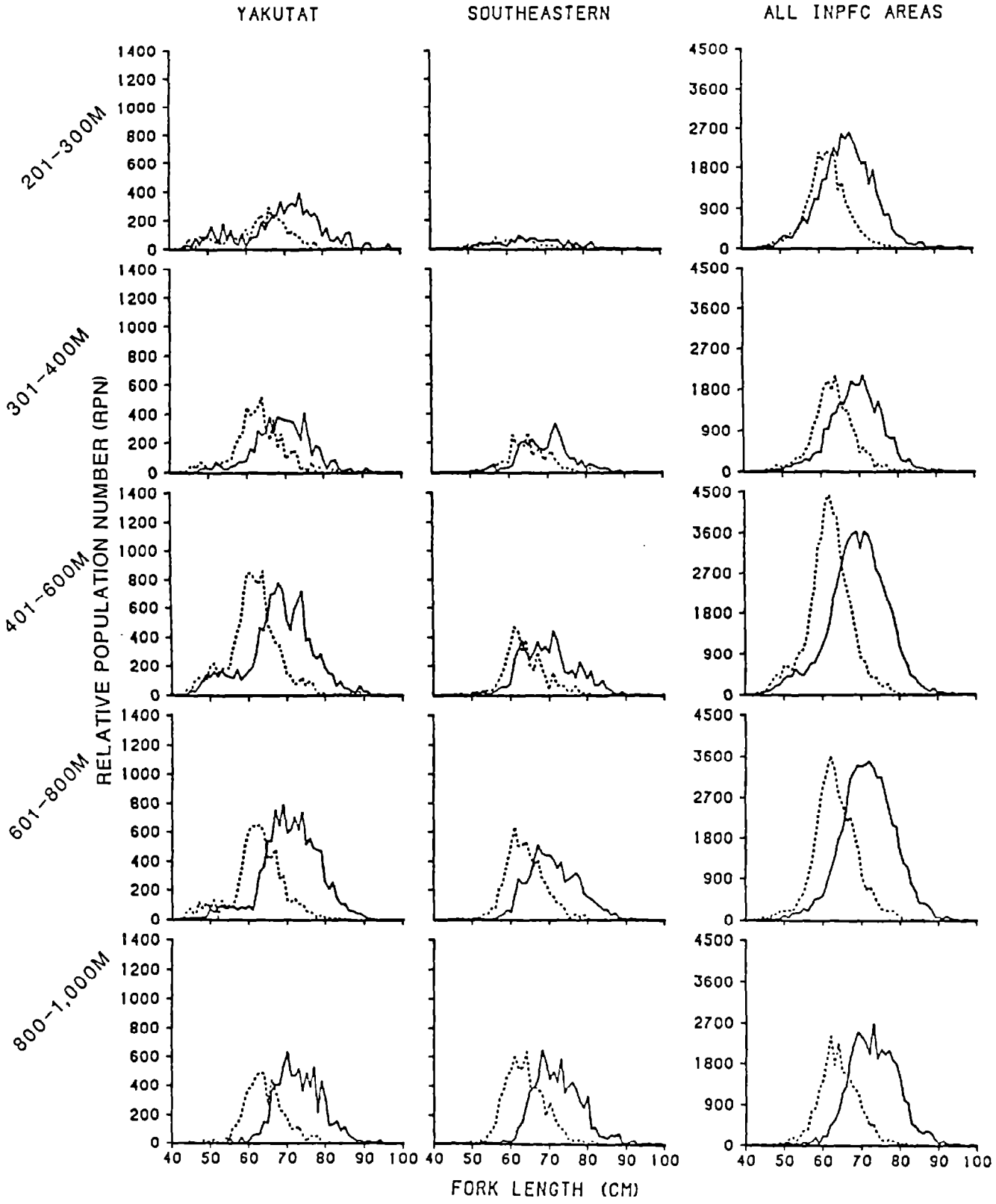


Figure 4. --Length frequencies weighted by relative population number of male (------) and female (———) sablefish for the upper continental slope of the Gulf of Alaska by International North Pacific Fisheries Commission statistical area and depth strata. Domestic longline survey, 1987.



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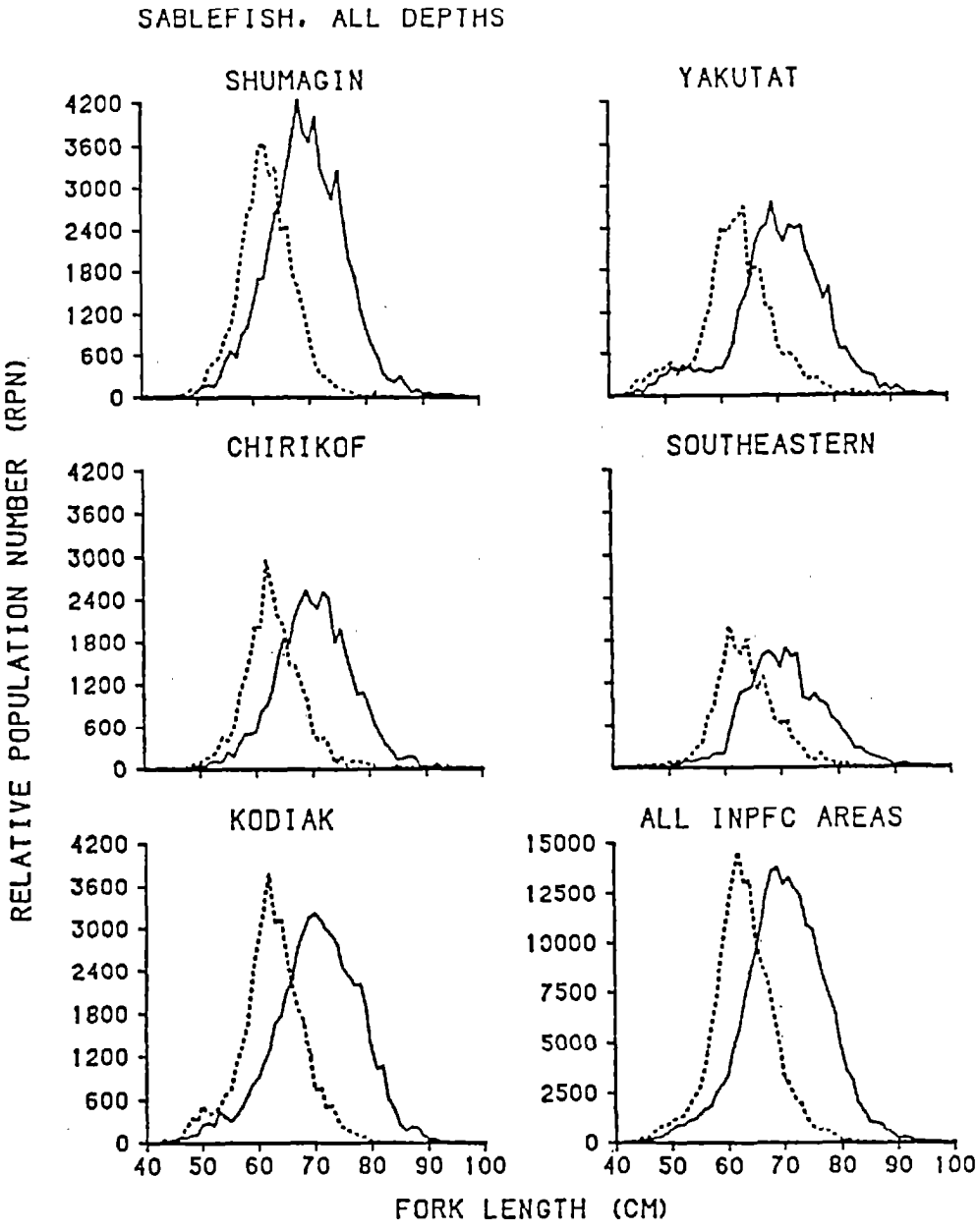

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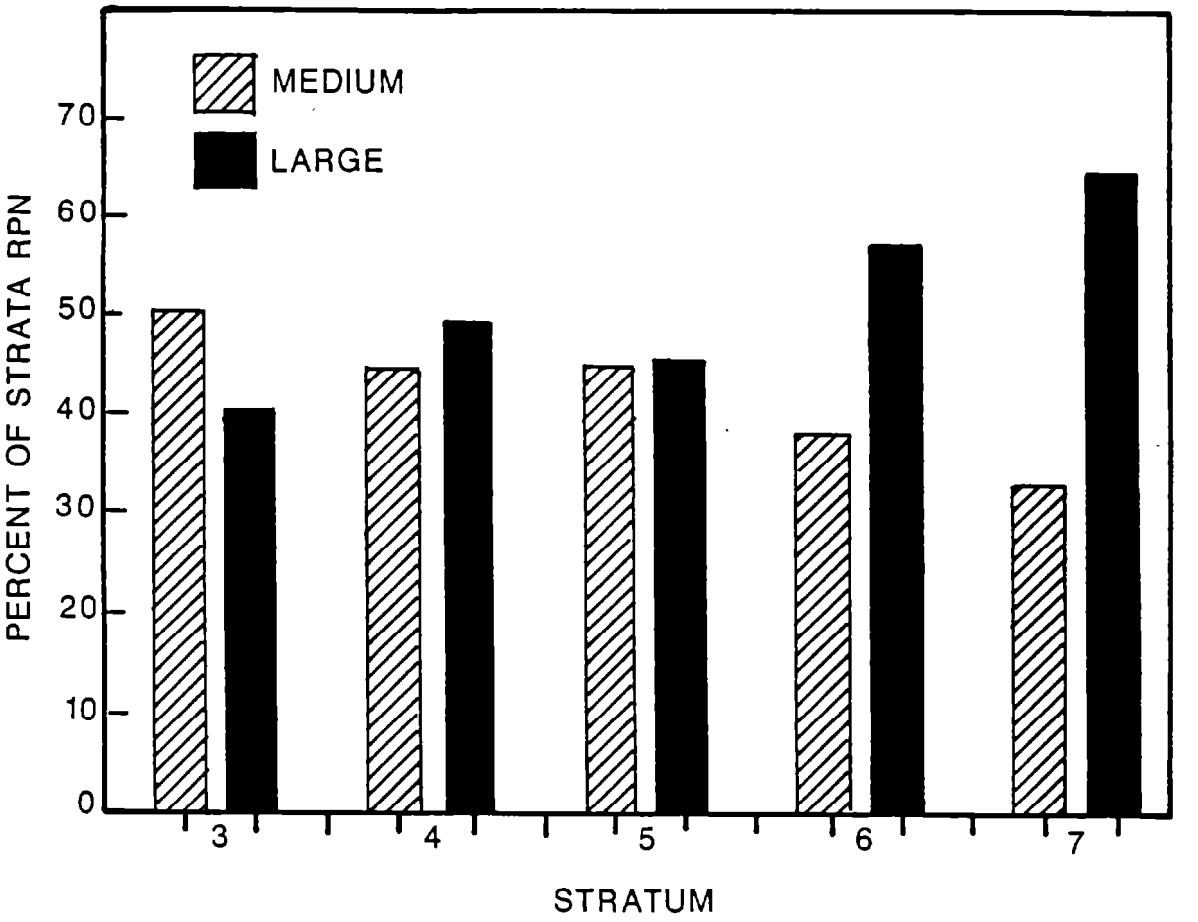


Figure 5.--Relative population number (RPN) of sablefish by body size for the upper continental slope of the Gulf of Alaska expressed as a percentage of the RPN of sablefish for the depth strata. Medium size sablefish are 57-66 cm FL and large size sablefish are > 66 cm FL. Strata: 3 = 201-300 m, 4 = 301-400 m, 5 = 401-600 m, 6 = 601-800 m, 7 = 801-1,000 m. Domestic longline survey, 1987.

Modes at 51-54 cm FL for the Shumagin, Yakutat, and Southeastern areas for depths 101-200 m may be attributable to a relatively strong 1984 year class (Fig. 6). Modes at 55 cm FL in the Shumagin, Chirikof, Yakutat, and Southeastern areas for depths 101-200 ❑ were observed in the 1987 Japan-U.S. cooperative longline survey (Sigler 1988). The prospect of a relatively strong 1984 year class, which is expected to recruit to the fishery primarily in 1989, has been noted previously for both the Gulf of Alaska (Sigler 1987) and the eastern Bering Sea (McDevitt 1987).

Catch rates for sablefish were higher in the gullies (Shelikof Trough, Ommaney Trench) than in the adjacent upper continental slope (Table 10). These differences were not significant however ($P > 0.10$, T-test in Snedecor and Cochran 1967), probably because of the small number of stations sampled in the gullies. The length composition for Shelikof Trough was rightward of the length composition for the adjacent upper continental slope; whereas the length compositions for Ommaney Trench were leftward of the length compositions for the adjacent upper continental slope (Fig. 7). These differences were statistically significant ($P < 0.05$, Smirnov test in Conover 1980) and indicated that the gully and slope populations differed.

Rougheye and Shortraker Rockfish

Rockfish were the fourth most abundant species group in both numbers and weight (Tables 3, 4) and consisted primarily of rougheye and shortraker rockfish. These two species were most common at depths 201-400 m and in the Yakutat and Southeastern areas (Figs, 8a, b). Their depth distribution, as well as the observation that their catches were most common over hard, steeply sloped bottom, indicate that these two rockfish species were associated with the shelf edge (200-300 m).

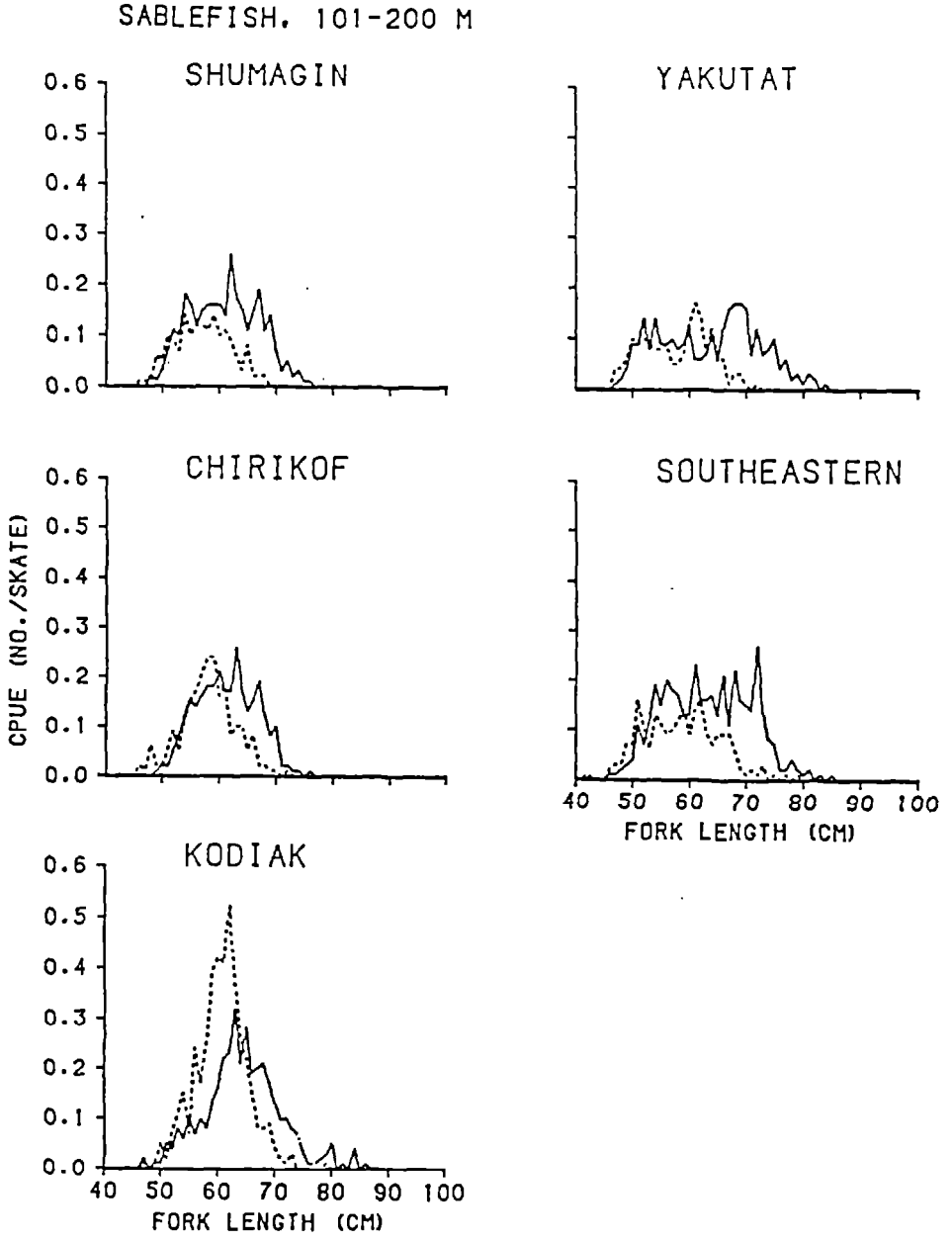


Figure 6. --Length frequencies weighted by catch per skate of male (------) and female (———) sablefish for the upper continental slope of the Gulf of Alaska at depths 101-200 m by International North Pacific Fisheries Commission statistical area. Domestic longline survey, 1987.

Table 10.- -Sablefish catch rates (sablefish per 100 hooks) for gullies and adjacent upper continental slope.

Region	Depth	Mean	Standard deviation	Number of stations
Shelikof Trough	201-300	16.0	4.0	2
Chirikof slope	201-300	23.1	13.8	7
Ommaney Trench	301-400	29.8	3.8	2
Southeast slope	301-400	15.6	10.9	8
Ommaney Trench	401-600	34.4		1
Southeast slope	401-600	28.0	11.3	8

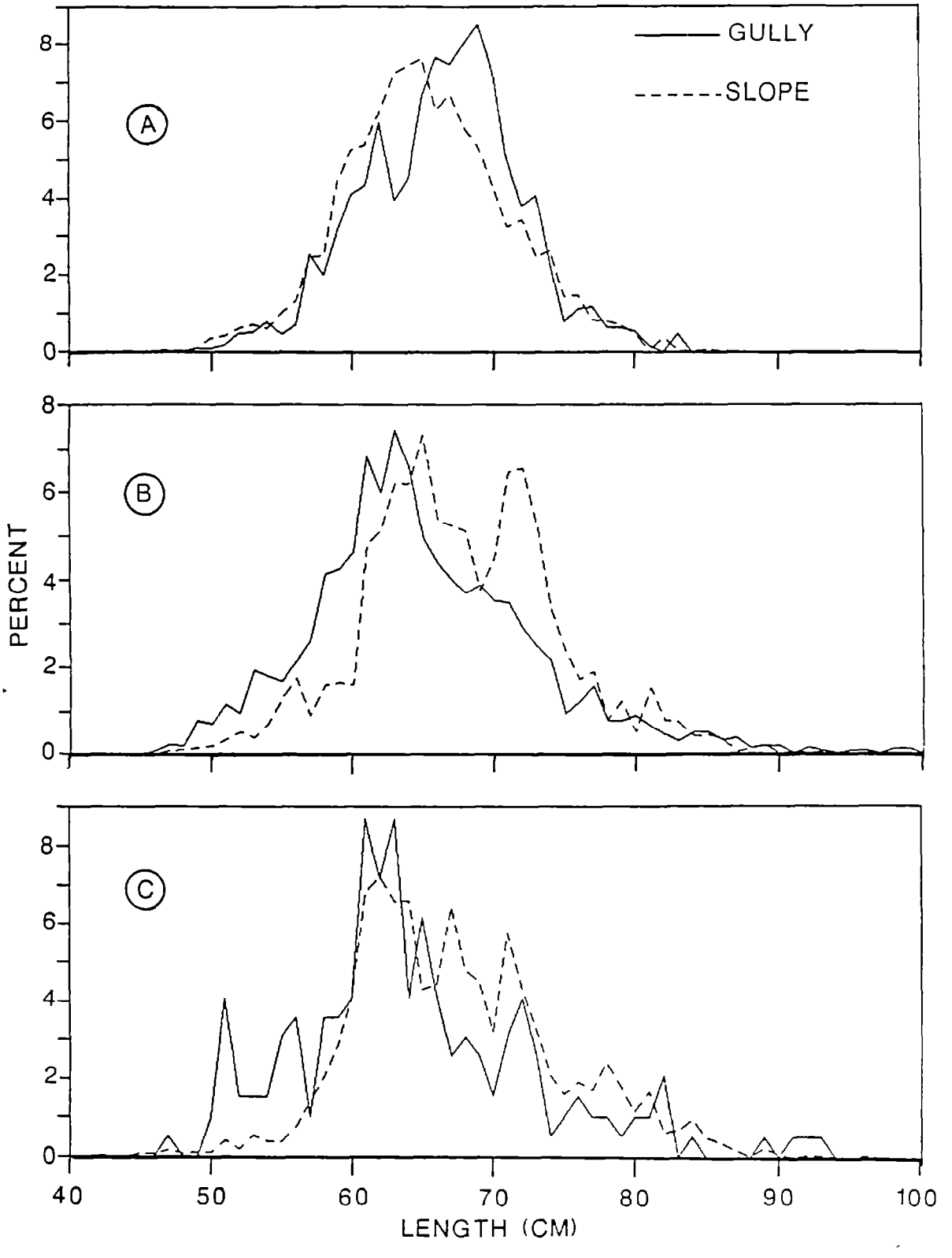


Figure 7. --Percent length frequencies of sablefish for gullies and the adjacent upper continental slope. A - Shelikof Trough and the upper continental slope of the Chirikof International North Pacific Fisheries Commission (INPFC) statistical area at depths 201-300 m, B = Ommaney Trench and the upper continental slope of the Southeastern INPFC statistical area at depths 301-400 m, C = Ommaney Trench and the upper continental slope of the Southeastern INPFC statistical area at depths 401-600 m.

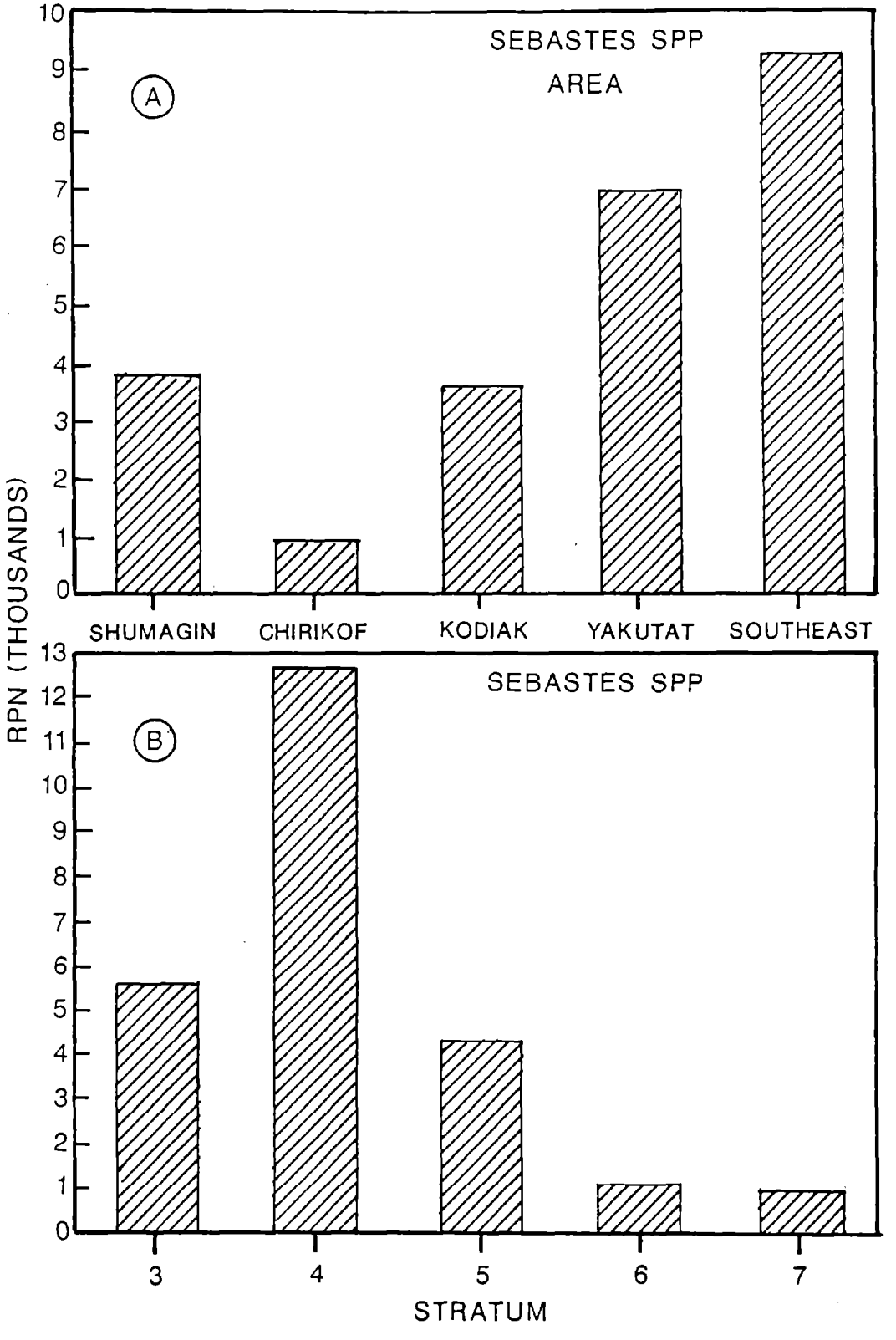


Figure 8. --Relative population number of *Sebastes* spp. for the upper continental slope of the Gulf of Alaska by International North Pacific Fisheries Commission statistical area (A) and depth strata (B). Strata: 3 = 201-300 m, 4 = 301-400 m, 5 = 401-600 m, 6 = 601-800 m, 7 = 801-1,000 m. Domestic longline survey, 1987.

Rougheye rockfish biomass was twice the shortraker rockfish biomass (Table 6). The difference in abundance was due primarily to the large biomass of rougheye rockfish in the Southeastern area. Rougheye and shortraker rockfish biomasses were similar in the remainder of the Gulf of Alaska.

Mean size of shortraker rockfish was greater than that of rougheye rockfish (Fig. 9). The largest shortraker rockfish caught (93 cm FL) was 2 cm longer than the greatest length cited in Hart (1973). For both species, a wide range of sizes were observed-, although the length frequency for rougheye rockfish in the Southeastern area was characterized by a sharp spike at 40-55 cm FL.

Thornyheads

Thornyheads were the fifth most abundant species group in numbers (Table 3), the sixth most abundant species group in weight (Table 4), and probably were composed mainly of shortspine thornyheads. Thornyheads were most abundant in the Shumagin and Kodiak areas and least abundant in the Southeastern area (Fig. 10a). Thornyheads were most abundant at depths 401-800 m (Fig. 10b). The largest thornyheads were found in the Shumagin and Southeastern areas (Fig. 9). The steep left portion of the length frequency distributions for all INPFC areas indicates that this species recruits to the survey gear at about 30-35 cm FL.

Pacific Cod

The results of this domestic longline survey are not representative of the Pacific cod population in the Gulf of Alaska. Pacific cod are common on the continental shelf in relatively shallow water during the summer (Zenger and Blackburn 1986), whereas sampling was restricted mostly to the upper continental slope at depths greater than 200 m. However, the results for Pacific cod are presented here because this information provides indices of population size.

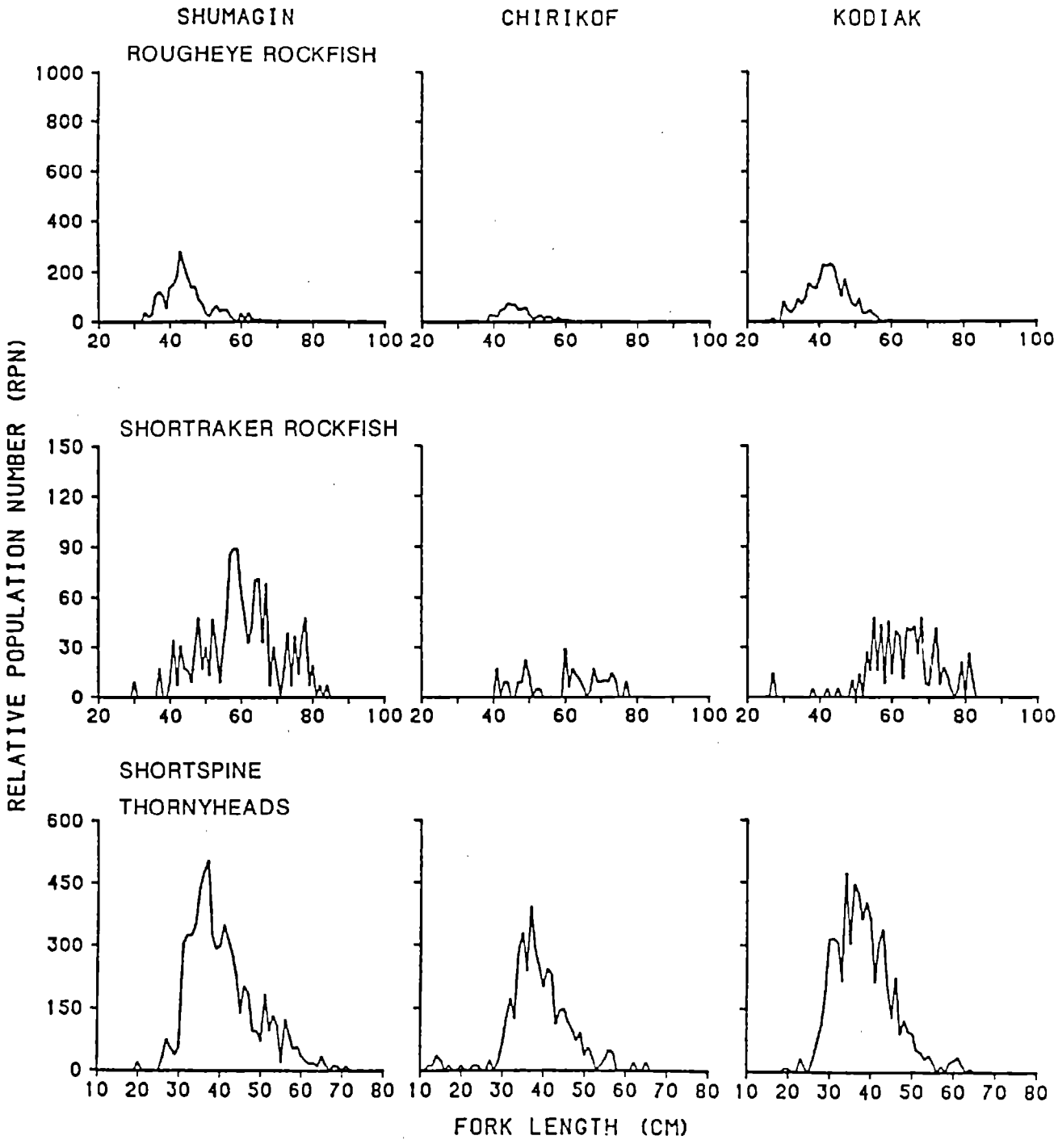
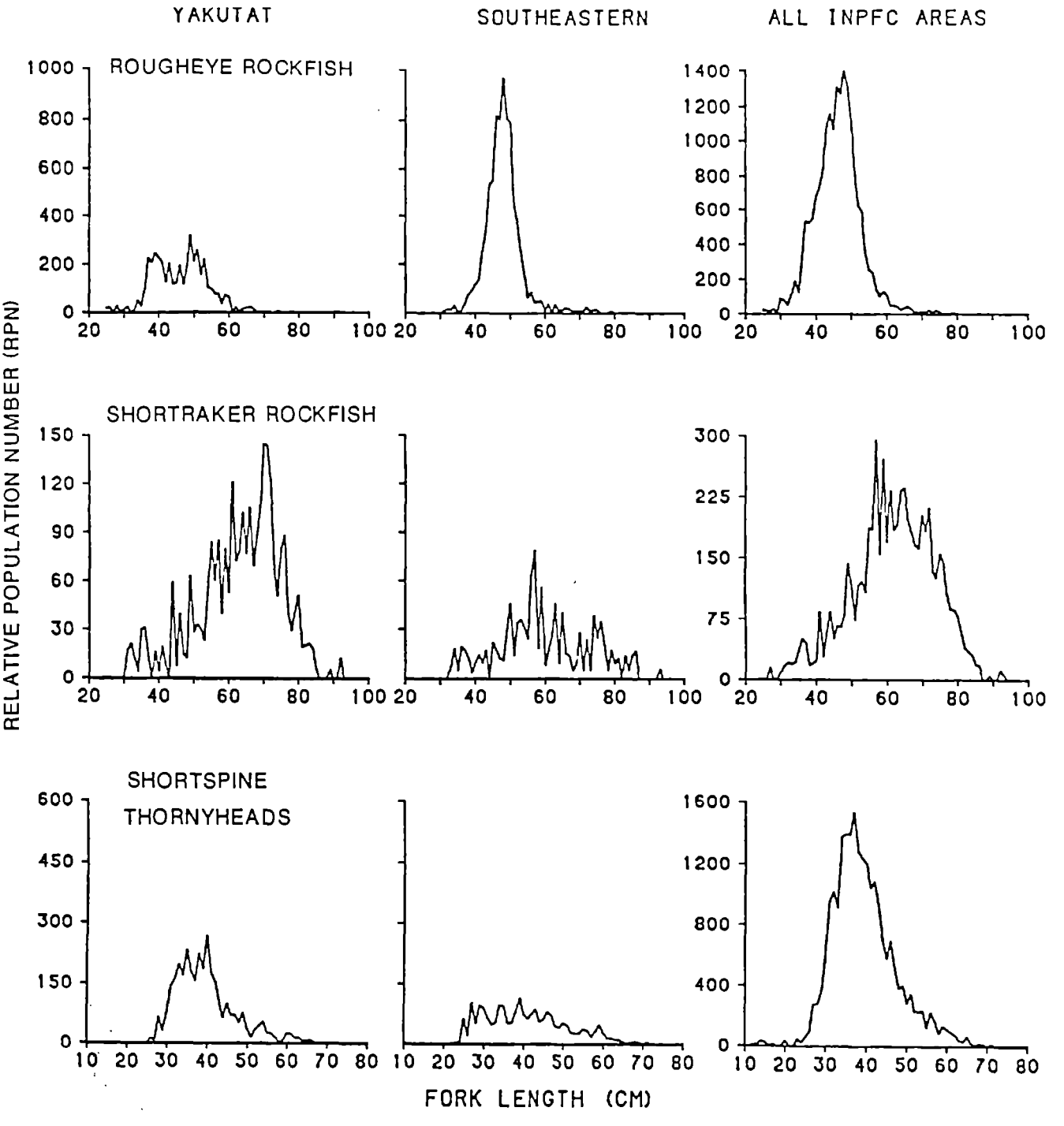


Figure 9. --Length frequencies weighted by relative population number for the upper continental slope of the Gulf of Alaska of rougheye rockfish, shortraker rockfish, and shortspine thornyheads by International North Pacific Fisheries Commission statistical area, domestic longline survey, 1987.



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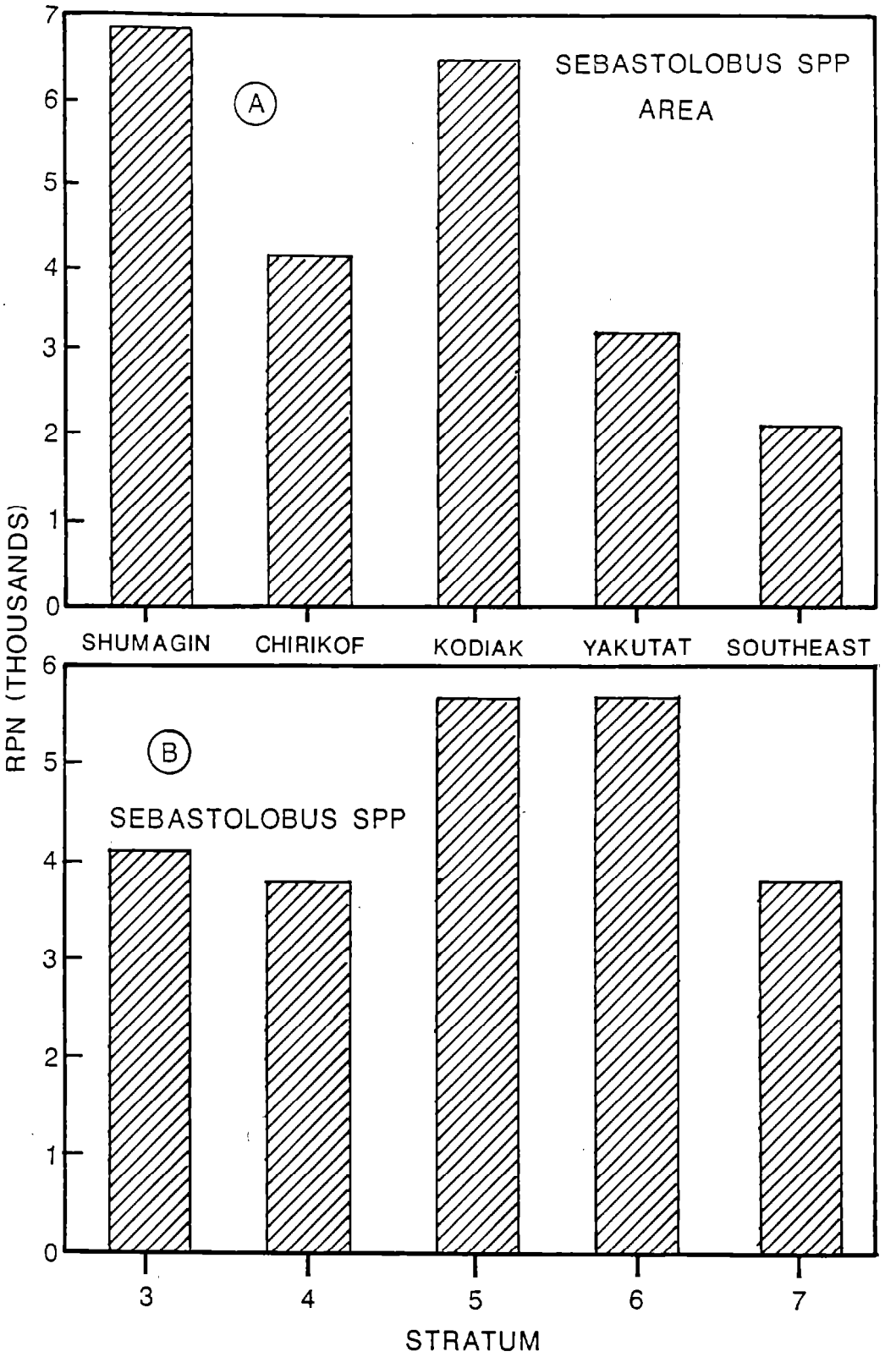


Figure 10.--Relative population number of Sebastolobus spp. for the upper continental slope of the Gulf of Alaska by International North Pacific Fisheries Commission statistical area (A) and depth strata (B). Strata: 3 = 201-300 m, 4 = 301-400 m, 5 = 401-600 m, 6 = 601-800 m, 7 = 801-1,000 m. Domestic longline survey, 1987.

Pacific cod ranked sixth in numbers and fifth in weight (Tables 3, 4). The number of Pacific cod was highest in the Shumagin area, followed by the Kodiak, Yakutat, Chirikof, and Southeastern areas (Fig. lla). Most (94%) were found at depths 201-300 m (Fig. 11b). The principal mode in the length compositions for depths 201-300 m (Fig. 12) corresponds to an age of 5+ years (Niggol 1982).

Generally speaking, the Yakutat area is the eastern limit of commercial quantities of Pacific cod in the Gulf of Alaska, yet the number of large fish there (Fig. 12) was relatively high. The size distribution is not roughly bell-shaped like the distributions for the other statistical areas and may indicate emigration or irregular recruitment, or may result from the generally small sample sizes of Pacific cod.

A mode at approximately 55 cm FL, corresponding to an age of 3+ years (Niggol 1982), appeared in all areas, indicating that the 1984 year class is relatively strong (Fig. 13). This conclusion is tentative, however, because only a small portion of Pacific cod habitat was sampled, A relatively strong year class in 1984 was previously noted by Zenger and Blackburn (1986), but was not observed during the 1987 triennial trawl survey of groundfish in the Gulf of Alaska[3]. Coincident strong year classes for sablefish and Pacific cod occurred in 1977 (Balsiger and Alton 1981; Zenger and Blackburn 1986).

Other Species

Grenadiers, although ranked second in numbers and weight, were only one-ninth as numerous as sablefish, the top ranked species (Tables 3, 4). The most common grenadier species was the giant grenadier *(Albatrossia pectoralis).* Two other species, Pacific grenadier *(Coryphaenoides acrolepis),* and popeye

[3]E. Brown, Fisheries Research Biologist, Alaska Fisheries Science Center, 7600 Sand Point Way N.E., BIN C15700, Seattle, WA 98115. Pers. Commun., 1988.

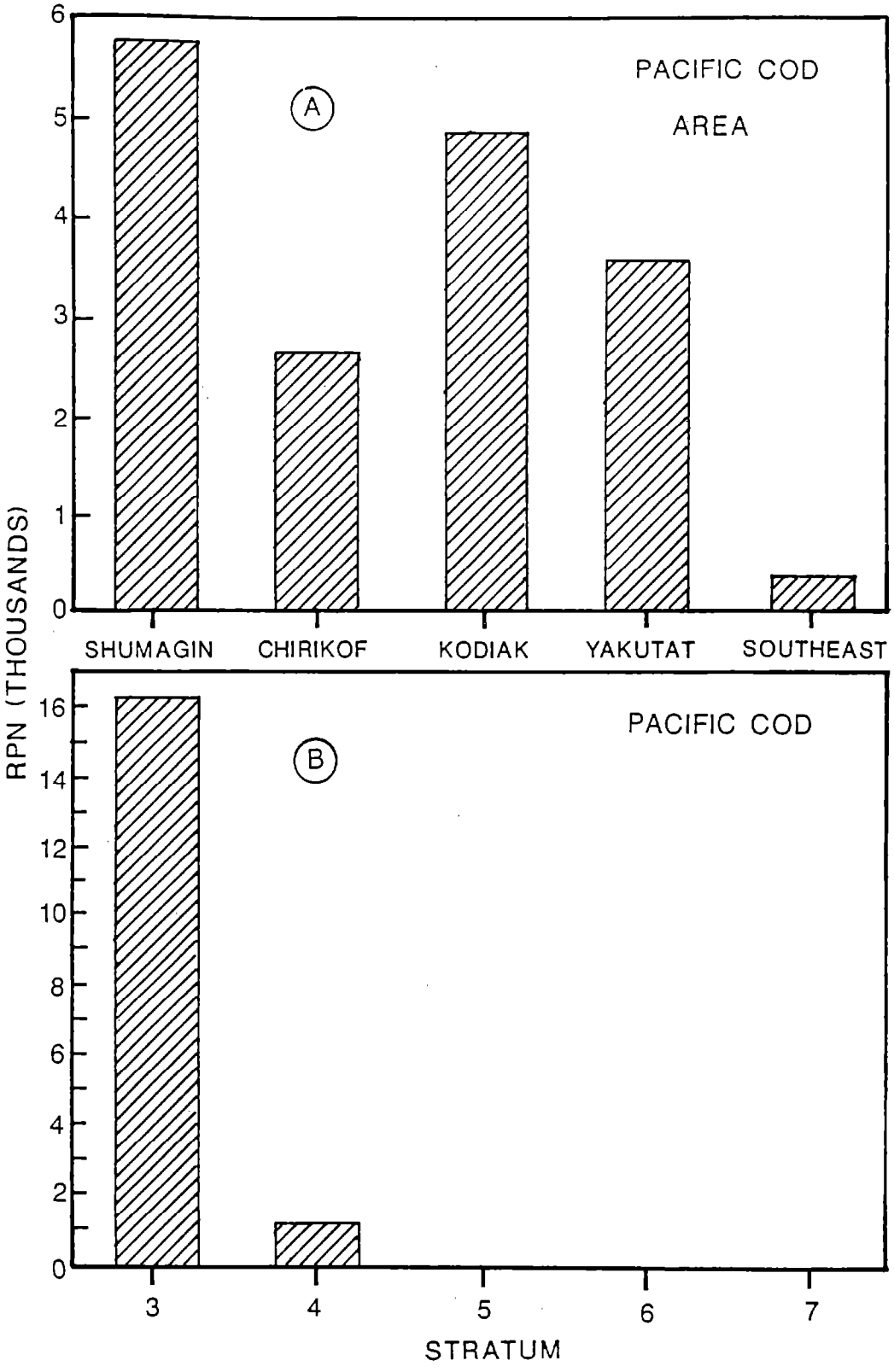


Figure 11. --Relative population number of Pacific cod for the upper continental slope of the Gulf of Alaska by International North Pacific Fisheries Commission statistical area (A) and depth strata (B). Strata: 3 = 201-300 m, 4 = 301-400 m, 5 = 401-600 m, 6 = 601-800 m, 7 = 801-1,000 m. Domestic longline survey, 1987.

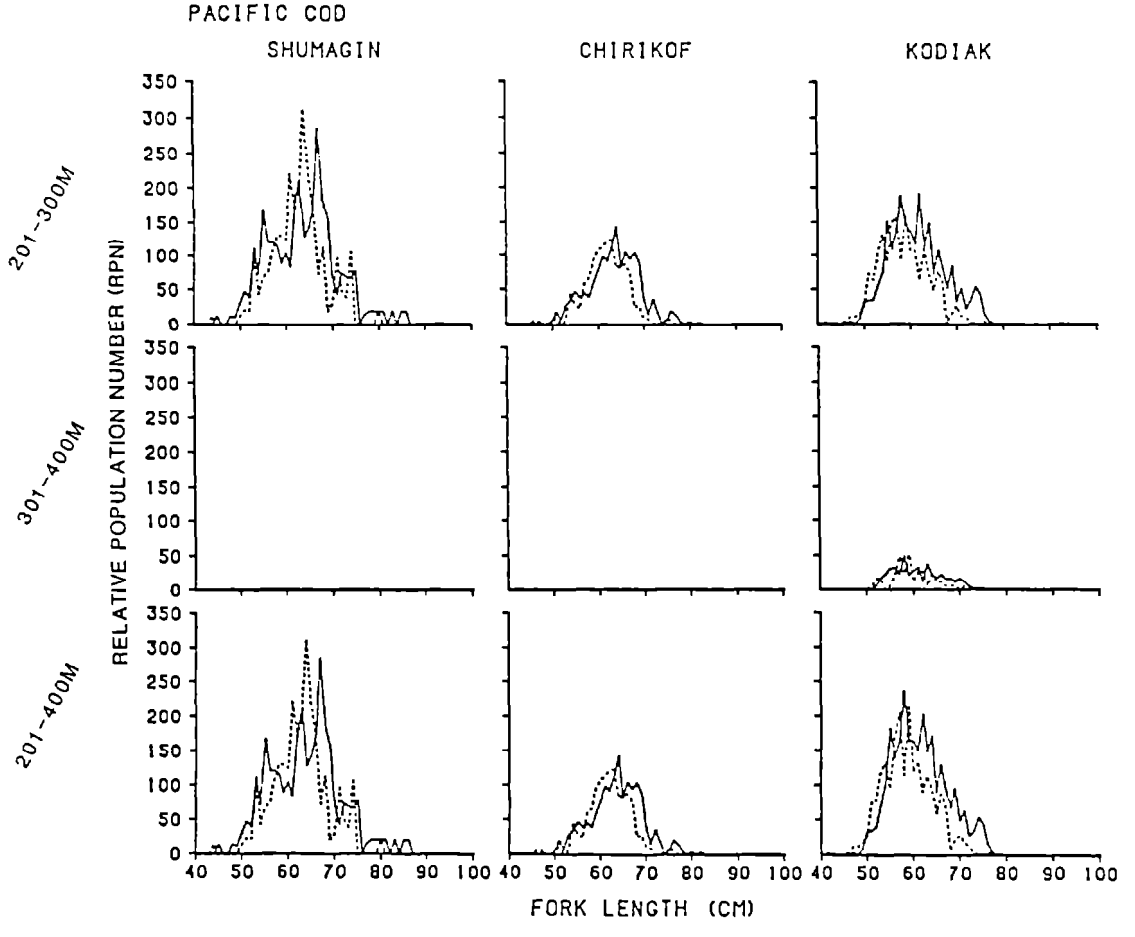
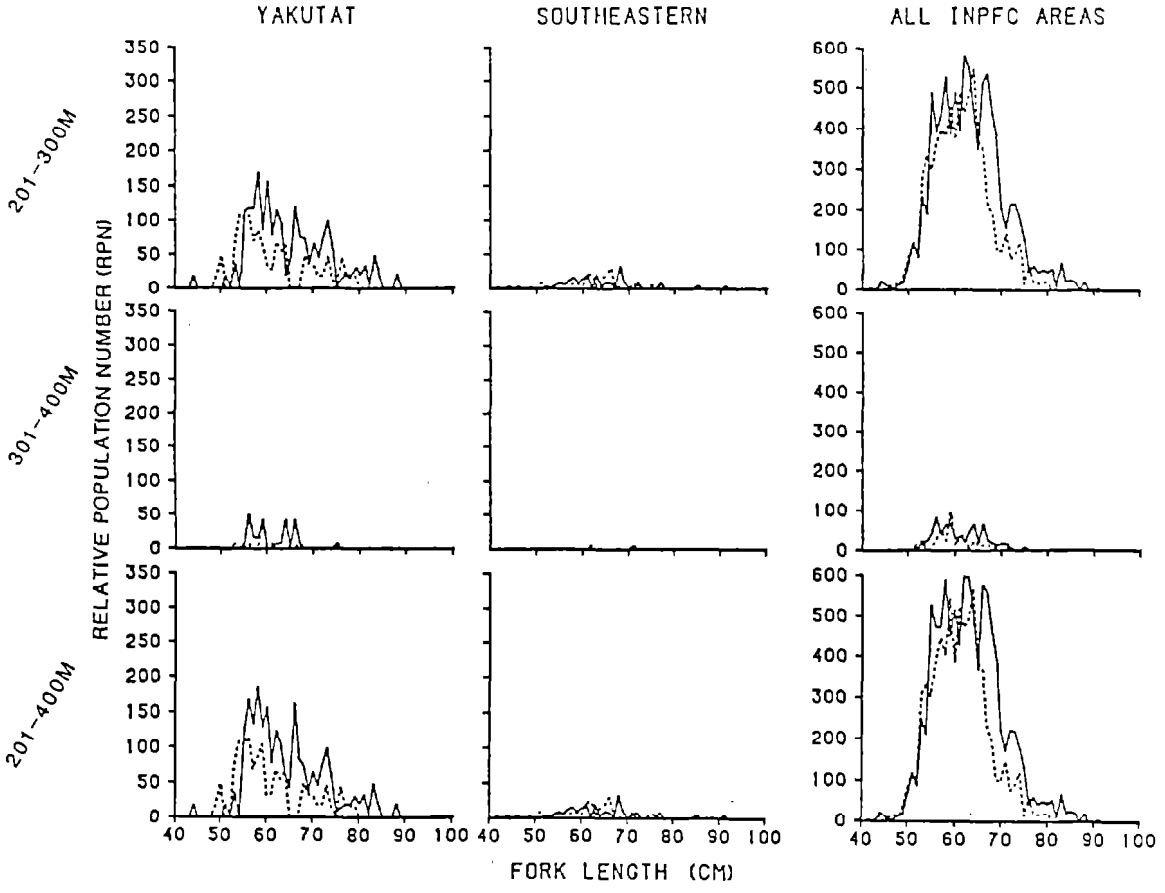


Figure 12. --Length frequencies weighted by relative population number of male (———) male and female (------) Pacific cod for the upper continental slope of the Gulf of Alaska by International North Pacific Fisheries Commission statistical area and depth strata. Domestic longline survey, 1987.



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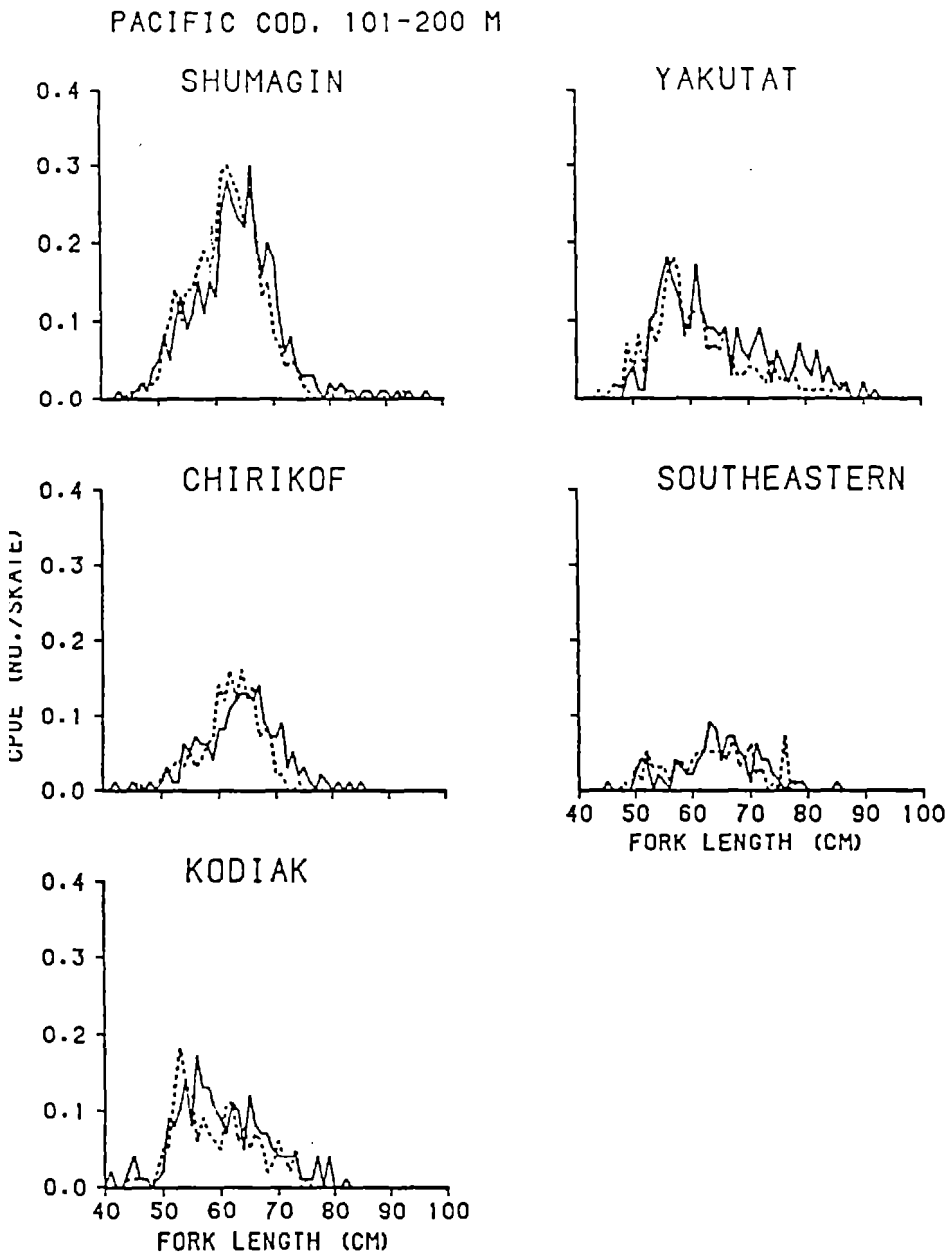

Figure 13. --Length frequencies weighted by catch per skate of male (———) and female (------) Pacific cod for the upper continental slope of the Gulf of Alaska at depths 101-200 m by International North Pacific Fisheries Commission statistical area. Domestic longline survey, 1987.

grenadier (C. cinereus) were captured infrequently. Grenadiers were the only group whose abundance increased with depth without exception (Tables 7, 8). Grenadier numbers were highest in the Kodiak and Shumagin areas and lowest in the Southeastern area (Tables 3, 4). Modes were present at 20 cm anal length (tip of snout to anus) in the Kodiak, Yakutat, and Southeastern areas and at 30 cm anal length in the Shumagin, Chirikof, and Kodiak areas (Fig. 14).

Pacific halibut were the seventh most abundant species caught during the survey (Table 3) and were most abundant in the Shumagin and Yakutat areas and at depths 201-300 m (Table 7). No RPW was computed because halibut were released before they were hauled aboard. At depths greater than 301 m, the numerical abundance of halibut compared to that of sablefish was 0.75%, indicating that halibut by-catch in longline fisheries at these depths is small, at least from July to September. Some large Pacific halibut hooked may have broken the hook or gangion and not reached the surface. Thus, the number of halibut hooked may have been greater than the number recorded.

Arrowtooth flounder were the second most abundant species in the Shumagin, Chirikof, and Kodiak areas at depths 201-400 m, whereas rockfishes were the second most abundant species at these depths in the Yakutat and Southeastern areas (Tables 5, 6). Fish from 65-75 cm FL dominated the arrowtooth flounder population in the Shumagin and Chirikof areas, whereas fish from 50-60 cm FL dominated in the Kodiak area (Fig, 15).

Skates were not identified to species and were a minor component (0.4%) of the total catch (Table 3). They were most common in the shallowest depths (201-400 m) (Table 7).

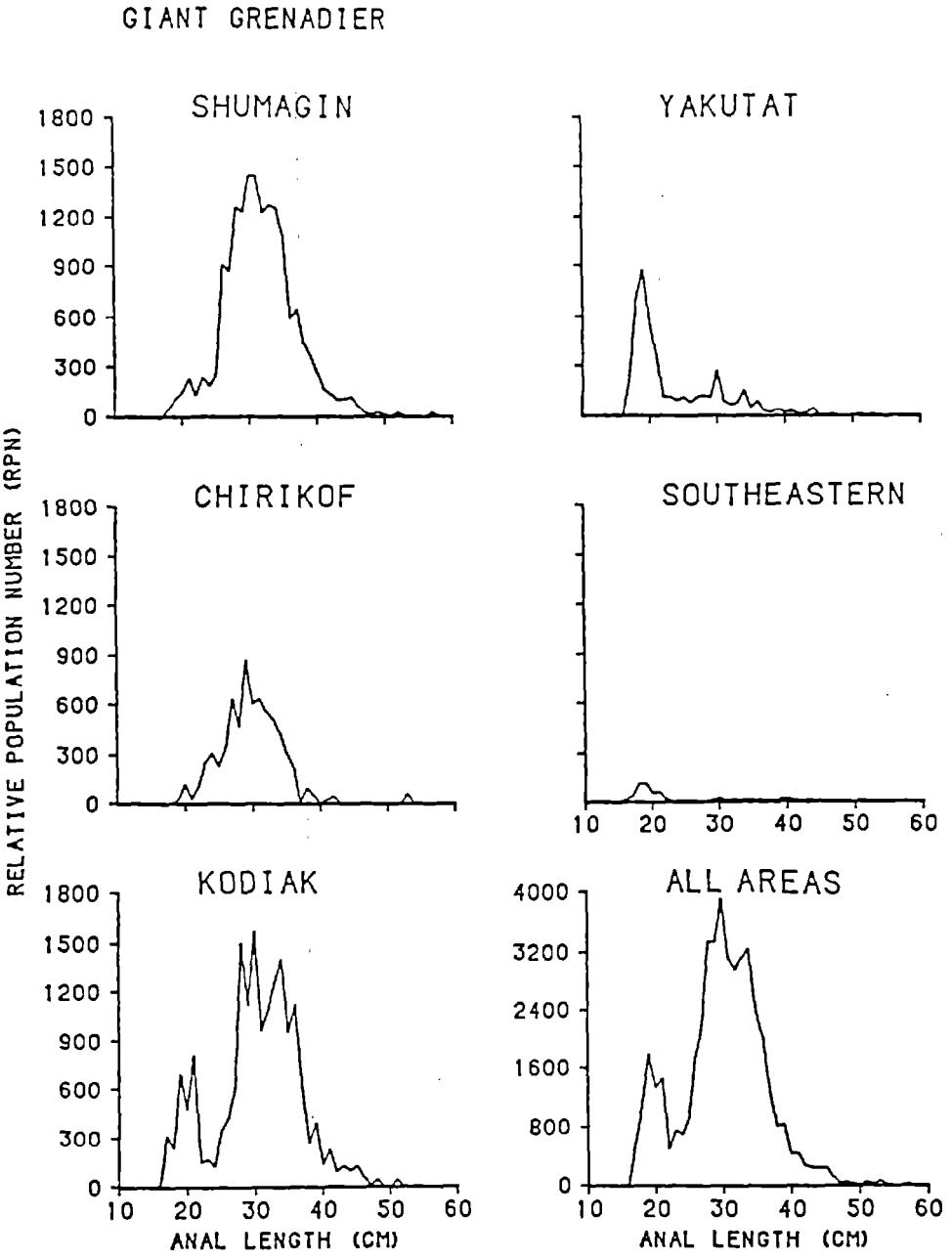

Figure 14.--Length frequencies weighted by relative population number of giant grenadiers for the upper continental slope of the Gulf of Alaska by International North Pacific Fisheries Commission statistical area. Domestic longline survey, 1987.

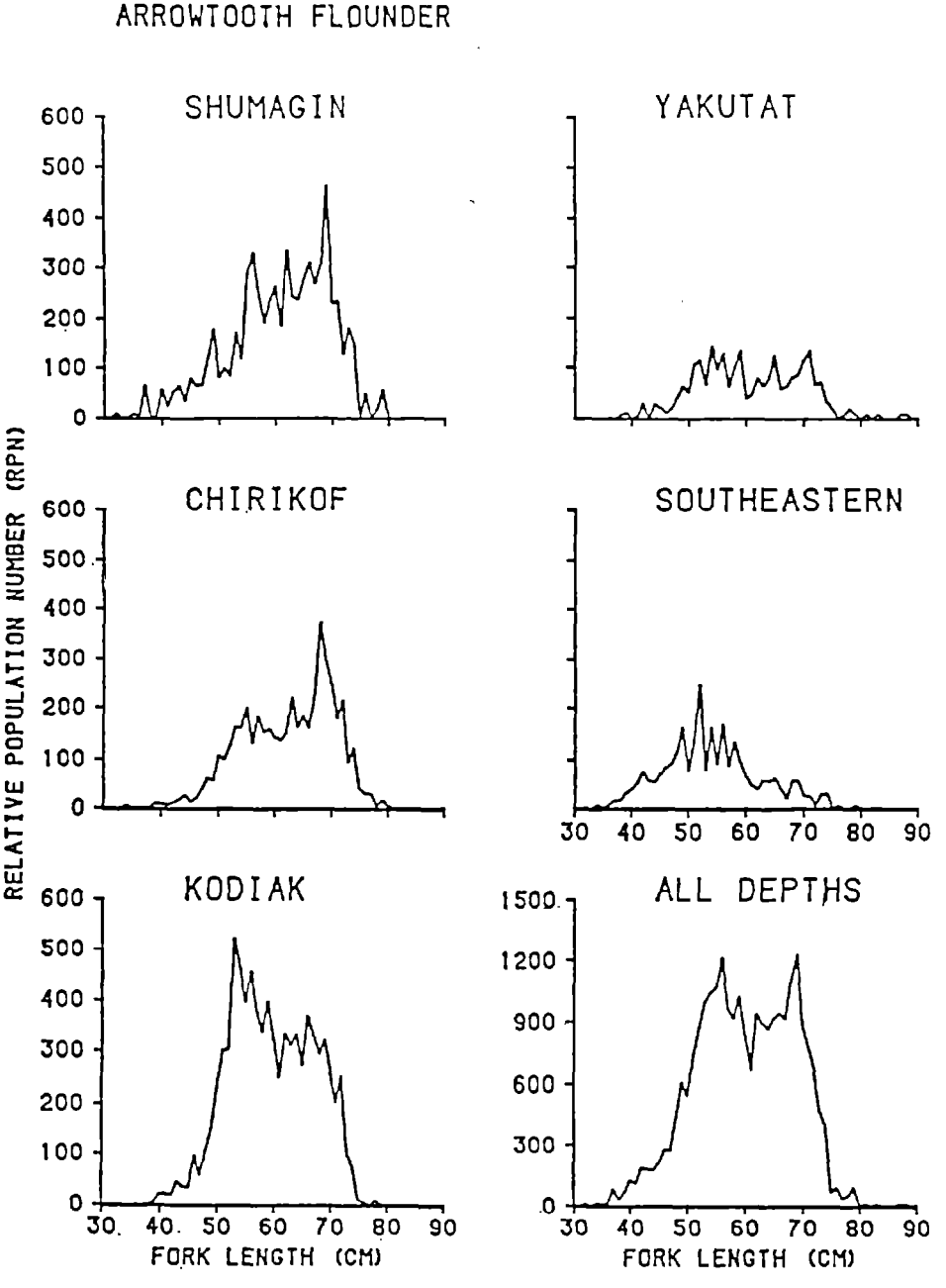

Figure 15.--Length frequencies weighted by relative population number of arrowtooth flounder for the upper continental slope of the Gulf of Alaska by International North Pacific Fisheries Commission statistical area. Domestic longline survey, 1987.

Twenty-four other species (or species groups) were captured during the survey (Table 11). Their greatest catches were in the Southeastern area (Table 3).

Table 11.--Numbers of other species caught during the 1987 domestic longline survey, listed in descending order.

Common name	Scientific name	Number caught
Spiny dogfish	*Squalus acanthias*	573
Walleye pollock	*Theraga chalcogramma*	76
Starfish	(class Asteroidea)	54
Yellow Irish lord	*Hemilepidotus jordani*	45
Lingcod	*Ophiodon elongatus*	42
Dover sole	*Microstomus pacificus*	36
Spotted ratfish	*Hydrolagus colliei*	35
Flathead sole	*Hippoglossoides elassodon*	23
Searcher	*Bathymaster signatus*	21
Giant wrymouth	*Delolepis gigantea*	18
Snow (Tanner) crab	(*Chionocetes* spp.)	9
Coho salmon	*Oncorhynchus kisutch*	8
Pacific pomfret	*Brama japonica*	8
Darkfin sculpin	*Malacottus zonurus*	6
Pacific flatnose	*Antimora microlepis*	6
Blue shark	*Prionace glauca*	5
Pacific sleeper shark	*Somniosus pacificus*	5
Chinook salmon	*O. tshawytscha*	3
Octopus	*Octopus* spp.	3
Snails	(Order Gastropoda)	2
Twoline eelpout	*Bothrocara brunneum*	2
Bigmouth sculpin	*Hemitripterus bolini*	1
Pink salmon	*O. gorbuscha*	1
Rock sole	*Lepidopsetta bilineata*	1

Catch Rate Comparison

The average and maximum catch rates of sablefish per skate were 9.7 and 22.3, respectively, for the domestic longline survey and 11.4 and 30.3, respectively, for the cooperative longline survey. The mode for both catch rate distributions was 14 sablefish per skate and both distributions were skewed to the left (Fig. 16).

Locally weighted regression and smoothing techniques indicate that the catch rate relationship is not linear; where abundance (i.e. catch rate) is high, catch rates for the domestic longline survey decreased relative to catch rates for the cooperative longline survey (Fig. 17, line a). This relationship indicates that when sablefish abundance is high, the cooperative longline survey gear measures changes in sablefish abundance more accurately than the domestic longline survey gear.

The equation resulting from derivative-free nonlinear regression closely tracked the curve estimated by the robust locally weighted regression and smoothing routine (Fig. 17, line b), but was unsatisfactory for adjusting the catch rate for the cooperative longline survey to that for the domestic longline survey: although several CPUEs for the domestic longline survey are greater than 15, these CPUEs cannot be obtained from any cooperative longline survey CPUE value using this relationship.

Geometric mean regression (Fig. 17, line c) estimated a slope of 0.8167 and a y-intercept of 0.1155, and indicates that the cooperative longline survey gear captured about 19% more sablefish on the average than the domestic longline survey gear. This procedure is the most satisfactory of the three tried, because the resultant catch rate relationship includes the range of CPUEs observed for both surveys.

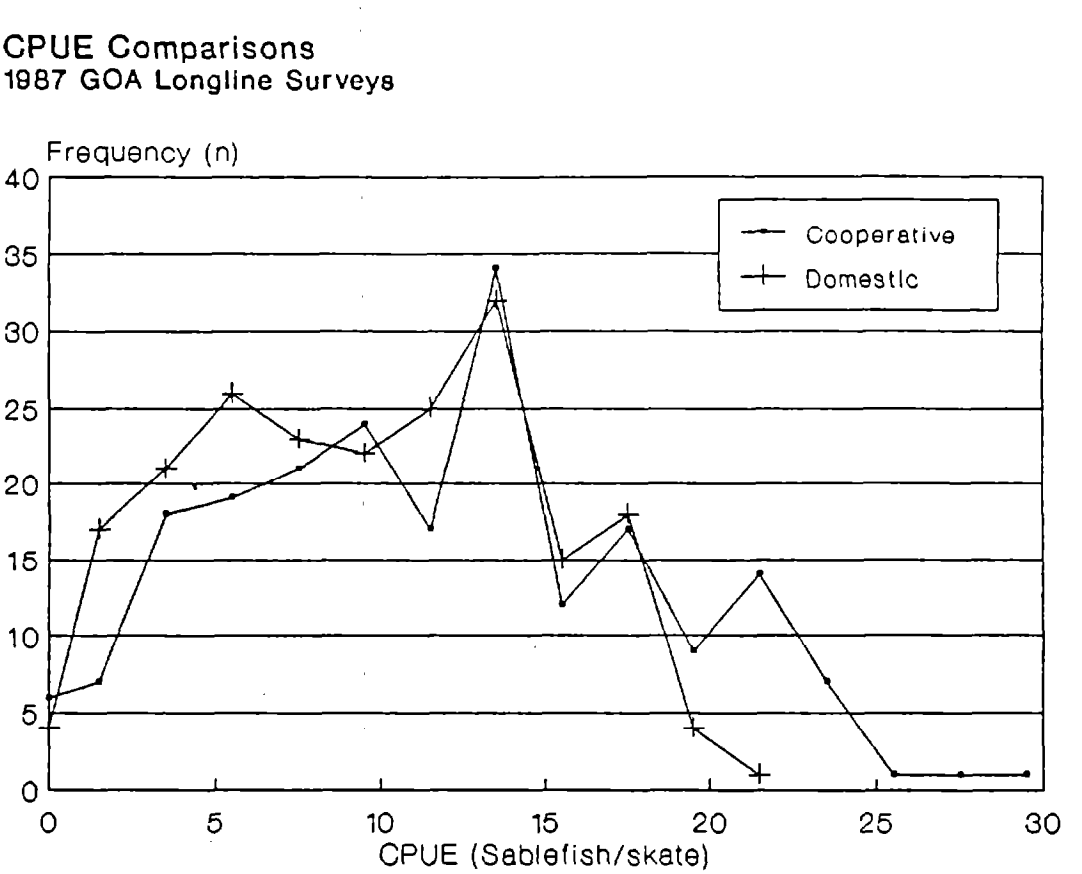

Figure 16. --Frequencies of catch per unit effort of sablefish from the Gulf of Alaska for the 1987 domestic longline survey and the 1987 Japan-U.S. cooperative longline survey.

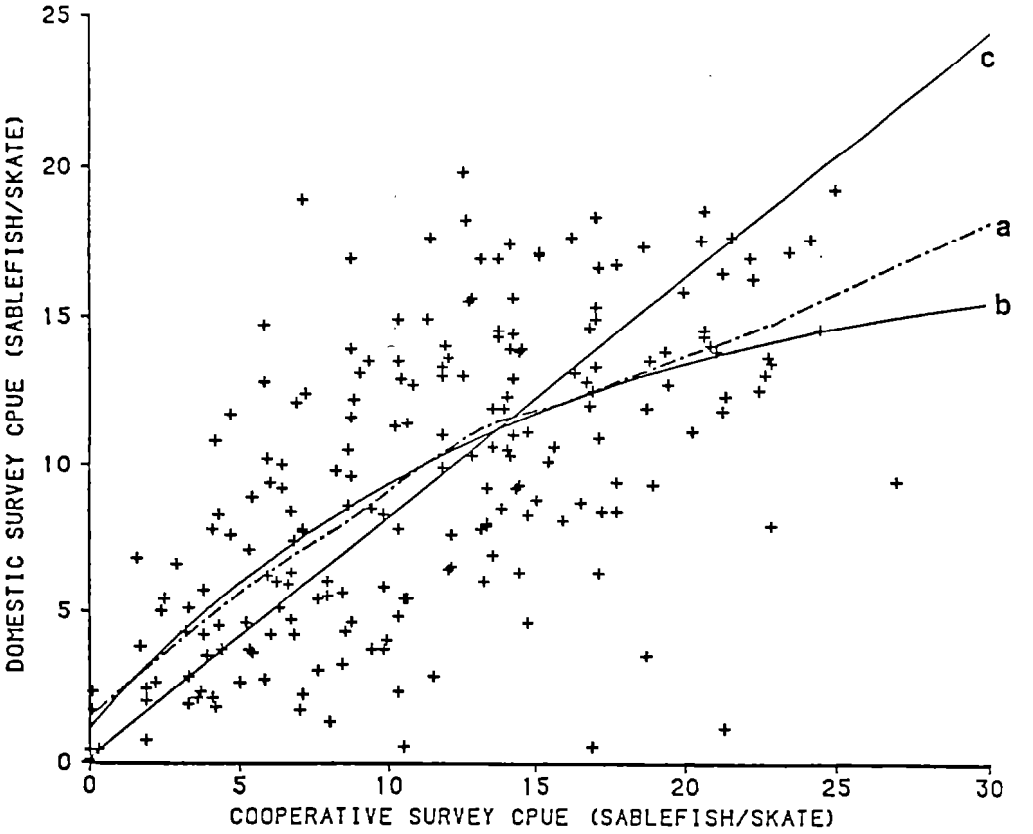

Figure 17. --Comparative catch rates from the 1987 Japan-U.S. cooperative longline survey and the 1987 domestic longline survey. Preliminary data analysis yielded: line a, from a locally weighted regression and smoothing routine; line b, from a derivative-free nonlinear regression analysis; and c, from a functional least squares regression.

A technique not tried because of its programming complexity is a locally weighted regression procedure that incorporates a geometric mean algorithm. This procedure is not biased towards either axis and would account for the curvilinearity indicated by the locally weighted regression.

We do not know why the catch rates differ between the two surveys, but hypothesized that the herring bait used during the domestic longline survey is not as durable as the squid bait used during the cooperative longline survey. To test this hypothesis, an experiment was conducted during March 1988 that compared catch rates of sablefish using squid and herring for bait[4]. Hooks baited with squid caught 12% more sablefish for a 3-hour soak time and 8% more sablefish for a 7-hour soak time than hooks baited with herring. The difference in catch rates was statistically significant ($P < 0.05$, analysis of variance for a Latin square design in Box et al. 1978). For 3-hour soaks, bait retention (number of baited hooks remaining when the sampling gear came on board) for herring was only 13-35%, compared to 40-57% for squid. For 7-hour soaks, bait retention of herring was 3-8%, compared to 20-30% for squid. Thus, much of the difference between the catch rates of the two surveys may be due to differences in retention of the two bait types.

We also hypothesize that the circle hook, reputedly effective for holding hooked fish, is a slower fishing hook and may not hook a fish as easily as the J hooks which were used during the cooperative longline survey. As a result, the bait might be stripped from the hook before the hook is set.

[4]M. Sigler, Unpubl. data. Alaska Fisheries Science Center, Auke Bay Laboratory, P.O. Box 210155, Auke Bay, AK 99821.

1988 SURVEY

A few changes were made in the 1988 domestic longline survey based on what we learned during the 1987 survey. (The results of the 1988 survey will be presented in a separate report.) The bait type was changed from herring to squid, based on the comparison of the catch rates from the two surveys in 1987, as well as the bait comparison study conducted in March 1988. These comparisons indicate that where sablefish abundance is high, longline gear baited with squid can measure changes in sablefish abundance more accurately than longline gear baited with herring. The frequency of weighting the longline with lead balls was increased from every 400 m to every 100 m to ensure that the longline gear stayed on the bottom in areas of uneven substrates.

Currently, the NOAA triennial trawl survey in the Gulf of Alaska estimates Pacific cod abundance. An objective of the 1988 survey was to determine the feasibility of assessing Pacific cod abundance using longlines because of the rapidly expanding longline fishery for Pacific cod. To meet that objective, several shallow-water stations were added to sample Pacific cod.

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